Irreversible Noise:

The Rationalisation of Randomness and the Fetishisation of Indeterminacy

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Declaration

I declare that the work presented in this thesis is my own:

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0.0 Contents:

1.1

Abstract

This thesis aims to elaborate the theoretical and practical significance of the concept of noise with regard to current debates concerning realism, materialism, and rationality. The scientific conception of noise follows from the developments of thermodynamics, information theory, cybernetics, and dynamic systems theory; hence its qualification as irreversible. It is argued that this conceptualization of noise is entangled in several polemics that cross the arts and sciences, and that it is crucial to an understanding of their contemporary condition.

This thesis draws on contemporary scientific theories to argue that randomness is an intrinsic functional aspect at all levels of complex dynamic systems, including higher cognition and reason. However, taking randomness or noise as *given*, or failing to distinguish between different descriptive levels, has led to misunderstanding and ideology. After surveying the scientific and philosophical context, the practical understanding of randomness in terms of probability theory is elaborated through a history of its development in the field of economics, where its idealization has had its most pernicious effects.

Moving from the suppression of noise in economics to its glorification in aesthetics, the experience of noise in the sonic sense is first given a naturalistic neuro-phenomenological explanation. Finally, the theoretical tools developed over the course of the inquiry are applied to the use of noise in music. The rational explanation of randomness in various specified contexts, and the active manipulation of probability that this enables, is opposed to the political and aesthetic tendencies to fetishize indeterminacy. This multi-level account of constrained randomness contributes to the debate by demystifying noise, showing it to be an intrinsic and functionally necessary condition of reason and *consequently* of freedom.

1.2

Introduction

Noise; conceived as interference, randomness, and fluctuation below the threshold of measurement; is often framed, in the humanities, as undermining the 'static ontology' of representative reason. I propose that this is a misunderstanding based on a failure to adequately engage with the scientific account on the one hand, and on a faulty articulation of the relevant philosophical concepts on the other hand.

In particular, understanding the place of noise in this debate requires a careful treatment of the relationship between causality and freedom, and between representation and the apparent immediacy of experience. The aim here is to give a multi-level explanation that differentiates and co-articulates the scientific concepts of randomness and noise, as well as accounting for them at the level of experience. This is achieved by distinguishing between nested levels of dynamics within complex systems, and showing how each level has a distinctive 'geometry' with regard to probability.

The concept of noise straddles two classically opposed worlds; on one side is qualitative sensation and subjective judgement, on the other is the quantitative calculation of objective probabilities. In both cases, the meaning of noise is principally defined by its relation to unpredictability and disorder, whether through vague aesthetic feeling or accurate scientific measurement. However, randomness is not the same everywhere, and this means discriminating between different descriptive contexts for noise too. Randomness and noise are not the same for molecules, mountains, machines, moose, and men.

The description of a sound as noise is generally considered to be determined by a subjective judgement regarding how pleasant the sound is. From the perspective of experience, this judgement appears to be immediate and decided by nothing other than one's own tastes and desires. The quantitative analysis of noise, on the other hand, is mediated by a formal calculation and indifferent to wants or meaning. The argument of this thesis will be that noise is relative to information processing dynamics, and that the divergence between qualitative and quantitative determinations of noise can be accounted for within a unifying conceptual framework that specifies different levels, formalisms, and interpretative contexts of information processing.

The contemporary understanding of noise developed with the rise of information and communication technologies. This transition to thinking noise in terms of information and probability resulted in precipitous social and cultural transformations. However, several hundred years of scientific and mathematical developments had prepared the way by creating the conceptual and technical conditions in which it could arise.

Whilst the pre-modern conception of futurity was generally characterised by fatalism and a submission to chance in the form of fortune, the construction of a calculus of probability enabling the statistical prediction and control of randomness in the form of risk was an essential factor in the transition to modernity and the birth of capitalism.[1] This probabilistic conception of randomness was also the basis for many of the most important discoveries of modern science, notably thermodynamics, evolutionary theory, and the explanation of matter in terms of the random movement of atomic particles.

The term *irreversible* refers to the thermodynamic conception of the 'arrow of time', which describes the tendency of systems to go from a relatively ordered state towards increasing disorder such that returning the process to order is not energetically viable. This is a fundamentally geometric conception of time and probability, since the direction of time is the result of a global asymmetry. The thermodynamic measure of disorder was linked to the modern science of information via the concept of entropy.

We can call the conceptual nexus that brings together various measures of disorder under an informational paradigm *irreversible noise*. The title of this thesis then refers to the historical constitution of the contemporary concept of noise, whose advent is prepared by the mathematics of probability, the thermodynamic conception of disorder, and the stochastic randomness of the atomic composition of matter that Boltzmann's measure of entropy is predicated on.

The modern notions of probability and randomness are not only central to many of the discoveries of physics, chemistry and biology, but are also the basis of political economy and the surge in speculative financial investments from the seventeenth century to the present. This turn to a rational understanding of chance has momentous repercussions for philosophy, dramatically altering how we understand the world and our place in it. Taken together, these shifts amount to a thoroughgoing conceptual revolution, which is equally transformative for art and music.

It is as a result of this historic process that in the twentieth century, amidst the rapid growth of information and communication technologies, the concept of noise gains its current cultural significance. Tying together information, randomness, probability calculus, indeterminacy and noise, the effects of this new conceptual nexus are registered across multiple practical and theoretical domains of knowledge.

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[1] Maistrov, L.E. (1974) *Probability Theory: A Historical Sketch*. New York: Academic Press.

A central premise of this thesis is that randomness and noise are relative to the specification of a scale and language for analysis, this follows from René Thom's critique of the hypostatisation of chance in Continental theory.[2] The first chapter then outlines several distinct conceptions of entropy, showing how the measures of disorder and noise can be related to different scales of analysis and levels of information processing. It explores how these different strata relate to determinism, randomness, and computation.

It is proposed that a full understanding of noise requires a description of the multi-scale dynamics of complex hierarchically nested systems. The fetishisation of self-organising randomness is countered by an emphasis on the structural constraints of systems and how these enable the functional properties of higher-level dynamics.

The second chapter gives a philosophical genealogy of the contemporary concept of noise by tracing how the notion of freedom transformed with the understanding of mechanistic determinism. Freedom is linked to noise through the opposition of thought and experience to mechanistic determinism. Though various developments in modern science (self-organising systems, complexity theory, etc.) allow for an overcoming of this duality, the discrepancy between lived experience and its scientific explanation remains a stubborn problem.

In particular, there are ruthless reductionist accounts that aim to eliminate the inherited illusions of folk psychology on the one hand, and emergentist accounts that argue for the irreducibility of thought to causal processes on the other hand. The former deny the normative-linguistic force of reason, the latter deny the causal-naturalistic explanation of reason.

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[2] Thom, R. & Chumbley, R.E. (1983) Stop Chance! Silence Noise! *SubStance*, Vol. 12, No. 3, Issue 40: Determinism. pp. 11-21.

In contrast with either tendency this thesis contributes to the theoretical articulation of noise by arguing for the necessity of an inferentialist account of reason that is fully naturalistic, in the sense that it is amenable to scientific explanation in terms of its causal structure and its functional properties, whilst also maintaining a normative conception of freedom that must be addressed at the level of commitments and entitlements in the space of reason.

The discussion here departs from the distinction that Wilfrid Sellars makes between the manifest and scientific images of man, and explains his claim for the necessity of a stereoscopic fusion of the images that would provide a successor theory preserving both their central insights.[3] This follows Sellars argument that thinking is inferential and conceptually mediated, that freedom relies on the normative constraint of behaviour according to rules, and that a naturalised account of these cognitive capacities is possible. Sellars' inferential approach is contrasted with Deleuze's metaphysical claims for the immediacy of intensive difference through a comparative analysis of their different readings of modern philosophers such as Hume and Kant.

The third chapter focuses on the theoretical and practical development of probability theory in political economy. It argues that classical and neoclassical economics is based on various ideological assumptions concerning market dynamics; in particular, a substantialist conception of value, a belief in the tendency towards equilibrium and fair price formation, and in the possibility for the quantification of risk according to statistical probability models. This is countered by contemporary heterodox economic theories, such as ecological economics, which acknowledge the non-equilibrium dynamics of markets, pervasive feedback effects, information asymmetries, and irreversible path-dependent processes.

Against the dogma that market prices reflect true values, the liquidity function of money is understood as a performative technology for the management of uncertainty, constituted through a process of mimetic convergence that is fundamentally normative.[4] Finally, ecological economics theories based on maximum entropy and on the computational modelling of opportunity landscapes are shown to have illegitimately imported assumptions from physics that are not pertinent to the higher-level dynamics of complex systems such as biological ecologies and economic markets.[5] Most notably, such systems cannot therefore be conceived as robust to noise since they are characterised by a cascade of symmetry breaking transitions better understood in terms of resilience.[6]

The final chapter examines sonic noise and the twentieth century expansion of music from the harmonic ordering of periodic tones to the more complex textures of sound masses towards the aperiodic end of the spectrum. It begins by detailing the phenomenal description of sound and noise as temporal objects, and follows by showing how neurophenomenology can provide a naturalised explanation of the active nature of auditory scene analysis by drawing on dynamic systems theory.

In particular, multistable phenomena are shown to result from the non-linear dynamics of fast-acting cell assemblies, and it is argued that unconscious 'inferences' are regular features of normal perception.[7] Analyses of music based on extremal principles are rejected, along with

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3 Sellars, W. (1963) *Science, Perception and Reality*. Ridgeview Publishing Company.

4 Orléan, A. (2014) *The Empire of Value: A New Foundation for Economics*. MIT Press.

5 Koppl, R. et al. (2015) Economy for a Creative World. *Journal of Institutional Economics*, Vol. 11, Issue 01. March. pp. 1 – 31.

6 Felin, T. et al. (2014) Economic Opportunity and Evolution: Beyond Landscapes and Bounded Rationality. *Strategic Entrepreneurship Journal*, Vol. 8, issue 4: pp. 269–282.

7 Varela F.J. (1999) The Specious Present: A Neurophenomenology of Time Consciousness in Eds. Petitot, J. et al. *Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science*. Stanford University Press.

those that remain within the narrow remit of aesthetics or that flatten thought onto self-organising systems by focusing on affect. Finally, it is argued that a topological analysis of music is a more pertinent level of description, allowing for the physical, semiotic, and semantic aspects of music to be treated under a unifying framework.

1.0

Multi-Scale Randomness

1.1

A Botched Dialectic

It is well known that randomness and noise are key to many twentieth century developments in the context of science: information theory, cybernetics, the genetic theory of evolution, dynamic systems theory, psychology, computer science, quantum mechanics, chaos theory, neuroscience and complexity theory. We might characterise a widely held position in which modern scientific discoveries going back to Copernicus represent a collapse of theology and the metaphysics of necessity, replaced by a secular rationalization of probability.

After the Cartesian split between mind and matter, the problematic knot concerning the relation between probabilistic randomness, mechanistic determinism and freedom is developed notably by philosophers such as Leibniz, Hume, and Kant. All three of these philosophers can be understood as reacting to the new mechanistic explanation of the 'sublunar and supralunar' world under universal laws, and attempting to account for the apparent irreducibility of the intelligible or sensible to causal mechanical explanation.[1]

It is in the twentieth century that this quandary is compounded by the burgeoning significance of information and noise, whose conceptual pairing is an inaugural moment of the modern perspective. The scientific conceptualization of non-quantifiable randomness is most explicitly given a vitalist interpretation in Continental theory, where the concept of noise is expanded to metaphysical proportions. This could be said to begin with Bergson's anti-mechanistic conception of mind as duration.

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[1] Petitot, J. et al. (1999) *Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science.* Stanford University Press.

Bergson's anti-representationalist account of temporal experience is in particular directed against the fundamentally reversible picture of the world described by Newton, Laplace and Boltzmann. He is adamant that 'conscious force' is irreversible, non-quantifiable, and irreducible to any spatialising representation.[2] This cosmic exaltation of life against intellection, mechanism and representation is transversally extended across other disciplinary contexts precisely through the use of the semantic indeterminacy or multi-contextual nature of the concept of noise, notably by Gilles Deleuze and Michel Serres.

A metaphysics of chance comes to replace necessity, and this is associated with relativist conceptions of freedom, diversity, and the spontaneity of desire. Many of the modern outcomes of science; such as non-linear dynamics, Gödelian incompleteness, Heisenberg's uncertainty principle and the wave-particle duality of quantum mechanics; are frequently wielded as fundamental limitations to the capacity for the rational description of the world. In contrast with this antiscientific use of science, we may argue that such developments demand instead a reconceptualisation of reason and of mechanism. Several recent accounts within philosophy[3] and science[4] allow just this.

Though uncertainty and incompleteness appear to some as a check to the hubris of scientific rationality, and to the necessary progress of knowledge envisaged by Enlightenment philosophy, they should rather seen as important stages in the progressive refinement of the scientific image of natural phenomena, representing an expansion of its descriptive capacity. This is why we need to re-examine the historical constitution of the philosophical and scientific conceptualization of randomness and probability.

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[2] Bergson, H. (2008) *Time and Free Will: An Essay on the Immediate Data of Consciousness*. Cosimo Classics. p.154

[3] For example the work of Reza Negarestani, Ray Brassier, or Gabriel Catren.

These developments will be explored through two very different twentieth century philosophers, hailing from the Continental and Analytic traditions respectively, for whom these questions are central: Deleuze and Sellars. Both attempt to confront or transcend the conflict between the inherited framework of philosophical thought and contemporary scientific descriptions of the world; both are strongly influenced by Charles Sanders Pierce; and both revisit the work of Enlightenment philosophers such as Leibniz, Hume and Kant in the light of modern science. These latter three historical figures can be understood as important precursors to the contemporary conception of randomness and noise in philosophy, and we shall therefore examine how they are reconceived in the work of Deleuze and Sellars.

This will notably include an account of how Leibniz redefined necessity according to probability and made some early remarks on the connection between noise and unconscious microperceptions, prefiguring Bergson's use of continuous multiplicities;[5] how Hume provided a model for the way in which cognitive systems develop a picture of the world through sensory impressions and inferential associations; how Kant refuted Hume's radical sceptical empiricism by postulating a revisionary model of reason that we may retrospectively identify with the process of negative feedback central to the cybernetic treatment of noise;[6] and how Peirce argued for a principle of absolute contingency (tychism) that he considered to be dialectically woven together with a principle of absolute continuity (synechism).[7]

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[4] For example, Wimsatt, W. (2007) *Re-Engineering Philosophy for Limited Beings*. Harvard University Press.

[5] Risi, V. De (2007) *Geometry and Monadology: Leibniz's Analysis Situs and Philosophy of Space*. Birkhäuser. p.413

[6] This will be developed later. Kant, I. (2007) *Critique of Pure Reason*. Palgrave Macmillan.

[7] Peirce C.S. (1992) *The Essential Peirce - Volume 1: Selected Philosophical Writings: (1867-1893) v. 1*. Eds. Houser, N. & Kloesel, C. Indiana University Press.

Zalamea, F. (2014) Peirce's Tychism: Absolute Contingency for our Transmodern World in ed. Mackay, R. *Collapse: Philosophical Research and Development*. Vol VIII. Urbanomic. pp.907-922

While Deleuze draws on these philosophers in order to castigate the ideology of 'good sense' and the rational form of judgement, to exalt the chaotic and elevate aesthetics to first philosophy; Sellars does so in order to undermine the epistemic primacy of sensory experience supposed by empiricism or phenomenology, and to stress the fundamental character of propositional judgement to intelligent thought. In order to understand how we can give a positive account of scientific rationality, and how this affords a radically different understanding of noise than that implied by Deleuze, we must turn to Sellars' conception of the 'successor images' of science, and his distinction between the scientific and manifest images of man.[8] Moreover, this will prove key to understanding the various senses of the concept of noise.

In contrast with Sellars' commitment to scientific reason, the use of non-linearity in the service of a secular worship of chance is exemplified by Continental theorists of science such as Michel Serres,[9] Gilles Deleuze and Manuel DeLanda[10]. Going even further in this direction, the non-philosophical usage of quantum mechanical randomness (or 'generic science' of quantum mechanics) disqualifies *any* determinate description of phenomena for Francois Laruelle.[11] Several theorists working within science and philosophy offer an alternative perspective, in which the ungrounding of classical dynamics may be seen as an extension of the deterministic description of natural phenomena, rather than an unexplainable contradiction.

For Michel Bitbol the probabilistic status of quantum mechanics is ontological rather than epistemological; quantum mechanics is 'nothing less than a meta-contextual probability

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[8] Sellars, W. (1963) *Science, Perception and Reality*. Ridgeview Publishing Company.

[9] Serres, M. (2001) *The Birth of Physics*. Clinamen Press.

[10] DeLanda, M. (2002) *Intensive Science and Virtual Philosophy*. Continuum.

[11] Laruelle, F. (2010) *Philosophie Non-Standard – Générique, Quantique, Philo-Fiction*. Éditions Kimé, Paris. pp.106-121

theory'.[12] Catren argues for 'stratified extension of science'[13] allowing for a phenomenological ontology that extends the formal ontology of mathematics to a language more capable of a richer description of physical and biological phenomena. William Bechtel proposes a 'dynamic mechanistic explanation' following from a renewed conception of mechanism as explanatory description of the structural components and functional operations of a system.[14]

While this thesis focuses on how scientific and mathematical treatments of probability can be accounted for at an abstract *theoretical* level in various fields of philosophical enquiry (phenomenology, epistemology, ontology, metaphysics), we must also examine the *practical* significance of these developments at the level of social organisation. In particular, we will investigate the elaboration of the concepts of randomness and noise in political economy and in music, concepts that have been prominent features of these disciplines since modernity and have only increased in the twentieth century.

There are several reasons why this choice is not an arbitrary one. Firstly, both music and political economy are fundamentally mathematical, and both have been profoundly affected by the developments of modern science already mentioned (models from physics, dynamic systems theory, cybernetics, etc.). Secondly the contemporary concept of noise has unavoidable political and aesthetic dimensions, since it is bound up with the conceptual navigation of the opposition between order and disorder, freedom and necessity, etc. Lastly, music and economics, like the concept of noise, require a multi-level analysis that is able to account for physical, chemical, and

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12 Bitbol, M. (2014) Quantum Mechanics as Generalized Theory of Probabilities. in ed. Mackay, R. *Collapse: Philosophical Research and Development.* Vol VIII. Urbanomic. p.947

13 Catren, G. (2011) Outland Empire: Prolegomena to Speculative Absolutism, in Eds. Bryant, L.R. et al. 'The Speculative Turn – Continental Materialism and Realism'. re.press, Melbourne. p.341

14 Bechtel, W. (2010) *Discovering Complexity: Decomposition and Localization as Strategies in Scientific Research*. MIT Press.

biological processes, as well as that of unconscious information processing, conceptually suffused perception, and conscious rational inference.

Pointing to the deep affinities between music and political economy is not an unprecedented suggestion; indeed most of the existing literature in sound studies or sonic culture acknowledges or explores the *politics* of music.[15] However, the pertinence of this connection is demonstrated by two texts in particular where music and political economy have been linked precisely through an explicit treatment of the concept of noise.

Firstly, Jacques Attali's 'Noise: A Political Economy of Music', which describes the political economy of music in terms of historical epochs whose transition thresholds are prophetically announced by new musical forms which appear as noise to mainstream tastes.[16] This links the scientific and economic conception of the information-noise nexus to the domain of aesthetics. However, not merely are there numerous problems both with Attali's conception of noise and with his analysis of its political economy; but really the whole conceptual framework that he departs from must be rejected as stemming from an illegitimate overextension of the concept of noise, bound up with a fetishisation of self-organising systems and an exaltation of chance.

Secondly, 'Capitalism and Noise', a collection of essays edited by Anthony Iles and Mattin, demonstrates and explores the political implications of the concept of noise as it is used in music, understood through notions of disorder, indeterminacy, and excess.[17] However, in both of these examples and many other similar texts, the concept of noise is principally defined in opposition to order and reason, and as escaping quantification or generic categorisation. What

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[15] For example: Goddard, M. et al. (eds.) (2012) *Reverberations: The Philosophy, Aesthetics and Politics of Noise*. Continuum.

[16] Attali, J. (2003) *Noise - The Political Economy of Music.* University of Minnesota Press.

these accounts of noise lack is not only a thorough exploration of the philosophical implications of noise with regard to the manifest and scientific images, but also a sustained examination of the treatment of randomness in scientific discourses such as physics, biology, and economics.

There is an immediately political dimension to the existing literature on the concept of noise, where it is associated with the uncontrolled element or uncontrollable force that leads to revolutionary transformation. Noise is frequently alluded to as the irrepressible chaos of the multitude, or of desire, against the forces of oppression and repression. This is exemplified by the Lucretian concept of the *clinamen* found in Serres[18] and Deleuze,[19] the micropolitics of desire in Deleuze and Guattari,[20] and its development in the radical post-Marxist tradition of Italian Autonomism.[21]

However, noise is just as commonly co-articulated with the sound of the industrial revolution, the horrors of total warfare, and the apparatus of machinery that comes to suffuse and organise all life in the techno-scientific development of instrumental rationality – and this, from a historical perspective, is of course inseparable from the growth of capitalism. Noise is furthermore cast as the leitmotif of modernity, abstraction, alienation, rupture with nature, and loss of foundations.[22]

There are three main shortcomings in all the existing literature on noise within the humanities. Firstly, they maintain the epistemic primacy of experience and its irreducibility to any

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[17] Iles, A. & Mattin (eds.) (2009) *Noise & Capitalism*. Arteleku.

[18] Serres, M. (2001)

[19] Deleuze, G. (1994) *Difference and Repetition*. Columbia University Press. p.232

[20] Deleuze, G. & Guattari. F. (1990) *Anti-Oedipus – Capitalism and Schizophrenia*. Athlone Press.

[21] Hardt, M. & Negri, A. (2001) *Empire*. Harvard University Press.;

Lotringer, S. & Marazzi, C. (1980) *Autonomia: Post-Political Politics*. Semiotext(e).

[22] Ross, A. (2008) *The Rest is Noise: Listening to the Twentieth Century*. Fourth Estate.

scientific description. They characterise noise as resistance and excess in opposition to order, often conflating the latter with capitalism and or scientific reason. They thus fail to recognize the multi-scale complexity of noise or its intrinsically functional relationship within biological, social political and economic systems, as well as with music and with inferential reason. So, in general, there is a Continental theory inflected glorification of chance and rejection of the quantified descriptions of science, associating the latter with capitalist exploitation.

Against this fetishization of noise, the aim of this thesis will be to show how a rational account of randomness is possible, and how a more dynamic conception of reason transforms the understanding of noise. In particular this will necessitate the co-articulation of the mathematical treatment of randomness in science with the appearance of noise in qualitative sensory experience, and how this impacts on conceptions of freedom and normativity. It will be argued that the principle way in which this problematic has been overcome in twentieth century thought has been through a 'botched dialectic'[23] that makes 'self-organising' randomness and perturbations below the threshold of measurement the wellspring of freedom and creativity against the rational description of systems in terms of mechanistic determinism.

Countering this 'pseudo-libertarian imposture of chaos'[24] does not mean returning to a dualistic conception in which material processes are opposed to reason. Rather, it demands a reconceptualization of the relation between reason and randomness that resists the temptation to hypostatise chance and exalt noise. This argument follows René Thom's criticism of the glorification of chance and noise in the form of random fluctuations and perturbations in the diverse philosophies of Monod, Prigogine, Atlan, and Serres.[25] I propose that Thom's critique can be extended to the very different ways in which randomness, self-organising systems and

[23] Châtelet, G. (2014) *To Live and Think Like Pigs*. Urbanomic & Sequence Press. p.27

[24] Badiou, A. in forward to Châtelet, G. (2014) *To Live and Think Like Pigs*. Urbanomic & Sequence Press. p.27

noise have been misconceptualised and fetishised in philosophies such as Deleuze and Laruelle, in political economy, and in the theory and practice of music.

Thom's critique is audacious and his conception of indeterminism is contestable (he provocatively claims that 'the illegitimate use of chance'[26] began with Darwinism), however it highlights the problematic knot concerned with the relationship between reason, freedom, and irreversible noise that will be explored throughout this thesis. His argument follows from a negative definition of randomness, as what exceeds simulation or formal description. He explains that the capacity for the latter is relative to a certain scale of observation, and that this is particularly true for the analysis of hierarchically organised systems.[27]

Though noise is thus relativistic on this account, it does not follow that it is either subjectivist or 'relational', as many humanities or sound studies texts would have it.[28] Rather, we must construct an account capable of showing the ways in which subjective perspectives and relations are functional properties generated by the 'enabling constraints'[29] embedded in the dynamic structural organisations of complex hierarchically nested systems, and only *then* do we have the proper tools to describe the ways in which subjectivity shapes perception.

That is, we can give a naturalised explanatory account of freedom in the causal sense according to contemporary biology and complexity theory, and show how randomness and noise are intrinsic to this analysis, without succumbing to their antiscientific veneration. Further we can extend this to the social and economic level via the recursive collective formation of

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[25] Thom, R. & Chumbley, R.E. (1983) p.11

[26] Ibid. p.12

[27] Ibid. p.17

[28] See for example: Hainge, G. (2013) *Noise Matters – Towards an Ontology of Noise*. Bloomsbury.

[29] Felin, T. et al. (2014)

institutions and their hierarchically nested dynamics. Following Sellars, we must have a normative account of freedom that maintains the critical autonomy of reason while also affirming the ultimate truth of the scientific image. This can be understood as the *logical irreducibility cum causal reducibility* of rational thought.[30]

The rejection of the fetishization of indeterminacy and noise is not accomplished simply by agreeing with Thom's polemic. For many of the theorists explored in this thesis, randomness and contingency must be given ontological status beyond their definition in terms of cognitive or computational finitude. In this sense it could be argued that Thom has a merely epistemological understanding of randomness, and cannot thereby think its ontological scope.

However, this would be mistaken; his argument is that any talk of randomness presupposes the definition of a frame of reference, or context, and a language or means of representation; 'any discussion on the theme of "chance vs. determinism" must begin with an examination of the languages and formalisms which permit making a phenomenon the object of a realm of knowledge.'[31] This approach is corroborated by James Crutchfield's 'computational mechanics', which also argues that any measure of disorder is relative to the descriptive tools employed, and the specification of this language is defined by what the model is intended to observe.[32]

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[30] O'Shea, J.R. (2007) *Wilfrid Sellars: Naturalism with a Normative Turn*. Polity.

[31] Thom, R. & Chumbley, R.E. (1983) p.12

[32] Crutchfield, J.P. (1994) The Calculi of Emergence: Computation, Dynamics, and Induction. *Physica D, Proceedings of the Oji International Seminar Complex Systems - from Complex Dynamics to Artificial Reality.* Elsevier North-Holland, Inc. New York, NY, USA.

This thesis follows Sellars' inferentialist account of reason, and its development in contemporary neo-rationalist and neo-functionalist philosophies.[33] Like the neorationalists, Thom begins with an epistemological definition of randomness and draws an ontological conclusion from this; he affirms the ultimate describability of nature in principle (i.e. the non-existence of fundamental limits to reason), and *thereby* denies the hypostatisation of chance: 'To assert that "chance exists" is therefore to take the ontological position which consists in affirming that there are natural phenomena which we shall never be able to describe, therefore never understand.'[34]

Thom's negative ontological claim might be rephrased as the positive assertion that for any context-specific or scale-relative *appearance* of randomness and noise, there are no *a priori* limitations to its description or scientific understanding at another scale. One might argue then that noise exists (has an objective ontological status), but *only* as an effect of information processing dynamics and multi-scale complexity.

Just as we repudiate the veneration of chaos we must also caution here against the fetishization of complexity; this is to be achieved by demystifying any processes or entities postulated either as complex or ineffable through offering explanatory accounts and hypotheses. Complexity is not intrinsically 'better' than simplicity, indeed in most cases simplicity is favourable, and many natural processes are perhaps better explained under the notion of 'simplexity'.[35] Complex adaptive systems, such as the financial market, should not be valorised on account of their complexity – to naturalize such as system is not the same as to endorse its present form.

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[33] Such as Ray Brassier, Reza Negarestani, and Peter Wolfendale.

[34] Thom, R. & Chumbley, R.E. (1983) p.11

[35] Cohen, J. & Stewart, I. (1994) *The Collapse of Chaos: Discovering Simplicity in a Complex World.* Viking.; Kluger, J. (2008) *Simplexity: The Simple Rules of a Complex World.* John Murray.

To understand noise then, we need to do more than postulate its ontological existence. It must rather be *explained* in terms of the capacity to describe the dynamics underlying the appearance of randomness at multiple scales and across multiple contexts. This is why a multi-scale, meta-contextual understanding of noise is necessary.

At the very least, there are two basic distinctions in scale and context that must be accounted for. Firstly, that between the macroscopic realm of relatively stable appearances and the random movement of microscopic particles; and secondly, that between the description of the world according to natural language and its description according to mathematics. It is worth reiterating here that, according to Thom, noise is relative to descriptive capacity, and that these are the only two means of description at our disposal. These two basic distinctions coincide to a considerable degree, since natural language generally refers to the experiential content of a possible manifest world, and the random movement of microscopic particles is not available to sensory experience but defined by the mathematics of statistical probability.

As Thom explains, though they overlap to some extent, mathematics and natural logic generally describe different aspects of the same real world. Since modernity mathematics has been increasingly capable of description in a way that disenchants and ungrounds the classical conceptions of natural logic. This dispelling of the illusions of natural logic facilitated by the greater descriptive power of mathematics occurred over a series of irreversible events that have been referred to by Guerino Mazzola as 'breakdowns of uniqueness principles: from geocentricity (Copernicus), to anthropocentricity (Darwin), chronocentricity (Einstein), and ratiocentricity (Turing)'.[36]

[36] From talk entitled 'Melting Glass Beads: The Multiverse Game of Strings and Gestures' given in New York 22/04/14 for 'Glass Bead: Navigating Epistemologies', http://glass-bead.org/

What appeared static and stable was revealed to be dynamic and unstable; perhaps the greatest recent signifier of this instability is the naming of the current era as the *anthropocene*, which registers the effects of human civilization and industrial growth at the geological timescale. The scientific discovery of randomness, instability and non-linearity everywhere that had been hitherto supposed ordered should not be taken as demonstrating the failure of the project of rational determination.[37] On the contrary, they attest to a remarkable explosion of knowledge in the form of the mathematical description of dynamic systems and the rationalisation of randomness in terms of probabilities operating at several different scales.

The extraordinary success of mathematical description in modern science (its supposedly 'unreasonable effectiveness')[38] led to an expectation that all natural phenomena would be precisely explainable in mathematical language, rendering natural language descriptions obsolete. This conceit is 'magnificently expressed in the famous formulation of Laplacian determinism'[39], as well as in 'ruthless reductionism'[40] and 'eliminative materialism'.[41] However, Thom stresses that for many of the objects sufficiently described by natural language, 'a rigorous mathematical description of the Laplacian type would not only be very difficult, but, moreover, not pertinent'.

Thom argues that this is because the concepts of natural language (e.g. 'cat', 'noise') denote complex equivalence classes that are not well described by specifying the position and

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[37] Galileo, Poincaré and Einstein at the cosmological scale, Brown and Hooke at the microscopic scale, Carnot for energetics, Boltzmann for atomics, Lorenz for meteorology, Heisenberg at the sub-atomic scale etc.

[38] Wigner, E. (1960) The Unreasonable Effectiveness of Mathematics in the Natural Sciences, in *Communications in Pure and Applied Mathematics*, vol. 13, No. I, February. John Wiley & Sons, Inc.

[39] Thom, R. & Chumbley, R.E. (1983) p.13

[40] Bechtel's example is: Bickle, J. (1992) Revisionary Physicalism, in *Biology and Philosophy* 7/4: 411–430.; Bechtel, W. (2010)

velocity of their molecular components.[42] This is particularly true when the concepts refer to biological organisms or social systems, which do not follow predictable deterministic trajectories. Therefore, the natural language conception of noise cannot simply be eliminated in favour of an uncompromising mathematical description.

Nevertheless, two mathematical descriptions of disorder will be highly important to this thesis: the thermodynamic formula for entropy describing the statistical mechanical disorder of atoms (Boltzmann entropy), and the information theoretic description of disorder (Shannon entropy). They describe different processes, and should not be confused, but they are both quantifiable measures of disorder according to probability or expectation.

Both scientific measures describe quantities of disorder that are effectively invisible and inaudible; though we can hear the effects of Shannon's information theoretic quantity over a bad telephone connection for example, or see the effects of thermodynamic entropy on a piece of rotting fruit, the degree of entropy is not available to experience, and the quantity of randomness has no counterpart in natural language.

In order to understand the concept of noise, an explanatory framework is required that is able to describe how these two measures of disorder relate, and how both mathematical descriptions can be situated with regard to phenomenological experience, rational subjectivity and the natural language description of the world. It is argued here that it is this discrepancy that Thom points to between our natural language conceptions of the world according to 'lived experience', and the scientific description of the world according to probabilistic randomness that is at the core of the problematic of irreversible noise. This is why it is necessary to untangle

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[41] Churchland, P. M. (1981) Eliminative Materialism and the Propositional Attitudes, in *Journal of Philosophy* 78: 67–90.

the philosophical dispute surrounding this distinction, and to give an explanatory account of how the two levels relate to each other. This explanation must be capable of encompassing all of the broad disciplinary contexts we have mentioned without brutal reduction or conflation.

This will mean, firstly a clarification and exploration of the philosophical problem regarding the distinction between 'immediate' sensory experience, language based reasoning, and the mathematical description of randomness at various scales beyond sensation. This will be explored further with reference to Wilfrid Sellars' proposal for a stereoscopic fusion of the manifest and scientific images of man.[43] Secondly, the twentieth century tendency to hypostatise chance, glorify chaos, and overextend the concept of noise within Continental theory must be identified, explained, and overcome through the postulation of an alternative explanatory framework. The argument here, following Sellars, will be that in order to do this it will be necessary to explain normative-linguistic freedom in terms of causal-naturalistic processes.

Various recent theorists offer unifying explanations, bringing together the differing measures of disorder in thermodynamics, information theory, cybernetics, and dynamic systems theory to describe the emergence of complex systems with top-down and bottom-up control structures, driven by non-equilibrium thermodynamics, and maintained away from Boltzmann entropy by a constantly changing hierarchically nested architecture of constraints.[44]

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[42] Thom, R. & Chumbley, R.E. (1983) p.13

[43] Sellars, W. (1963)

[44] Deacon, T.W. (2012) *Incomplete Nature – How Mind Emerged from Matter*. W.W. Norton & Company.

Juarrero, A. (1999) *Dynamics in Action: Intentional Behavior as a Complex System*. MIT Press.

Schneider, E.D. & Sagan, D. (2005) *Into the Cool: Energy Flow, Thermodynamics and Life*. The University of Chicago Press.

Furthermore, several of these accounts extend to the analysis of higher cognition,[45] as well as economic and social systems,[46] including analyses of the practice of music making,[47] as well as the structure of musical compositions.[48] Others draw on contemporary mathematics, in particular category theory, allowing them to compare vastly different systems existing at different scales, for example a piece of music and the structure of a synthetic protein.[49] The same process of identifying, explaining and rationally delimiting the overextension of the concepts of noise and randomness must be applied within the theory and practice of political economy and music.

There is also a political argument here regarding the characterisation of noise as resistance, or as exceeding exploitation by instrumental rationality. This is rejected on the basis of the widespread exploitation and domestication of randomness and noise through technologies of prediction and control.[50] It is argued instead that there is a necessity to transform rather than resist power, and to reconceptualise reason rather than denounce it as objectifying, exploitative or static.

Randomness, chaos and uncertainty are often posed as undermining reason or representation. On the contrary, we must think of the elaboration of the former as the outstanding achievement of the latter. Reason is not opposed to noise; on the contrary it thrives on the discovery and explanation of noise, the prediction and control of random processes. The

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[45] Ehresmann, A. & Vanbremeersch, J.P. (2007) *Memory Evolutive Systems: Hierarchy, Emergence, Cognition*. Elsevier.
Wimsatt, W. (2007)

[46] Felin, T. et al. (2014)

[47] Mazzola, G. & Cherlin, P.B. (2009) *Flow, Gesture, and Spaces in Free Jazz: Towards a Theory of Collaboration*. Springer.

[48] Jedrzejewski, F. (2010) *Mathematical Theory of Music*. Editions Delatour France & Ircam-Centre Pompidou.

[49] Cranford, S.W. & Buehler, M.J. (2012) *Biomateriomics*. Springer Science+Business Media Dordrecht.
Ehresmann, A. & Vanbremeersch, J.P. (2007)

[50] This is true of the whole history of modern finance, but can also be shown in more concrete applications such as audio technologies. See for example: Sterne, J. (2012) *MP3 – The Meaning of a Format*. Duke University Press.

argument of this thesis is that noise is as intrinsic to reason, in the positive sense, as it is to cognition and to the revisionary-constructive elaboration of freedom.[51]

Following this process for the sphere of economic activity will entail an investigation of the roots of probability theory in political economy, demonstrating how concepts from physics have been illegitimately imported to the sphere of finance. In particular the way in which prices are said to move toward equilibrium in a free market through the random interactions of financial agents.

Importantly, this means dispelling the myth of equilibrium dynamics that is the cornerstone of neoliberal dogma by making a distinction between the physics of inert matter whose trajectories are specific and predictable, and higher levels of complexity such as found in biological and economic systems. Making such a distinction requires a description of randomness at several different levels, including thermodynamics, information theory, and dynamic systems theory.

Lastly, we must describe the ways in which the use of randomness and noise expanded the space of music, how indeterminacy has been fetishized in contemporary art[52] under the auspices of the ambiguity of the concept of noise, and how various musical practices employing randomness and noise may be distinguished from the glorification of chance through a neo-functionalist analysis capable of accounting for multiple scales of complexity as well as multiple contexts across which the measure of randomness alters.

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51 Negarestani, R. (2014) The Labor of the Inhuman, in Eds. Mackay, R. & Avanessian, A. *#Accelerate: The Accelerationist Reader*. Urbanomic.

52 Cf. Malik, S. (2015) Reason to Destroy Contemporary Art, in Eds. Cox, C., Jaskey, J. & Malik, S. *Realism, Materialism, Art*. Sternberg Press.

In order to understand the overextension of the conceptual nexus we have called irreversible noise, it is necessary to engage in a hyperbolic expansion of the concept, followed by rational delimitation and rigorous distinction of the terms. As irreversible noise was historically constituted along several different pathways - philosophical, scientific, political-economic, and artistic - we will need to recapitulate the historical formation of the nexus in each domain.

1.2

Entropy, Ambiguity, and Context

There are three ways of thinking about noise that often lead to confusion in theoretical approaches both to sound practices employing noise, and to the wider social and political interpretations of the concept. Firstly, there is a qualitative conception of noise as unwanted sound made in subjective judgement.[1] Secondly, information theory offers a quantitative conception of noise conceived as the level of interference in the communication of a message,[2] or the amount of information available at r (receiver) that did not come from s (sender).[3] Thirdly, there is a cybernetic conception of noise that is defined as the forces that disrupt the informational consistency or the pattern of organisation of the system.[4] The confusion between these three uses of the term noise is compounded by three different specifications of the technical term entropy in thermodynamics, information theory and cybernetics.

Thermodynamic entropy, or Boltzmann entropy, is a statistical measure of the disorder of a system in terms of the number of microstates (atomic and molecular configurations of the system) that a given macrostate can take. This measure is related to the quantity of energy the system makes available, since at maximum entropy the microscopic components are at equilibrium and all differences in temperature, density, or pressure have been equalised. This means that no energy can be extracted and no work can be done unless it is coupled with another system that introduces a difference.[5]

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1 Hegarty, P. (2007) *Noise/Music – A History*. Continuum.

2 Shannon, C.E and Weaver, W. (1963) *Mathematical Theory of Communication*. University of Illinois Press.

3 Juarrero, A. (1999) p.79

4 'Organism is opposed to chaos, to disintegration, to death, as message is to noise.' Wiener, N. (1988) *The Human Use of Human Beings: Cybernetics and Society*. Da Capo Press. p.95

5 Deacon, T.W. (2012) p.374

At equilibrium the system is then homogenous and the positions of its components are maximally random so that there is no pattern or order to their arrangement and no information can be garnered from specifying the position or velocity of one of the atomic or molecular components. Information and order are thus inversely correlated in thermodynamics. A highly ordered system has low entropy and high information; the more randomly arranged the components are the higher the entropy.

Information theory was developed to maximize transmission efficiency on electronic communication networks. Shannon determined that the amount of information a signal conveyed could be measured by the reduction of uncertainty that it achieves in relation to the probability space defined by all other possible signals in a given language or informational context. This measure is irrespective of the meaning of the message, and concerns only the probabilistic quantification of information. A message encoded in binary has an entropy rate of one bit (the uncertainty the signal eliminates is one other possible state), whereas one encoded in the Roman alphabet has an entropy rate of twenty-six bits.

Since the number of different possibilities a given signal could take is analogous to the number of microstates in a thermodynamic system it was also named entropy. Information theory states that no communication channel can be entirely free of noise, and this is partly because the material components involved in transmission are susceptible to thermodynamic degradation in the form of wear and tear or friction. There are also interference effects from other vibratory media, and from thermodynamic fluctuations in the channel itself.[6]

Though transmission noise cannot be eliminated, Shannon's innovation was to show that a certain degree of *redundancy* allows the receiver to discriminate between information and noise.

The most basic example of this is to send the message more than once so that the outcomes can be compared and the noise identified. Clearly this reduces the information capacity of the channel, as does any introduction of redundancy. In information theoretic terms redundancy is a predictable pattern or order - any communication must have a certain degree of redundancy since interpretation at the receiver end is predicated on a shared set of conventions that constrain the possibility space defining the language in which it is transmitted.

A signal in which neither rules nor any pattern of redundancies are discoverable can convey no information. Since all possibilities are equiprobable and no correlations are to be found, any given signal would reduce no uncertainty: 'the equiprobability of static crackle equates with unpredictability and maximum freedom…But a series of totally random or equiprobable signals is meaningless: no pattern or message is extractable from the disorder. There is none. At equilibrium, message variety is therefore a great but idle potential - actual information is zero.'[7] This leads to a fundamental tenet of information theory – a message with zero entropy rate is impossible since it could communicate nothing but the repetition of the same. Without different signal possibilities no uncertainty can be reduced and no information conveyed.

In order for a system to be away from equilibrium there must be some constraint that introduces order. Alicia Juarrero, using terminology introduced by Lila Gatlin, argues that there are two forms of constraint: context-free constraints and context sensitive constraints.[8] She gives as an example of a context-free constraint in a physical system, a piston introduced into a chamber of gas at equilibrium. If the movement of the piston causes the molecules to move to one side of the chamber it has acted as a context-free constraint, creating more order in the system. It is context-free because it does not matter in which order the molecules move.

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[6] Kahn, D. (2013) *Earth Sound Earth Signal.* University of California Press.

[7] Juarrero, A. (1999) pp.133-134

In the situation of information transmission, context-free constraints can ensure accuracy but are costly in terms of speed and capacity. A more efficient way is to introduce what Juarrero calls *context-sensitive redundancy* into the encoding language. A natural language has so many context sensitive redundancies that a significant amount of the message can be contaminated by noise without losing the intended meaning.

While Boltzmann entropy measures the *physical* dynamics of a system in terms of the predictability of its components, Shannon entropy measures the information carrying potential of a system in terms of the *logical* possibilities of its components. As such, it can be extended beyond the analysis of messages intended for communication, to give a measure of disorder to any system or environment. Both the Boltzmann and Shannon entropy of an untidy room is higher than that of a tidy one. However, in the case of Shannon entropy the more ordered a system is the less information it can convey. A highly ordered, low entropy system thus has low information carrying potential.

Shannon's measure of entropy therefore equates disorder and noise with a high quantity of information. A certain measure of redundancy, while lowering the information carrying capacity of the channel, facilitates the discrimination of signal and noise and so decreases the possibility of error in transmission. The binary nature of digital encoding reduces the information capacity of the channel but also maximizes the efficiency of noise detection and correction. This is why binary encoding has the lowest rate of entropy, despite the length of its descriptions.

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[8] Gatlin, L. (1972) *Information and the Living System*. Columbia University Press.

Finally, in (first order) cybernetics the structural and functional integrity of the system is threatened by thermodynamic entropy. According to Wiener's homeostatic model, the cybernetic system maintains itself at equilibrium by adjusting to perturbations through negative feedback; a process called negentropy in which entropic forces are locally resisted. However, cybernetic systems are also information processing systems whose signal detection capacity is therefore related to Shannon entropy. In cybernetics then, both Boltzmann entropy is noise to the system in terms of physical dynamics and Shannon entropy is a measure by which the system controls the signal to noise ratio of its information processing dynamics.

We are thus presented with several conceptions of, or formulas for, the relation between noise and information that are highly divergent. In popular usage, noise is deemed meaningless by choice – its information content is considered irrelevant and intrusive according to personal taste. In information theory, noise is described as an information-rich, observer-dependent interruption of a message, and is objectively determinable according to impersonal criteria; since information theory suspends or brackets the analysis of meaning noise is neither meaningful nor meaningless (just like information). Finally, in cybernetics noise is characterised both as an indeterministic chaos that is the opposite of information and must be kept at bay through the negentropic maintenance of order; and as interference to information processing or obstruction to program execution.

The lack of unifying definition attending the concept noise is not due to under-theorization or a fundamental indeterminacy, nor even to a surfeit of meanings that overflows rational traction but rather to a generative abundance of explanations and approaches that is relatively common in natural language. This is certainly not dysfunctional but should rather be thought in terms of 'strategic ambiguity'.[9] It is the ramification and elaboration of these semantic pathways that renders the concept logically and practically efficacious, robust and error-tolerant.[10] This fecundity, far from exceeding scientific reason, is intrinsic to its successful functioning, allowing for the transference of knowledge across disparate contexts of application. Other similarly polyvalent or diffuse concepts traversing disciplinary boundaries, contexts and scales include 'cell', 'stress', 'energy', 'code', 'function', etc.

Rather than taking the uncertainty of noise as an expression of a fundamental epistemological or ontological indeterminacy that stymies all efforts toward rational determination; due to the supposed messiness of bodies, the porosity of conceptual borders or the vibratory nature of matter; this thesis will attempt to show how the concept noise has enabled a progressive rationalization, capture and control of randomness across many scales and disciplines.

It is precisely because of this ratcheting effect in the rational elaboration of the concept, as well as the multi-dimensional functional diversity of its instantiations, that noise offers an exemplary site for a cultural theoretical analysis. One of the principal unifying meanings of noise is a disruption of order. Since it will most often not be possible to reverse the ensuing transformation and reinstate order I've qualified the term noise in the title as irreversible. Irreversible noise can be basically conceived as an unpredictable perturbation to the system that irrevocably alters the dynamics of its evolutionary trajectory.

This disturbance may be a continuous fluctuation occurring below the threshold of measurement, which may lead via non-linear dynamics from a micro to a macro effect (possibly

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[9] Malaspina, C. (2012) The Noise Paradigm, in Eds. Goddard, M. et al. 'Reverberations: The Philosophy, Aesthetics and Politics of Noise'. Continuum. pp.58-72

resulting in a discontinuous break); or at the macro scale, there may be a discrete unpredictable event with a high impact across externally connected or internally nested systems. In such cases, a perturbation to the system may be followed by a cascade of perturbations to the systems it is endogenously or exogenously coupled with. For example a perturbation to the ecology is passed down to the flora and fauna within it; or a perturbation to the economy may pass from the markets to the traders, then on to the consumers and commodities.

Wiener's research into stochastic systems and noise in electronic engineering led to the homeostatic control apparatus model of early cybernetics, in which the system is geared towards the maintenance of organisational consistency and the minimization of the impact of perturbations through negative feedback.[11] The system thus polices its internal consistency, bringing its functions back into coordination or equilibrium after the unpredictable disturbance. This model is related to the Freudian conception of the death drive and his discussion of the role of the primitive membrane as that portion of the organism sacrificed to the excessive excitations of the exterior to preserve the local enclave of consistency and order that is the organic interior.[12]

This model is now generally referred to as 'first order cybernetics', after the development of the paradigm by the likes of Gregory Bateson, Margaret Mead, Heinz von Foerster, and Humberto Maturana, and the theorisation of second and third order cybernetics. A system that is relatively open to such perturbations, and may adaptively 'self-organise' in response to the changing conditions, may enter into positive feedback loops, for example where behaviour satisfies a desire and this satisfaction reinforces the initial desire in turn, such as occurs in addiction.

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[10] Negarestani, R. (2014)

[11] Wiener, N. (1988)

Positive feedback loops lead to an amplification of noise, and are often seen as the sign of a system out of control and accelerating towards its own destruction, however they may also lead to a transformation threshold, or be sustained in a process of continuous transformation. It is crucial to understand positive feedback as an intrinsic factor in all evolutionary development, especially of complex intelligence.

[12] Freud, S. (1991) Beyond the Pleasure Principle, in *The Penguin Freud Library Vol. 11: On Metapsychology*. Penguin.

1.3

Signs, Rules and Logic

The aim here will not be to ask the metaphysical question, 'what is noise?' Instead we will trace the 'ramified path structure' of the topos of the concept noise in its various uses.[1] This does not entail a rejection of metaphysical or ontological claims. On the contrary we will maintain a realist metaphysics compatible with contemporary science, and will explore the ontological, epistemological and phenomenological dimensions of noise that follow from this.

This approach, at once pragmaticist and neo-functionalist,[2] enables the space-coordination of a 'topos of noise' that no longer takes conceptual oppositions as dichotomies which noise disrupts by leaking through their interstices,[3] but takes concepts as cognitive tools for navigation in a world whose complexity demands progressive rationalization precisely because it exceeds exhaustive conceptual determination. The multi-dimensional diversity of noise will be explored at various levels of practical and theoretical determination. In particular this moves beyond the privileging of experience inherent in the description of noise as subjective category of aesthetic judgement.

In order to practically orient within the topos of noise, we can group the disparate and conflicting definitions of noise already mentioned into three categories with which this thesis is equally concerned: physical, semiotic, and inferential. It is important to note that none of these

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[1] Mazzola, G. (2002) *Topos of Music - Geometric Logic of Concepts, Theory, and Performance*. Birkhäuser. p.10

[2] This follows the recent work of Reza Negarestani and Ray Brassier, who draw on contemporary rearticulations of functionalism by theorists such as William Wimsatt and William Bechtel.

[3] Greg Hainge writes for example of 'noise's intersistence, the way in which noise dissolves categorical distinctions' Hainge, G. (2013) p.136, and that 'noise arises in the in-between of the expressive assemblage' Ibid. p.150

categories are primarily defined by subjective judgement, and the conscious phenomenal experience of 'unwanted sound' is only one aspect of the third category. Furthermore the inferential ascription of noise depends on the two more basic categories (physical and semiotic) that condition its possibility.

The first category may be defined as physical differences existing before and without their differentiation by information processing systems or sensory-cognitive experience. As we've already seen, noise should be thought as existing only in relation to information processing. So it could be argued that noise does not exist at the level of non-sentient physical formations. This is complicated by the fact that information processing occurs in purely physical systems, both naturally occurring 'self-organising' systems such as 'gravel polygons,'[4] and in artificial mechanisms such as thermostats.

According to a scientific realist position, varying degrees of informational complexity exist whether or not this is registered by any information processing mechanism *as* randomness or noise. However, even though noise in the sense of disturbance and interference are objective mind-independent facts, this can only be grasped *as* noise through its definition with regard to some end-directed system.

The second category - signal transmission - is an effect at the system level that may be quantified according to probabilities and is unaffected by subjective determinations of aesthetic judgment. Noise is a crucial aspect of signal transmission systems, by which we mean not just language and gesture as we know it, but distributed information processing systems manifesting at various ecological and evolutionary scales.

The question of where to draw the line between 'brute' information processing and semiotics is still a contested distinction. I propose here that information processing may properly be considered semiotic only when a specific informational content is discriminated from other information (background noise) and coordinated with a response that picks it out as a sign *of* something. This follows Peirce's triadic conception of semiosis, whose three components are *sign, object* and *interpretant*.[5]

Pierce's architectonic conception of semiotics is such that there is no danger of reducing thought to symbol manipulation or even to natural language. Signs may be iconic, indexical or symbolic; icons have an analogical relationship of resemblance or similitude with their object (e.g. a portrait of Nelson), indexical signs have a factual connection with their object (e.g. the direction in which a weather cock faces is indexical of the wind), and symbols are signs whose interpretation depends on normative conventions (this includes but is not restricted to natural language and mathematics). Furthermore Peirce considers the propositional form in logic to be the explicit form of a certain kind of sign that is ubiquitous in nature, which he calls the 'dicisign'.[6]

Though dicisigns are everywhere, their interpretation requires the cognitive co-localization of the indexical (subject) and iconic (predicate) functions of the sign.[7] As such it can be argued that the interpretation of dicisigns begins with the evolution of biological life and is prevalent in all cognitively mediated behaviour. The implicit propositional form of the dicisign thus precedes its explicit symbolic formalization in logic, and exceeds its scope.

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4 Deacon, T.W. (2012) p.242

5 Peirce C.S. (1998) *The Essential Peirce - Volume 2: Selected Philosophical Writings: (1893-1913) v. 2.,* ed. by The Peirce Edition Project. Indiana University Press. p.xxxv

6 For an excellent account of Peirce's notion of the dicisign see: Stjernfelt, F. (2014) *Natural Propositions: The Actuality of Peirce's Doctrine of Dicisigns*. Docent Press.

According to Peirce's definition, semiotic activity only occurs when cognitive systems with sensory arrays enter into the *triadic* relations of semiotic interpretation. A sunflower that turns towards the sun can be thought as a (complex organic) mechanism that adjusts its facing direction according to the registration of phototropic stimuli. The flower could be said then to pick out the sun from the background, and respond to it *as* a source of light.

However, whether this activity is a degenerate form of triadic relation, as Peirce implied, or merely a dyadic relation - a stimulus response mechanism that involves no interpretation - is debatable. The argument that this should be considered dyadic is based on the assumption that the sunflower does not refer to anything other than the stimuli itself and its behaviour cannot therefore be considered correct or incorrect. For example, if a different light source is placed in its environment, and the flower receives more light from this than the sun, it will turn in this direction. This is not a faulty interpretation on the part of the sunflower since it only responds to phototropic stimuli and does not interpret this *as* the sun.

Though Peirce's definition of semiosis therefore requires the mental activity of *reference* (and all mental activity is conducted in signs for Peirce) in his later writings he does allow for the possibility of non-mental signs, using precisely the example of the sunflower.[8] He distinguishes this degenerate triadic interpretation from semiosis proper (which is fully triadic and cognitive), referring to thought as the 'chief, if not the only, mode of representation'.[9] The former is the basis for the now well-established science of biosemiotics.

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[7] Peirce C.S. (1998) p.277

[8] Ibid. p.273

[9] Ibid.

Such biosemiotic activity should be distinguished in turn from purely deterministic mechanisms such as the thermostat, which function according to an extrinsically imposed order rather than the intrinsically imposed constraints of self-organising, or autopoietic systems.[10] Though a thermostat or a sunflower cannot be said to have incorrectly interpreted a sign their operations may still be affected by noise, though neither the thermostat nor the sunflower can recognise this.

Noise at the level of semiosis is certainly not unilaterally undesirable; consider the milieu of the jungle in which predators and prey alike must navigate the confusion of flora and fauna, by disambiguating the environmental noise and concealing themselves within it simultaneously. The strategic use of randomness and noise in in biological systems is called crypsis, and has three main functions: to mask a signal (e.g. camouflage), to deceptively present a signal (e.g. brightly coloured non-toxic snakes and insects), or to frustrate prediction and disorient focus (e.g. flocking activity). Random mutation and copying errors in genetic replication have also been theorised as noise however, as we shall see, this kind of variability is so functional in biological evolution that describing it as noise is an illegitimate overextension of the term.[11]

The third category refers to noise at the level of conscious inferential activity or reasoning. The Peircean pragmatic account of semiotics radically extends the scope of rational inference such that all cognitive activity (including sensory perception, emotion, sensory-motor control, and even unconscious thought) is inferential and conducted in signs. Classical logic comprises three forms of inference. Deductive inference is a form of logical implication where

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[10] Maturana, H.J. & Varela, F.J. (1980) *Autopoiesis and Cognition: The Realization of the Living.* Boston Studies in the Philosophy of Science, Vol. 42. D. Reidel Publishing Company.

[11] Bravi, B. & Longo, G. (2015) The Unconventionality of Nature: Biology, from Noise to Functional Randomness. *Invited Lecture*, Unconventional Computation and Natural Computation Conference (UCNC), Auckland (NZ), 31/8 - 4/9/2015, proceedings to appear in Springer LNCS, Eds. Calude, C.S. & Dinneen M.J. pp. 3-34.

'the truth of the conclusion of the inference is guaranteed by the truth of the premises on which it is based'[12]. Deduction proceeds from reasons to consequences, or from a general premise to a specific conclusion. Inductive inference moves in the opposite direction, going from specific consequences to generalized reasons.

In classical logic, any form of reasoning that is not deductive or inductive is fallacious, where a fallacious inference is considered an improper use of logic. Deduction is non-ampliative since the information provided by its solution is no greater than the information contained in its premises, while induction is ampliative in the sense that it generalizes from particular observations, thereby producing more information. Deduction is also monotonic or 'truth-preserving', meaning that the any additional premises will not change the truth of the inference.

A deductive argument is therefore considered to be non-defeasible in classical logic, meaning that it provides certain knowledge. However this depends on the validity of the initial premises. For example, an argument that appears to be deductively true could run as follows: all mammals are warm-blooded, a naked mole-rat is a mammal, and therefore naked mole-rats are warm-blooded. However, this is not a valid deductive argument since in fact naked mole rats are a rare exception to this rule (they are 'poikilotherms', producing little metabolic heat).

Circumstances in which an inference does not hold are called 'defeasors'. If we think of a logical proposition as the program of a system in the cybernetic sense (for example a robot might be programmed to destroy all mammals, and to recognize mammals by their warm blood) then defeasors can be thought as noise to the system. However, rational agents are not computational systems following deterministic programs.

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12 Magnani, L. (2009) *Abductive Cognition: The Epistemological and Eco-Cognitive Dimensions of Hypothetical Reasoning.* Springer. p.14

The Peircean perspective highlights the fact that most cognitive activity, and most knowledge generation, is neither inductive nor deductive but consists of a third kind of inferential reasoning that is *not* fallacious; he call this *abductive* inference. Abduction may be understood as a form of rational thought that is ampliative like induction, but that remains at the level of particularity rather than generalizing as induction does. More importantly, unlike deductive and demonstrative logics, abductive inference is non-monotonic, capable of hypothesis generation, fundamentally dynamic and open to revision.[13]

Gabbay and Woods characterise abduction as essentially 'ignorance preserving', however Magnani argues in contrast that abductive inferences commonly *do* arrive at truths. In situations of uncertainty where the interpretative context is continually changing (i.e. most human activity, especially social interaction), abductive inference is the key facilitator of intelligent behaviour. Magnani distinguishes between the 'eco-cognitive immunisation' of deductive logics and the 'eco-cognitive situatedness' of abduction. In this sense abductive reasoning is not robust to noise in the manner of a well-programmed machine, but further, resilient to noise, in the sense that its efficacy relies on its revisionary-constructive sensitivity to perturbations and context changing events.[14]

The extreme effectiveness of the non-monotonic character of abduction in cognitive systems is based on the long evolutionary development of biological intelligence, and its resilience is not as yet replicable by algorithmic procedures or within formal logics. This is not to say that abductive logics may not be computationally implemented, Magnani refers for example to Carnielli's demonstration of automated abduction using paraconsistent logic, but also cites

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[13] Ibid. pp.65-70

[14] The distinction between robustness and resilience derives from Bravi, B. & Longo, G. (2015)

Girard,[15] who argues that the irreducibility of abductive reason to formal logics is demonstrated by the undecidability result of Turing's 'halting problem'.[16]

This fact identifies the insuperable failures of the classical computational approach to cognition (based on symbol manipulation), which cannot account for the spatial dynamicity of embodied thought and gesture, or the temporal dynamicity of irreversible change. This is not to argue that thought is irreducible to computation but rather that the present state of AI and computational science inadequately models the hierarchically nested dynamic complexity and the linguistically enabled general extensibility of intelligence that is the genetic condition of rational thought.

Following Andy Clark, we may understand the brain as primarily an organ evolved for problem solving through pattern association, manipulation and completion.[17] Pattern association is the basis for recognition, pattern manipulation is the basis for creative problem solving, and pattern completion is the basis for anticipation. More generally these three pattern based activities underlie the capacities of imagination, invention and discovery that facilitate complex problem solving. They also make possible the inferential modelling and exploitation of unpredictable behaviour and the strategic outmanoeuvring of predictive control. Clearly, noise may interfere with or totally obstruct the processing of patterns, it may also be falsely recognised as a pattern.

Probably the most famous advocate of deductive problem solving in popular culture is Arthur Conan Doyle's character Sherlock Holmes, who often exclaims variations of the maxim

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[15] Magnani, L. (2009) p.69

[16] Ibid. p.28 n.39

[17] Clark, A. (1997) *Being There: Putting Brain, Body, and World Together Again.* MIT Press.

'eliminate all other factors, and the one which remains must be the truth.'[18] However, this assumes the possibility of enumerating all other factors, something that is simply not feasible in most real life situations. In this respect, the study of problem solving was greatly advanced by Herbert Simon's investigations into the economic and administrative criteria of rational decision-making. His main premise was that exhaustive enumeration of all alternative outcomes of a decision or solutions of a problem is generally not possible due to time constraints, cognitive finitude, unavailability of information, and other practical limitations.

Administration is concerned with efficient resource allocation, and since for most problems the cost of calculating all possibilities is computationally exorbitant, exhaustive search is uneconomical or an inefficient use of cognitive resources. Simon thus supplants the traditional conception of rational decision making; which is global and optimizing (search considers all possibilities and finds the best solution); for one that is bounded and *satisficing* (search is constrained by the economics of cognitive resource allocation and the solution is good enough for the present purposes, or the best given the constraints). If it is not possible to list and evaluate all possibilities, then a solution cannot be found by (valid) deduction alone.

Deductive inference is still useful, even necessary, but it must be supplemented with other forms of inferential reasoning. Simon argues that in most cases, heuristics are the most *efficient* method of problem solving, even though they may be less *effective* in terms of achieving the optimal solution.[19] He therefore substitutes deduction with retroduction, a term that Peirce uses interchangeably with abduction, but that can be reasonably surmised to include the

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[18] Doyle, A.C. (1981) The Sign of Four, in *The Penguin Complete Sherlock Holmes*. Penguin Books. p.92

[19] Bechtel, W. (2010)

subsequent following of deductive logical implications and the inductive checking of hypotheses, in what Magnani calls the 'abductive cycle' of diagnostic reasoning.[20]

'The problem-solving process is not a process of "deducing" one set of imperatives (the performance programme) from another set (the goals). Instead, it is a process of selective trial and error, using heuristic rules derived from previous experience that is sometimes successful in *discovering* means that are more or less efficacious in attaining some end. … it is a *retroductive* process.'[21]

The importance of heuristic methods is therefore related to cognitive economy and decision-making speed in a noisy environment of information excess. As educated guesses, intuitive hunches, or stereotypes, heuristics can often fail and may lead to systematic errors or be affected by cognitive bias. However, heuristics can also be used to overcome such bias, and by focusing on relevant information rather than considering all details (effectively separating signal from noise), in some cases they may yield more accurate results than exhaustive search processes. Gigerenzer and Todd's research with the ABC group has made this abundantly clear: 'Fast and frugal heuristics employ a minimum of time, knowledge, and computation to make *adaptive* choices in real environments.'[22]

This parsimony was also clearly recognised in Peirce's original formulation of abductive inference (which he explicitly associates with heuristics), in which the economy of thought and explanation was a generalized principle underlying his whole project; 'the art of discovery is purely a question of economics. The economics of research is, so far as logic is concerned, the

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[20] Magnani, L. (2009) p.16

[21] Simon, H.A. (1977) *Models of Discovery and Other Topics in the Methods of Science*. Reidel. p.151 quoted in Magnani, L. (2009) p.6

[22] My emphasis. Gigerenzer, G. & Todd, P. (1999) *Simple Heuristics that Make Us Smart*. Oxford University Press.

leading doctrine with reference to the art of discovery. Consequently, the conduct of abduction, which is chiefly a question of heuristic and is the first question of heuristic, is to be governed by economical considerations.'[23]

The error tolerant and ignorance-preserving nature of heuristic procedures is most importantly to be contrasted with the truth-preserving character of algorithmic operations. While the former are usually widely applicable to a variety of different purposes ('*resilient* across a wide range of environments')[24], and are intended to provide a fallible solution, the latter are generally meant to provide a correct solution for a single application, with an unvarying outcome.[25]

The most obvious sense of noise in the context of inference is related to the information theoretical conception of noise as interference to a signal, but also as a defeasor to a propositionally articulated rule, model or explanation. As such, noise is generally deemed an impediment to successful interpretation of data, and attempts are made to reduce or cancel it, however it is just as often sought out as significant in its own right.

This is particularly evident in science, where the presence of noise may be an important indication of the theoretical inconsistencies and practical deficiencies of the investigation or procedure. Wimsatt argues that models and heuristics are indispensible tools for scientific research precisely because calculation of all aspects of a problem in the manner of a Laplacean demon is not possible: 'the scientist must consider the size of computations, the cost of data

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[23] Peirce, C.S. (1902) *Logic, Regarded As Semeiotic* (The Carnegie application of 1902) MS L75.329-330, from Draft D of Memoir 27.

[24] Bechtel, W. (2010) p.xxvi

[25] Wimsatt, W. (2007) p.10.

collection, and must regard both processes as "noisy" or error-prone'[26]. He turns this apparent shortcoming into a virtue by demonstrating how the failures that ensue from the application of heuristics reveal important facts about the object under investigation.

It should also be stressed that there is a wide range of examples in technology, science, art, and music, where noise is purposefully incorporated into the system as a beneficial effect or as a functional aspect of its operation. Importantly this generation of 'noise' or stochastic randomness is also a major element in the functional coordination of neuronal activation. However, keeping in mind Thom's critique of the anti-scientific over-extension of the concept of noise, we should be careful not to succumb to the temptation to consecrate the chaotic activity of the brain. It will be argued here that Deleuze and Guattari are liable to such accusations when they claim that 'there is extracted from the chaos [into which the brain plunges] the shadow of a "people to come" in the form that art, but also philosophy and science, summon forth: mass-people, brain-people, chaos-people - nonthinking thought that lodges in all three'.[27]

These categories (physical, semiotic, inferential) are all fundamentally related then to the notion of *pattern*, which is not opposed to noise but in a relation of complex reciprocity. The categories are distinguished according to their relation to information and its processing at the three different levels. The first category refers to patterns of purely physical differences displaying varying degrees of regularity. *Physical noise* exists in the form of random fluctuations, perturbations and interference before the emergence of sentient life and constitutes its necessary precondition, however it can only be grasped as such by information processing.

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[26] Wimsatt, W. C. (1985) Heuristics and the study of human behaviour, in Eds. Fiske D.W. & Shweder R. *Metatheory in social science: pluralisms and subjectivities* (pp. 293–314). University of Chicago Press. pp.296-7

The second category refers to the transmission of a signal – that is to the quantifiable aspects of noise in the production of a sign or message, its transmission on a medium or channel, and its reception as pattern by an end-directed information processing system or sentient organism. Both the internal incoherencies and the external horizon of this information bound by the sensory-motor responses of organisms constitutes a *semiotic noise* related to *pattern governed behaviour*.[28] Again, the ascription of noise is only pertinent within a certain defined context and at a specific scale of analysis. Randomness and interference are so intrinsic to the variability, adaptivity, and learning of pattern governed behaviour that the concept of noise is often not appropriate to its description.

This is even truer with respect to noise at the level of inference. When we dispense with the model of rationality drawn from classical logic, which is based on the foundationalist requirement for the eco-cognitive immunisation of the 'necessary truths' of deduction, and embrace instead a more dynamic pragmaticist conception of reason, inference is not characterisable in terms of noise because it is generally non-monotonic and defeasible.

The emergence of inferential intelligence may be understood as constituting a *rule obeying behaviour*[29] that is predicated on automatic pattern-governed processes of self-organising systems but logically irreducible to them since it requires a further level of description. It is precisely because obedience to rules is not mandatory but freely revisable (within given physical and social constraints) that sapience, understood as rule obeying behaviour, is intrinsically normative.

Inferential noise is noise that may be measured, conceptualized, or rationally accounted for by explanatory hypotheses but that exceeds conceptual identification or cognitive traction

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[27] Deleuze, G. and Guattari. F. (1994) *What is Philosophy?*. Verso. p.218

[28] Sellars, W. (1963) pp.324-327

within the current theoretical framework. As well as occurring at the level of the individual, any scale of social group will also hold intrinsic and extrinsic relations with inferential noise. It could be argued that since there is no rule that syntactically binds the knowledge of all processes, no ultimate pattern of patterns, then there is a horizon of intelligibility beyond which is absolutely unintelligible noise.

However, following Thom (and others such as Sellars and Catren) it is argued here that there is no fundamental limitation to what can fall under a rule-based explanation, so there is no *a priori* horizon of intelligibility and hence no absolute noise. This is true even though, or rather because, we accept Wittgenstein's argument that the formal explicitation of rules enters into an infinite regress that must ultimately find meaning in implicit rule following practices.[30]

Besides distinguishing between the description of randomness and noise at these three different levels, we must also specify their relationship to computational systems and formal logics. Turing's great advance was to externalize the problem of Gödelian incompleteness onto a practical physical device, enabling a mind-independent proof of undecidability at infinity within formal logical systems while remaining distinctively aware of the unpredictability of deterministically chaotic physical systems at the finite scale.

Longo argues that Turing's work on discrete state machines (DSM) has often been misunderstood, leading some to claim that 'a DSM is a model of the brain, or even that the brain

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[29] Ibid.

[30] Wittgenstein, L. (2009) *Philosophical Investigations*. Wiley-Blackwell.

Cf. Brandom, R. (1994) *Making it Explicit: Reasoning, Representing and Discursive Commitment*. Harvard University Press. pp.13-30 is a DSM itself.'[31] In fact, Turing makes a rigorous distinction between logical machines that function through the binary processing of meaningless sequences of signs, and continuous dynamical systems like the brain, which he describes as 'unorganized machines'. Whereas the former are understood as ideal Laplacian machines (i.e. predictable and deterministic), the latter are prone to 'exponential drift' (Turing's term for what would is now called sensitivity to initial conditions – i.e. non-linear unpredictability).

Indeed, the Laplacian nature of DSM's are their main attribute, and essential to their usefulness; if computers were open to random fluctuations that could exponentially drift into different states it would cause the storage, computation and transmission of information to be highly problematic or even unworkable. This formal aspect of logical machines is the necessary condition for the portability of software, a fundamental property of programmable computing. A DSM will always produce the same output when asked to compute from a given conjunction of initial settings unless it is 'interfered' with in some way, by altering either hardware or software components.

Longo makes clear that such a machine can be endowed with indeterminacy, for example through the addition of pseudo-random number generation modules, however this is a 'probabilistic type of abstract indeterminacy, already well studied by Laplace, and which is not the same mathematical concept as the unpredictability of deterministic dynamical systems, in the modern sense'.[32] That is, while the behaviour of a DSM may be practically unpredictable due to the length of its program or the quantity of information held in its database, this is an unpredictability caused by 'incompetence' and is therefore fundamentally different from the 'epistemic unpredictability' of chaotic systems.

[31] Longo, G. (2008) Laplace, Turing and the "imitation game" impossible geometry: randomness, determinism and programs in Turing's test, in eds. Epstein, R., Roberts, G., & Beber, G. *Parsing the Turing Test.* pp. 377-413, Springer.

In contrast, the characterization of the brain as an unorganized machine is due to its openness to continual interference or re-programming, resulting in 'largely random constructions' whose dynamic sensitivity is irreducible to computational formalism. The unorganized machine 'self-organizes' through 'semiotic activity that is reified in the external environment and then re-projected'[33] in the internal structure of neuronal pattern formation. Human intelligence is only realized within a suitable 'eco-cognitive' environment, consisting of interactions: with other unorganized machines, with external systems of knowledge, and with some educatively coordinating set of incentives and disincentives. It is only when the unorganized machine is relatively free from interference, and able to employ the internalized resources of externally developed knowledge, that it approaches the functioning of a universal machine.

[32] Ibid.

[33] Ibid.

1.4

Nested Patterns and Processing Dynamics

In fact, the three categories of noise outlined earlier (physical, biological and inferential) may be more specifically defined as referring to three dimensions of dynamic complexity. The base level is the global asymmetric diffusion towards equilibrium defined by Boltzmann entropy. The distribution of order and disorder across space and time has a distinctive geometry that acts like a backdrop against which processes of increasing order stand out. Any system exhibiting a state of disorder less than the value of thermodynamic entropy must have been caused by some external perturbation or internal structural organisation that temporarily maintains the system away from this global basin of attraction.

Any system that is not at thermodynamic equilibrium will also diverge from equiprobability in the information theoretic sense. The presence of a pattern that stands out from this flow towards disorder implies the appearance of a regularity deviating from the universal tendency, and is mathematically quantifiable in terms of redundancies supported by some constraint on movement in probability space. A self-organising physical structure, such as a crystal, exhibits redundancies that are the result of constraints. The formation of such a physical structure leads to a local increase in order (or decrease of internal entropy) that is compensated for by exporting entropy to its surrounding environment, in the form of heat for example.

This increase in local order cannot occur in an isolated system and is the result of tapping an available energy gradient. A purely physical self-organising system consumes the energy gradient that gave rise to it according to a metabolic rate defined by its structural constraints. In the case of a crystal this process is relatively quick and results in the formation of a stable state that is somewhat durable to external perturbations.

A complex dynamic system such as a whirlpool or tornado does not achieve a stable state but is metastable; it maintains itself away from equilibrium by continually exporting entropy to its surroundings. Metastable systems also have metabolic rates, and their durability is defined by the ongoing capacity to maintain organisational consistency by tapping energy gradients. Since matter-energetic resources are finite, and cannot be tapped without waste, the capacity of the system to maintain itself dissipates over time. Such processes have been theorised as 'dissipative systems'[1] or non-equilibrium thermodynamic systems (NETS).[2]

A biological organism is also a metastable dissipative system, however it differs from purely physical dissipative systems since it correlates and propagates these constraints in order to maintain itself against the entropic forces of dissolution (through processes such as respiration, cell replication, sexual reproduction, etc.). The evolutionary process leads to the formation of biological structures and functions that, in some sense, *respond* to the environmental conditions in which they develop. The ways in which evolutionary systems respond to environmental conditions should be distinguished from the sapient capacity for reference; the former is a blind information processing mechanism while the latter is inferential and has truth conditions. The failure to make this distinction clear is one of the problems with Deacon's account of the 'aboutness' he takes to occur in evolution.[3]

Evolution may then be understood as a minimal form of semiosis, constituting a form of information processing that must be distinguished from inference. It is important to note that

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1 Prigogine, I. & Stengers, I. (1984) *Order Out of Chaos: Man's New Dialogue with Nature*. Bantam Books.

2 Schneider, E.D. & Sagan, D. (2005)

such minimal semiotic processes do not constitute thinking, and are purely automatic processes of registration. A biosemiotic understanding of evolutionary development shows how it is fundamentally driven by information processing and sign systems operating at several different scales of selection pressure: ecologies, populations, organisms and behaviour or cognitive niche construction.[4]

There are a remarkable quantity of evolutionary strategies that mobilize signs in order to exploit evolutionarily structured pattern governed behaviour for deceptive purposes: cuckoos being a well known example. The call of the cuckoo chick acts as a *supernormal* stimulus for the 'parent' bird, enabling it to demand twice as much food. This is semiotic noise. Evolutionary game theory demonstrates an ongoing arms race effected through the strategic use of noise or 'crypsis' in both predator and prey. The most widespread tactic is the mimesis of environmental randomness in camouflage, another strategy is unpredictable movement, while predatory examples include the stroboscopic patterns of hunting cuttlefish, and prey examples include the randomly distributed use of prime numbers in the larval gestation times of cicada.

With the emergence of living systems then we have another set of terms related to this capacity for the preservation of internal order against the informational excess of the noisy exterior. From the very earliest stages of evolutionary development, life requires a membrane to protect it from the harsh milieu where it emerges. Brassier explains this remarkable aspect of Freud's theory of the death drive: 'A primitive organic vesicle (that is, a small bladder, cell, bubble or hollow structure) becomes capable of filtering the continuous and potentially lethal torrent of external stimuli by sacrificing part of itself in order to erect a protective shield against excessive influxes of excitation. In doing so it effects a definitive separation between organic

[3] Deacon, T.W. (2012)

interiority and inorganic exteriority'[5]. So membrane, envelope, shell and carapace are all terms related to noise via entropy, death, and the death drive.

Noise is thus linked to contagion; both are unpredictable in outbreak, in their non-linear spread, and in degenerate critical points[6] to systemic transformation; they may both threaten the present organizational order or bolster it. Closely related to the membrane, and discussed in this relation by Sloterdijk, is the concept of immunization.[7] The immune system is the result of biological contagion (it is composed of ancient viruses) and also the means for its control. The immune system, the womb, the carapace, the membrane, the house, the air-conditioned mall; all effect an immunological shield to the excessive forces of the Outside.

Of course, excess does not merely threaten from the outside, there are numerous homeostatic mechanisms to maintain the metabolism of even the 'simplest' cell,[8] including the conservation and reservation of high entropy heat energy, the filtering of toxins and the excretion of waste. At the level of populations we may talk about pollution, toxin buildup, resource depletion and ecological tipping points as noise to the system.

Let us examine more closely this complex reciprocity between the concept of noise and pattern. The notion of pattern is abstracted from temporal and causal dynamics and may be conceived in terms of probability space, thought purely geometrically or topologically. The

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4 Magnani argues that cognitive niche construction is an evolutionary process in its own right. Magnani, L. (2009) pp. 317-353

5 Brassier, R. (2007) *Nihil Unbound: Enlightenment and Extinction*. Palgrave Macmillan. p.237

6 This is the more generalized geometric notion of what is commonly known as a tipping point, as theorized by René Thom's 'Catastrophe Theory'. Thom, R. (1994) *Structural Stability And Morphogenesis*. Westview Press.

7 Sloterdijk, P. & Hoban, W. (2011) *Bubbles: Spheres I - Microspherology: 1*. MIT Press.

8 As Longo argues, the metabolic complexity of a cell is similar to a whole elephant. Longo, G. & Montévil, M. (2012) *Randomness Increases Order in Biological Evolution*. Frontiers in Physiology, n. 3, 39.

condition of irreversible global asymmetric flow toward equilibrium described by thermodynamics means that there is a pattern of change that universally constrains the organisation of all portions of space-time.

Even in a system at thermodynamic equilibrium there is a constant Brownian motion caused by the chaotic collision of particles at the molecular level. Such molecular scale interactions can be described by Newtonian mechanics, which enables a rigorous quantification of mechanical *work* that Joules later demonstrated to entail the generation of thermal energy (the most entropic form of energy).

Each percussive molecular encounter results in the generation of a minute quantity of mechanical or energetic work that is measurable in joules. Without this random movement at molecular, atomic, and sub-atomic scales nothing could ever change, and according to some theories the universe would not have emerged from the void.[9] This is the sense of the Lucretian concept of the *clinamen,* fetishized by Serres and Deleuze. While we must accept the scientific description of randomness below the threshold of measurement, there are two principle reasons why we should reject the attendant glorification of chance. Firstly, following Thom, randomness is relative to analytic frame of reference (scale and descriptive formalism). Secondly, order only *appears* to issue from randomness, where in fact it is the generation of constraints that is really productive.

Patterns are definable by the amount of work needed to produce and maintain them, and the amount of work necessary to transform them to a different pattern. A system at thermodynamic equilibrium is highly resistant to a transformation of this tendency and 'can only be driven away from its dynamically symmetric basin by being coupled to a second system with a different value of some system variable, such as temperature or pressure'.[10] Any region not at thermodynamic equilibrium must maintain its structural organization by resisting this tendency toward the loss of constraints. Some *work* must have been done either in the formation of the pattern (e.g. in relatively stable morphodynamic structures such as crystals), or in its maintenance (e.g. in metastable systems such as whirlpools).

A complex dynamic system may register processes that it is coupled with in the form of patterns of change. Patterns may be distinguished from one another but some work must be done to achieve this. A pattern is distinguished from its background when it is correlated with a selective gesture or bound by a habitual response. Rather than thinking the existence of objects as given, as object oriented ontologies do, this follows a pragmaticist approach demanding that the epistemic grasping of the object requires a perturbation of the environment that precedes any inference as to the objects ontological existence.

The contemporary mathematics of category theory, in particular Yoneda's lemma, formalises and corroborates this philosophical approach.[11] A gesture is a pre-subjective movement that embodies a set of constraints in behavioural probability space.[12] From the perspective of the conceptual framework of category theory an 'object' exists only in so much as it is transformed by a functor, or mode of address, and is therefore better described by a group of morphisms (functorial transformations).[13]

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[9] Overman, D.L. (2001) *A Case Against Accident and Self-Organisation*. Rowman & Littlefield Publishers. p.193

[10] Deacon, T.W. (2012)

[11] Mazzola, G. (2002) pp.175-189

[12] Mazzola, G. (2014) *Melting Glass Beads—The Multiverse Game of Strings and Gestures*, talk at e-flux, New York, 25/04/14 http://glass-bead.org/

[13] Zalamea, F. (2012) *Synthetic Philosophy of Contemporary Mathematics*. Urbanomic.

In computational terms, the complexity of patterns can be analysed in terms of redundancy or regularity with an algorithmic compressibility ranging from completely ordered to the limit case of compression: the incompressible. In putting forward a position of intermediate realism that avoids the binary opposition of realism about the existence of beliefs versus the eliminative materialist view that beliefs are folk psychological fictions that will be superseded by (neuro-)scientific knowledge, Daniel Dennett asks the question whether patterns exist outside of our intentional experience of them, and what ontological status they can be given.[14]

Early functionalist accounts such as Fodor's argues that a pattern exists in as much as we cognitively process it as a pattern, so the pattern really exists but as a belief in the brain; eliminative materialists such as Churchland think the intentional stance has predictive leverage but is ultimately a heuristic device that is better explained by neuronal activation models, and thus deny the existence of beliefs. Dennett takes a middle ground by claiming that beliefs are similar to abstract objects such as centres of gravity, which are neither entirely real nor entirely fictional but nevertheless useful.

He gives the example of a pattern of alternating blocks of black and white, which he calls a 'bar chart', and provides six different instantiations of this pattern with variable percentages of noise added to the signal. At 50% noise the pattern is phenomenally indiscernible, and yet he argues the pattern is still *there* in the formal sense in which the image was produced through a procedure of randomized pixel substitution. He then draws on Chaitin's algorithmic information theory to assert that a pattern is real if it can be compressed into a description that is shorter than its entire bit length.

[14] Dennett, D.C. (1991) Real Patterns. *The Journal of Philosophy.* Vol.88, Issue 1, Jan, pp.27-51

Dennett's argument is that if there is a procedure whose functional implementation will result in the exact reproduction of the pattern without specifying the value of each individual pixel then we may be confident in the assertion that a real mind-independent pattern exists. However, different descriptions may be available with different rates of compression and thus different signal to noise ratios. Ultimately, as Crutchfield argues, algorithmic compressibility is therefore not a pertinent measure of structure or pattern since it presupposes the specification of a language (such as binary) while different languages will yield different rates of compression.[15]

Whether a highly compressed description with a high noise ratio is better than a less compact description that is more error tolerant is relative to the pragmatic situation, this depends on the speed at which pattern recognition is required, the risks associated with failure, and to cognitive resource allocation problems in general. In effect, the sensory experience of biological organisms is a highly evolved mechanism for pattern recognition whose lossy compression rate allows for a significant quantity of 'noise'. The pay off is a reduction in cognitive processing cost allowing for rapid response times.

While Churchland argues that folk psychological talk of beliefs and intentions are inferior compression algorithms that will give way to lossless neuroscientific explanations, Dennett maintains that this is not clear, since in many cases the speed and utility benefits of a lossy format outweigh the error reduction capacities of higher resolution maps. The important point to take from this is that pattern recognition is not an all or nothing affair, since there are variable degrees of resolution; and that differing descriptions of the same pattern cannot be gauged purely in terms of accuracy of correspondence since many other factors are also in play.

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[15] Crutchfield, J.P. (1994)

We may analogize the question of the existence of patterns with a philosophical question concerning the ontological and epistemological status of mathematics. Zalamea explains that the standard fourfold division is between ontological idealism and ontological realism, coupled with either epistemological idealism or epistemological realism (so any combination thereof yields four positions).[16] He then goes on to show how contemporary mathematics extraordinary effectiveness depends on a constant complex transits between the real and ideal, so that reducing maths to any exclusive combination of these four positions fails to account for its richness. Patterns should be thought of likewise; the concept of pattern also allows for complex transits between the ideal and real.

The scientific and mathematical use of technologies allows us to discover the existence of many patterns that are beyond our sensory perceptual or cognitive capacities to detect. Many processes that were perceived to be highly ordered are now shown to involve significant amounts of randomness, while other processes we assumed were patternless are revealed to have underlying orders.

Patterns are then relative to information processing dynamics in the same way that noise is, however this does not make either of them subjective. There is an observer dependent reality for the detection of patterns related to the specificities of information processing power and the functional operation of the system, constituting a 'point of view' that is determined by various criteria already mentioned (the pattern's spatial and temporal distribution, limitations on sensory input and cognitive tractability, evolutionarily tendencies, computational resource allocation decisions etc.).

[16] Zalamea, F. (2012) p.10

However, there is also an observer independent reality such that patterns exist whether or not they are known to exist, since their relatively coherent or integrated structure has a unified cause or effect. Without the mind-independent or real existence of patterns it would be impossible to predict the behaviour of anything and there would be no adaptive reason for the evolutionary development of the brain, whose main function is the anticipation of future contingencies through pattern recognition, manipulation and completion. Of course, this is in line with Kant's response to 'Hume's problem', which we will explore later, and Dennett also argues that folk-psychological prediction 'depends on there being some order or pattern in world to exploit' and on which it has some (noisy) traction.[17]

[17] Dennett, D.C. (1991)

1.5

Asymmetric Diffusion as the Motor of Complexity

In order to move beyond the various impasses we have identified we must give an account of how the normative freedom of the person characterized within the manifest image relates to the causal framework of the scientific image. This requires a more in-depth analysis of the concepts that form the basis of the scientific understanding of randomness and noise; for example, entropy, information, predictability, perturbation, phase space trajectories, symmetry, and equilibrium. In particular, we need to understand the apparent opposition between the second law of thermodynamics, which describes a global tendency towards increasing disorder, and increasing complexity in biological and social phenomena. Let's begin with evolutionary biology.

The first attempt to explicitly deal with the discrepancy between increasing disorder in the physical domain and increasing order in the biological realm is Erwin Schrödinger's famous lecture series in 1943,[1] in which he attempted to unite physics and biology. The main premise of his account is that, since the material composition of the body is continually changing, what characterises life is neither some material substance nor some immaterial spirit or *élan vital,* but a pattern of matter-energetic organisation that could be understood in informational terms.

He proposed that what was crucial to understanding the specificity of biological systems with regard to physics is that they not only required an explanation of increasing order in the statistical *formation* or establishment of life - *order from disorder*, the basic thesis of Darwinian evolution - but also of the *maintenance* of order against the onslaught of extrinsic perturbations

[1] Schrödinger, E. (1944) *What is life? : The Physical Aspect of the Living Cell.* Cambridge University Press.

and the irreversible exacerbation of entropy. His argument was that the latter required a new explanation based on *order from order*, and he speculated that information stored in something like a quasi-periodic crystal could serve the purpose of supplying a *code-script* for the propagation of living order, essentially predicting the existence of DNA and providing its theoretical justification.

Though the discovery of DNA confirmed Schrödinger's theory, the computational analogy at the basis of his suggestion of a code or program has subsequently been invalidated.[2] Nevertheless, the notion of negative entropy (or negentropy) as the maintenance of order through metabolic processes such as photosynthesis, respiration, cell regeneration and the acquisition of nutrients and low entropy resources in the form of food is still a pertinent theory. However, those operations that maintain internal organisation, and thus *locally* reduce entropy, are unable to reverse the ineluctable process of organisational degradation within the body, so negentropy only ever prolongs life by postponing death and is never a positive number. Moreover, the perpetuation of living organisation is also an irreversible process that *globally* increases entropy by exporting it to the exterior as waste.

Though Shannon mathematically formalised negentropy in the context of information processing, Schrödinger did not propose an equivalent biological formalism. There have since been many attempts to import Shannon's formula into the biological domain.[3] However, as Bailly and Longo argue, the scope of such approaches has remained at the molecular level, which is precisely what Schrödinger sought to move beyond in highlighting the *systemic* effects of order

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[2] Keller, E.V. (2003) *Making Sense of Life: Explaining Biological Development with Models, Metaphors, and Machines*. Harvard University Press.

[3] For examples see: Bailly, F. & Longo, G. (2009) Biological Organisation and Anti-Entropy, in *Journal Biological Systems*, Vol. 17, No. 1, pp. 63-96.

from order.[4] They argue that the mathematics of such accounts is insufficient for describing the biological situation, which is far from the predictable trajectories of inert matter. Therefore, the concept of negentropy cannot describe the *increasing* complexity of biological phenomena.

Bailly and Longo draw on Gould's deceptively simple illustration of the increasing complexity of biological life over evolution, and recognise that it describes something extraordinarily mathematically challenging.[5] Gould's graph shows the frequency of organisms along the y-axis and complexity across the x-axis. Gould notes that there is a much greater frequency at the lower end of complexity, forming a 'left wall' that diffuses towards the right resulting in the evolution of more complex organisms.[6] While thermodynamic entropy describes the tendency of physical systems to diffuse over space and in time, Bailly and Longo argue that the increasing complexity of biological systems at the evolutionary scale can be modelled in an abstract *dimension of complexity* using a diffusion equation.[7]

This asymmetric diffusion is not driven by any program or goal, but is the result of a random walk within the bounded phase space of complexification. A random walk in any bounded phase space will result in a similar asymmetric diffusion. The key factor facilitating evolution and ontogenetic development is that, unlike in computing, iteration is never identical.[8] It is only because of this intrinsic biological variability that, with the addition of selective pressures, there is any possibility of increasing complexity. The phase space of complexification is bounded on the left since there is a minimal degree of complexity (bacterial life). The evolutionary process begins with a massive diversification of simple life forms. We can think of more complex life

[4] Ibid.

[5] Ibid.

[6] Gould, S.J. (2011) *Full House: The Spread of Excellence from Plato to Darwin*. Harvard University Press.; Gould, S.J. (2000) *Wonderful Life: Burgess Shale and the Nature of History*. Vintage.

[7] Bailly, F. & Longo, G. (2009)

forms being more 'costly' both in evolutionary terms and in terms of the metabolic capacity to resist entropic degradation, while variation at the lower end of complexity is comparatively low cost.

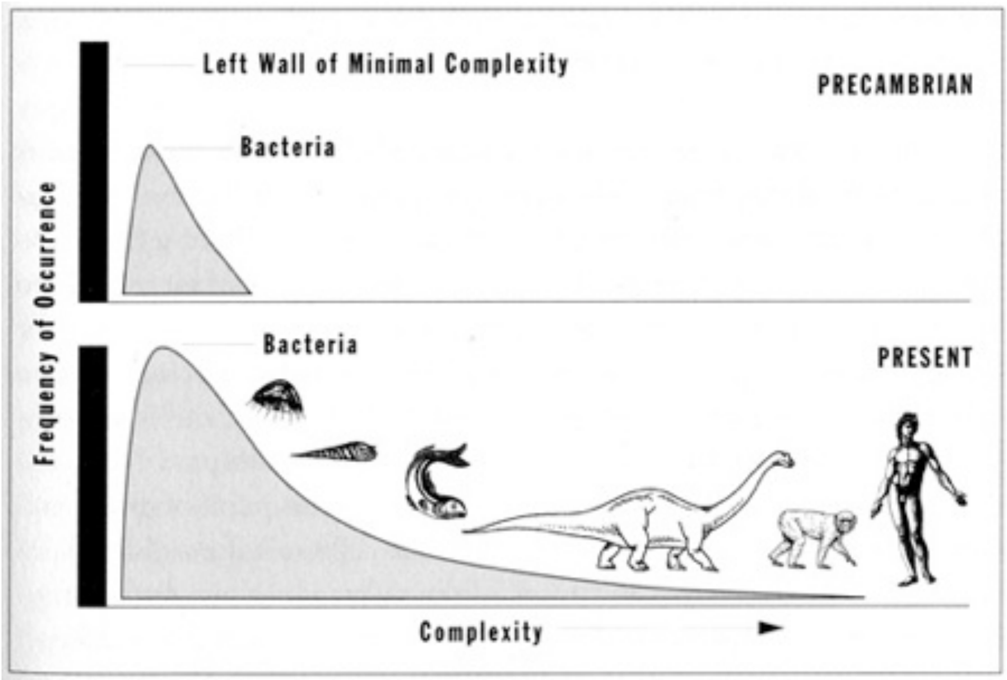

Figure 1. Gould's diagram of complexity over biomass[9]

The drift to complexity occurs through statistical probability: the huge pressure of niche occupation at the 'left wall' leads to the generation of an extended tail of complexity along the x axis. Even though it is more costly, a more complex lifeform sporadically emerges that is able to survive because it can take advantage of the vast diversity of simple organisms that precede and support it. Progressive complexity in biological life-forms is therefore not the result of a bias towards increasingly 'sophisticated' physiologies. If this were the case simpler lifeforms would have died out long ago. Multi-cellular organisms do not evolve because they are more successful than forms of life with lower complexity; in fact, the reverse is true, since simple lifeforms such

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[8] Longo, G. & Montévil, M. (2012) p.2

[9] Gould, S.J. (2011)

as bacteria are by far the most 'fit' organism, and outstrip multicellular life in terms of population longevity, diversity and biomass.[10]

Longo and Bailly mathematically formalize Gould's insight by specifying complexity according to three parameters derived from embryogenesis and phylogenesis: combinatorial complexity (measured by the number of different non-interchangeable cell lineages and defining a cellular combinatoric), morphological complexity (measuring the structure or form of biological organisation in topological terms), and functional complexity (which measures the relations between structural components in terms of the functional properties they support).[11] This enables a diffusion equation to be written, describing the evolutionary generation of biological complexity, which they argue must be understood as 'anti-entropic' since, in contrast to negentropic processes that only minimize entropy and therefore produce a negative value (if the stable state is 0 and entropy is -1, then negentropy moves towards 0 but never achieves it), anti-entropy results in a positive value.[12]

There are several important factors that should prevent us from adopting a smug satisfaction at occupying a biological niche of high complexity. Firstly, the asymmetric diffusion leading to complex life forms is highly contingent, resulting from random processes at several orders of magnitude, and not the result of a supposed intrinsic superiority.[13] Secondly, a distinction must be made between mean and modal complexity; where the former increases with

[10] Ibid.

[11] Bailly, F. & Longo, G. (2009)

[12] Ibid.

[13] Brassier quotes Gould: 'The vaunted progress of life is really random motion away from simple beginnings, not directed impetus towards inherently advantageous complexity.' Brassier, R. (2007) p.227

evolutionary development, the latter is largely determined by the extraordinary frequency, diversity and fitness of simpler organisms.[14]

Thirdly, the ability of complex life forms to sustain themselves is predicated on the fitness and variety of simpler life forms on which they parasitically feed. Lastly, an increase in complexity at one level of dynamics not only requires a higher rate of energy extraction from the lower-level dynamics it is supported by, but is also at a higher risk of system failure from low frequency high impact events due to the high degree of integration and lower-level dependencies.

Morphologically and functionally complex multi-cellular organisms have a higher entropic throughput than simpler life forms. In learning to use fire and projectile weapons early humans massively increased throughput, and more recent socio-economic and technical development has amplified this metabolic rate to dangerously high proportions – witness the anthropocenic effect of mass extinctions and wholesale resource depletion effected by the entropic momentum of capitalism.

While inert matter follows (rather than 'computes'[15]) an optimal geodetic trajectory, the evolutionary trajectories of living systems are 'sub-optimal'; they do not conform to the extremal principle defining the path of least resistance. The sub-optimality of biological systems is not a design fault; rather, random variation occurring within existing biological and ecological constraints is a functional driver of increasing complexity.

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[14] Ibid. p.226

[15] As Longo argues, the minimal definition of a computation must involve the discrete state specification of an input value and an output value, so that the term *computation* cannot be extended to cover all physical systems. Longo, G. (2009) Critique of Computational Reason in the Natural Sciences, in eds. Gelenbe, E. & Kahane, J.-P. *Fundamental Concepts in Computer Science*, Imperial College Press, pp. 43-70.

This accords with the exaptational theory of evolution put forward by Gould and Lewontin in their seminal paper against the dogma of adaptational optimization.[16] They argue that it is the ubiquity of functional underdetermination and redundancy in structural mutations that allows for complex multi-component body parts, or functions such as flight to evolve. Effectively, such *spandrels*[17] are an expression of the way in which biologically evolved systems are not just robust but resilient to noise, and how random variability is intrinsic to the dynamic maintenance of functional coherence in biological systems. The sub-optimality and unpredictability of higher level dynamics means that such complex systems significantly differ from models based on the equations of maximum entropy.

The way in which biological or social systems can become increasingly complex is further specified by the notion of generative entrenchment (GE) put forward by William Wimsatt.[18] An adaptation can provide the enabling conditions for further adaptations, and if these further adaptations are successful the enabling adaptation can be described as generatively entrenched. GE thus describes the way in which contingent features become necessary structural components through a nested dynamics. This can be applied at all levels of analysis as long as the differing dynamics are specified. The contingent development of any more or less regular or stable feature (i.e. not thermodynamic equilibrium) can function as a platform for other contingent developments to occur on its surface.

It is because of the constraints embedded in its structure that it is able to ramify its complexity by capturing randomness. Without constraints randomness goes nowhere and does

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[16] Gould, S.J. & Lewontin, R.C. (1979) The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme, *Proceedings of the Royal Society of London, Series B, VOL. 205, NO.1161* pp. 581-598.

[17] Ibid.

[18] Wimsatt, W. (2007)

nothing, when a constraint is added further constraints can accumulate on its basis. In biological systems, constraints are not merely maintained but correlated and propagated, and randomness is *canalised*.

Waddington introduced the concept of an epigenetic landscape in which the developmental possibilities have a certain geometry characterised by canals that guide the evolutionary trajectory.[19] This makes the system robust to perturbations to the trajectory, whether from intrinsic or extrinsic sources of randomness. Canalisation describes the specificity of biological robustness, where random variation is functional, as opposed to the robustness of a machine. As Bravi and Longo argue, randomness in physical and computational theories means 'unpredictability with regard to the intended theory', however in biological systems it is key to their structural stability and thus cannot be understood as noise.[20]

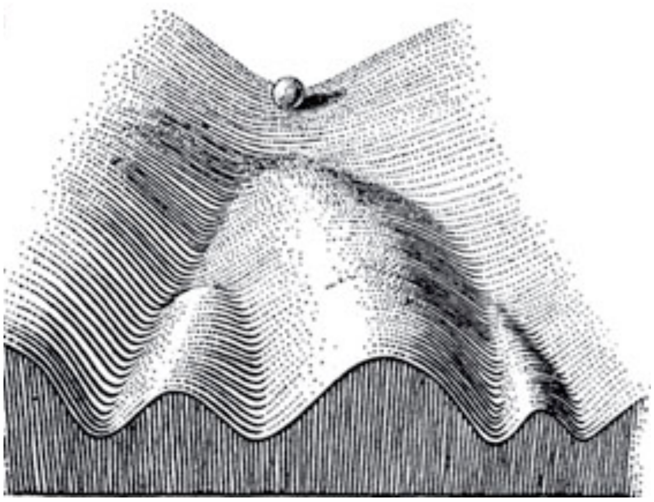

Figure 2. An epigenetic landscape

This chapter has served as an introduction to the various scientific understandings of randomness and noise, and outlined the necessity of a multi-scale account specifying different levels of information processing dynamics. However, reasoning and rational agency must be distinguished from information processing. To see how, it is necessary to further investigate the

[19] Waddington, C.H. (1957) *The strategy of the genes*. George Allen & Unwin.

philosophical articulation of the concept of noise with regard to freedom and causality. In particular, the discrepancy between lived experience and the scientific description of materiality has resulted in a 'botched dialectic' because it has misconceptualised the relationship between randomness and rationality.

The next chapter will outline the argument for Sellar's inferentialist account of this problem, which claims that a causal-naturalistic explanation of thought is possible but that rational agency and freedom is essentially normative-linguistic. It will then excavate the differences between this Sellarsian framework and that of Deleuze through a comparison of their distinctive readings of some of the major names of modern philosophy, in particular Hume, Kant, and Leibniz.

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[20] Bravi, B. & Longo, G. (2015)

2.0

The Metaphysics of Illusion: Freedom, Causality, and Noise.

2.1

The Resonant Clash

It is the contention of this thesis that many of the problems involved in theorizing noise may be helpfully explained by referring to the distinction that Sellars drew between the *manifest image of man* and the *scientific image of man*. This is because the concept of noise refers to several different levels of organisation (physical, semiotic and inferential), and crosses many different perspectives and contexts. The manifest image (MI) may firstly be understood as the implicit 'conceptual framework' in which 'man came to be aware of himself as man-in-the-world'.[1] The image is *manifest* since it provides the framework for a person to passively *suffer* or experience, to conceptually *think*, and to rationally *act* in a world of manifest appearances, where a *person* is essentially defined by these three capacities.

The simplest way of characterizing the MI is to understand it as the 'common sense' picture of the world, and Sellars often treats them alike. However, he is careful to stress that he is not opposing a basic, naïve image to a more advanced and mature one. Both images are global and of 'essentially the same order of complexity'.[2] Though the two images *clash*, they are not in direct opposition since the affirmation of one does not necessarily entail the negation of the other, so that several different combinations of the images are possible. Indeed, the MI develops and becomes more sophisticated in response to the threat of the scientific image (SI), which provides a competing total description while building on and implicitly maintaining many of the presuppositions of the MI.

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1 Sellars, W. (1963) p.11

2 Ibid. p.10

The conceptual framework or 'logical space' of the MI is the enabling condition for the critical reflection and evaluation of perceptual contents, thought and behaviour, the ability to give an account of the sensed environment and the movements of its parts according to reasons and rules. Obviously the medium in which this occurs is natural language, or better 'socially embedded discursive rationality'.[3] However the MI should not be conflated with language use, since on the one hand meaningful or semantically and logically consistent symbol manipulation is possible in cases where it is not justified to assume the existence of a person or MI (i.e. trained sentient creatures, existing forms of artificial intelligence); and on the other, Sellars will show that language use depends on the formation of the MI rather than the other way around. Though, as we will see, from the perspective of the scientific image (SI) it becomes possible to give an explanatory account of the co-evolutionary development of language use and intelligence in social groups.

The account-giving capacity of the person includes being able to distinguish between sensory and perceptual contents (sensation from intention), and between concept and object, as well as to give explanations in terms of extrinsic forces, intrinsic characteristics (essential and accidental attributes), and normative commitments. The MI is articulated in many philosophical positions that presuppose some form of *direct* knowledge, whether this foundation is conceived as purely intellectual, purely sensory, or in terms of their lawful correspondence, however Sellars will argue that this is not a necessary feature of the view from the MI.

Much of the conceptual framework of the MI is carried over into the SI, or forms the guiding assumptions by which the SI is constructed. That is, the logical space of the SI is dependent on the implicit conceptual framework of the MI to the extent that it merely assumes

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3 Brandom, R. (1994)

rather than explains the reliability of perceptual reports, the efficacy of conceptual thought, and the autonomy of rational action from natural impulsions.

The emergence of conceptual thought appears as a paradox from within the MI, since the conceptual self-encounter requires as precondition the logical space it may only suppose to exist as its result. Man must know himself in order to encounter himself, and encounter himself in order to know himself. Importantly, what appears from the MI to be an unbridgeable hiatus or 'irreducible discontinuity' is from the point of view of the SI a 'reducible difference' (i.e. explainable in evolutionary terms).[4]

In as much as the SI is able to give an adequate explanatory account of the emergence of the MI in terms of natural science it need not maintain this framework as an implicitly *assumed* structural condition. Sellars contention is that while we must look to natural science and evolutionary theory for an explanation of the emergence of reasoning from more primitive forms of cognition (and therefore their causal continuity), the truth of this discontinuity must be articulated from within the space of reasons and the perspective of the synoptic fusion of the two images.[5]

Sellars explains that the increasing sophistication of the MI has both an empirical and a *categorial* dimension, where the latter is understood as a naturalized interpretation of Kant's transcendental categories (quantity, quality, relation, modality, etc.). It is in specifying this

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[4] Sellars, W. (1963) p.11

[5] Brandom describes this discontinuity in terms of the distinction between sentience and sapience, and Brassier upholds this claim, however other Sellarsians, such as Johanna Seibt, reject this traditional split and emphasise the continuity between animal cognition and human reason. See 'Prediction, Process, Reason' Conference, Goldsmiths University, 02/06/15
https://vimeo.com/135651455

empirical dimension as that of '*correlational* induction', and reserving the procedure of '*postulational* induction' for that of the SI, that Sellars reveals the core difference between the two images.

The construction of the SI rests on the postulation of chaotic yet predictable swarms of 'imperceptible entities' (atoms, electrons, photons, phonons, etc.) for the explanation of observable behaviours, whilst the MI is a sophisticated treatment of naturally observable objects according to the correlation of their manifest sense-perceptible properties. Sellars notes that this treatment includes procedures such as the extraction of lawful regularities through statistical inference at the level of populations, just as the SI does at the level of microscopic imperceptibles.

Indeed, one of the founding moments of the formation of the SI – Boltzmann's postulation of statistical effects occurring at the atomic level – is inspired by the Darwinian treatment of population dynamics within the MI. The latter is itself modelled on the Scottish enlightenment understanding of economics as a self-regulating system occurring at the level of populations, and of course all these models derive from the mathematics of probability. The categorial dimension of refinement refers to the basic elements presupposed by the image and the corresponding classificatory schema. While the SI is, according to Sellars, fundamentally concerned with explaining the world according to the predictable movement of *particles*, the 'primary objects of the manifest image are *persons*', and their *character*, which Sellars takes great pains to distinguish from the notion of predictability.[6]

A possible misinterpretation should first be cleared up: to treat something as a person is not the same as to infer the existence of a 'spirit' or 'mind' that would inhabit the body as its ghostly double. In fact, according to Sellars, the development of such a composite image of man (mind body dualism) is predicated on the more originary development of the holistic notion of persons within the MI.

Rather, the divisions that traverse the MI pertain to what is and isn't characteristic of the person, and what is deliberate as opposed to habitual in their actions, bearing in mind that none of these distinctions are determinable in terms of the opposition between predictability and unpredictability. To act deliberately means, for Sellars, to be able to give an account (at least in principle), from within the 'space of reasons', as to why this rather than that behaviour was engaged in. Thus Sellars argues that the movements of an earthworm can only be metaphorically conceived in terms of habit or deliberate action, since 'only a being capable of deliberation can be said to act, either impulsively or from habit'.[7]

The framework of the MI is a refinement of an 'original image' in which *all* objects are understood as persons. Despite this apparently primitive animistic impulse in the basis of the MI Sellars maintains that it should not be seen as non-scientific, unsophisticated or superstitious. The refinement of the MI is that of a *de-personalization* of objects, resulting not merely in a change in belief, but a change in *category*, which is a more radical transformation according to Sellars.[8]

It is important to note here that Sellars himself admits that the two images are 'idealizations', however he compares the practical nature of such a conception to the supposition of frictionless bodies in physics (i.e. it is a useful initial approximation, or heuristic, that may later allow for greater precision). He also makes clear that there are several SI's, for example bio-chemistry and atomic physics, and argues that they may be 'telescoped' into one another.[9] The

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[6] Sellars, W. (1963) pp.14-17

[7] Ibid. p.15

[8] Ibid. p.14

[9] The extent to which this is true is debatable as we shall see later.

sense in which the plural SI's are able to form a single SI is predicated on the consistency that it borrows from the MI on which it is built: 'there is no such thing as *the* image of man built from postulated entities and processes…*the* SI is a construct from a number of images, each of which is *supported by* the manifest world.'[10]

There are also many different systematic constructions or refinements of the MI. Remembering the two images are to be seen as idealized global conceptual frameworks, Sellars also describes them as poles toward which philosophies have tended. Sellars considers the articulation of the MI to be not only the central project of ancient and medieval philosophy, but also contemporary Continental thought, and British and American 'common sense' philosophy. Moreover, the MI is also 'endorsed as real' (such that the MI is considered the *true* global image, and the SI is capable only of filling in its local details) by what Sellars calls the 'perennial philosophy'. The perennial philosophy constitutes a long tradition beginning with the Pre-Socratics, Plato and Aristotle (who is the exemplary philosopher of the MI according to Sellars) and is developed by Descartes, Kant, Hegel, Husserl and Wittgenstein.[11]

It is important to note that though Sellars is critical of the distorted perspective that results from this over-investment in the MI to the detriment of the SI, he considers the perennial philosophy (in particular Kant) to have made important developments from within the MI that are similarly perverted or lost by those philosophies that tend toward the exclusive endorsement of the SI. Though the postulation of imperceptible micro-components can be traced back to Greek atomism, the SI does not begin to properly develop until the Enlightenment.[12]

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[10] Sellars, W. (1963) p.22

[11] O'Shea, J.R. (2007) p.193 n.2

[12] Sellars, W. (1963) p.27

Sellars cites Hobbes and Hume as examples of the philosophical development of the SI against the MI, and Spinoza as an early attempt at synoptic philosophy that endorses the emancipatory power of the SI over the falseness of the MI.[13] Sellars thinks that despite the progress they make in refining the SI, important aspects of the MI are missed in the accounts of Hobbes and Hume, and Spinoza's deterministic vision is a botched synthesis.

'To the extent that the manifest image does not survive in the synoptic view, to that extent man himself would not survive. Whether the adoption of the synoptic view would transform man in bondage into man free, as Spinoza believed, or man free into man in bondage, as many fear, is a question that does not properly arise until the claims of the scientific image have been examined.'[14]

We may already begin to see how Deleuze would be positioned according to Sellars' distinction since Deleuze names his philosophical system 'transcendental empiricism' after Hume, and considers Spinoza the 'prince of philosophers'.[15] As we shall see, this will be decisive for the Deleuzian conception of noise. Sellars does think the SI has shown the MI to be false in many respects, and he also calls for a synoptic view, but one that would preserve the specific refinement details lost by any philosophical co-articulation of the two images so far. He thus argues for the necessity of a stereoscopic fusion of the images that maximizes the retention of useful perspectivally derived insights.

However, he is most vigilant against the kind of conciliatory synthesis in the more refined versions of logical empiricism being developed at the time by Rudolf Carnap, Ernest Nagel and Carl Hempel, which Sellars called 'irenic instrumentalism', since they restitute

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13 Ibid.

14 Ibid. p.21

common sense and the primacy of the manifest image through effectively muffling the clash of the images.[16] To understand the context of Sellars' rejection of this position it is necessary to enter briefly into the debate between scientific realism and empiricism.

Sellars is defending a scientific realist view against the traditional empiricist claim that theoretically postulated imperceptible entities are only abstract tools or mediating devices for organizing the meaning of immediately observable phenomena, and against the placatory gesture of the irenic empiricist who suggests that the antagonism is merely an appearance brought on by contradictory discourses. For the empiricist the existence of phenomena is non-conceptual and undeniable or *given*, while the status of postulated entities are merely as a provisional explanatory hypothesis for the manifest-perceptible behaviour of macroscopic objects. Sellars breaks down the dispute into three possible approaches:

'(1) Manifest objects are identical with systems of imperceptible particles in that simple sense in which a forest is identical with a number of trees. (2) Manifest objects are what really exist; systems of imperceptible particles being "abstract" or "symbolic" ways of representing them. (3) Manifest objects are "appearances" to human minds of a reality which is constituted by systems of imperceptible particles.'[17]

Let us deal with the second claim first, which condenses the traditional empiricist argument we have already mentioned. It should be noted at the outset that although Sellars rejects this position, and defends a radical version of scientific realism (the third position), he

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[15] Deleuze, G. (1992) *Expressionism in Philosophy: Spinoza.* Zone Books. p.11

[16] O'Shea, J.R. (2007) p.29

[17] Sellars, W. (1963) p.27

does not thereby reject the empirical basis of knowledge (scientific or otherwise), but considers himself to be a 'corrected empiricist'.[18]

It should also be made clear, lest the reader think we are involved in some archaic or pedantic philosophical quibble, that this is not a question as to whether atoms exist, or are 'real', even less whether atomic science is mistaken, but a question regarding the *status* of such postulated yet imperceptible entities with regard to experience and knowledge. Moreover, it should be born in mind that according to the SI, the atomic scale of matter must be further explained through recourse to sub-atomic particles, quantum mechanics and other theoretical entities such as strings, whose existence is certainly not accepted scientific consensus.

Microphysical particles such as atoms, photons or quarks cannot be seen with the naked eye, just as phonons cannot be heard, therefore we must rely on 'indirect' knowledge of them through their effect on observable entities. We now have very well developed technological devices that allow for 'imaging' down to the level of large atoms, however this is far from being simply *aided* manifest vision in the sense in which a regular microscope provides, since at this microphysical scale the wavelength of the photons that are needed to see the object creates interference.

In order to transcend this noise limit the structure of the object is revealed using electrons instead, whose wavelength is much smaller (electron tunnelling microscopes). Such technologies thus provide a prosthetic experience or indirect knowledge of the particulate microphysics underlying manifest objects, and this may be confirmed as true knowledge by its correlation with other facts that we consider to be directly known. However, what these supposedly directly known facts are, and how we have knowledge of them are still questions that

[18] O'Shea, J.R. (2007) p.24

require argument and justification. We are therefore forced to confront the age-old philosophical problem of the grounds or foundation for knowledge.

Confirming the existence of these imperceptible effects constitutes what Sellars calls a 'theory contaminated observational generalization'.[19] According to Sellars, the difference between the correlation of manifest perceptible properties on the one hand, and the correlation between the performed experiment and its explanation in terms of imperceptible microphysical objects on the other, is an epistemological rather than an ontological distinction. 'Both theory-contaminated observations ($*O_i$) and manifest observations (O_i) are perceptual observations insofar as they are *reliable non-inferential classificatory responses to an object*.'[20]

What was previously formulated as an 'iffy' state of affairs (if a gas has a certain pressure and volume, then it should have a certain absolute temperature) can now be given an explanation in which the manifest empirical regularities follow lawfully within strict parameters. The manifest theoretical correlation is shown to be *tantamount* to a truth that is given explanatory coherence within the framework of its corresponding successor theory. Sellars gives the example of the kinetic theory of gases as a successor theory to Boyle's law, and the transition from Newtonian to Einsteinian physics.[21]

Returning to the three choices that Sellars laid out, as we have just seen, the second alternative (manifest objects are what really exist; systems of imperceptible particles being 'abstract' or 'symbolic' ways of representing them) may be rejected since it supposes an ontological difference between imperceptible particles and manifest objects, and endorses the reality of the latter over the allegedly representational nature of the former.

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[19] Ibid. p.33

[20] Ibid.

We may now consider the first alternative, which assumes the truth of *both* the manifest and scientific images in some kind of emergentist framework in which they may coexist. Sellars does not deny the existence of emergent properties that are only evident at the holistic level of the system in the simple sense in which the pieces of wood that make up a ladder are not themselves ladders and do not have ladder properties.[22] His argument however, is that certain manifest perceptible properties do not appear to be emergent in this respect since they could not be composed from parts that do not themselves have this property.

Sellars example is a pink ice cube; the *sensation* of which he argues cannot be made of anything other than smaller instances of pink sensation. While we might explain the appearance of the pink ice cube in terms of colourless microphysical structures that reflect and absorb light spectra in a certain way, the pink sensation itself is made of nothing but a 'pinkly' sensed continuum (this point holds for a variegated or multicoloured facing side, but is less obvious). Sellars thus speaks of the irreducible conflict between the homogeneity of sensory qualities and their granular explanation in terms of colourless particles.[23]

This is just as true for auditory perception; we may understand the sound of a bassoon as being composed of silent packets of energy (phonons) mechanically transferred across a medium as a complex waveform, however the sensed timbre itself appears to be nothing but bassoon all the way down (a bassoonly duration, as Sellars might say). A neurophenomenological explanation of this apparent continuity of perception is given in the final chapter (See sections 4.2 to 4.4).

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[21] Ibid. p.25

[22] Sellars, W. (1963) p.28

There is an essential clash then, according to Sellars, between the current conceptual framework of the SI – based, as it is in Sellars' rather contrived characterization, on the predictable mechanical movement of discrete particles – and the homogenous continuity of sensory qualities. According to Sellars, this is because while any section of a colour expanse is itself a colour expanse, the neural equivalent of this manifest property must be composed of the states of discrete neurons, which ought to provide its ultimate grain.[24] The point is more difficult to maintain in the case of sound, since timbre has a specific minimal length below which only pitch (and rhythm or beat at smaller divisions) will be apparent, nevertheless the same is true of the perceived *sensation* of timbre.

Sellars maintains the metaphysical principle that inasmuch as this bassoonly sensation has a real existence in the world it must have real causal effects. However, if it cannot be reduced to the mechanical movement of particles, how can it be causally effective? Such an antinomy is the basis of the epiphenomenalist or functionalist (in the sense elaborated by Putnam for example, not the Sellarsian or neo-functionalist explanation that will be endorsed here) assertion that sensory contents are merely intentional projections existing only in the mind as functional correlations or side-effects of real causal processes. The problem may be condensed into the reconciliation of three propositions that Sellars wants to uphold, which we will here translate into sonic terms:

1) No aggregate of inaudible scientific microparticulate movements can constitute an immersive duration of occurrent bassoon timbre.

[23] O'Shea, J.R. (2007) p.164

[24] Sellars, W. (1963) p.35

2) Immersive durations of occurrent bassoon timbre nonetheless undeniably exist and the best explanation for their nature and status is that they are sensory states of perceivers.

3) Persons as conceived within the scientific image are complex aggregates of inaudible microphysical particles across which mechanical energy is transmitted in granular form or discrete packets.[25]

However, Sellars does not remain content to affirm the opposition between the mechanical collision of particles and the 'lived experience' of sensation-duration, as many of those writing about noise do. Instead he argues that in the 'ideal long run' of scientific inquiry, as envisaged by Pierce, there must be a successor SI whose fundamental categorial elements will no longer be the discrete particles envisaged by the 'the scientific ideology of the autonomy of the mechanical', but 'absolute processes' that are intrinsically capable of accounting for the continuous effects of sensory qualities.[26]

He thus argues that 'we must penetrate to the non-particulate foundation of the particulate image.'[27] However, this does not mean that the causal-mechanical interaction of particles is fundamentally inadequate for describing the processes underlying qualitative sensation. As the second proposition above maintains, sensory qualities are naturalistically explainable as cognitive states; as such, they must have a causal efficacy (rather than being merely

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[25] The original text runs: '1) no aggregate of colourless scientific microparticles can constitute a volume of occurrent pink; 2) volumes of the occurrent pink nonetheless undeniably exist and the best explanation for their nature and status is that they are sensory states of perceivers; 3) persons as conceived within the scientific image are complex aggregates of colourless micro physical particles.' Ibid. p.27

[26] Sellars, W. (1981) Foundations for a Metaphysics of Pure Process: The Carus Lectures. *The Monist*, Jan, Vol. 64, No. 1, pp. 3-90.

[27] Sellars, W. (1963) p.37

epiphenomenal), and such causality must ultimately be explainable in terms of (neurophysiological) particulate interactions.

If the atomic level of causality is not sufficient for describing the homogeneity of sensory qualities, Sellars suggests that 'electronings' and 'quarkings' may be candidates for the successor scientific image that would encompass the causality of physical objects and sensory phenomena within an ideal mono-categorial framework. As we shall see later however, though Sellars poses the continuity of perception as fundamentally irreducible to the particulate framework of the SI, contemporary neuroscientific accounts of the apparent 'smoothness' of perception have no recourse to sub-atomic physics in accounting for the illusory phenomenal experience of infinite homogeneity as a function of the temporally integrated neural mechanisms that generate such properties.[28]

Many different philosophical systems have posited a foundational stratum, or *given*, in order to deal with the potential regress of justifications for asserting knowledge. Platonism shores up the ostensible untrustworthiness of the senses by positing an ideal realm of forms or Ideas that the intellect has direct access to. For Descartes the indubitable regress-stopping foundation is the doubting faculty of the mind itself. Sense data theorists argue that although we may be mistaken about what something *is* (e.g. a tomato), the *appearance* of a coloured expanse (red, round and bulgy) cannot be doubted. This information is claimed to be immediate, presuppositionless and non-inferential. Sense data or other foundations for the given are grasped at as invariant certainties in a sea of noise – everything is suspect, variable and relative but this one immediate datum.

Accepting this belief is what Sellars calls swallowing the myth of the given. However, in denouncing this myth in all its myriad forms, Sellars does not reject the notion of a non-inferential knowledge either of a field of sensation or of the introspective self-awareness of thought processes. It should be noted however that he does make a strong distinction between these two types of non-inferential knowledge in that he considers the latter to be essentially linguistic.[29] This means he is able to uphold the common sense notion that there is an experiential knowledge that we have privileged access to, without thereby asserting a presuppositionless given.

By rejecting the notion of the given he does not plunge us into the fathomless uncertainty of an isotropic sea of noise, but shows rather that the language of *seeming* ('looks talk', sense data theory, etc.), which prompts the discourse of doubting and the search for indubitable epistemic foundations, is parasitic on a prior *knowing* that must be given both a causal-naturalistic and a normative-linguistic explanation. Following O'Shea, the myth may be analysed into two parts: the myth of the epistemic given, and the myth of the categorial given. The former is the foundationalist assumption which we have just sketched, that there must be a presuppositionless datum immediately given to sensory or noetic experience that serves as guarantor of all inferentially articulated, or indirect, knowledge.[30] To understand the latter we must first recall the Kantian notion of categories on which it is based.

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[28] 'C]onsciously experienced presentational content is not "infinitely" homogenous; homogeneity does not go all the way down – rather it is a functional-representational phenomenon emerging at a certain level of complexity.' Metzinger, T. (2004) *Being No-One – The Self-Model Theory of Subjectivity*. The MIT Press. pp. 196-7

[29] Sellars, W. (1963) p.33

[30] O'Shea, J.R. (2007) p.108

Kant calls the categories ontological predicates, or pure concepts of the understanding, and argues that they are necessary for the experience of any object in general.[31] They may be understood as a naturalistically inverted development of the list of general predicates that Aristotle compiled, and which can be asserted of any object at all. They are naturalistically inverted in the sense in which Kant's 'Copernican revolution' deployed a normative-functionalist understanding of cognition (objects conform to judgements of thought rather than the other way round), so that the categories are no longer considered as 'unexplained explainers', miraculously given to the noetic experience of rational man, but rather the functional fulfilment of the transcendental condition for the possibility of rational thought.

Though the categories are a socially constructed normative structure for thought, they are also naturalistically evolved functionally adequate mechanisms for the coordination of behaviour. Sellars' position is that the categories are therefore to be understood as 'second-order concepts, or meta-concepts…that functionally classify what are the most basic kinds of first-order concepts we possess, and hence what basic kinds or *sorts* of items there are in reality as conceived from within the standpoint of a given conceptual framework or "logical space"'.[32]

Sellars argues that the most radical and widespread form of the myth of the given is the treatment of categorial status as a given. He formulates its underlying propositional content thus: 'If a person is directly aware of an item which has categorial status C, then the person is aware of it *as* having categorial status C.'[33] In the case of the red, round and bulgy sense content then, the myth of the categorial given is the assumption that when we are aware of something red this is an immediate presuppositionless knowledge rather than a learned linguistic response relying on the acquisition of concepts (red, etc.) and the meta-conceptual framework in which those

[31] Kant, I. (2007) § 79

[32] O'Shea, J.R. (2007) p.115

concepts make sense (space, quality, etc.). Against this myth, Sellars holds that 'all perceptual cognition involves conceptualization', and gives an account of this in terms of language entry and exit transitions.

A stimulus in the world gives rise to a perceptual-linguistic identification or entry transition (even if indeterminate), this is followed by intra-linguistic transitions (formation and inferential linking of propositions), and results in a departure transition whereby propositionally contentful attitudes are expressed in behavioural responses (volitions, intentions). Although all adult perception is thus concept-laden for Sellars, and this means normatively structured (following contingent culturally evolved semantic rules); he will also allow that such perceptual capacities are built on causal-naturalistic correlations between the world and the sensory-cognitive apparatus that are non-conceptual. There is thus a coincidence of pattern-governed behaviour and rule-obeying behaviour so that it is difficult to separate them, since they 'track' each other. Sellars argument is that the concept of sense data is a 'mongrel idea' that fails to adequately distinguish between a non-inferential sensing, or *seeing of,* and a propositionally structured perceiving, or *seeing as*.[34]

What we take to be direct knowledge is therefore dependent on (metacognitive)[35] assessment of the adequate context for justified belief in a particular proposition. The apparently immediate experience of qualities such as noise is dependent on a conceptual framework where it is possible and meaningful to make such qualitative sensory reports. Sellars illustrates this with a thought experiment: he imagines a man working in a tie shop who has only ever seen anything in 'standard conditions'. When the shop invests in fluorescent lighting he runs into some problems; a customer asks what colour a certain tie is and he replies 'green' when in fact the tie is

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33 Sellars, W. (2007) *In the Space of Reasons: Selected Essays of Wilfrid Sellars*. Harvard University Press. p.236

34 Sellars, W. (1963) p.122

blue and only appears green under the new lights. It is only after a customer complains and shows him that in daylight the tie is blue that the tie salesman works out the difference between being and seeming green, and thus acquires the *is/looks* conceptual contrast.[36]

Sellars argument is therefore that the concept of *appearing* green presupposes that of *being* green. This flies in the face of the 'broadly Cartesian' tradition, encompassing traditional empiricism and phenomenology, whereby *appearance* has epistemic priority over *being.* Moreover, the ability to make reports about private sensory episodes requires also having many other concepts, such as the difference between private and public, and the circumstances that may affect perceptual reliability judgements (e.g. adverse lighting or acoustic conditions, objective perspectival differences such as angular distortion, trickery, physiological impairments, hallucination, etc.).

The inferential judgement of a rational agent may be made explicit in the form of a proposition articulated in natural language or in different formalizations of logic; for example 'this tie is green', 'there is a noise', 'd is a property of x in condition m', 'a(md)' etc. To act on the basis of this inference entails a risk, however knowing is not possible without risking, and not acting has its own risks.

The proposition 'this tie is green' that is the explicit form of the language exit transition informing the tie salesmen's action may be understood in cybernetic terms as the state of a system. When it comes up against an exception to its rule, or information that directly challenges or negates it, this can be thought as noise to the functional organization of the system in the cybernetic sense. However, since rational agents are capable of the dynamic revision and

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35 Proust, J. (2013) *The Philosophy of Metacognition*. Oxford University Press.

36 O'Shea, J.R. (2007) p.121

construction of inferential rules this perturbation leads to system transformation or model adjustment.

In logical terms these kinds of exceptions are called defeasors. The bedrock of classical logic since Greek times has been deductive logic, which is supposed to be non-defeasible. For example the proposition 'all bachelors are unmarried men' is true by the meaning of its terms and has no exceptions. In contrast, inductive and abductive inferences are susceptible to defeasors; that is, conditions or cases in which the proposition would not be true. Peirce must be applauded for showing that most rational cognitive activity is in fact abductive and defeasible rather than deductive and non-defeasible.

Noise in this sense is thus key to the development and elaboration of practical and theoretical reason. The proliferating variety of strategies brought to bear on endogenous and exogenous sources of noise, as well as the active incorporation of noise within systems leads to the complexification of behavioural space, and the ramification of commitments within the normative space of reason. However, in as much as this noise has a functional role for cognition it ought not to be conceived as noise at all.

2.2

The Delirium of Reason

A preliminary definition is useful at this point: we may understand metaphysics as referring to the '*critical*' distinction (in its ancient Greek sense, *krinein*, meaning separation) of truth and falsity, or of necessity and chance, and to the capacity of rational thought to articulate their relation and to specify the content of either category (i.e. to sort what is necessary from what is contingent, true from false).[1] While there are certainly truths that are relative to experience, the discussion of truth and necessity in metaphysics aims at the articulation of what structures experience and is unaffected by any opinion we may have of it.[2]

However, metaphysics is also understood as an inherited conceptual framework. This is why Deleuze on the one hand describes himself as a 'pure metaphysician',[3] and on the other hand praises Hume for his 'concerted destruction of the three great terminal ideas of metaphysics: the Self, the World, and God'.[4] The scope of metaphysics is extremely broad then, however there are two key principles that directly impinge on the determination of noise: *existence*, that is, 'being' and its various analytical divisions (essence and accident, actual and potential), and *causality*, which pertains to the relation between determinism, chance, agency and freedom.

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1 Badiou, A. (2014) *The Critique of Critique: Critical Theory as a New Access to the Real.* Talk given at Global Center for Advanced Studies, Jan 8. http://bit.ly/JMsI3A

2 Deleuze often inveighs against opinion in the name of philosophy. See for example: Deleuze, G. and Guattari. F. (1994) pp.79-80

3 Beaulieu, A. et al. (eds.) (2014) *Gilles Deleuze and Metaphysics*. Lexington Books. p.94

4 Deleuze, G. (2001) *Pure Immanence: Essays on A Life*. Zone Books. p.39

Metaphysics is thus key to thinking the correlation between being and thought; and since modern and contemporary philosophy is still largely defined by its relation to Kant's critical injunction against metaphysical knowledge of things-in-themselves we must examine how different metaphysical positions affect the understanding of noise. The benefit of exploring the glorification of noise in Deleuze is that he proposes an explicit metaphysics. While most accounts of noise in sound studies have mounted an attack on rationality drawn from a Deleuzian perspective on Bergson and Nietzsche, or from Deleuze and Guattari's analysis of territoriality and the refrain, they suffer from a lack of engagement with Deleuze's rejection of anti-metaphysics.

The implicit (anti-)metaphysical stance that these accounts invariably depart from is characterised by the valorisation of lived experience (in the form of duration, rhythm, vibration) over intellection, the exaltation of chance over mechanical determinism, and the glorification of noise (as fluctuation below the threshold of measurement) over all rational attempts to describe the world independently of experience. Countering this tendency requires paying closer attention to the complex relation that Deleuze shares with the great *proponents* of reason that he writes about; Leibniz, Kant, Hegel and Peirce in particular. It also necessitates moving beyond Deleuze's antipathy to representational rationality. In this section we will examine how Deleuze articulates a project of 'transcendental empiricism'[5] through his understanding of Hume.

In a fundamental break with metaphysics in general, and with the theological grounding of existence and causality in particular, Hume develops the radical empiricist argument that causality is nowhere given in experience, and is merely inferred due to constant conjunction or habitual association. According to Deleuze's account of Hume, causal inference is not an

[5] Deleuze, G. (1994) p.56

operation of the understanding, but a perception - 'Causality is *felt*.'[6] For instance, if I clap my hands there will be a sound, these are two separate ideas or impressions. According to Hume's account, I experience the clapping action and associate it with the ensuing sound, but the feeling that the former *caused* the latter is neither deduced by the understanding nor given to sensation but inferred by the imagination.

Hume's point is not to deny causation, but to demonstrate that any attribution of causality extends beyond what is immediately given to experience. Hume's own examples are the inference from fire to heat, and from lightning to thunder; the argument is that the idea of fire is separable from the idea of heat (it is possible to imagine a fire with no heat) so that to establish a necessary connection between one and the other (to make a causal inference) is to associate two distinct ideas.[7] For Deleuze, the externality of relations to their terms is the key advance of Hume's philosophy, and the essence of empiricism is found in the principle of difference that underlies this thesis. It is crucial to Deleuze's anti-representationalist account of temporal synthesis that this difference is immediate and without any kind of presupposition; in particular it should presuppose no form of conceptual mediation.[8]

Similarly, when we make statements such as 'fire always produces heat', we have asserted something that can never be verified in experience, since we cannot check what happens 'always'. For Hume this transcendence of the given is a fundamental attribute of human nature, which he accordingly argues is characterised by inference and invention, or belief and artifice.[9] It is important to note, as Deleuze does, that belief and invention are born from habit and

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[6] Deleuze, G. (1991) *Empiricism and Subjectivity: An Essay of Hume's Theory of Human Nature*. Columbia University Press. p.26

[7] Hume, D. (2008) *An Enquiry concerning Human Understanding*. Oxford University Press. p.17

[8] Deleuze, G. (1991) pp.87-88

[9] Ibid. p.85

anticipation, and that these are normative characteristics of rule creating and following that are thereby bound up with convention.[10] Moreover, in the sense that factual knowledge in general is supposed to refer to what is true under any circumstances (e.g. the sun rises in the east, water boils at 100°C) rather than what is contingently true for a particular moment, this probabilistic and artifactual transcendence of the given is also the basis of knowledge and the crux of the problem of subjectivity.[11]

Hume presents two reciprocally defining theories that together describe the externality of relations; associationism is his theory of relations, atomism is his theory of ideas.[12] Ideas must be associated because they are fundamentally atomistic; that is, they are essentially indivisible, having no parts, but only external relations of association.[13] Neither ideas nor impressions represent objects;[14] ideas represent impressions, and impressions are an innate[15] 'affection of the mind'.[16] Association is the way in which the free exercise of the imagination transcends the given; however, it is not the subject or mind that associates ideas, rather the mind *is* the synthetic association of ideas.[17]

Belief and invention are related to the binding of the past in habit and the binding of the future in anticipation; the subject is constituted within this temporal synthesis. Deleuze considers the conjunction of these two processes in a single 'fundamental dynamism' to contain the core

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[10] Ibid. p.86

[11] Ibid. pp.86-87

[12] Ibid. p.105

[13] Ibid.. p.90

[14] Ibid. p.88

[15] This does not mean we are born with impressions, rather they are innate for Hume if they are 'original or copied from no precedent perception'. Hume, D. (2008) p.21

[16] Deleuze, G. (1991) p.28

[17] Ibid. p.24

thesis of Bergson's concept of duration.[18] Importantly for Deleuze then, Hume's empiricist critique of rationalism functions by affirming the primacy of relations over representations: 'representations cannot present relations'.[19] Terms such as 'always' and 'never' are understood as relations by which the mind transcends the given; by the same token that they cannot be experienced, they cannot be representations either.

Hume therefore redefines knowledge in terms of belief and probability; this is his 'first great displacement' of philosophy according to Deleuze.[20] It is no coincidence that Hume formulates this remarkable attack on dogmatic rationalism amidst the 'Scottish Enlightenment', where we also see the huge success of statistical methods in diverse theoretical domains (Adam Smith and Hume's political economy, Charles Darwin's natural selection). Indeed, Hume's audacious critique of the rationalist conception of causality is effectively an application of the prime rule of statistical induction - 'correlation does not imply causation' - but generalized so that it applies to all thought.

As Deleuze notes, the definition of empiricism as 'a theory according to which knowledge derives from experience'[21] therefore fails to capture what is at stake in Hume's philosophy. Most importantly for Deleuze, the essence of empiricism is to explain how the subject both transcends the given and is constituted *within it* simultaneously. Part of Deleuze's answer to this is indicated by his formulation of the problem in the terms of systems, foreshadowing his later work, which more explicitly engages with systems theory and second

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18 Ibid. p.92

19 Ibid. p.30

20 Deleuze, G. (2001) p.40

21 Deleuze, G. (1991) p.108

order cybernetics. 'The subject who invents and believes is constituted inside the given in such a way that it makes the given itself a synthesis and a system'.[22]

However, finding the more comprehensive answer requires understanding why he chooses to call his entire philosophical project 'transcendental empiricism'. Against classical empiricism, which confines truth to sensation and affirms the capacity of the subject to represent objects in a way that corresponds to reality, he defines transcendental empiricism as being 'in contrast to everything that makes up the world of the subject and object'.[23] How does this relate to Deleuze's formulation of the problem in terms of synthesis and system?

Firstly, the synthetic manner in which the given becomes a system is more thoroughly specified in his later account of the three syntheses of time[24]. The first synthesis of time attempts to give a materialist explanation, in terms of the panpsychic notion of larval subjectivity, of Bergson's claim[25] that the lived experience of duration resists and exceeds every representational description.[26] As well as postulating a vital process by which the lived experience of duration comes about, it may also be understood as Deleuze's account of how the subject is constituted *within* the given. Larval subjectivity is supposed to provide a material basis for the registration of intensive differences, however as Brassier argues regarding Bergson, since intensive differences are fundamentally opposed to any spatial extensity, there can be no localization of the process, nor any scientific explanation of duration in terms of quantity or mechanism.[27]

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22 Ibid. p.87

23 Deleuze, G. (2001) p.25

24 Deleuze, G. (1994)

25 Bergson, H. (2008)

26 Brassier, R. (2011) *Bergson, Lived Experience and the Myth of the Given*. Talk given at 'To Have Done With Life - Vitalism and Antivitalism in Contemporary Philosophy' conference at MaMa, Zagreb. June 17-19. http://donewithlife.mi2.hr/

27 Ibid.

The second and third syntheses correspond respectively to the passive and active aspects by which the subject transcends the given. Secondly, the double movement by which the system is both constituted and constituting will be later formulated in terms of assemblage theory (*agencement*), the impersonal process of becoming (as actualization of pre-individual singularities), and the double structure of the object[28] and the event.[29] It is important to realise how this double movement encompasses the tension between several important 'dyads' that populate the work of Deleuze: being and becoming, the actual and virtual, chance and necessity.[30]

The process of doubling is pervasive across all Deleuze's texts, and strongly related to the notion of feedback and reciprocity that can be found in systems theory, in particular the second order cybernetics of Bateson,[31] Maturana and Varela,[32] in which the environment and organism are included in a single self-referential system through a double process of feedbacks. It can be found in his treatment of Nietzsche, where the tragic power of Dionysian affirmation, which 'has no object other than itself',[33] is nothing without its 'redoubled affirmation' in the labyrinthine ear of Ariadne.[34]

Deleuze points to the convoluted structure of Ariadne's ear because of the 'circular'[35] and sonorous[36] nature of the labyrinth, the way in which the ear constitutes a 'nexus of

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[28] Deleuze, G. and Guattari. F. (2003) *A Thousand Plateaus*. Athlone Press. pp.209-210

[29] Ibid. p.265

[30] Deleuze, G. (2006) *Nietzsche and Philosophy*. Continuum. p.30

[31] Bateson, G. (1979) *Mind and Nature: A Necessary Unity*. Hampton Press.

[32] Maturana, H.J. & Varela, F.J. (1980)

[33] Deleuze, G. (2006) p.175

[34] 'The ear is labyrinthine, the ear is the labyrinth of becoming or the maze of affirmation.' Ibid.

[35] The eternal return is not circular in the cyclical sense, in fact, Deleuze likens it to Borges' straight line labyrinth, however it is circular in the sense of the self-referentiality of second order cybernetics; it does not refer to anything other than itself. Deleuze, G. (2004) *The Logic of Sense*. Continuum. p.201

prehensions'[37] that processes differentials of frequency through its own internally differentiated form.[38] Serres points out that the interface of sensation is often achieved through the fractal formation of an intricate set of non-negotiable pathways that resolve differences in fine detail. 'Mazes maximise feedback…they are often to be found in sensation, whose problems they solve clearly.'[39]

According to Deleuze, Hume's 'second great displacement' is to take the dogmatic rationalist concern with correspondence error[40] and to turn it inside out, so that it is no longer a question of whether the idea we have matches the reality which is out there, but whether the transcendence of the given has resulted in a legitimate belief or an illegitimate fantasy. Since truth and fiction transcend the given in precisely the same way (through the association of ideas), there can be no external criteria for their verification; the truth of an idea or impression may only be checked by associating it with further impressions and ideas. Thus, 'we are not threatened by error, rather and much worse, we bathe in delirium'.[41]

This is very much related to the distinction we have already seen between the homeostatic model of first order cybernetics and the autopoietic model of second order cybernetics. The rationalist conception of error as a problem of correspondence presumes that the human mind is essentially rational; that false reasoning is anomalous to its proper functioning; and that it is in its nature to detect and swiftly rectify any falsity. This is analogous to the way in which a homeostatic apparatus detects the presence of noise through reference to a

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36 Deleuze, G. (1998) *Essays Critical and Clinical.* Verso. p.104

37 Deleuze, G. (2006b) *The Fold – Leibniz and the Baroque*. Continuum. p.88

38 'the ear is itself a refrain, it is shaped like one' Deleuze, G. & Guattari, F. (2003) p.302

39 Serres, M. (2008) *The Five Senses – A Philosophy of Mingled Bodies*. Continuum. p.142

40 Deleuze, G. (1994) p.148

41 Deleuze, G. (2001) p.43

goal state and brings the system back into order through negative feedback according to control parameters.

Second order cybernetics makes the relationship between the organism or machine and its environment into a single system. It is no longer a case of the maintenance of internal order against the noise of environmental perturbations, or the re-establishment of equilibrium through negative feedback. Rather, the system maintains itself far from equilibrium through both positive and negative feedbacks; this is what Von Foerster calls 'order from noise', distinguishing it from Schrodinger's 'order from disorder'.[42]

A quantity of noise therefore becomes integral to the functional organisation of the system. Moreover, whereas with first order cybernetics the threat is from external disorder, the distinction between a beneficial quantity of noise and the excessive noise that threatens the system is now defined purely by its own 'autonomous' internal organisation.[43] Analogously, in Hume's account of human nature, 'the illegitimate exercise or belief is incorrigible, inseparable from legitimate beliefs, and indispensable to their organisation'.[44]

Since the subject both transcends the given and is constituted within it, Deleuze's reading of Hume is clearly not prey to the myth of the given in the same way that classical empiricism is. This is because Deleuze wants to account for the dynamic and synthetic constitution of subjectivity. However, the given is thereby shifted into two different registers in Deleuze's reading: empirical and transcendental. Firstly, the given occurs in terms of the dual process of the subject's constitution and transcendence that is for him the essence of empiricism.[45]

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[42] Foerster, H. von (2003) *Understanding Understanding: Essays on Cybernetics and Cognition*. Springer.

[43] Maturana, H.J. & Varela, F.J. (1980)

[44] Deleuze, G. (2001) p.43

[45] Deleuze, G. (1991) p.108

Secondly, the given takes on a transcendental register, where it does not appear in space and time, but rather space and time are constituted in the relations between objects *in the given*.

On this account, space and time are produced by the habitual and anticipatory association of ideas; they are therefore synthetic or cognitive phenomena.[46] Sellars' treatment of Hume is in direct contrast. Deleuze considers Hume to have discovered the essence of empiricism in the thesis of the externality of relations, and emphasises the immediacy of experience and the non-representational character of duration. Sellars understands Hume as having produced the first philosophical account of the 'matter-of-fact' isomorphisms between sensory experiences and the objects of the physical world, which with a minor modification allows for a naturalistic explanation of the representational capacities of cognitive systems and rational agents.

We should firstly note that these two interpretations are not as divergent as they may seem, since Sellars also stresses the self-referentiality of Hume's system in the sense that impressions never come into contact with an external world against which they may be checked (indeed, this is precisely why he takes Hume to have discovered matter-of-fact isomorphisms). Sellars argues that we can favourably understand what Hume calls impressions or 'likenesses' as following from an evolutionary conception of the capacity of a cognitive system to build a picture of the world through constant conjunction operating at the level of statistical probabilities. He stipulates that in order to make such an interpretation of Hume it is necessary to change the reductive empiricist conception of impression from one of duplication or 'first-order similarity' to a 'second-order isomorphism' in which the picturing relation is mediated by certain 'rules of projection'.[47]

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[46] Ibid. p.91

[47] Sellars, W. (1963) pp.41-58

Sellars derives this correction of Hume's impressions from Wittgenstein's discussion of 'picturing', where he gives the example of a phonographic recording as picturing a piece of music, and describes the apparatus of the gramophone as a structure for the translation of this picture into sound according to its rules of projection. There is thus the development of a 'relation between two relational structures';[48] that is, the physical processes occurring in the mind as impressions and the physical processes in the world that they refer to[49]. It should be clear then from the fact that the grooves of the record do not resemble the music that the same is true for the material substrate of ideas (i.e. neuronal activation patterns); they need bear no resemblance to the objects or processes they pick out in the world and are rather to be understood pragmatically in terms of the behavioural possibilities attached to them.

It is important to understand that for Sellars this capacity for picturing is further augmented by natural inference in primitive cognition and by representational systems endowed with natural language and logic such as humans.[50] A Humean cognitive system, having generated an impression, may associate it with other impressions and ideas in any number of ways, make probabilistic calculations based on the regularity of these associations, and draw inferences by making new associations. In fact, Sellars understands Hume's conception of association as a naturalistic explanation of primitive inference. Association is therefore, for Sellars contra Deleuze, representational in character, and even propositional in form (without necessarily being logical).[51]

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[48] Sellars, W. (1968) *Science and Metaphysics: Variations on Kantian Themes*. Routledge and Kegan Paul. p.135

[49] Sellars, W. (1963) p.196

[50] Ibid. p.197

[51] Sellars, W. (2007) p.292

However, despite Sellars' sympathetic reading he still considers Hume to have failed to coherently articulate the distinction between ideas and impressions and between perception and inference,[52] having confused three separable notions: a red triangle, seeing a red triangle, and believing that there is a red triangle.[53] He draws on W. E. Johnson's distinction between determinates (e.g. red) and determinables (e.g. colour) to claim that, along with Locke and Berkeley, Hume is thus prey to the myth of the given in presupposing 'an unacquired ability to be aware of determinate repeatables'.[54] Hume differs from Locke and Berkeley in rejecting the assumption that 'there are occurrent thoughts of determinables'[55]; that is, for Hume the idea of colour (as opposed to the impression 'red') is constructed through the association of ideas and thus transcends the given, as we have already seen.

This is where Sellars' modification comes in. Sellars suggests that if we replace Hume's conception of the basic matter-of-fact building blocks of knowledge (i.e. impressions *of red*) with a successor concept that is 'purged of epistemic aboutness' (i.e. sensations of *red particulars*), then 'Hume's view, expanded to take into account determinates as well as determinables, would become the view that all consciousness of sorts or repeatables rests on an association of *words* (e.g. red) with classes of resembling particulars'.[56] So, in direct contrast with Deleuze, Sellars argues that thinking in terms of relations (through ideas such as 'always') is an acquired conceptual capacity that does not precede representation but rather follows from the acquisition of language. Moreover, the capacity for non-inferential knowledge of sensory particulars[57] (determinate repeatables such as red) rests on having already acquired the necessary conceptual framework for its identification.

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[52] Sellars, W. (1963) p.197

[53] Sellars, W. (1968) p.27

[54] Sellars, W. (1963) p.146

[55] Ibid. p.146

[56] Ibid. p.147

Sellars comments that Spinoza attempts a synoptic fusion of the manifest and scientific images in which the scientific image dominates, while the manifest image is denounced as false.[58] Hume also announces the falsity of the manifest image in the sense that he rejects the common sense understanding of cause, and applies a sceptical and probabilistic framework to knowledge.[59] However, in another sense, Hume reconstructs the manifest image from the bottom up, atom by atom.

In Deleuze's reading, Hume's philosophy is an odd synoptic image in which the manifest and scientific are likewise distorted. The manifest image is positively atomised as the contraction of habit, in the sense of the indivisibility of ideas and the externality of their relations. That is, the manifest image may be brought to a minimum, or 'terminating idea,'[60] such that the sensible properties of coloured and shaped objects are contracted to an indivisible point lying *between* the ideal non-extended point of mathematics and the necessarily extended physical point. Deleuze then claims that this sensible atom is the *only* real point.[61]

A neurophenomenological explanation of this apparent atomic ground to perception will be given later (see sections 5.2 to 5.4). From a Sellarsian perspective, the claim that the indivisibility of the terminating idea is the only *real* point must clearly be rejected since it endorses the truth of the manifest over the scientific image and fails to articulate and avoid the myth of the given. Since Deleuze already explicitly understands this sensible atom according to a principle of difference that is supposed to guarantee the truth of Bergsonian duration, it is not

57 Ibid.

58 Ibid. p.21

59 Ibid. p.30

60 Deleuze, G. (1991) p.90

61 Ibid. p.91

difficult to recognise in this assertion the seeds of what will be later developed in Deleuze's conception of intensive difference. As we shall see, the temporal syntheses of habit and anticipation that are constitutive of the subject and its transcendence are also further specified in Deleuze's later work.[62]

Before going on to see how Deleuze develops his anti-representationalist metaphysics of experience, lets briefly look at how the causation-correlation problem in statistical probability is related to the concept of noise. In studying a data set many correlations will be apparent; that these apparent *correlations* exist is an indisputable fact that requires no inference. In contrast, imputing a *causal* relationship between two correlated facts is always an inferential judgment. Variables that are correlated appear as a signal of their causal connection. When a causal connection is inferred but the correlation is merely contingent then the inference is a false positive; what was taken for signal was in fact noise. Conversely, correlated variables may be taken to be only contingently related and ignored as noise. In such a case, if in fact there is a causal connection then what was understood as noise was actually signal; a false negative.

In some cases, inferring a causal relation will be reasonable because there may be explanations for the link. However, if there is no discernible reason for the two variables to be correlated, then imputing a causal relationship is based purely on statistical probability. Since, for most data sets, relations of contingent correlation far outweigh causal connections, inferring the latter may be a high risk strategy. The larger the data set the more clear and accurate some correlations will *appear*, however as a result there is a higher risk of false inference.[63] This is because there is no way to discriminate between purely contingent correlations and an actual causal connection unless we have a causal hypothesis that can be tested. This is the problem with

[62] Deleuze, G. (1994) p.223

the recent claims made for the power of 'big data' analysis; as Calude and Longo argue, the relinquishment of causal hypothesising in favour of the big data doctrine of letting the numbers speak for themselves unleashes a 'deluge of spurious correlations'.[64] This is the contemporary delirium: information processing without reason.

In searching for the existence of something difficult to observe, or attempting to predict the occurrence of an event, a cognitive agent or system may scan for indications based on effects that may be associated with it. For example, the search for extraterrestrial intelligence (SETI) looks for signals such as electro-magnetic radiation, which would suggest the presence of biological life. Or, if we consider more terrestrial concerns, many attempts have been made to predict earthquakes based on various premonitory phenomena, such as animal behaviour or signature tremor indicators. However, these examples are too uncommon to show the extent of the problem.

More prosaically then, a sensation such as tiredness may be correlated with any number of potential causes (e.g. low blood sugar, boredom, lack of sleep, imminent death, etc.) meaning that cognitive agents are thus continually obliged to distinguish between possible causes, and to judge their probability, even if they are not aware of the process. In the contemporary context of digital telecommunications infrastructures a large number of these evaluation and prediction tasks are now automated; for example, spam filter programs assess the likelihood that a message

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[63] The connection between many well correlated variables are so implausible that inferring a causal connection would be more than foolish. Many examples can be found online: http://bit.ly/1sr1COO

[64] Calude, C. & Longo, G. (2016) The Deluge of Spurious Correlations in Big Data. *Part II of the Opening Lecture*, Colloque Lois des dieux, des hommes et de la nature. Accessible online: http://www.di.ens.fr/~longo/download.html

is unsolicited based on an aggregate of associated signals. The susceptibility of such attempts to failure is due to the signal to noise levels that determine the difficulty of discrimination.[65]

These are examples where the level of difficulty of separating pattern from noise renders the complex processes of correlational induction, logical deduction, and hypothetical abduction underlying cognitive behaviour explicit. Though we can give physical explanations of these cognitive dynamics there's still a disconnect between the materiality of the enabling constraints and the causal efficacy of thought and sensation. We need to account for the continuity between higher cognition and less sophisticated information processing systems by giving a naturalized explanation of its evolution, but we also need to identify a discontinuity that occurs with the emergence of reason that alters the context for analysis by introducing a new class of information processing that is inferential, self-reflexive, meta-cognitive, and meta-linguistic.

We should then distinguish, as Sellars does, between pattern-governed behaviour and rule-obeying behaviour. Brandom reinforces this distinction by associating the former with sentience and the latter with sapience.[66] On Brandom's account pattern-governed behaviour is coordinated with reference to a collection of reliable differential responsive dispositions (RDRDs) that can be thought as tracking the environmental stimuli that they pick out.[67] RDRDs are a wide class of phenomena including purely physical information processing systems, but this tracking capacity is presupposed by any more complex generalised control structure such as a TOTE unit. A TOTE unit is a feedback loop with a two-way information flow, a top-down command sent to effectors and a reafferent evaluation of the success of the action – test,

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[65] Silver, N. (2012) *The Signal and the Noise*. Penguin Books. p.371

[66] Brandom, R. (1994)

[67] Ibid. pp.33-42

operate, test, exit.[68] This enables comparison between expected and observed outcome followed by recalibration.

A simple RDRD or TOTE unit cannot learn (e.g. thermostat). The adaptive behavioural control and learning displayed by more complex systems can be abstractly conceived as a complex coordination of TOTE units into an integrated dynamic architecture of hierarchically nested and causally interconnected input-output mechanisms. This enables the system to cope with varying and uncertain situations (environmental noise) and to generate behavioural solutions for novel problems. But higher complexity and flexibility comes at a higher energetic and computational cost, and may lead to a reduction in response speed. If the system is too coarse there will be a lot of false positives, if it is too fine-grained there will be many lost opportunities.

The Environmental Complexity Hypothesis (ECH) argues that behavioural complexity is an evolutionary adaptive response to environmental complexity.[69] The environment of a sea anemone is not the same as a shark; the environment is determined by the scale of the organism as well as its capacities and tendencies, so there is really rather a structural coupling between behavioural and environmental complexity. In a simple environment (such as that of a sea anemone) low-cost rigid input-output rules are generally sufficient. In a complex environment (such as that of the shark) the high cost of a flexible response is both a strategic advantage and a survival necessity.

Clearly, this structural coupling can be extended to include the way in which the complexity of the environment is *artificially* increased. In fact, the development of human

[68] Proust, J. (2013) p.15

[69] Ibid. p.23

intelligence can be thought as a positive feedback effect in the reciprocal correlation of environmental and behavioural complexity. Behavioural complexity increases with cognitive flexibility and this requires a capacity for the identification of control opportunities, i.e. detecting new patterns in the environment as well as developing new patterns of behaviour in response. As both of these increase in complexity there are cognitive and energetic resource allocation problems as well as risk calculations that must factor into decision-making.

We can model the probability distribution of signal detection in a noisy environment using the Receiver Operating Characteristic developed in signal detection theory.[70] The agent can move the decision criterion from one side to the other on a scale of increasing resolution. If *signal* security is the main concern in a situation of detection a strict criterion will be necessary because false positives are so costly; while if *response* security is paramount a lenient criterion will be effective because of the cost of missed signals. Similarly with memory problems in higher cognition, the decision criterion may be adjusted for *exactness* such as in a math test; or for *exhaustiveness* such as in shopping list recall.[71] Since adjusting the criterion requires the comparative evaluation of a range of cognitive strategies, the adjustment process is a metacognitive operation.

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[70] Ibid. p.25

[71] Ibid.

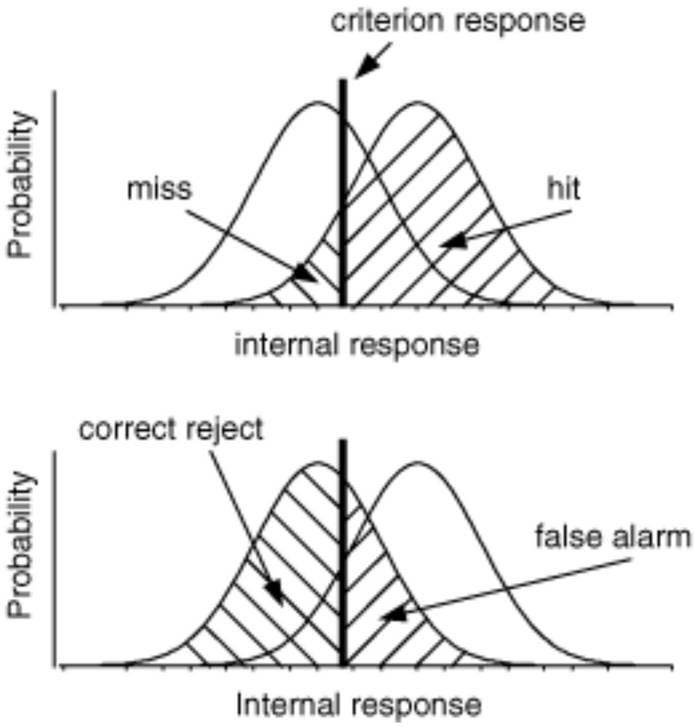

Figure 3. The Receiver Operating Characteristic

As Joelle Proust says: 'Metacognition is part of every mental action, just as some form of comparison (anticipation, retrospective evaluation) between expected and observed outcome is part of every physical action.'[72] While all sentient motile organisms have adaptive control of their behaviour by extracting feedback from motor activity and sensory arrays, only sapient organisms have the same control of cognitive activity. Higher cognition is a costly trait that is not adaptive for most organisms, it only becomes so when the complexity of environmental coupling reaches a certain critical threshold (including the need to model other agents intentions and weigh up the risks and opportunities of interaction strategies), this is why it only occurs in animals where social intelligence affects the chances of reproduction.

While pattern-governed behaviour can be extrinsically evaluated in terms of adaptability (more or less successful strategy of RDRD) it is not right or wrong in itself. In order to

[72] Ibid. p.9

understand, monitor, and control both the organism's own behaviour and that of other organisms, some form of representation in the form of more or less explicit rules is necessary. It is only when such conventions are grasped that behaviour may be considered correct or incorrect. This rudimentary form of belief attribution (to self and others), including the metacognitive assessment and dynamic adjustment of beliefs, is at the basis of higher cognition, responsibility and agency.

The biological world is full of signals that have co-evolved with the RDRD's of other organisms, such as the bright colours of toxic organisms or the long tails of peacocks, but it is also full of physical adaptations and behavioural strategies designed to disguise signals and to use signals as deception (e.g. stealth, camouflage, and other forms of crypsis). These traits exploit the capacity of the receiver to discriminate between noise and signal. In higher cognition signal interpretation has a higher complexity, there is a greater capacity for reading signals, but there are a wider diversity of pertinent signals, so more chances for error, disguise and deception. The Machiavellian Intelligence Hypothesis postulates that deception and the necessity for its detection is a key driver in the development of higher cognition since it requires 'theory of mind', belief attribution, and complex strategic thinking.[73]

The everyday life of most biologically evolved cognitive agents constitutes an extraordinary capacity for adaptive and predictive behavioural responses to diverse contingent phenomena. Artificial intelligence has not yet been able to replicate this kind of fluid capacity for disambiguation or decision criterion calibration, and is unable to achieve pattern formation and matching activities that seem effortless to a rabbit let alone a human.[74] However, this phenomenon of effortless movement, of immediate thought, may be understood as a neuro-

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[73] Ibid. p.30

computational illusion that masks the process of its own sub-personal constitution.[75] Not only is the brain an evolutionary ancient and highly sophisticated organ for the detection and disambiguation of signals, but also a key aspect of this complex capacity is that it functions precisely through the ampliative *generation* of stochastic randomness.[76]

It is possible then to argue, somewhat paradoxically, that the brain achieves noise reduction through noise generation. This apparent paradox is however due to the semantic ambiguity of the concept noise, since noise *reduction* refers to the detection of an external signal in the presence of external sources of interference, while the 'noise' *generation* process in the brain is an endogenous source of randomness that increases sensitivity to signals through harnessing the beneficial effects of stochastic resonance.[77] As Bravi and Longo argue in the context of evolution, it is misleading to characterise randomness in biological systems as noise since this variability is rather a functional property that is far from constituting an interference.[78] Similarly, the endogenous generation of stochastic resonance is an intrinsic aspect of the brain's functional dynamics and should therefore not be considered as noise.

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74 Baird, B. (1986) Nonlinear dynamics of pattern formation and pattern recognition in the rabbit olfactory bulb. *Physica D: Nonlinear Phenomena Volume 22, Issues 1–3*, Oct–Nov, pp. 150–175

75 Metzinger, T. (2004)

76 Deacon is in line with Metzinger and other neuroscientific theorists when he argues that brains disambiguate the noise of environmental stimuli precisely through the amplification of dynamical chaos in neural pattern firing. Deacon, T.W. (2012) p.501

77 Deco, G. et al. (2009) Key role of coupling, delay, and noise in resting brain fluctuations. *Proc Natl Acad Sci USA. June 23; 106(25): 10302–10307*. doi: 10.1073/pnas.0901831106

78 Bravi, B. & Longo, G. (2015)

2.3

Discordant Accord

Kant's early writings (before 1770) are charged with a Leibnizian influenced certainty about the rational structure of being and causality. The *critical* turn is signalled in a now famous remark, where Kant explicitly refers to Hume's radical critique of such classical metaphysics as that which had woken him from 'dogmatic slumber', leading him to question whether any metaphysical knowledge is at all possible.[1] In this modern period of philosophy, a clear dichotomy had emerged between Empiricism and Rationalism; where the former generally grounded itself in experience and was sceptical of ideas that could not be inductively derived from it, while the latter was grounded in the deductive truths of reason and mistrustful of raw sensation.

The crux of this dispute may be reductively glossed for present purposes by defining (dogmatic) rationalism as the belief that experience is fundamentally susceptible to error, so that we should trust only those pure Ideas of the intellect; and empiricism as the reverse claim that only experience can be free from doubt, so that all ideas that go beyond its verifiable bounds are liable to be illusory. Kant's great merit is to have advanced the image of reason beyond this apparent impasse by subsuming sensibility and intelligibility under the conditions of possibility of rational agency. He thus dispenses with the seemingly interminable debate as to whether it is sensory experience or reason that is in error, by redefining the issue in terms of the formulation of 'false problems,' and rendering illusion as the internal effect of the functional relationships

[1] Kant, I. (2012) *Prolegomena to Any Future Metaphysics*. General Books LLC. p.7

between legitimate and illegitimate uses of the faculties of mind[2]. In particular that of the understanding (transcendental illegitimate use), and of reason (transcendent illegitimate use).[3]

As both Deleuze and Sellars recognise, Kant owes a debt to Hume for making this move from external error to internal illusion available. However, Kant completely transforms the outcome by sloughing its sceptical empiricist presuppositions and couching knowledge in terms of the rule-governed conduct of the rational agent. Let us be explicit here: a transformation has occurred in the understanding of error from the dogmatic to the critical image, whereby the modern concept of noise begins to be rendered philosophically and scientifically tractable.

The possibility of error that troubled the dogmatic account in making judgements concerning the external world is internalized in the form of the discordant and illegitimate uses of the faculties. This means it is no longer the threat of error from the outside that is the concern, but instead there are several different specific internal causes of illusion that may be identified. Furthermore they are not merely local malfunctions but considered globally constitutive for the possibility or good functioning of rational intelligence.

Kant rejects dogmatic rationalism's claim to supersensible knowledge, and to the metaphysical truths that it posits, but he also rejects empiricism's claim to have sensible knowledge without presupposing supersensible Ideas and concepts, or transcendental categories (which Sellars understands as meta-conceptual). Kant's transcendental idealism operated as a refutation of Hume's scepticism, and the empirical method in general, by *agreeing* with Hume's claim that ideas such as 'necessary' and 'cause' are not to be found in sensory experience, and then showing how such suprasensible ideas are *already presupposed* within empirical discourse.

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2 Deleuze, G. (1995) *Kant's Critical Philosophy*. Athlone Press. p. 25

3 Ibid. p. 26

Kant's great innovation within logic is to posit the possibility of synthetic *a priori* knowledge, thereby yielding a fourfold distinction between the terms (analytic *a priori,* synthetic *a priori,* analytic *a posteriori,* synthetic *a posteriori*).

In order to appreciate the radical philosophical upheaval that this entails, and how it impacts on the concept of noise, we must first understand the way in which Kant's critical philosophy accomplishes an inversion of the standard model for metaphysical inquiry. In a much discussed analogy from the preface to the second edition of 'The Critique of Pure Reason', Kant compares his method to Copernicus' experimental suspension of geocentrism, since he overturns the standard procedure whereby knowledge must be shown to conform to the object, and considers instead the ways in which objects conform to knowledge.[4] While some commentators have argued that Kant's philosophy is far from analogous to the Copernican displacement of anthropocentric conceit, and actually effects a Ptolemaic counter-revolution that re-centres on human subjectivity,[5] it is also possible to consider Kant's move as a naturalization of epistemic finitude, and thus as taking the first steps within modern philosophy towards a desacralization of human knowledge under the condition of a true science of cognition.

There are two crucial aspects to Kant's project that reinforce such a naturalist interpretation: the explanation of thought in terms of the doctrine of faculties (understood here as the decomposition of cognitive functions, and thus as cognitive science *avant la lettre*), and the 'transcendental method' itself, which is an immanent critique of the illegitimate overextension of reason by and within reason itself (i.e. without recourse to transcendent foundations outside of the finite capacity for reasoning, e.g. God).

[4] Kant, I. (2007) p.22

[5] Meillassoux, Q. (2008) *After Finitude*. Continuum.p. 118

Kant's three critiques make up a complete system that is intended to describe the universal conditions for the possibility of thought. Cognition is separated into active and passive modalities, where the former concerns the synthesis of *representations* and is termed 'intelligibility', and the latter is an empirical diversity 'given' to sensibility as *presentation*. Time and space are the *a priori* forms of intuition in which phenomena appear, since no object, whether sensible or intelligible, may be grasped unless it is distinguished from other objects without presupposing the form of space and time within which it is differentiated.

Kantian metaphysics is unprecedented in effecting this reversal, whereby subjective knowledge has no longer to explain how it conforms to the true nature of space and time, but rather the experience of space and time become transcendental conditions of subjectivity and conform *to* it. Some suggest this is spectacularly confirmed by the success of Einsteinian relativity,[6] and even implicitly conserved in Bohr's philosophy of quantum mechanics.[7] Space is unhooked from its determination by coexistence, and time is decoupled from the notion of succession, since in both cases the determining predicate (coexistence, succession) presupposes the form of intuition it is meant to explain. Space thus becomes the form of exteriority, while time becomes the form of interiority, in which phenomena appear; and without which no appearing could be possible.

Deleuze condenses Kant's philosophy into four poetic formulas that encapsulate for him the importance and novelty of the critical position, the first two of which relate directly to this redefinition of time as the internal condition of subjective experience[8], and the second two of which are concerned with the relationship between order and disorder and between law and

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[6] Ryckman, T. (2005) *The Reign of Relativity: Philosophy in Physics 1915-1925*. Oxford University Press.

[7] Bitbol, M. (2013) *Bohr's Complementarity and Kant's Epistemology,* lecture at Niels Bohr (1913 -2013) - Seminaire Poincaré - 7 Dec. http://bit.ly/1NlIcsO

[8] Deleuze, G. (1995)

freedom. Each of the four formulas correlates with what Deleuze considers to be a reversal of a traditional order of explanation or hierarchically privileged term. The first formula invokes the phrase from Hamlet, 'time out of joint', and refers to the unhinging of time from its measurement by movement. It should be noted that this is a heterodox interpretation of Kant. According to Deleuze, instead of a 'cardinal' notion of time that is eminently metric (measured by movement), Kant reveals its 'ordinal' nature as that 'immutable form of change' which is presupposed by succession.

This is a reversal of the hierarchal privilege given to movement over time. In connection with the concept of noise it should be noted here that, in Deleuze's account, since time has been freed from its regulation by the orderly progression of movement it is no longer a linear notion of time guaranteed by a first cause at its origin, but is the relativistic product of multiple coexistent syntheses. As well as drawing on the resources of contemporary science to argue that there are intrinsically non-linear, unpredictable, path-dependent, and irreversible processes constituting time, Deleuze also makes the metaphysical claim that there must also be a purely static and immobile form of time in which these processes occur.

Above all, for Deleuze time is not an orderly progression of cause and effect (mechanistic time); necessity and chance are no longer opposed in this 'demented time or time outside the curve which gave it a god'.[9] Not only does this Shakespearian formula begin Deleuze's discussion of Kant in 'Kant's Critical Philosophy',[10] it is also a central element of his magnum opus, 'Difference and Repetition',[11] where he develops his own account of the three syntheses of time, as we shall see shortly. Deleuze transforms Kant's pure and empty form of time from a procedure whereby the subject synthesises phenomena as distinct distributions in

[9] Deleuze, G. (1994) p. 88

[10] Deleuze, G. (1995) p. vii

space and time - effectively a model based on discrete computation - to a continuous process of analogue synthesis that precedes the constitution of the subject.[12]

The second formula, Rimbaud's 'I is another', is related to what Deleuze claims is the discovery by Kant of a 'caesura', or 'fracture in the I', between the passive Ego (receptive faculty), and the active syntheses of the imagination in conjunction with the understanding and reason (the active faculties constituting the I). The Cartesian cogito is then split between determination (*I think* of the active syntheses) and determined (the passive *I am*); the I and the Ego are 'separated by the form of time'.[13] While Deleuze disparages Rimbaud's phrase as the romantic expression of hylomorphism – the Aristotelian distinction between matter and form, whose intermediary is the *mould* – he considers Kant to have uncovered the principle of infinite *modulation* (third synthesis) as transcendental condition of subjectivity.

Deleuze relates this 'pure and empty form of time' to many other figures, including the 'straight-line labyrinth' in Borges, Oedipality and the death drive in Freud, as well as the eternal return and its poetic expression in the form of 'Ariadne's thread' in Nietzsche. The second reversal is then the relation between time and the subject. Kant's redefinition of time as the 'form of interiority' means for Deleuze that 'not only is time internal to us, but that our interiority constantly divides us from ourselves, splits us in two: a splitting in two which never runs its course, since time has no end. A giddiness, an oscillation which constitutes time.'[14]

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11 Deleuze, G. (1994) p. 88-9

12 Wolfendale, P. (2011) *Ariadne's Thread: Temporality, Modality, and Individuation in Deleuze's Metaphysics.* Accessible online: http://bit.ly/1SsdrCn

13 Deleuze, G. (1995) p. viii

14 Ibid. p. viii

The third formula reverses the traditional subordination of the Law to the Good, so that rather than laws being imperfect representations that substitute for a forgetting of the Good, as Deleuze remarks of Plato's *Republic*, the acknowledgment of rules is primary and the Good is dependent on and defined only by subjective law. Like Hume's impressions, Kant's rules are endogenously generated or grasped, and refer to nothing outside their own order. According to Deleuze, as the 'pure form of universality',[15] the moral law dictates no specific behaviour but only a generalized self-referential imperative that has 'no content but itself'.[16] The law has no content because this would be to subordinate it to the Good. The form of the law is empty just as the form of time is pure. The Kantian subject sentences and executes the law in the same action; since the law has no content it cannot be known but only enacted. This is why Deleuze condenses what he sees as this inscrutable opacity of the moral law in a phrase taken from Kafka's *The Penal Colony*: 'The Good is what the Law says'.

It is the fourth poetic formula that has the most direct relationship both to the doctrine of the faculties and to the concept of noise, and which Deleuze considers to be 'the great discovery of the *Critique of Judgement,* the final Kantian reversal.'[17] The phrase that Deleuze uses to summarize this comes again from Rimbaud and his attempt to achieve the sacred delirium of the seer, whose prescient capacity to access the unknown required the systematic 'disorder of the senses'. According to Deleuze, the Kantian content of this formula doesn't rest in the mystical affirmation of the synaesthetic unity of the *senses*, but in a genetic account of the accord of the *faculties* whose basis is that of a 'free and unregulated' use in 'an aesthetic of the Beautiful and the Sublime, in which the sensible is valid in itself and unfolds in a *pathos* beyond all logic, which will grasp time in its surging forth, in the very origin of its thread and its giddiness.'[18] That is, as read

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[15] Ibid. p. x

[16] Ibid. p. x

[17] Ibid. p. xii-xiii

[18] Ibid. p. xii

by Deleuze, the Critique of Judgment reveals the free play of the faculties in aesthetic experience as the genetic condition of subjectivity and self-determination according to the moral law. Since the notion of the sublime is one of the key ways in which noise has been theorised, let us see how this is possible.

As mentioned earlier, besides the presentation given to the receptive faculty of intuition, there are a number of active faculties that are defined along two axes, or with two senses: the *forms of representations* are determined by the faculties of knowledge, desire, and feeling (of pleasure and pain), while the *sources of representation* are classified as the faculties of reason, the understanding, and the imagination. Deleuze explains that each critique takes one of these faculties (in the first sense) as its object, determines its legitimate and illegitimate uses with regard to the faculties in the second sense, and asks what the higher use of this faculty consists of. A key claim is that rational cognition is underlain by a 'systematic plurality of interests', only *some* of which are in accord.[19] This registration of discord at the core of reason is a major departure from the ancient philosophical identification of rationality and harmony.[20]

The C*ritique of Pure Reason* argues that the use of reason in the speculative interest leads to illegitimate transcendent claims to suprasensible knowledge (reason claims to know the noumenal), but that the faculty of knowledge finds autonomy, or achieves its higher form, when the faculty of understanding legislates in the speculative interest, yielding *a priori* synthetic knowledge of the phenomenal (logical common sense). Likewise, the *Critique of Practical Reason* shows that in the faculty of desire (first sense of faculty), its higher form is not legislated over by its counterpart in the second sense of faculty (i.e. the understanding), but by reason in accordance with the moral law (moral common sense).

[19] Ibid. p. 7

[20] Deleuze, G. (1994) p.140

The *Critique of Judgement* however, reveals a fundamental difference in the faculty of feeling pain and pleasure. Here neither the practical nor speculative interest of reason dominates, since aesthetic judgement is disinterested, and no faculty legislates; instead there is a free and indeterminate accord in the unregulated use of all the faculties, in particular with the experience of the sublime (aesthetic common sense). Deleuze argues that it is the unlegislated generation of this accord, through a fundamental discord, that is presupposed by the legislated accords and makes possible their higher uses.[21] While the higher forms of knowledge and desire achieve autonomy in the logical and moral common senses, aesthetic common sense has no object to legislate over but itself, and is therefore described as 'heautonomous'.[22] Aesthetic judgement is pure, and beauty is free, as long as it does not fall under the jurisdiction of a determinate concept legislated by the understanding.

Pure aesthetic judgement furnishes an accord with the understanding by relating the free exercise of the imagination to an indeterminate concept only, such that no schema legislates its activity. This properly generative discord, which gives rise to a subjective harmony, is felt as the 'indeterminate suprasensible unity of all the faculties'.[23] The higher use of knowledge has a 'suprasensible destination' in *a priori* synthesis, and the faculty of desire finds the most elevated of suprasensible destinations in the moral law, however neither of these destinations would be remotely accessible without the prior possibility of a free and indeterminate accord of the faculties that enables a suprasensible destination for the imagination, and prepares the soul for the supremacy of the faculty of desire under the moral law. It is this fundamental dissent of the faculties, this friction or noise in the substrate of cognition that Deleuze pronounces as the basis of all moral life and the subjective experience of time.

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[21] Deleuze, G. (1995) p. 55

[22] Ibid. p.48

'A new music as discord, and as a discordant accord, the source of time.'[24]

Though Deleuze is evidently indebted to Kantian anti-metaphysics,[25] he rejects transcendental idealism, referring to his own philosophy, in contrast, as transcendental empiricism. The reasons for this choice are complex, and will hopefully become clear over the following explanations. However, as an initial pointer we should hold in mind that Kantian idealism is characterized by the necessity of unity and identity as transcendental modes of appearance for cognition, while for Deleuze the empirical is immanently given as diversity and change. Kant's system is insufficient for Deleuze because it is an attempt to ground a representational model of thought, and its capacity to access truths as if they existed independently of the construction of concepts.

Deleuze argues that Nietzsche effects a reversal of Kant's synthetic a priori,[26] such that synthesis is no longer the transcendental condition of the subject but rather an infinite process of impersonal actualisation – 'philosophy is no longer synthetic judgement; it is like a thought synthesizer functioning to make thought travel, make it mobile'.[27] This is why; in contrast with the anti-metaphysical climate of 20th century philosophy, Deleuze unabashedly claims to be a 'pure metaphysician'. Deleuze's argument is that the system of representation privileges the concepts of identity, opposition, analogy and resemblance over those of difference and

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23 Ibid. p. 51

24 Ibid. p. xiii

25 Deleuze, G. (1994) p.87

26 'Nietzsche turned synthesis (Kant) into a synthesis of forces'. Deleuze, G. (2006) p.48

27 Deleuze, G. & Guattari, F. (2003) p.343

repetition, the latter of which are presupposed by these four bulwarks of classical reason, and should therefore take precedent both logically and metaphysically.[28]

More generally one can say that if critical philosophy inaugurates a Copernican revolution by reversing the relationship of conformity between thought and thing; by submitting the (phenomenal) object to the transcendental conditions of *possible* experience as posited by the active rational subject; Deleuze, by contrast, demands a truly genetic account of the transcendental conditions of *real* experience. He claims that this can be achieved by understanding the process of individuation as intensive differen*tiation* and extensive differen*ciation*, and through the three syntheses of time understood as constituting three modes of repetition that precede and inform the production of subjectivity, or psychic individuation. As we shall see, this has strong implications for the conceptualization of noise.

According to Deleuze, Kant's attempt to shore up representation entails that the radicality of his reversal of time is defanged, and the three corollaries of such an empty form of time are thereby also tamed (the passive self, the fractured I, and the death of God). In the first case, while the receptivity of the passive Ego that Kant posits entails that it has no synthetic functionality, Deleuze will give an account of the passive *syntheses* of the unconscious as intrinsically multiple. Drawing on the notion of habit developed by Hume and Bergson, and on the Freudian conceptualization of drives, Deleuze describes this primary form of repetition, 'neither representing nor represented', as subrepresentational contractions performed by 'larval subjects'.[29]

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28 Deleuze, G. (1994) p.34

29 Ibid. p.110

In the second case, in Kant's system the fractured I is 'quickly filled by a new form of identity'[30] (the active synthetic unity of apperception),[31] while Deleuze maintains the caesura as the re-doubled affirmation of the eternal return, or disjunctive synthesis. Thirdly, transcendental idealism resurrects God as the necessary postulate of practical reason in its higher form, while Deleuze is resolutely atheist in his very definition of philosophy, which is conceived as the creation of concepts on a plane of immanence in contradistinction with the 'religious' nature of transcendence.[32] Moreover, his maintenance of a hard principle of ontological univocity prohibits the onto-theological notion of a necessary entity.[33]

Deleuze's three syntheses of time relate directly to Bergson's three paradoxes of time: the contemporaneity of the present which passes as it is present, the coexistence of the former present with the present present, and the pre-existence of the pure element of the past in general.[34] The first synthesis is the primordial sub-representational contraction of habit effected by the 'larval subject' of any 'spatio-temporal dynamism' – the repetition of the past in the present (the atomisation of the manifest image we saw in the last chapter). The second synthesis is the contraction of memory, which injects past presents into the passing present. The 'foundation of time' is the passive synthesis of habit (Habitus), its ground, however, is the passive synthesis of memory (Mnemosyne) – time's presentation is thus grounded in its representation (the site of illusion). This is not possible, however, without an unconditioned or ungrounded time in which 'the presents are embedded'; this is Aion the third synthesis 'time out of joint'.[35]

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30 Ibid. p.87

31 Ibid. p.87

32 Deleuze, G. & Guattari, F. (1994) p.43

33 Deleuze, G. (1994) p.36

34 Ibid. p.82

There are two orders of time; Chronos is both bare and clothed repetition, and is 'composed only of interlocking presents,' Aion is pure repetition 'constantly decomposed into elongated pasts and futures.'[36] These correspond to the double structure of the event (its actual and virtual sides), and to the double movement whereby the subject is constituted within and simultaneously transcends the given. Neither order of time is progressive in the sense that it was taken in Enlightenment thought: '[o]ne is cyclical, measures the movement of bodies and depends on the matter which fills it out; the other is a pure line at the surface, incorporeal, unlimited, an empty form of time, independent of all matter.'[37]

When repetition is released from its subordination to identity it is no longer the repetition of a form subject to recognition and prediction, but that which both dissolves form into its infinitesimally small differences and inflates form beyond recognition until it bursts into formless disparity. 'Repetition is the formless being of all differences, the formless power of the ground which carries every object to that extreme "form" in which representation becomes undone.'[38]

The capacity of thought to contract difference, whether extensive or intensive, can only be held by a differentiated system existing in extension; that is, a relatively ordered system with structural components and functional properties. In contracting this difference the system enters into an irreversible order of explication (un-folding) or de-differentiation; i.e. the asymmetric drift to entropy postulated by thermodynamics. Intensive difference, however, is the 'inexplicable', the unequal itself (the disparity leading to a threshold of a transition), that is

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35 Ibid.

36 Deleuze, G. (2004) p.73

37 Ibid. p.73

38 Deleuze, G. (1994) p.57

cancelled by its explication in extensity[39] but kept in that it remains 'implicated in itself', a move that bears an uncanny resemblance to the Hegelian *Aufhebung*. Intensity is thus expressed in extensity as thermodynamic explication whilst remaining in-and-for-itself a purely static repetition of difference, dislocated from the irreversible direction of entropy.

The affirmation of eternal recurrence produces a noematic time that is purely static, or of a different cardinality than the entropic movement of matter - the 'metaphysical surface (transcendental field)'[40] of sense. Firstly this is what enables the noise of existence to be sensible and intelligible, through effecting a 'distinct distribution of language and bodies, or of the corporeal depth and the sonorous continuum'.[41] Secondly this is a paradoxical surface that is both a limitless continuum and ontological rupture; it is 'a cerebral crack at the limits of which the event appears.'[42] This is, of course, not the phenomenological split between subject and object, or the epistemological split between concept and object; it is the 'unlimited limit' generated by the rhythmic or productive Difference *between* actual noise and virtual silence. This is perhaps the clearest example of Deleuze's fetishization of chance, in the vitalist or panpsychic framework of transcendental empiricism, and in the form of noise:

'The real difference is not between the inside and the outside, for the crack is neither internal nor external, but is rather at the frontier. It is imperceptible, incorporeal and ideational. With what happens inside and outside it has complex relations of interference and interfacing of syncopated junctions – a pattern of corresponding beats over two different rhythms. Everything noisy happens at the edge of the crack and would be nothing without it. Conversely, the crack pursues its silent course, changes direction following the lines of least resistance, and extends its

39 Ibid. p.223

40 Deleuze, G. (2004) p.142

41 Ibid. p.142

42 Ibid. p.279

web only under the immediate influence of what happens, until sound and silence wed each other intimately and continuously in the shattering and bursting of the end.'[43]

[43] Ibid. p.177

2.4

Noumenal Time, the Bee Dance, and the Kingdom of Ends

Once again, Sellars reading is very different. In order to give an idea of the divergence and how it relates to the conceptualisation of noise lets now look at how the conceptual framework that Sellars develops might help in understanding Deleuze's four poetic formulas. It should straight away be pointed out that the first formula is a highly Bergsonian interpretation of Kant. Brassier comments that underlying all of Deleuze's work there is a consistent attempt to 'systematize the key insights of Bergson'.[1] Bergson's notion of duration is precisely predicated on the separation of intensive time and extensive space that Deleuze claims to locate in Kant. For Bergson there can be no quantitative measure of time as this would be to illegitimately conceive it in spatial terms. Bergson considers duration to be the 'immediate data of consciousness'; that is, duration is given to experience without any conceptual mediation or 'intellection'.

As Brassier argues however, the distinction between intensive time and extensive space that Bergson claims to be immediately given to experience is in fact mediated by the conceptual framework of the manifest image. From a Sellarsian perspective, 'Bergson mistakes a legitimate account of the logic of sensation from within the manifest image, for a metaphysical account of its absolute nature'.[2] The legitimate account of the logic of sensation that Bergson gives is related to the continuity of perception and duration; that is, the way in which the manifest world appears to resist a discrete analysis.

[1] Brassier, R. (2011)

[2] Ibid.

This is also what Sellars points to with his 'pinkly sensed continuum'. However, as we have seen, for Sellars the capacity to notice this fact is only possible after having acquired a whole set of conceptual linguistic tools and understanding their practical consequences. The lived experience of duration is therefore no more immediate than the ability to use the word red; once we have the concept red we can notice red things non-inferentially, similarly when we have the concept time we can non-inferentially notice the phenomenon of temporal succession. However both non-inferential acts of recognition presuppose, rely on and are mediated by an already existing conceptual framework.

Sellars argues that Kant's stipulation that spatial relations must be metric in the sense of physics means that his attempted distinction between 'outer sense' and the space of mechanics cannot succeed. Similarly, Sellars thinks Kant's chronometric conception of time needs to be supplemented by something like the Bergsonian notion of durée, but clearly it must first be shorn of vitalism, anti-representationalism and any trace of the myth of the given.[3] The fact that Kant demands that physical objects necessarily *appear* to us as spatially extended and as subsisting in time, may lead us to infer that things as they really are have no such characteristics at all. This opinion is bolstered by Kant's definition of space and time as forms of intuition rather than as phenomena themselves; according to Kant there is no noumenal space-in-itself, space is 'Unding', a 'non-thing'.[4]

Moreover, transcendental *idealism* is precisely the rejection of the thesis of the transcendental *realism* of space and time. However, Sellars argues that Kant's definition does not entail that the spatio-temporal extension of phenomena is an illusion bearing no resemblance to the noumenal reality of physical things. Rather, 'it is not only *possible* for the in-itself to be, in an

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[3] Sellars, W. (1968) p.37

[4] Ibid. p.53

interesting sense, *analogous in structure* to the spatio-temporal world but that it is reasonable to think of it as having such a structure.'[5] Nevertheless, Sellars thinks that Kant is right in enforcing the distinction between how things appear to us in space and time, and how they really are 'in-themselves'. The difference for Sellars however, is not the metaphysical distinction between the phenomenal and noumenal, but between the conceptual framework of the manifest image and the theoretical entities postulated by the scientific image.[6]

This means that for Sellars, but not for Kant, there is a 'time-in-itself' (i.e. outside of its correlation with experience), and this is not a noumenal reality that we are metaphysically barred from knowing, but the conception of time realised in the scientific image.[7] Time as it appears in the manifest image, including Bergson's duration and Deleuze's intensive difference, is then in an important sense false in Sellars' account. In keeping with his commitment to a synoptic image however, the manifest experience of duration cannot simply be denounced as false and eliminated. As we have seen, insofar as the Newtonian mechanical conception of time cannot account for the experience of the continuity of perception in lived duration, the scientific image as Sellars characterises it is incapable of giving a full account of the manifest image.

Bergson and Deleuze claim duration and intensive difference as a fundamental limit to the scope of scientific representation. Sellars argues in contrast that the manifest appearance of extension and duration are in some sense justified illusions that can and must be explained by science rather than eliminated, and that the absolute nature of time and space 'in-themselves' will eventually be revealed in the 'ideal long run of science'.[8] This clearly has important consequences for the theorisation of noise, since within the humanities and sound studies literature noise has

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[5] Ibid. p.48

[6] Ibid. p.143

[7] Ibid. p.173

[8] Ibid. p.50

mostly been understood with some kind of more or less implicit Bergsonian or Deleuzian assumptions concerning the non-representational character of lived experience.

In regard to the second poetic formula ('I is another'), we have already dealt with temporality, however there is another aspect here related to the identification of a necessarily durational component (the thread of time) to the internal split in the subject between the passive receptive Ego and the active determinations of the I. We have already seen how Sellars explains the formation of habit firstly in terms of the pattern-governed behaviour of any cognitive system and secondly in extending this capacity for picturing matter-of-fact isomorphisms to rule-obeying behaviour and rational inference. The thread of time that enters between the passive and active function of the subject is first of all explained by the Peircean maxim that 'all thinking is in signs', and therefore thinking takes time; this is true for any information processing system.

For Sellars, the difference between pattern governed and rule obeying behaviour is that the latter is supported by a conceptual framework that allows behaviour to be evaluated and enacted according to reasons. Pattern governed behaviour is a more or less sophisticated or adaptable stimulus-response mechanism. Rule governed behaviour can in some senses be understood simply as an upgraded system, where pattern governed behaviour is coordinated and controlled at a higher level of complexity through language entry-exit transitions. The schism that Deleuze points to between the active act of determination (I think) and the passive receptivity of the determined (I am) is, on Sellars' account, a functional characteristic of the subject-predicate structure of language.

Sellars argues that in the question of physical objects, the manifest world of objects is epistemically primary (in the order of knowing) while the scientific image of microphysical objects is ontologically primary (in the order of being). That is, we first come to formulate the concept of physical objects through the empirical examination of the macroscopic objects of the manifest world (correlational induction), and later are able to develop explanations of what these physical objects 'really are' through the postulation of unobservable atoms (postulational induction). In the case of thinking, Sellars argues that 'thinking aloud' in language is to the order of knowing what 'animal representational systems' are to the order of being.[9] That is, by starting from the manifest experience of linguistic thought, we can move to a more generalised conception of representation that explains how such a capacity has physically come about (in evolutionary terms) and what the differences are between primitive representational systems and our own manifest experience of thinking.

Much has been made of the fact that human language has a subject-predicate form, but Sellars rejects the idea that this is what distinguishes linguistic and pre-linguistic, or propositional and non-propositional representational systems. This discussion is clearly at stake in the example of the cogito that Deleuze gives. For Sellars the subject-predicate form is dispensable, or rather, the predicate is an 'auxiliary symbol'[10] and not a necessary condition of propositional intentionality. That is, we can imagine languages in which there is no separate sign for the predicate and subject,[11] as long as it has '*referential* and *characterizing* functions'.[12] Thus a primitive representational system such as a bee-dance can refer to a source of nectar and characterize it as lying in a certain direction and a certain distance away.

This is already serving the basic requirements of a proposition for Sellars. This is also the case for Peirce, for whom, as we've already seen, the dicisign is prevalent in nature. A primitive

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9 Sellars, W. (2007) p.283

10 Sellars, W. (1969) *The Notre Dame Lectures 1969-1986*. The Bootleg Version. Accessible online: http://bit.ly/21p9yEo p.387

11 In fact, Sellars invents such a language to clarify his point.

12 Sellars, W. (2007) p.295

representational system can be hijacked, exploited, and subject to signal detection problems amongst noise. Stjernfelt gives the example of a predatory firefly that uses the mating signal of a different species of firefly in order to attract males as prey.[13] The important distinction for Sellars is between those representational systems that are logic-using and those that aren't; the bee-dance is a pre-logical representational system. Arguably, any primitive representational system will involve a split between the act of determination (reference function) and a determined it refers to (characterising function); as Sellars argues, this may even be self-reflexive.[14] However, the self-reflexivity of the cogito is at a meta-conceptual level and formulated in an explicitly propositional, syllogistic form. It does not merely refer to the self and characterise it as something, but takes it as an instance of *any* thinking thing.

The important point here with regard to the difference between Sellars and Deleuze is that though they both follow Peirce in considering the referring-characterising function as a pre-linguistic semiotic capacity, for Sellars only logic-using second-order representational systems such as ourselves can be aware of and responsible for the use they make of signs. The fractured I is thus in no way immediately given to experience as Deleuze wants to claim. A primitive representational system may be aware of something *as* noise, by responding to it appropriately, however to have *awareness* of something *as* noise requires the mediation of a concept-laden understanding of the world embedded in a coherent linguistically structured representational system.

The third poetic formula expresses an aspect of Kant that is very important to Sellars, and we can treat it together with the fourth poetic formula because both are concerned with law and order. Firstly it should be noted that Deleuze is highly critical of Kant in general, calling him

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[13] Stjernfelt, F. (2014) p.149

[14] Sellars, W. (2007) p.293

an 'enemy',[15] and in particular castigating the *Critique of Judgment* for establishing 'a fantastic subjective tribunal' and thus failing to critically dismantle the form of judgment itself.[16] Deleuze links the deferral of judgment in the empty form of the law with the assumption of an 'infinite debt'[17] sustained by 'a moral thread' that issues from an unending guilt and joins the 'thread of time' in constituting the merciless Thanatropic structure of the 'straight-line labyrinth'.[18]

The form of judgment is of course the representative function of the proposition with its subject-predicate structure. For Deleuze this is a model based on negativity that represses the positivity of desiring relations and suppresses difference and repetition, both of which precede and exceed the fourfold root of representative reason (identity, analogy, resemblance and opposition).[19] Contrary to Hume, Kant takes the fundamental unit of cognition to be the form of the proposition. Deleuze's whole project is aimed at overcoming this move, and this is why he must return to, and reconceptualise, the pre-critical understanding of universals and particulars. Sellars, in contrast with Hume and Deleuze, follows Kant in arguing that the more or less explicit propositional structure of thinking in humans is the basis of agency, responsibility, and normative freedom.[20]

Brandom explains that before Kant the philosophical 'tradition took it for granted that the proper order of semantic explanation begins with a doctrine of *concepts* or *terms*, divided into singular and general'; Kant overturns this by claiming that the meaningfulness of concepts is dependent or parasitic on the propositional form and the categories of judgment, both of which

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[15] Deleuze, G. (1995b) *Negotiations*. Columbia University Press. p.6

[16] Deleuze, G. (1998) p.126

[17] Ibid. p.33

[18] 'Time empty and out of joint, with its rigorous formal and static order, its crushing unity and its irreversible series, is precisely the death instinct.' Deleuze, G. (1994) p.111

[19] Ibid. p.29

[20] O'Shea, J.R. (2007) p.220

take 'pragmatic priority'.[21] Sellars attack on the myth of the given follows from accepting this move, in the sense that he takes all cognitive awareness, including empirical experience of particulars, to have the implicit referring-characterising structure of the proposition (though not necessarily the subject-predicate form).[22]

Intentions, volitions, and moral attitudes all rely on the propositional form and the semantic and syntactic capacities of language use. For example the intention to open the door, though not explicitly expressed as 'I shall now open the door', requires something like this proposition to have occurred in the brain.[23] The pragmatic priority of the proposition entails that, contra Deleuze, neither meaning, truth, or intentionality can be construed as relations rather than representations. According to Sellars, though they presuppose real relations with the world, truth and intentionality are not themselves relations to the world.[24] This follows Sellars' functional role account of meaning, so that truth is defined in terms of semantic assertability within a language.[25] Words relate to other words and never to the world. The meaning of the concept noise is just understanding the appropriate use of the term and coordinating behaviour accordingly. This doesn't result in social relativism because it is a metalinguistic functional role account.

Meaning, truth and intentionality must be understood as having both a naturalistic and normative dimension. There is a causal-naturalistic correspondence or isomorphism between mental representations and the world (Sellars' interpretation of the Humean impression as naturalistic picturing); and there is a normative-linguistic propositionally structured act of

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21 Brandom, R. (1994) p.79

22 O'Shea, J.R. (2007) p.220

23 This is not necessarily in natural language, and Sellars talks of the analogous propositional language occurring in the brain as *Mentalese*. Sellars, W. (1968) p.35

24 O'Shea, J.R. (2007) p.177

referring and characterising which can be thought in terms of the subject's binding itself to a rule or making a commitment to a truth.[26]

The normative dimension can be explained by beginning with the Kantian notion of hypothetical imperatives as rational self-binding in the form a commitment or obligation (an 'ought'). Beliefs and intentions may have implications, consequences or entailments. For example if I intend to keep the house tidy and this implies doing some housework, I cannot be said to have reasonably committed to the former without having also committed to the latter. This can then be formulated into the general hypothetical imperative - one should do housework if one intends to have a tidy house. In logical form this can be written: If *p* implies *q*, then Shall(p) implies Shall(q).[27]

Similarly, holding a belief means having formulated (not necessarily consciously) something with the functional characteristics of a proposition of the form 'x is φ', and this will imply other beliefs; for example, if I believe that 'John Cage's 4'33" is a piece of music', then this implies I also believe that 'music need not necessarily involve the intentional production of sound on an instrument'. If I do not believe the latter I cannot reasonably believe the former. Therefore, making a *rational* commitment to an intention or belief ought to be understood in terms of the corollary implications and consequences entailed by this: 'An ideally rational being would intend the implications of his intentions, just as he would believe the implications of his beliefs'.[28] Thinking through these implications may often alter one's initial commitment. This is

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25 Sellars, W. (1968) p.101

26 This is further developed by Brandom in terms of 'deontic scorekeeping' and the dialectic between saying and doing, or between taking as true and making true. Brandom, R. (1994)

27 O'Shea, J.R. (2007) p.179

28 Sellars, W. (1968) p.183

what Negarestani means by arguing that the labour of the inhuman involves the ramification of entailments and commitments.[29]

Sellars understands the distinction between hypothetical imperative and categorial imperative to be analogous to that between a valid and a good argument. The validity of an argument is judged according to whether it follows logically from its premise. Sellars argues that a good argument not only follows from its premise, but its premise can be considered reasonable or true in itself. Hypothetical imperatives are relative to a certain end (e.g. if I want to rule the world I ought to invest in nuclear weapons). A categorial imperative is universal, however it can still be relative to appropriate circumstances, and derivative to a more basic imperative, which Sellars calls the categorically reasonable premise.[30]

Having shown this, Sellars then asks if there are any non-derivative or intrinsically reasonable categorial imperatives. He finds just such an intrinsically reasonable intention, expressed in ideal form, in Kant's notion of the 'moral polity' or 'kingdom of ends'.[31] Sellars uses a notation where the subject is written in subscript after the verb, so that 'It shall_{we} be the case that' means 'we commit to the intention that such and such be the case'. He thus formulates a proposition in which the subject of the intention is 'the community of rational beings' and the categorial imperative is:

It shall_{we} be the case that our welfare is maximized

Deleuze understands morality as the organisation and control of desire according to a transcendent code. Drawing on Spinoza and Nietzsche, he replaces it with an immanent theory

29 Negarestani, R. (2014)

30 Sellars, W. (1968) p.213

of ethics operating within and through desire. He substitutes the facilitative *can* of ethics for the constraining *must* of morality. For Spinoza, ethics are defined in terms of affective encounters: a joyful encounter is one in which both parties of the encounter increase their power to affect and be affected, a sad encounter is where this capacity is diminished for one or both parties. For Nietzsche actions are either passive, reactive and bound to slave morality, or they are active, strong, and affirm life. For Deleuze there is no external perspective on desire. Beneath every perception, conception or action there is a teeming multiplicity of competing desires or drives.

On Deleuze's account freedom is kindling a passion or following a tendency, the affirmation of life, thought and sensation against all causal or logical necessity. Acting in accordance with the law, or submission to moral norms, is not noble abstention but merely a slavish desire. It is quite the opposite for Sellars; he considers life, thought and sensation to be completely explainable in causal-naturalistic terms, but that normative-linguistic self-binding according to rules should be understood to a certain extent as free acts of self-determination in the sense that Kant argued. Of course, Sellars is not denying that one can follow rules in a way that is determined by social-economic forms for instance (i.e. the Marxist thesis), but he argues that the only way to avoid such slavish conformity is to critically interrogate and transform the normative rules one is bound by.

[31] Ibid. p.122

2.5

The Coronation of Chaos

Whilst Kantian critique may be understood as the logical suspension of metaphysics according to a transcendental framework of epistemic finitude, it is the Heideggerian 'overcoming' of metaphysics that has dominated later modern thought, and has prevailed over its replacement with a narrower focus on purely ontological questions. Heidegger achieves this by characterizing the history of philosophy as the forgetting of the question of Being, such that it is misunderstood as referring to the 'physics' of 'beings as such'.[1]

The existential analytic asserts three basic propensities leading to the obfuscation of Being as such, all of which must be overthrown. These are, *presentism* (the prioritization of the present over past and future modalities, and the corresponding substantialist conception of Being), *onto-theology* (the tendency to think Being in terms of an absolute entity, which attests to a human desire to ground knowledge and mastery of nature in the positing of a 'first cause'), and *abstraction* (understanding the essence of Being through the elimination of the variable, and thus inessential, aspects of beings).[2]

Each of the three tendencies may be related to the concept of noise; presentism derives from the uncertainty of the past and future due to the instability of memory, cognitive finitude, and the unpredictable trajectories of systems in the environment; onto-theology is concerned with the grounding of causal necessity, and is thus bound up with the discussion of contingency and purpose that is also key to the conception of randomness; and abstraction is a process that

[1] Heidegger, M. (2000) *Introduction to Metaphysics*. Yale University Press. p.20

separates the salient from the redundant, which is therefore related to the distinction between signal and noise. Deleuze is able to address and reformulate these three tendencies in an entirely different manner, through a revival of metaphysics that is due in no small part to his anti-Hegelian reclamation of dialectics.

If the Kantian system is an exemplary instance of '*finite* representation';[3] which departs from the presupposition of a fundamental separation of being and thought and grounds the legitimacy of their correspondence in the active synthesis of the self-sufficient subject and the transcendental unity of apperception; Deleuze's affirmation of the Parmenidean axiom (i.e. the identity of being and thought) means that he is both closer to and further away from the two systems of '*infinite* representation' that sit either side of Kantian critique historically speaking. These are: Leibniz's 'monadology' and Hegel's 'science of logic'. We will explore the former's relation to the concept of noise shortly; let us now examine Deleuze's reformulation of the Platonic dialectics of the Idea against Hegel's logic of negation, followed by an account of his resuscitation of the metaphysical principle of sufficient reason after its destruktion by Heidegger.

The problem of defining both Deleuze's anti-Hegelian dialectics and his post-Heideggerian metaphysics is not without difficulty, however the resurgence of metaphysical questions in contemporary debate renders this task imperative with regard to the conceptualisation of noise. This is not least because of the intricate and multiple relationships that philosophy has with the arts and sciences, and the extraordinary transformations that these have gone through in the last century, but is also the result of this complex reformulation of metaphysics after its multiple negations. The question traditionally considered central to metaphysics ('what is x?') is revoked at the outset in its contemporary reformulation in

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[2] The articulation of these three tendencies is based on the indispensable clarity of Peter Wolfendale's analysis. Wolfendale, P. (2009) *Metaphysics after Heidegger*. Accessible online: http://bit.ly/1HAHF5Z

Continental thought, and this has impacted on many other domains such as ontology, epistemology and aesthetics.

Deleuze follows Nietzsche, for example, in rejecting the question, 'what is beauty?' as presupposing a disjunction between the accidental appearance of specific or concrete objects and the necessary essence of the general or abstract Idea. That is, since the inception of philosophy in ancient Greece, the formulation of the metaphysical question 'what is x?' is understood as a trap designed for the express purpose of leading the questioned to offer a particular example as a reply, whereupon Socrates may show how this object is only *contingently* beautiful and must be seen as derivatively taking part in what is *necessarily* beautiful, which can only be the Idea of Beauty in its essence.[4] Deleuze repeatedly states that Hegel represents the apogee of a long history of distortion of the dialectic that follows from missing the Socratic irony of this question.[5]

The dichotomy between contingency and necessity, or rather the status of their dialectical interpenetration and the rational capacity to distinguish them, is of vital importance to an understanding of the concept of noise. It is precisely because Deleuze confronts these questions with the aid of terms from modern science and mathematics, and sets the agenda for their subsequent cultural reception, that we must understand how he is able to move beyond the classical dialectical oppositions between essence and accident, or necessity and chance. However, in contrast to what we might call the archi-metaphysical anti-essentialism of sound studies, which dismisses metaphysics in favour of a 'relational ontology', Deleuze rearticulates the concept of essence through appropriating and transforming the Platonic notion of the Idea, whilst submitting the Platonic system to a radical and thoroughgoing reversal.

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[3] Deleuze, G. (1994) p.48

[4] Deleuze, G. (2006) p.71

For Deleuze, the real content of the question is understood as asking not *what* the object 'beauty' (or 'noise') is, which would imply some underlying substantial truth to the object in-itself that transcends its appearances, but *which force* has taken hold of it. This is rendered as 'qui', referring both to the impersonal meaning of 'which one?' and to the capacity of thinking, that is the question of *who* is capable of thinking such an object. While Hegelian dialectics overcomes subjective finitude, or the critical gap between being and thought, through proclaiming the *identity* of subject and object categories in the absoluteness of the concept; Deleuze replaces the infinite synthetic process of identification with an infinite synthetic process of *difference*.

In particular, the representative relation between concept and object and the hierarchal privilege this implies is flattened, so that thought no longer represents an object but *is* the object. Both subject and object are thus described by dynamic processes of ontogenesis or individuation through the reciprocal determinations unleashed by the 'free form of difference'.[6] In contrast with the 'major' question ('what is x?'), which is based on the four pillars of representation; identity, analogy, opposition, negation; these 'minor' questions presuppose instead a genetic principle of infinite synthesis based on the primacy of difference and repetition. 'And so the question "which one?" reverberates in and for all things: which forces, which will? This is the *tragic* question.'[7]

We cannot understand this infinite differential synthesis without reference to the Hegelian model of thought that Deleuze argues it is formulated explicitly against. Hegel transforms dialectics into a thoroughgoing natural order (speculative idealism), using the terms abstract-negative-concrete. For Hegel synthesis can only be achieved through overcoming the

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[5] Deleuze, G. (1994) p.188

[6] Ibid. p.145

mediation of the negative in a circular process of sublation, the negation of negation. This vacillation between presence and absence is termed the ontological reversal: the abstract thesis is indeterminate Being, the negation or antithesis is the identification of Being with Nothingness, and the concrete synthesis is Becoming, or *Dasein* (determinate Being).

Deleuze follows Nietzsche in excoriating the teleological assumption of natural progression in Hegelian history, the sovereignty of thought abstracted from its bodily constitution, and most emphatically, the negativity of Hegel's dialectics.[8] According to Deleuze, this is because it is based on the product of already given oppositions, rather than the affirmative genetic principle of Difference, which 'produces opposition as mere appearance'.[9] He rejects the Hegelian opposition of Being to Non-Being, postulating instead a generative becoming that precedes identity and its opposition, whose actualization is engaged in a process of mutual elaboration within a virtual field of differential relations described as '?-being'.

'[B]eing is difference itself. Being is also non-being, but non-being is not the being of the negative; rather it is the being of the problematic . . . Difference is not the negative; on the contrary, non-being is Difference: heteron, not enantion. For this reason non-being should rather be written (non-)being or, better still, ?-being.'[10]

Unlike finite representation; which as we saw represents difference through epistemic *mediation* between matter and form, and the Aristotelian division into species and genera (which cannot thus represent the individual with a singular concept); infinite representation includes

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7 Deleuze, G. (2006) p.72

8 This opposition to opposition is redoubled in Serres, M. 'The Five Senses – A Philosophy of Mingled Bodies'. Continuum, 2008. p.73

9 Deleuze, G. (2006) p.149

10 Deleuze, G. (1994) p.64

difference *immediately* through the extraction of a principle of sufficient reason that guarantees the rational, or well-ordered, distribution of essences and properties or universals and particulars. Instead of beginning from the need for articulating a rational foundation that would secure the passage across the hiatus between being and thought, the passage *itself* operates as foundation for an immediate mediation. However, according to Deleuze, this immediate inclusion of difference, as much as it pushes the representation of difference and the difference of representation to their conjoint limit (at the scale of the infinitely Large for Hegel and the infinitesimally Small for Leibniz), still maintains the subordination of difference to identity as the condition of intelligibility as such.[11]

Here we must stress again how this impacts on the concept of noise. In Kant's system of finite representation the indeterminate is what lies beyond epistemic or cognitive finitude, however, once this transcendental limit is accepted this indetermination does not threaten to collapse conceptual efficacy since the adequation of thought to its object (i.e. the realm of phenomena) is grounded in the synthetic activity of relating representations to representations through the rule-based deployment of the concept – this is the Kantian definition of knowledge.

This activity necessarily operates through abstraction – in order to relate two representations and discover their underlying connection in the universality of the concept, the particularities must be culled like so much noise. We cannot grasp the absolute nature of the particular thing-in-itself, but the abstract rule that governs the cognitive capacity to relate representations can be known with certainty. While space and time are the *a priori* forms of intuition *necessary* for the individuation of any object, the existence of quantitatively determinate

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[11] Ibid. p.49

abstract universals (sortals rather than qualities according to the Aristotelian distinction)[12] are the forms of understanding *sufficient* for individuation.

In the Hegelian account, thought is able to grasp the absolute precisely through the inclusion of itself, as form of determinability, within the *concrete* universality of the concept. Hegel posits the existence of concrete universals in explicit antagonism to the Kantian system of finite representation, where the universal is given to the understanding through a synthetic process of abstraction. That is, for Hegel the 'notion' is most often misunderstood as abstract generality – i.e. he rejects the assumption that we arrive at the notion through a process of subtraction and addition of particular or contingent details to arrive at the necessary common features of a class – for Hegel, the universality of the Idea is irreducible to abstract determinations such as class or type, and its necessity is that of a 'self-specifying' individual (the classic definition of Substance).[13]

Deleuze condemns Hegelian dialectics; above all its grounding of representation in the circular principle of identity. However, since he does not want to replace infinite representation with finite representation and the mediation of the understanding, reverting to the opposition between abstract universals and concrete particulars is clearly precluded. Deleuze therefore needs a differential account of the concrete individuation of universals. It is Bergson's vitalist critique of the negative that is the crucial facilitator allowing Deleuze to posit such a conception, since it replaces opposition and negation with the pure positivity of the virtual as immediate auto-differentiality.[14] Deleuze recounts Bergson's example of the two ways of determining the commonality of colour; firstly, one can abstract particular colours in order to form a generalized

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[12] Wolfendale, P. (2011)

[13] Hegel, G.W.F. (1975) *Hegel's Logic: Being Part One of the Encyclopaedia of the Philosophical Sciences*. Clarendon Press. § 163, p.123

[14] Deleuze, G. (2003) *Desert Islands and Other Texts (1953-1974)*. Semiotext(e). p.42

concept that differs from but subsumes the objects that fall under it; secondly, one can converge all frequencies of the light spectrum into a single point, resulting in a 'pure white light' where concept and object participate in a concrete universal, or Idea (recall Deleuze's fascination with Hume's sensible atom).

Object and concept are thus identified, but without the subsumption of the former by the latter, and without the subordination of the four yokes of representation.[15] Similarly, white noise, in *perplicating* all sonic vibration, is held to be the 'Idea of sound'.[16] On the Platonist account, universals such as beauty or noise have an ideal existence and particular things partake of this to some relative extent; this is a transcendent conception of universals. Aristotle reverses this so that beautiful or noisy particulars are the condition for the existence of the universals beauty and noise; this is an immanent account of universals. However, for Deleuze, following Bergson and Simondon, the Aristotelian account of universals is far from constituting a successful reversal of Platonism. This is largely due to Aristotle's hylomorphic separation of matter and form, and is best explained with reference to Simondon.

Simondon's central insight is that philosophy has always taken the already constituted individual (subject and object) as its target for analysis, and has attempted to explain the problem of the transformations that these individuals undergo only after positing the givenness of their being.[17] Starting thus with ontological stasis, it is forced into making convoluted explanations to account for the dynamics of becoming. Instead, he reverses this procedure by taking becoming as the given framework for understanding the exceptional status of being, and formulates a methodology for explaining the constitution of the individual on the basis of a *process* of individuation. Individuals are always the problematic result of processes occurring within a

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15 'the concept is identical to the thing itself.' Ibid. p.43

16 Deleuze, G. (1994) p.206

milieu of preindividual potential that precedes and exceeds the individual. There is always a preindividual residue left over in any process of individuation, an unactualized potential that could lead to further becoming.

The concept of individuation is posited in explicit rejection of hylomorphic and atomistic ontologies, where the former is considered deficient due to its presupposition of an inert matter whose dynamic form must then be added, and the latter due to the reduction of becoming to the movement of minimal units of pre-constituted being (atoms). The theory of individuation that Simondon elaborates is the result of an application of the contemporary physics of dynamic systems to ontology, resulting in an ontogenetic theory explained according to the phase transformations that underlie the different states of matter-energy compositions. A particular becoming is understood as a process of dephasing, where becoming in general is conceived as polyphased, and being is defined as without phase.[18]

Being is thus no longer conceptualised according to the presupposition of a stable state or equilibrium whose unity of identity is given prior to any exterior action of perturbation, but instead is explained as the transitory effect of far-from-equilibrium dynamics that inform the metastability of individuated objects, and the transductive unity of their diverse phases. Philosophical notions of substance as the unchanging base for physical transformations, such as found in atomist accounts, are rejected along with the hylomorphic distinction between matter and form, and replaced with transductive processes of matter-information. Information, as Simondon theorizes it, is not the result of the communication of knowledge, but the distribution

[17] Simondon, G. (1992) The Genesis of the Individual, in eds. Crary, J. & Kwinter, S. *Incorporations*, pp.296-319.

[18] Combes, M. (2013) *Gilbert Simondon and the Philosophy of the Transindividual.* MIT Press.

of energy transformations across a pre-individual field that precedes the possibility of any knowledge or its transmission.[19]

Ontogenesis is thus first philosophy, and precedes any attempt at the postulation of epistemological foundations according to Simondon. The Simondonian theory of the ontogenetic process of information production flattens being and thought into a transductive unity, since both physical and psychic domains may be understood according to the excess of the pre-individual milieu in its constitutive reciprocity with a particular instance of individuation. For Simondon the question as to whether or not a universal such as beauty or noise exist is thus wrongly posed, and Deleuze argues that it is rather the concrete universal Idea of beauty or noise that is the condition for its individuation.

In order to understand Deleuze's anti-representationalist affirmation of the identity of concept and object in the concrete universal, we should first examine the role of the ground. Infinite representation relates an essence and a ground immediately through a principle of sufficient reason. Deleuze claims that 'to ground is to determine the indeterminate',[20] he also states that 'to ground is always to ground representation'[21] and further that it is 'the operation of the logos, or of sufficient reason'.[22] Grounding is the action of securing a foundation for the adequation of representation, as such it functions to legitimize the cancellation or equalization of difference that is wrought through common sense and good sense, where the former is related to recognition and the latter to prediction.[23]

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[19] Simondon, G. (2005) *L'individuation à la lumière des notions de forme et d'information*. Editions Jérôme Millon.

[20] Deleuze, G. (1994) p.275

[21] Ibid. p.274

[22] Ibid. p.272

[23] Ibid. p.226

Clearly, recognition and prediction are key to the conceptualisation of noise. As we have seen, for Deleuze the self-sufficiency of the active synthetic subject is *un*grounded by the habitual contractions of the unconscious, the demented form of time, and the 'impersonal individualities and pre-individual singularities' that individuated experience presupposes.[24] To explain Deleuze's metaphysics requires showing how this ungrounding yields a differential conception of the Idea and an atheistic principle of sufficient reason.[25] In this regard, Deleuze comments that Hegel's famous criticism of Schelling (as having produced a philosophy that Hegel likens to an 'indifferent night in which all cows are black') is unwarranted, since it is only from the position where the illusion of good sense and common sense are legitimated in the grounding of representation that 'groundlessness should lack differences, when in fact it swarms with them'.[26]

In order to understand this groundless thronging of difference, we should keep in mind the connection between grounding and the approbation of common and good sense. Deleuze considers the latter to be 'the ideology of the middle classes'[27] and argues that the representative model of recognition and prediction presupposes 'crowned anarchy or difference'.[28] The pre-individual syntheses of habit and anticipation thus *unground* representative reason, but only when they are understood as differential and intensive; i.e. only when the model of prediction and recognition are revealed as illusory in the affirmation of the eternal return (third synthesis). He associates good sense with the first synthesis, and with the representation of time as moving from general to particular, from the unequal to the equal, and from the unpredictable to the predictable.

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[24] Ibid. p.299

[25] Ibid. p.194

[26] Ibid. p.277

[27] Ibid. p.225

[28] Ibid. p.224

Deleuze identifies this cancellation of difference with the thermodynamic concept of entropy, where every differentiated structure moves predictably towards homogenous disorder. He is right to castigate the dogma of bourgeois political economy, which rests on the assumption that price divergences will be cancelled by market forces in a manner analogous to the formation of stable equilibria in physics. However, his affirmation of lived time and differential intensity as irreducible to this scientific image is highly problematic and cannot be reconciled with a realist approach. To grasp what Deleuze means by this ungrounding of representative identity in difference and repetition we must now turn to Leibniz, and examine the ways in which his monadological model of infinite representation differs from Hegelian synthesis.

Hegel can be understood, along with Fichte and Schelling, to attempt a reformulation of philosophy after Maimon's critique of Kant's transcendental idealism. According to Deleuze, Maimon's critique demanded the substitution of external conditions of *possible* thought or experience (Kant's account) with the internal conditions that are genetic of *real* experience. The real includes the actual and the virtual for Deleuze, where the virtual is understood as potential and distinguished from the merely possible. Deleuze argues that the Hegelian 'solution' cannot account for *genetic* difference, and that it is paradoxically a return to the pre-critical philosophy of Leibniz that will allow for the 'deduction' of the primacy of difference over identity.[29] If Hegel's strategy for overcoming finitude was to include infinite synthetic difference in the movement of the finite Self, Leibniz had presented the inverse operation whereby the finite Self, or monad, is included in infinite analytic Substance.[30]

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[29] Smith, D.W. (2012) *Essays on Deleuze*. Edinburgh University Press. p.43

[30] Deleuze, G. (1994) p.58

Threatened by the collapse of ancient philosophical principles with the onset of modern science, the Leibnizian tactic is not to reduce principles to a bare minimum, as Descartes had, but to multiply them. The principles that form the core of Leibniz's project are: the principle of identity (PI), the principle of sufficient reason (PSR), the principle of continuity (PCO), the principle of causality (PCA), and the principle of identity of indiscernibles (PII). Leibniz grounds his system of principles with the PI. A staple of logic since ancient Greece, it may be reduced to the both indubitable and banal or empty statement A = A. This principle of identity describes any proposition whose predicate reciprocates with, or is included in its subject (e.g. a bachelor is an unmarried man). A reciprocating analytic proposition refers to the domain of essences (ratio essendi) and is therefore indifferent to the existence of the subject or predicate (i.e. the proposition 'a bachelor is an unmarried man' is true whether or not any unmarried men exist).

Leibniz is able to rephrase the logic of the PI as the axiom 'all analytic propositions are true'. Since he takes this itself to be an analytic proposition he is able to reciprocate the terms such that 'all true propositions are analytic'. Thus any existing state of affairs (which may be individuated by its difference from all other states of affairs, and which, since it exists, must be true) must yield a propositional formulation in which there is a predicate that is included in the subject. So the reciprocal inversion of the PI leads to the invention of the PSR, which states that for any difference (down to the infinitesimal) there is a sufficient reason for its occurrence that uniquely describes it. Again, this is a deceptively innocuous formula from which Leibniz is able to draw wide-reaching repercussions. To understand the originality of the PSR we must first distinguish it from the principle of causality (PCa), which states that any effect must have a necessary cause.

The cause of an effect is determined by an infinite series of encounters with other bodies; a chain of causes and effects that is entirely mechanistic (necessary) while also being contingent due to the compossibility of worlds (in contrast with Spinozan necessitarianism). The sufficient *reason* for an event is determined by the infinite series of predicates that inhere in the completely individuating concept that logically describes it. Note that while ratio essendi and the PI constitutes a domain of finite analysis, the PSR that determines ratio existendi are necessarily infinite analyses. This is because sufficient reason must include all the predicates contained in the concept of the thing – this means not just its essence (whose predication is determinable by a finite series of operations according to logical necessity) but also its 'accidents', or the contingent series of events that befall it: 'sufficient reason is what comprehends the event as one of its predicates'.[31]

The PSR thus leads directly to, or reciprocates with, the PII, which states that any two things that are not conceptually discernible are identical. For Leibniz the plurality of differential points of view are both physically real and conceptually identifiable – every difference has its own concept, and this is its sufficient reason. Leibniz thus overcomes the limitation or finitude of the particular with regard to the universal, or the inessential with regard to essence, by 'constructing essence from the inessential'; i.e. by including the event in the completely individual concept. While Deleuze castigates the sham vertigo of the movement of contradiction, and the 'insipid monocentricity of the circles in the Hegelian dialectic', he finds the 'intoxification less feigned' in Leibniz, even if the giddiness of this infinitesimal difference is ultimately subordinated to representation.[32]

This is because Leibniz presents a micro-scale metaphysics of perspective that is equally present in all of Nature. Each real distinction presupposes an extended material body and an immaterial monad that occupies a point of view. In contrast with Kant, for whom the principle

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[31] Ibid. p.45

[32] Ibid. p.263

of continuity and the PII are incompatible, for Leibniz there is a fundamental continuity between the intelligible and sensible, or real and ideal, such that they cannot be understood as two worlds.[33] Also unlike in Kant, spatio-temporal location is not necessary for the total conceptual individuation of a perspective since it is defined by its topological position in the monadological hierarchy. There is a fundamental or dominant monad for each body as well as an infinity of 'sub-harmonic' monads corresponding to the real distinctions in the composite body. Each monad, however infinitesimally small the body is that it relates to, is endowed with perception and appetition.

Leibniz refers to the roaring of the sea as an example of his famous thesis of '*petite perceptions*'; he argues that the noise is composed of the sound of thousands of small wavelets, none of which we can hear individually in apperception, but that however small the noises are, they must be perceived in *some* way unless we are to suppose a perception composed of imperceptible parts.[34] This argument both expresses and rests on the PCO, which is fundamental to Leibniz's whole edifice, forming a major premise of his '*analysis situ*', which presents a remarkable early attempt at formulating a geometric account of modern physics that contains the seeds of algebraic topology.[35]

Daniel Smith makes the connection between the continuity of perception and the information theoretic conception of noise clear: 'Every conscious perception constitutes a threshold, and the minute or virtual perceptions (infinitely small perceptions) constitute the obscure dust of the world, its background noise.'[36] The manifest continuity of perception is thus

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[33] Deleuze, G. (2006b) p.75

[34] Leibniz, G.W. (1996) *New Essays on Human Understanding Preface and Book I: Innate Notions*. Cambridge University Press. p.55

[35] Risi, V. De (2007)

[36] Smith, D.W. (2012) p.54

identified absolutely with the continuity of the physical world revealed by the scientific image (i.e. the mathematics of differential calculus). In Sellarsian terms we might say that Leibniz, like Spinoza, denounces the manifest image as false in the sense that the manifest objects of apperception are composed of imperceptible monads, however he also attempts to reconcile the clash of the manifest and scientific images by making the infinitesimal descriptions of the latter pertain to ideal perspectives of the former.

Contained within the argument for minute perceptions are three different aspects of Leibnizian infinite representation that are important to an understanding of Deleuze's rearticulation of the Baroque according to the notion of the fold.[37] Firstly, it follows from the presupposition of the truth of perspective not as subjective limitation but as differential unfolding (explication) of the integrally folded (implication). This is illustrated with the famous example of conic sections: the base of the cone is a circle, and the top a point, sections of the cone will not only reveal different sizes of circle (whose 'eccentricity' is zero), but when intersected with a plane at oblique angles will reveal all the eccentricities greater than zero – i.e. the ellipse, the parabola and the hyperbola are all implicated or folded into the cone. These disparate geometric figures may be understood as true perspectives of the same object that require different positions for the *subject*.

Perspectivalism is thus 'not a variation of truth according to the subject, but the condition in which the truth of variation appears to the subject'.[38] Deleuze's metaphysics is pared down in comparison with Leibniz; his three key principles are closer to Spinoza; the principle of sufficient reason (PSR), the principle of the univocity of being (PUB), and the principle of

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[37] Deleuze compounds this logic of the fold through his choice of diction, employing a whole series of terms that include the Latin core 'plicare', meaning to bend, fold or twist: ex*pli*cation, im*pli*cation, re*pli*cation, per*pli*cation, com*pli*cation, multi*pli*city.

[38] Deleuze, G. (2006b) p.21

immanence (PIM). However, all three principles may be understood according to the distinctly Leibnizian conception of this infinitely folded continuum of micro-differential perspectives. The sufficient reason of the parabola is just the intensive difference constituting the point of view that actualizes it. This is crucial to Deleuze's affirmation of ontological univocity, where the interiority of the subject is the result of a folding in of the outside (as Foucault had shown), and Being is understood as an infinitely self-differentiating continuum or endless process of folding and unfolding on a plane of immanence.[39]

Secondly, it resonates with the Deleuzian conviction that the source of 'Problems-Ideas' are differential and unconscious, subrepresentative and extra-propositional[40] – that they must be considered at their limit as ideal and intensive since they are irreducible to any conscious measurement, identification or opposition.[41] Leibniz thereby points to the plurality of unconscious imperceptible micro-differences that give rise to the awareness of unified perceptions at the macro-scale. Furthermore, in contrast with the Cartesian notion of clear and distinct ideas dear to common sense and the logic of recognition, these imperceptibles are described as distinct and *obscure,* while conscious perceptions are clear and *confused.* This is the sense in which the manifest image is revealed to be illusory for Leibniz, and Deleuze's metaphysics pushes this point to its limit: 'Distinction-obscurity becomes here the true tone of philosophy, the symphony of the discordant Idea.'[42]

Thirdly, this passage fosters within it an overcoming of the opposition between the many and the one, and also of the general and the particular, in a problematic or dialectical conception of the positive multiplicity. The Leibnizian theory of the fold shows 'how the multiple belongs to

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[39] Ibid. p.66

[40] Deleuze, G. (1994) p.267

[41] Ibid. p.108

[42] Ibid. p.146

a distributive unity, but also how a collective unity pertains to the multiple'.[43] Besides the cosmological and theological tenor to this chiastic reflection of the One in All and the All in One, this dialectical interpenetration of the many and the one is bolstered by two more terrestrial or natural scientific reciprocities – that between music and mathematics, and that between sensibility and intelligibility – as well as being directly related to what we would now call the psychoacoustics of sound perception. In the next section we shall see how.

[43] Deleuze, G. (2006b) p.145

2.6

The Subrepresentative Curvature of the Absolute

Leibniz famously understands music as deriving from the pleasure of counting without the effort of conscious arithmetical operations: 'a secret and unconscious mathematical problem of the soul'. Music is thus on the one hand an abstract mental procedure, and on the other a concrete physical compulsion for the registration of mechanical pressure waves, 'an intellectual love of order and a measure beyond the senses, and an affective pleasure that derives from bodily vibrations'.[1] Of course, Leibniz is famed for his 'universal genius', but we must mention at this point another polymath with whom Leibniz was well acquainted, and undoubtedly strongly influenced by: Claude Perrault. Erlmann argues that Perrault's 1680 'Du Bruit' expresses the seventeenth century construction of modern liberty through the naturalization of reason according to a vibrational or resonant conception of the world that is equally material and immaterial, sensible and intelligible, thought and thing.[2]

Perrault rejects the Cartesian wax-seal model of perceptual retention, since it rests on a dichotomous opposition between the 'fundamentum inconcossum' of the actively thinking mind and the passive mechanical registration of the body. Descartes had restricted reasoning to the soul and considered the sensory organs and nervous system of the body to be a complex mechanical device for the *relaying* of percussive resonances. This is related to the psychoacoustics of the time, since it is on the basis of then existing empirical evidence that Descartes asserts that there is only a passive reception and transmission by the material body and it is the rational subjectivity of the immaterial mind that finds harmony agreeable.

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[1] Deleuze, G. (2006b) p.146

[2] Erlmann, V. (2010) *Reason and Resonance: A History of Modern Aurality*. Zone Books. pp.72-109

The revelation of new physiological knowledge (the discovery of the cochlear and its active role in the analysis of soundwaves) allows Perrault on the contrary to argue that every part of the body is engaged in reasoning, and to describe this in terms of a distinction between two types of 'thinking'; one that is 'distinct' since it is related to intentions, and another that is 'confused', meant here not pejoratively but to indicate the habitual and inexact nature of its operation. The former is explicit reasoning and exclusively found in humans, the latter is implicit reasoning, and according to Perrault, is common to animals and to biological functions such as the ear.

Perrault's argument is that what we would now call the robustness of the auditory system - its non-linear capacity for distinguishing signal from noise - cannot be reduced to a mechanistic description given the infinitesimal nature of acoustic differentials. Clearly, Leibniz's theory of *petite perceptions* owes much to Perrault. This is a rationalist vitalism of sorts then, based on the extension of elementary types of thinking to vital functions – thought and thing are thus underlain by the sufficient *reason* that is immanent to their differential articulation. There is thus a complex reciprocity between subject and object as well as a subjectless and objectless delirium to the continuous variation of Baroque aesthetics.[3]

The monadology combines rationality, theology and vitalism in an intricate system of infinite representation that guarantees the absolute reciprocity between thought and thing. The religious accord with the pre-philosophical image of common and good sense that this presupposes is nowhere more evident than in Leibniz's universalisation of 'Emanative Harmony'

[3] According to Erlmann, Perrault suggests that 'modern harmony differs from the simple cause-effect relationship underpinning ancient music…because it is predicated on a richer sense of multiply crisscrossing correlations between subject and object.' Ibid. p.92

between God and creation, 'Reflective Harmony' between compossibles, and 'Pre-established Harmony' between material bodies and immaterial monads.[4]

Despite the power of Leibniz's mathematization of infinitesimal differentials, according to Deleuze the cosmological or metaphysical principle of the differential calculus is irreducible to its mathematical formulation.[5] For Deleuze, the supra-mathematical element is intensive difference: 'Disparity – in other words, difference or intensity (difference of intensity) – is the sufficient reason of all phenomena, the condition of that which appears.'[6] To understand Deleuze's claim, and its relation to noise both in the information theoretic sense and in the sense of physical sound waves, we must briefly examine how he draws on Whitehead, whom he considers to be a natural successor to Leibniz.

Deleuze distinguishes three components of the event. Firstly, it is composed of extensions, an infinite divergent series of 'whole-part relations with no limit'.[7] The extensive composition of the event is 'a vibration with an infinity of harmonics or submultiples, such as an audible wave, a luminous wave, or even an increasingly smaller part of space over the course of an increasingly shorter duration'.[8] Secondly it is composed of intensions, an infinite convergent series related to its intrinsic properties and their thresholds or limits; and thirdly it is individual and composed of prehensions, a 'concrescence of elements' or nexus of traces. As we have already seen, the ear is such a nexus of prehensions, shaped by the audible waves it has evolved

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[4] Mercer, C. (2001) *Leibniz's Metaphysics: Its Origins and Development.* Cambridge University Press. p.218

[5] 'For Leibniz no less than for Hegel, infinite representation cannot be reduced to mathematical structure: there is a non-mathematical or supra-mathematical architectonic element in continuity and in differential calculus.' Deleuze, G. (1994) p.310

[6] Ibid. p.222

[7] Deleuze, G. (2006b) p.87

[8] Ibid. p.87

to differentiate. Deleuze's panpsychism means that ears 'anticipate psychic life', just as they 'think' for Perrault.[9]

Deleuze explicitly denies the possibility of a total determination of sound, stating that the concept of an 'absolute ear' is an illusion, but argues instead that the manner in which music mobilizes non-musical elements, rendering sonorous 'forces that are not audible in themselves, such as time, duration and even intensity', demands the formation of an 'impossible ear'.[10] Thus, just as philosophy is charged with rendering thinkable those 'forces that are unthinkable,'[11] music is capable of transforming itself through harnessing non-musical sound (noise). Deleuze makes it clear that the affective intensity of noise does not stem from its signifying capacity (as is supposed by much of the sonic culture literature) but on the contrary insists that it is significant *because* affective. He also brushes away the idea that sonic affect rests on the waveform characteristics of its physics, since light shares such transversal properties. Instead, he maintains that the potency of sound is due to 'a phylogenetic line, a machinic phylum that operates in sound and makes it a cutting edge of deterritorialization'.[12]

Serres, for his part, relates several Greek myths pertaining to the relationship between noise, information, and music. He highlights the different strategies of overcoming the noise of the Sirens played out by Ulysses and Orpheus; the former functions through the repression of noise (blocking the ears and being bound to the mast) while the latter proceeds through positive interference (the playing of divine music). He associates the former strategy with Leibniz's theory of the universal harmony of the *monad*, where all difference fits neatly within its assigned position in the global order of compossibilities; while the latter strategy must be understood as the

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[9] Ibid. p.88

[10] Deleuze, G. (2006c) *Two Regimes of Madness*. Semiotext(e) Foreign Agents. p.160

[11] Ibid.

[12] Deleuze, G. & Guattari, F. (2003) p.348

mobilization of Difference effected by Serres and Deleuze, resulting in the infinite speed and ecstatic musicality of the *nomad*.[13]

The most important difference between Leibniz's monadology and Deleuze's nomadology is that the global order or pre-established harmony among compossible worlds is no longer guaranteed by an all-knowing benevolent deity. This is why Deleuze considers the Leibnizian model to be transformed by Whitehead, since for the former 'bifurcations and divergences of series are genuine borders between incompossible worlds', while for the latter 'bifurcations, divergences, incompossibilities, and discord belong to the same motley world'.[14]

The Leibnizian system of compossible worlds is defined by a 'propositional manifold' with subjects on one axis and predicates on the other, so that the monad occupying any position is uniquely specified by it. All propositions are assigned a binary value according to two modalities: actual (true), and possible (false). No two true propositions can contradict each other, but rather, represent a bifurcation defining the existence of an incompossible world. The propositional manifold should be understood as a surface curving through the binary dimension of modality, so that the curvature of the surface describes which propositions are actual and which possible.[15]

Which propositions are actual and which possible is a matter of contingency; the whole system of possible worlds is designed to overcome the problem of the opposition between causal mechanical necessity and free will (both human and divine). Leibniz's claim that God chooses the best possible world, ridiculed by Voltaire, is based on the idea that the highest number of compossible states allows the richest variety of singular points and the greatest degree

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[13] Serres, M. (2008) p.126

[14] Deleuze, G. (2006b) p.92

of freedom.[16] As we have seen, Deleuze follows Bergson in acknowledging an excess of analog information processing over its discrete representation, and in relating this to the irreducibility of intensive temporal experience to its extensive spatial explication. Just as Deleuze transforms Kant's pure and empty form of time from a procedural logic of individuation analogous to discrete computation to a dynamic conception of information processing, so he transforms Leibniz's propositional manifold into a subrepresentative and extra-propositional manifold whose curved surface is in continuous variation.[17]

Again, we can explain Deleuze's intervention as a thoroughly atheistic updating of Leibnizian philosophy based on the insights of the contemporary science of dynamic systems theory (DST). According to the latter, a system such as a pendulum can be modelled by specifying its degrees of freedom (the number of ways in which it can move) and representing them as axes in a multi-dimensional phase space. All possible values of the variables of the system are represented as points on a graph; for the phase space of a deterministic mechanical system such as a pendulum, the pertinent variables are generally position and momentum. Given initial conditions (the values of the variables at a point defining the start of the system's evolution) the trajectory of the system may be calculated as the set of points whose curvature is consistent with these initial values.

The phase space is thus a graph of the totality of possible ways in which a given system can evolve over time, so that the time dimension is unravelled or collapsed, just as we saw with Deleuze's reconceptualisation of Kant's pure and empty form of time. The construction of a phase space thus reveals the tendencies of the system as well as topologically significant features such as singularities and attractors. Singularities are critical transition points where two or more

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15 Wolfendale, P. (2011)

16 Deleuze, G. (2006b) p.75

possible trajectories cross, and attractors are points towards which the system tends to evolve, such as gravitational equilibrium in the case of the pendulum.

For Deleuze, the phase space therefore represents as *possibilities* the virtual *potential* of a system; it should be stressed that in Deleuze's account the virtual potential of a system is irreducible to any totalized set of measured and specified possibilities. Nevertheless the virtual is something like the subrepresentational field of potential that the phase space represents. The trajectory of any system actualizes a series of virtual potentials by tracing a path through the high dimensional space. This is analogous to Leibniz's propositional manifold but now subrepresentational, extrapropositional, and exceeding binary encoding through continuous variation.

Deleuze's reconceptualization of metaphysics according to contemporary science and mathematics is a momentous philosophical achievement, and should not be dismissed along with other less useful elements of his enterprise (i.e. his vitalism, his panpsychism, and his susceptibility to the myth of the given). The three main metaphysical principles he postulates can be rearticulated from a Sellarsian perspective that is capable of overcoming the more problematic aspects of Deleuzian philosophy. The PSR may be rephrased simply as the contention that any event or process should yield in the long run to a causal-naturalist and or normative-linguistic explanation that accounts for its occurrence. This is a clearly a departure from the Deleuzian framework, in which certain events and processes; for example, the lived experience of time, the dynamic distribution of pre-individual singularities; are presupposed by, and exceed any representative account.

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[17] Wolfendale, P. (2011)

Secondly, the PUB can similarly be understood just as the premise guiding the ongoing efforts of scientific reason to explain all phenomena in terms of the causal-naturalistic order, which should be capable, again in the long run, of accounting for sensation, perception and conception in the same terms as other physical happenings, i.e. according to the notion of absolute process. Lastly, the PIM follows naturally from the rearticulation of the previous two principles, so long as it is shorn of any trace of the myth of the given, and any negative construal of, or fundamental limitation to, representative reason.

We have seen then how Deleuze appropriates and transforms the concepts of several different philosophers by embedding them in an anti-representationalist account of intensive difference. In particular, his reading of Leibniz's probabilistic manifold and the minute perceptions below conscious awareness; the constitution of the subject, the externality of relations and the sensible atom in Hume; the notion of haecceity he takes from Scotus; and the fundamental discord of the faculties that he finds in Kant's account of the sublime. All these philosophical concepts are used by Deleuze as armaments to usurp the orthodox image of thought as mediated by representative reason and to put in its place an immediate experience of difference that precedes identity.

Sellars, in contrast, argues that the continuity of perception is an *appearance* from the perspective of the manifest image, and is mediated by the conceptual capacities of language. Furthermore, he considers that the 'thing-in-itself' corresponding to this appearance is simply what is described in the scientific image, so the continuity of perception should be explainable in terms of the absolute process that will be the successor image to the current particulate framework. The most pernicious consequence of Deleuze's vitalist conception of intensive difference and the temporality peculiar to it is that he is therefore led to characterise entropy as a 'transcendental illusion'.[18] It should be noted here that not only is entropy an illusion according to Deleuze, but also the 'negative is illusion',[19] furthermore it is representation that provides the site of such a misconception.[20]

Sellars' account is in stark contrast. Firstly, he holds that the scientific image of time and space are the best descriptions that we have of their true nature, so that the experience we have of space and time should be ultimately describable in terms of the structure of causality revealed in the long run of science (absolute process). In this sense, thermodynamic entropy is an absolute truth of transcendental realism, the 'thing-in-itself' of physics (at least one of its major characteristics). It is rather our manifest experience of time that is illusory: a real illusion, one that must be explained rather than dispelled. There is still a logical irreducibility of thought to its causal description but only at the normative-linguistic level of inferential rationality. For Sellars, we are free but only in and by representation, and this has nothing to do with chance, chaos, or infinitesimals below the threshold of measurement.

Sellars understanding of abstract universals is likewise highly divergent from Deleuze, and yet there is some affinity. To understand this we need to refer to the debate between nominalism and realism with regard to abstract entities. Notably, this is also bound up with the problem of the many and the one. The classic Platonist position is that x is beautiful if it participates in the abstract object of beauty. The latter is not identifiable with any spatially or temporally concrete object, and on most accounts has no causal properties, but nevertheless has a real existence. The nominalist position holds on the contrary that only individuals or particulars exist and not universals.

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[18] Deleuze, G. (1994) p.229

[19] Ibid. p.202

Sellars espouses a naturalistic nominalism, so he understands universals such as beauty or noise to have a functional role in language use that does not refer to some substantial thing outside language which could be said to exist or not: 'the function in natural languages of abstract singular terms such as 'triangularity' is not to name alleged abstract objects, platonic or otherwise. Rather they are revealed to be *metalinguistic* terms that serve to pick out linguistic types or roles that may be played or "realized in" many linguistic materials.'[21] The similarity in the accounts is that the question as to the existence of universals is considered to be fallaciously posed, so that universals should be understood as conditions of individuation rather than as individuals themselves (recall Sellars' account of Kant's categories as second order concepts or metalinguistic sortals).

The difference is that for Sellars they are *instituted* by normative-linguistic rules of use, and are not *perplicated* in objects immediately given to experience. The ontological status of noise in the universal use of the concept is simply defined by its normative-linguistic rules of use; what noise *is* just boils down to how we use the term. This does not however mean that it is merely a socio-historically constituted concept that remains relative to its linguistic context. There are inferential implications and consequences of the term that define its proper understanding (its semantic assertibility in Sellars' terms), and this category of conceptual connections may be instantiated in other languages or substrates, such as neuronal patterns in the brain, or code in a possible future computer capable of correct linguistically enabled inference; this is why it is a 'metalinguistic distributive singular term'.[22]

Lastly, Deleuze's reconceptualisation of Leibniz's propositional manifold as a subrepresentational and extrapropostional probabilistic manifold in which the demented curve

[20] Ibid. p.265

[21] O'Shea, J.R. (2007) p.67

of time actualizes pre-individual singularities on a plane of immanence is correct insofar as it moves beyond the computational paradigm and acknowledges continuous processes of variation that exceed binary representation. However, the further claim that the probabilistic manifold is fundamentally beyond the scope of representative reason is an unwarranted metaphysical proclamation that should be overcome in the long run of scientific enquiry. This is just the kind of glorification of noise that Thom appeals against. Accepting Thom's argument does not mean denying the importance of critical transitions; it is after all Thom who developed catastrophe theory, which mathematically formalizes the topology of bifurcations and singularities leading to discontinuities in the properties of systems.[23]

Thom's argument is that the importance of the perturbation must be put in context, and is badly understood when framed as the origin of freedom. Perturbations and the discontinuities that they introduce can be classified, quantified and calculated; there are seven types of catastrophe point according to Thom.[24] Perturbations and catastrophe points do not issue from an irreducible randomness that is fundamentally without measure. On the contrary, we can only infer randomness when we have specified a formal context and scale of observation in which this makes sense. It is not the chance element that provokes change but rather the constrained context in which it occurs. Most importantly, the manifest freedom of rational agency cannot be flattened onto self-organising systems, and is not explained by randomness below the threshold of measurement or the putative collapse of causal mechanical determinism.

In order to understand how social systems have been understood in terms of probability theory and self-organising order from disorder, the next chapter will examine the development of economic theory from early political economy to contemporary finance. Economic modelling

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[22] Ibid. p.71

[23] Thom, R. (1994)

provides an expedient context for tackling the issues that are necessary for a more rigorous conception of noise for many reasons. Firstly, it is a well-researched field in which probability formalisms have been applied to human behaviour at the level of social organisation. The complex unpredictability of the market requires a multi-scale account of randomness, specifying processes of entropy, negentropy, and anti-entropy that constitute its nested dynamics. The self-referentiality and fundamentally semiotic character of the market takes the discrimination of signal and noise to a higher level (second-order observation). The scientific treatment of economics masks a violent ideology in which human freedom is reduced to self-organising statistical probability distributions.

[24] Ibid.

3.0

The Geometry of Risk

3.1

A Modern Wager

'The wager is situated on the dividing line between pure lived action and autonomous speculation: at once an impulse towards the future, a recognition of radical novelty, risk; and, on the other hand, an attempt at domination through the imposition of an order, and the establishment of symmetries.'[1]

The analysis of risk using formalised probability calculus, and the multi-scale hierarchically nested dynamics of randomness, contingency and noise that provokes this modelling behaviour (its physical, semiotic, and inferential dimensions) has today expanded to such proportions that it directly or indirectly affects every aspect of the world. This calculative exploitation of uncertainty is most intensively manifested in the 'risk order'[2] of the contemporary global financial system, which, through financialization, has extended the speculative administration of risk and opportunity to all aspects of the economy. In order to understand the current relationship between finance and noise we must examine the historical development of economic systems and their theorisation.

The argument we will put forward here is that money should be understood as a *technology* for the management of uncertainty, and a correspondent *binding* of time through a process of projection.[3] Finance can best be understood as a complex technical system tightly coupled to

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[1] Cavaillès, J. (2014) From Collective to Wager: On Some Recent Theories of Probability, in ed. Mackay, R. *Collapse: Philosophical Research and Development.* Vol VIII. Urbanomic. p.104

[2] Malik, S. (2014) The Ontology of Finance, in (Ed.) Mackay, R. *Collapse: Philosophical Research and Development.* Vol VIII. Urbanomic.

[3] Esposito, E. (2011) *The future of futures: the time of money in financing and society*. Edward Elgar.

other social and economic systems; it functions as a horizontally networked and hierarchically stacked information processing system engaged in the endogenous activity of pricing.

While price has been traditionally understood to reflect the intrinsic value of goods or assets, albeit with some degree of transient distortion or noise, the standard ontology must be reversed since it is the rather the primacy of the pricing process[4] and its organisation of risks and opportunities (i.e. the distribution of power) that determines the derivative notion of value. The primacy of pricing over value is increasingly evident in the contemporary situation where the derivatives market vastly exceeds the 'real' or 'productive' economy. In fact, the opposition between the 'real' economy and 'fictitious finance' is predicated on a substantialist conception of value that is no longer pertinent either to the theory or practice of finance.

Like a biologically evolved function, a technology may be defined as an adaptive means for the structuring of material relations in an environment in order to tap a gradient; i.e. the reduction of the material, energetic, or computational *costs* for the attainment of an end. As in biological systems, the functionality of the adaptation may serve several purposes, and may lead to further possibilities that were not previously available. In this sense, an adaptation or technological development cannot be reduced to its present functional organisation, since its importance rather lies in its generative capacity to open up unprecedented possibilities of action or knowledge attainment. Again, we have discussed this in the biological context with reference to the concepts of exaptation, generative entrenchment, and the discovery of adjacent possibles, all of which are related to a certain forward-directed openness to contingency.

[4] The argument for the primacy of the pricing process is put forward by a number of the authors drawn upon here, notably: Orléan, Mirowski, Esposito, Ayache and Malik.

Money can be understood then as a distinctive technological adaptation driving social evolution, by expediting already existing social functions and acting as a platform for the discovery and invention of other previously unimaginable or impossible processes. Money is generatively entrenched in the sense that because many social functions rely on it, its transformation or eradication would be far from trivial. The possession of money acts as a security against the fluctuating conditions of the environment by providing liquidity. It may thus be considered as a buffer for the reduction of the impact of unforeseen contingencies. However, as a technology of speculation it may also amplify positive feedbacks leading to lethal scarcities and excesses or to unprecedented transformations.

Though many financial actors use sophisticated scientific models for predicting the uncertain movements of the market, drawing on statistical physics and complexity theory, economic theory remains rooted in traditional assumptions, and this continues to strongly influence policy decisions with vast impacts worldwide.[5] Mainstream economic theory - its legitimation of financialization, and its expression in the global financial market - amounts to a metaphysics: of value as exogenously determined substance, of the ideal randomness of the probability calculus, and of the optimality of competition in the allocation of resources. This is the contemporary scientific image of economic man.

Against the dogma of market isolation,[6] it is argued here that economic actors are first of all social and technical rather than self-sufficient rational subjects, that is, they are engaged in a process of social and technical individuation; they communicate, use inherited knowledge

[5] For example, the deregulation of the banking sector was driven by arguments drawing on the theory of efficient markets, which we will look at later.

[6] Market isolation is the term Orléan gives to the neoclassical picture according to which economic actors have fixed individual preferences, are only concerned with prices and quantities rather than what others desire, and generally do not communicate. Orléan, A. (2014) p.38

embedded in technologies (including everyday use of language and mathematics, but also complex computational functions that few could understand), follow each other's lead (mimetic behaviour), and act strategically by evaluating the likely behaviour of others (strategic rather than parametric rationality).

One of the best ways to model this is through the simulation of an opportunity landscape, analogous to the biological conception of the fitness landscape, where one's position relative to the surrounding peaks and troughs defines access to gradients and the likelihood of economic 'survival'. A landscape may model many different possible parameters, for example it may display risk probabilities, availability of a certain form of matter, energy or information, or the supply of liquidity. It will be argued that, in the case of economic activity, the pertinent parameters are in such constant flux that no model can be accurately relied on for any extended duration.[7] This approach goes against the traditional economic picture, which assumes the neutrality of money, the exhaustive enumerability of all future states of the world, and the sovereignty and market isolation of *homo economicus*.

The contemporary market may be understood as a parallel distributed computational process for dynamically forecasting the movement of opinion; the financial agents that compose it are continuously recalibrating their probabilistic models according to revised interpretations of the past data, and generating a variety of new expectations of the future on this basis. According to several contemporary heterodox economics approaches, such as ecological economics, econophysics and 'computational evolutionary economics'[8], the financial market can be modelled as an *ecology* of evolving socio-technical systems and sub-systems such as investment banks,

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[7] Felin, T. et al. (2014)

[8] Mirowski, P. (2007) Markets Come to Bits: Evolution, Computation and Markomata in Economic Science, in *Journal of Economic Behavior & Organization* 63: 209–242.

hedge funds, derivatives traders, high-frequency trading algorithms, retail investors and pensions funds etc., all involved in the generation of prices.

Such a computational perspective is all the more necessary in the present situation where there has been a 'robot phase transition', a threshold change whereby there are more bot-to-bot trading interactions than those made between human traders.[9] The microstructure of automatic market-making can be understood as an 'ecological niche' developed by ultra-fast trading algorithms which 'feed' on the information processing asymmetries and disparities of the wider 'financial ecology'. They do this by dissipating noise and adding to the complexity of market microstructure, a behaviour that can push the whole ecology to critical thresholds, sometimes referred to as flash crashes. We shall later see the limitations of the computationalist perspective of ecological economics and it's modelling of opportunity landscapes.

Though algorithmic trade exceeds other trade in quantity and speed of transactions, the greatest movements of capital are to be found in derivatives trading (where the number of possible commodities has no in principle upper limit), and complex securitized instruments such as collateralized debt obligations (CDO), and asset backed securities (ABS). Again, with such instruments there are strategic manipulations of information, the camouflaging of toxic assets in bundles, and positive feedback effects leading to crises of confidence, as witnessed in recent market crashes.

So, the concept of noise is crucial to an understanding of contemporary finance, and moreover has an important relationship with the historical development of trade and economics, in the sense in which it is related to the nexus of linked yet differentiable terms: randomness, probability, contingency, risk, etc. Conversely, understanding what noise means today, and therefore how it should be understood in other contexts such as music, requires an examination of its relations to finance and economics.

No intelligent entity can escape the need to develop probabilistic models of risk and opportunity, even if they are implicit or unconscious. Without taking risks no opportunities will become available, and so abstention is a risk in itself. Conversely, taking an opportunity presents itself with new and different risks. Withdrawing from the process of projecting explicit probabilities or making strategic decisions merely leaves one relying on implicit models, either of which may be drastically skewed by cognitive biases or sampling errors. Making a model explicit aids in the discovery of invariants, and allows for the strategic manipulative testing of variables; furthermore, these processes may act as ongoing inputs for the dynamic recalibration of the model.[10]

The projective estimation of risk requires an assessment of the present signs of danger and of opportunity that an agent has access to. However, making such a calculation has costs: in time, energy and attention or cognitive processing. The technology of money allows, in principle, for any cost to be met and any risk to be hedged; however, deciding which costs and risks are worthwhile is always a wager. Decision requires a certain expertise as well as a metacognitive evaluation of that expertise; judging uncertainty is thus an uncertain process in itself.

It is therefore often more reliable and cost effective to observe the prevailing opinion by taking cues from the behavioural signs of other operators. However, since they may be doing the same thing, and are also potential competitors who pose threats in themselves, the signs they emit could be empty repetitions (noise qua rumour without content), or they may be giving out

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[9] Johnson, N. et al. (2012) Financial black swans driven by ultrafast machine ecology, *arXiv*, 7 Feb.

deceptive signals (noise qua crypticity). For the economic actor, making an adequate appraisal then entails observing the observations of other observers and judging the reliability of the behavioural signals they emit.

In systems theoretic terms this is called second-order observation. This self-referentiality is not just a question of transient irrational exuberance as the behavioural studies of finance have claimed, nor is it merely a question of epistemic finitude in the face of a fundamental randomness as others have argued, but a generative and endogenous capacity of the market that must be addressed at many levels. Financial speculation, derivatives trading, and high frequency trade is replete with both intentional and unintentional noise, and of course deeply predicated on the probabilistic calculation of randomness.

In certain highly restricted contexts, judging what will happen next can be thought as an exact science since the range of possibilities is exhaustively known and the future follows the past in an orderly succession. This is a situation of *perfect information* that was one of the major presuppositions of classical and neoclassical economics up until the loss of certainty brought on by the Great Depression. Though some of the most influential economists of the twentieth century have based their system on a rejection of this principle - ranging from Keynes' assumption of fundamental uncertainty and self-referentiality on the interventionist side to Hayek's preoccupation with information asymmetries and complexity theory on the side of the free market - mainstream economics, both in theory and practice, is still guided by the postulation of various symmetries that make up the tenets of what may be called *market objectivity*.[11]

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[10] Epstein, J. M. (2007) *Generative Social Science: Studies in Agent-Based Computational Modeling*. Princeton Univeristy Press.

These include the presupposition that financial agents have perfect information regarding the set of commodities on offer (their prices and qualities), a set of individual buying preferences that are fixed in advance by rational subjective judgement, a shared future outlook based on an exhaustive classification of contingent possibilities, a centralised and neutral coordination of supply side prices linked with a behaviour of passive price taking, and a tendency to utility maximisation that avoids two extremes of demand. Both extremes of demand lead to positive feedback processes that move the system away from equilibrium, and this is why indifference curves are modelled as convex with their ends curling to avoid the extremes. Exaggerated demand is where increased supply does not lead to decreased demand since having more of the commodity only incites wanting more of it, and exclusive demand is where decreased supply triggers increased price but does not lead to commodity preference substitution.[12]

The most *fundamental asymmetry* informing commerce is the irreversible difference between the past and the future, and though economic theory since the time of Keynes and Hayek has attempted to account for this historicity, the problem lies in the convoluted circularities introduced by the multiple feedback loops of the trader's projections. These are distributed along two virtual axes: firstly, the endless spectral game of self-referentiality;[13] and secondly the calculation of future risk in the present - the projection of a *present future*[14] - and the way that acting on this feeds back onto the asymmetric flow of time, creating turbulence and unexpected risk in the *future present.*[15] There is thus always a minimal angle of deviation from expectation, a quantity of noise that bleeds into the space between the present future and the future present.

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[11] Orléan, A. (2014) p.76

[12] Ibid. p.40

[13] Ibid. p.214

[14] Esposito, E. (2011)

[15] Ibid.

Making economic transactions therefore requires the dynamic revision of time binding (future commitments) and the complex multi-dimensional parsing of signal and noise. This is because the uncertainty of the future - the contingency of the future present - is only legible in the market movements that signal the present futures projected by other financial actors. Like language, money is a semiotic technology. Money is the sign for what everybody desires, and that is liquidity. Liquidity acts as a protection against the uncertainty of the future.

The function of liquidity that money fulfils emerged from a process of mimetic polarization in which actors unanimously converged on one good or token as possessing the highest liquidity. Money thus expresses at once a fundamental uncertainty (without uncertainty we'd have no need of the liquidity function), a positive openness to contingency (it enables previously unavailable actions and its value can be redeemed at any time for any good or service), and a self-referential stability (its liquidity). The latter is predicated on the ability of a currency to continue to hold onto prime position in a collective process of mimetic convergence of desires that depends on positive feedbacks.[16]

This is both a contemporary perspective on money, and a heterodox theory of economics. Whilst early modern finance is already engaged in the probabilistic calculation and pricing of risk, the flow of money is mostly driven by trade in goods. Classical economic theory is principally oriented towards production, while neoclassical economics shifts the emphasis to consumption. Both theories neglect the intermediary stage, passing over the question of money and paying scant attention to the social interactions that coordinate exchange.[17] They thus remain entrenched in a paradigm of barter (the commensurability of goods) that is paradoxical given

[16] Orléan, A. (2014) p.114

[17] Ibid.

their attempt to explain market economies, where the existence of barter indicates the failure of market mechanisms (the delegitimisation of money).[18]

Both classical and neoclassical economics present substance theories of value that attempt to explain how economic order arises from the disordered interaction of self-interested individuals isolated from the communicative medium of the market. For the former the substance is labour value, understood quantitatively in terms of energy expenditure; for the latter it is use value, understood quantitatively in terms of the satisfaction of subjective needs and wants (utility maximisation in a situation of resource scarcity). In both cases value is understood as an invisible and silent force lying beneath the manifest appearances of commerce and the noise of pricing. Value is conceived as the invariant essence underlying and making possible the equivalence of diverse goods, and price or money merely the accidental variables of its surface appearance.

The connection to our earlier discussion of the Sellarsian distinction between the manifest and scientific image should be clear, but let us reinforce this with a further observation: classical and neoclassical economics alike are predicated on a process of abstraction modelled explicitly on the natural sciences, whereby heterogeneous persons (their characters, qualities and subjective values) are taken as homogenous particles expressing random variables ('Robinson particles')[19] whose interaction is structured by quantifiable objective values (labour value or utility defined by the emergence of equilibrium in supply and demand).

The argument here will not be the typical humanities screed that economics should be condemned because it is a reductive scientific perspective that aims to maintain the injustices of

[18] Ibid. pp.12-18

[19] Châtelet, G. (2014) pp.35-43

power through quantification and abstraction - this would be to renounce the scientific image in favour of a distorted emphasis on the manifest - on the contrary, we must understand money, and the contemporary global financial order, as performative technologies that are capable of transformation and repurposing. Quantification and abstraction are not the problem; it is rather the way in which this information is used.

We should hold to the Leibnizian principle that understanding just *means* abstraction. Rather, it is a question of analysing and accounting for the specific losses that occur in such a process of compression and proposing alternative modes of abstraction. In the case of orthodox economic theory, the argument here will be that this process of abstraction has removed all the friction of the intermediate stage of circulation and exchange, and the clatter of the technologies of money and pricing that make this possible. This elimination of friction and noise allows exchange (pricing and money) to be thought in reversible terms so that it can be discounted from explanation, leaving only equilibria of supply and demand and the satisfying stability of commensurable goods.

The argument put forward here is certainly not how economics has traditionally been understood, and it is only after contemporary developments in finance that such a heterodox perspective becomes demonstrably compelling. Only after the global uptake of the Black-Scholes formula for pricing options in the early seventies, and the sudden magnification of derivatives trading that followed, are we able to retrospectively understand the history of modern finance as the cumulative development of a complex technical apparatus for the management of uncertainty and the binding of time. The understanding of money as a technology for time binding and risk management is a heterodox one because it posits a dynamic non-equilibrium model of *pricing* as a *process* of binding possible futures while mainstream (orthodox) economic theory is still largely oriented by static equilibrium models of *value* as a conserved *substance* (even if financial practices significantly diverge from this theoretical dogma).

Mainstream economic theory today, which is still predominantly neoclassical, is based on a generalisation of the concepts of scarcity and utility. Much of the writing on noise in the humanities, and in particular within sound studies, has followed Bataille in reversing this emphasis because utility has been equated with the cold calculations of instrumental rationality and scarcity is associated with the need for cut-throat competition. Instead they push utility maximisation to the opposite extreme of uselessness and destruction, championing the 'aesthetics of failure'[20] and equating noise with the formless 'informe' of the sublime.[21]

It should be clear that this is not the approach here, since the opposition of rationality and the social or imaginary must be overcome through a redefinition and extension of reason rather than an inundation of reason by desire. What both Mauss and Bataille correctly point to is the pervasiveness of non-equilibrium dynamics of positive feedback mechanisms in economic systems, and the fetishist social constitution of the function of liquidity, hence its mimetic delirium. Outside of academic sociology, the question of positive feedbacks in the context of capitalist or market-driven economies has been dealt with by the signal theoretic treatment of information asymmetries in later neoclassical economics[22] and by the study of the adoption of technologies.[23]

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[20] Cascone, K. (2000) The Aesthetics of Failure: "Post-Digital" Tendencies in Contemporary Computer Music, in *Computer Music Journal*, Winter, Vol. 24, No. 4, pp. 12-18. doi:10.1162/014892600559489

[21] Crowley, P. et al. (Eds.) (2005) *Formless: Ways in and Out of Form*. Verlag Peter Lang.

[22] Spence, M. (1973) Job Market Signalling. *The Quarterly Journal of Economics*, Vol. 87, No. 3. Aug., pp. 355-374. MIT Press.

[23] Arthur, B.W. (1989) Competing Technologies, Increasing Returns, and Lock-In by Historical Events. *The Economic Journal*, Vol. 99, No. 394. Mar., pp. 116-131. Royal Economic Society.; Arthur, B.W. (1990) Positive Feedbacks in the Economy. *Scientific American*, 262, 92-99, Feb.

Two contradictory positions can thus be identified: one upholds the dominion of order and of individual rational calculation in a situation of resource scarcity; the other defends the primacy of disorder in a situation of collective mimetic desire and the excess of energy and signs. The understanding of noise that we are advocating in this thesis is not restricted to one side of this apparent opposition, but is rather to be found in the complex transits across this problematic space.

That is, noise is just as often caused by information scarcity as it is by information excess. In fact, we may generalise the concept of scarcity to encompass excess (as Walras does in economic theory) by arguing that the problem of excess information is the result of a scarcity of appropriate information processing resources. Likewise, we may perform the inverse operation in explaining every situation of scarcity with reference to an excess that determines it. There is thus a dialectic of scarcity and excess that cannot be resolved by simply casting one's lot with one side or the other. As we've argued, it is a question of specifying the appropriate scale and level of analysis, a context-sensitive calibration of the decision criterion between signal and noise.

This is not the only dialectic we shall see that is implicated in the conceptualization of noise. In order to untangle the conceptual knot of scarcity and excess we need to look at the ways in which the concepts of randomness, probability and noise have developed in the natural sciences, including more contemporary computational accounts, and how this impacts on finance conceived as the technological management of uncertainty. As we shall argue here, both classical and neoclassical economics owe a largely unacknowledged debt to modern physics, in particular to the coupling of *conservation principles* and *variation principles* that emerged in the

David, P.A. (1985) Clio and the Economics of QWERTY, in *The American Economic Review*, Vol. 75, No. 2, Papers and Proceedings of the Ninety-Seventh Annual Meeting of the American Economic Association (May), pp. 332-337, nineteenth century conceptualisation of energy. At their most general we could say that conservation principles postulate an invariant that underlies and unites diverse variables making possible the transformation or exchange of one for the other; and variational principles give a unified description of how differing objects and processes change over time and space through losses or gains in energy and momentum. A series of interconnected dialectics should thus come into view.

Risk is associated with the evaluation of an action, which can be thought of in terms of the probabilities of success or failure, and the costs, and benefits that would be incurred in either case. Weighing up the probabilities involved in a risk entails making critical decisions regarding the distinction between signal and noise - as we have seen this may be thought in terms of adjustments to a receiver operating characteristic. The cost benefits analysis may be more or less explicitly formulated, and it may be directed to the optimisation of individual returns (e.g. marginal utility), the concerns of a locally circumscribed group, or thought in terms of its global ramifications.

Though evolutionary development obviously doesn't proceed via an explicit cost benefit calculation, it can to some extent be thought as expressing one in the sense that adaptations whose costs exceed their benefits are curtailed by selective pressures. However, the evolutionary process is not optimized towards teleologically circumscribed ends but is better described as the *satisficing* of multiple functions (which may result in trade-offs and interference on the negative side, and resonances and exaptation on the positive side) whilst maintaining a radical openness to contingency.

American Economic Association.

The kind of explicitly formulated currency-based representations of costs and benefits is thus of a different order of analysis: sapient, self-reflexive, and technically enabled rather than biosemiotic and unconscious. Most importantly, such an analysis must exhaustively enumerate all possible states in order to calculate potential costs, as well as expressing all variables in quantitative terms. The political and ethical nature of such an action, as well as the arbitrariness of financial evaluation becomes evident when the costs of human lives are calculated.[24]

This process may be called pricing, and the argument developed here will be that value is a derivative term that follows from the pricing process and the way this alters the risk landscape, rather than taking primacy as it does in classical and neoclassical economics. Whether the theoretical point of departure is scarcity and the necessity to maximise utility, or superabundant excess and the need for costly signalling, is determined by a prior process of pricing that is both *naturalistically conditioned* by resource availabilities and *normatively conditioning* as a social act, a wager made within a rational recognitive community. The stereoscopic synthesis of the manifest and scientific images of economic man must take account of both this naturalistic and normative side without collapsing one onto another.

In order to specify and control the 'too much' of excess and the 'not enough' of scarcity, the notion of measure is crucial, as are the related concepts of symmetry and equilibrium. As Mirowski argues following Kula's analysis,[25] the conceptualisation of metrology throughout human history has involved three broad stages of progressive differentiation (anthropometric, lineamentric and syndetic) of three reciprocally associated concepts: body, motion and value.[26] At

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[24] Ackerman, F. (2007) Priceless Benefits, Costly Mistakes: What's Wrong with Cost-Benefit Analysis?, in Fullbrook, E. '*Real World Economics: A Post Autistic Economics Reader*'. Anthem Press, 2007. pp.205-215.

[25] Kula, W. (2014) *Measures and Men*. Princeton University Press.

[26] Mirowski, P. (1991) *More Heat Than Light: Economics as Social Physics, Physics as Nature's Economics*. (Historical Perspectives on Modern Economics). Cambridge University Press. pp.107-109

the most basic level of metrology, the action of *measurement* allows for distinct *bodies* to be compared under a single *value* system.

Measure is thus fundamentally bound up with the epistemic primacy of gesture, as well as the dialectics of difference and identity, and of course the concept of noise. Noise is key to understanding measure for two reasons: firstly, the imposition of a unified scale of measure treats the heterogeneity of measured objects as extraneous to consideration (the abstraction of their differences); and secondly, there will always be a minimal divergence between the measurement and the measured object since all metrics have an approximation threshold or noise floor beyond which accuracy cannot be improved (e.g. for example at the scale of thermal noise for the ear, or quantum randomness for experiments in molecular science). This is not an objection against metric systems; a metric is a tool for comparison, it is necessarily related to a problem of comparison at a certain scale, and it necessarily abstracts by comparing. Abstraction and approximation are thus positive features in a process of ongoing reasoning (as well as rationalisation in the negative sense that was given it by the Frankfurt school); systems of measure are a *means* that serve as a platform for various *ends*.

While it is a common trope within the humanities texts to disparage the imposition of metric orders on the basis of these presumed deficiencies (approximation and abstraction to a class of equivalents, reduction to means and submission to ends) the approach taken here is rather the reverse. That is, the process of accounting for noise in the modelling of data is one of increasing rationalisation through theoretical understanding and practical operationalisation. More accurate measurement allows for greater control, and more efficient modes of abstraction allow for reduction of the computational load and greater flexibility or constrained openness to contingency (robustness to noise in the case of a theory, and resilience in the case of a complex adaptive system). Abstraction can be understood as an advanced information processing procedure of increasing hierarchal complexity in the organisation and compression of data according to a model.[27]

Abstraction and approximation are not the deficits of rationality or of the techno-scientific instrumentalisation of the environment, they are the principle tools of practical and theoretical reason both in the manifest and scientific image, and no understanding could be had without these elementary operations. Identifying regularities, quantifying probabilities, exploiting uncertainties and accounting for noise according to deviations from expectation are all intrinsic features of rational sapient cognition. Abstraction should be thought as operating through the construction of a model that binds salient details in terms of equivalence classes, and approximation as an ongoing process of projection, measurement and recalibration or revision.

However, though abstraction and approximation are tools allowing for greater control, this very fact leads to a situation of higher complexity where more abstraction, approximation and control are necessary. The aggregate effect of individual rational risk management is far from generating a simple linear progression away from uncertainty at the global or systemic scale. Though technologically advanced social systems mitigate and control many of the risks that more primitive ones must bear, they also rely on the exactitude of a great many interdependent measurements and the structural and functional integrity of a large number of highly connected systems and components in order to coordinate and maintain their complexity.

Tightly coupled information processing networks are protected from risks with a high frequency and low impact because the tremors are absorbed, but such systems may become more vulnerable to low frequency risks (outliers of the probabilistic model). This is partly as a result of overconfident behaviour due to a false sense of security, and partly due to the

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[27] Crutchfield, J.P. (1994)

contagious spread of information in highly interconnected networks; both effects lead to the improbable event having a higher impact. It is also because the scramble to claim opportunities involves the generation of risks for others, whether by unintentionally depriving them of resources (scarcity) or filling their milieu with waste (excess), or by campaigns of misinformation and sabotage.[28] To comprehend this contemporary predicament, which Taleb has called 'extremistan',[29] it is necessary to sketch a broad history of the pertinent developments leading up to the present situation.

[28] Malik, S. (2014) The Ontology of Finance, in (Ed.) Mackay, R. *Collapse: Philosophical Research and Development.* Vol VIII. Urbanomic.

[29] Taleb, N. N. (2007) *The Black Swan*. Random House.

3.2

Euclid's Yardstick

Classical economics understands the price to reflect a determinate objective value defined by the expenditure of work, neoclassical economics understands the price to reflect a determinate objective value defined by the satisfaction of needs, which may be thought in terms of energetic requirements. For the former, determinate value lies in the process of production, for the latter in the process of consumption. Both mute the noise of any channels of communication or commerce linking the two processes, and thereby miss the crucial understanding of money as a socially instituted and performatively maintained liquidity function.

Although stocks and securities had been traded for several centuries before the establishment of the Amsterdam stock market, it is only with this dedicated centralised market for their exchange that financial trade achieves a volume and *fluidity* characteristic of the modern financial system and its corresponding power structure, or 'social chemistry'.[1] The beginnings of political economy spring from the *early modern* attempt to rationalise trade in quantitative and corporeal terms, however these also drew on the ancient conservation principles of the Greeks, in particular Aristotelian commentaries on equalisation and stability in the economy of households making up the polity.

For Aristotle the household needed to compensate for accidental fluctuations in the proportions of various goods it produced by exchanging with other households those goods it had in excess for those it was lacking, thus equalising the stocks and maintaining the stability that was its essence. Other forms of chrematistic trade - speculation for profit - were considered to

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[1] Châtelet, G. (2014) p.77

upset the balance and to threaten the harmony of the social order. This prohibition began to yield with the rise of international trade and the introduction of double-entry book-keeping, which gave strength to the argument that lending for profit could pay dividends to both parties and reward the nation at large, thus bringing speculation into the Aristotelian picture of balance by equalisation, resulting in mutual benefit and social stability.

While the 'balance-of-trade' mercantilists based their value theory on the symmetrical exchange of precious metals between nations, and the 'free-trade' mercantilists attempted to find a 'par' based on the productivity of land and labour, the French physiocrats considered value to arise from wheat, and explicitly modelled their economics on the necessity for the free flowing motion of the blood.[2] The nascent conception of political economy is certainly influenced by Descartes program of rational mechanics, which reduced all physical phenomena to the motion of bodies and declared a principle of conservation equating cause and effect (the equality of cause and effect *entail* the conservation of motion for Descartes). The inception of economic theory, and the sudden increase in financial practices marking the onset of early capitalism, was thus tied to the development of the scientific image of man.

Aside from this corporeal treatment of wealth, the development of economic theory is bound up with the contemporaneous formulation of mathematical theories of probability, statistics, and later, the scientific concepts of energy and work. Though the notion of equilibrium was central to early probability theory, statistics and political economy, it is formulated in very general terms and its internal paradox is not properly tackled until the beginnings of the mathematisation of energy conservation and variation in the nineteenth century. That is, if a differential (between hot and cold, cost and profit, actual value and expected value) always leads to its cancellation in equilibrium, how does this process not inexorably lead to a state in which there are no differences, where no change is possible? In the later words of an influential neoclassical economist: 'Every change is an equalisation of the forces which produce that change, and tends to bring about a condition in which the change will no longer take place.'[3]

The emphasis on equilibria from antiquity through to the present is the hallmark of a conservative drive to the maintenance of stability through the imposition, presupposition or foregrounding of symmetries as *signal*. This is achieved only through the (deliberate or unconscious) suppression of disequilibria, asymmetries and instabilities as *noise*. The insistence on equilibria corresponds to the classical image of the true (founded on identity, equivalence and invariance), the good (stable, harmonious and equitable) and the beautiful (symmetrical, perfect and pure). While the suppression and control of disequilibria, asymmetry and instability is significantly challenged if not definitively overwhelmed in mid to late modernity; with the collapse of this classical image manifesting in some of the greatest achievements of science, art and philosophy; strong reactionary forces maintain traditional dogmas long after they have been shown bankrupt.

To grasp the modern conception of equilibrium we must trace its development in probability theory and statistics, and show how this knowledge is socio-economically implemented. The beginnings of probability theory had been laid with Gerolamo Cardano's sixteenth century analysis of games of chance, in which he argued that the investigation of systems with random variables gains in accuracy over successive trials. In some ways one can see this as the basis for the effectiveness of empirical science and thus as a pivotal moment in human history.

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[2] Mirowski, P. (1991)

[3] Knight, F.H. (1964) *Risk, uncertainty and profit*. Augustus M. Kelley. p.22

This intuition is finally proved by Jakob Bernouilli in the eighteenth century, and becomes known as the law of large numbers after its formalisation by Poisson in the nineteenth century. The scientific image of man, and the economic picture that is drawn (homo economicus) through its distorted lens, is thus rooted in the gesture of the wager. However, rather than surrendering to fortune as the pre-moderns had, modernity initiates an irreversible process of the operationalisation of uncertainty and the rationalisation of noise qua systems relative randomness, futural contingency, and deviation from expectation or measurement.

'To be modern is to depart from the archaic goddess of fortune on a voyage into risk that stimulates calculation, formalises agency, and restructures time, as hazard is transformed from an extrinsic menace to an intrinsic principle of action.'[4]

The booming business of gambling in seventeenth century France led to the formalisation of a *calculus of probabilities* that informed the modern system of insurance,[5] thus laying the foundations for the expansion of finance, and constituting a mathematical basis for the formulation of scientific theories of the political economy. The mathematics of probability are developed in the seventeenth century by Pierre de Fermat and Blaise Pascal, after a correspondence concerning the fair division of gambling stakes for an interrupted game. Fermat and Pascal's work led to the notion of convergence to 'expected value' in contrast with that of 'odds'. The law of large numbers (LLN) describes the way in which a sequence of random variables will converge on its 'correct' frequency over a sufficient number of iterated trials - so a coin will approach an even distribution (equilibrium) of heads and tails the more you throw it - thus asymptotically yielding closer approximations to the expected value.

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[4] Land, N. (2014) Odds and Ends: On Ultimate Risk, in (Ed.) Mackay, R. *Collapse: Philosophical Research and Development.* Vol VIII. Urbanomic. p.363

The complexities of administration in seventeenth century States, after several hundred years of carnage from repeated outbreaks of 'black death', as well as the rapid rise of mercantile economies, saw the development of a science of *statistics* and its application to the management of the population as a statistical 'mass', leading to the inauguration of the regime of biopower.[6] Important milestones in this development include John Graunt's statistical treatment of mortality, but also Hobbes' social contract theory 'Leviathan', which draws on this statistical framework in order to understand the social body as a regulatory mechanism (when guided by a strong but liberal sovereign) for the 'Chaos of hostile wills' that composes it: 'it is this extremely crude mechanics associated with the contingent that feeds Hobbes' fiction and makes it possible to found a *political arithmetic*'.[7] This treatment of people as random variables, or particles with a statistical probability distribution, though a 'crude mechanics' was nevertheless an effective tool giving concrete traction on the macro-social properties of the population, effected through the developing scientific image of man.

Returning to the triumvirate of terms constituting Kula's lineamentric metrology, we can see that *bodies* are increasingly understood in terms of inert matter and treated as statistical masses, *motion* is thought mechanically in terms of force or the conservation of cause in effect, and *value* is conceived as substance. Since labour crosses all these concepts too, work is fundamentally categorised by alethic modality in classical economics: productive labour is necessary, unproductive labour is merely possible (or frivolous),[8] labour without cost is impossible. Concurrent with the development of political economy according to conservation principles there is a shift in the understanding of nature, so that it is no longer characterised by capriciousness or cyclical abundance, but by thrift. Nature wastes no energy.

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5 Bostrom N. & Ćirković M, M. (Eds.) (2008) *Global catastrophic risks*. Oxford University Press. p.170

6 Foucault, M. (2004) *Society Must Be Defended: Lectures at the Collège de France, 1975-1976*. Penguin.

7 Châtelet, G. (2014) p.37

8 Mirowski, P. (1991) p.167

While the foundations of the mechanistic worldview had been laid down by Descartes' substance dualism, it is the triumph of the Newtonian laws of motion that ushers in a new age of calculation for *dynamic* systems. Differential and integral calculus, as formulated independently by Newton and Leibniz, is inspired by Fermat and Pascal's probability calculus, and made possible by Descartes' development of analytic geometry (allowing for the integration of algebra and geometry). Leibniz, who was in correspondence with Malebranche, places the frugality of nature at the heart of his whole philosophical and mathematical edifice - famously condensed in the formula '*natura non facit saltus*' (nature does not leap) - and arguably formulates the first mathematical statement of a variational principle on its basis.

In fact, it is Jacob Bernoulli's employment of Leibniz's differential calculus to mechanical and geometrical problems that allows for the formalisation of LLN, as well as corroborating Leibniz's intuition concerning the conservation of force, and laying the groundwork for the understanding of diffusion and thermodynamics. Bernoulli's demonstration is supposed to represent a transition from the questionable metaphysical principles of probability laid down by Leibniz to an empirical science of frequency, however as Cavaillès cautions:

'Bernoulli's theorem does not assure the passage from supposedly a priori probabilities to frequencies, but only states that there is probability very close to 1 that, over a long series of trials, the gap between the frequency of a result and its probability is tiny.'[9]

As we shall see this duality between probability theory as empirical truth and as metaphysical assertion continues to this day. This mathematisation of probability, and the capacity it has for detecting and exploiting both regularities and uncertainties, now plays out on computer networks operating at superhuman speeds, and amongst derivatives traders at volumes of capital far exceeding the world's GDP.

Another pillar of modern probability theory emerges at this time with De Moivre's (1733) postulation of an early formulation of the *central limit theorem* (CLT), which describes the manner in which a system whose components are random variables with 'standard deviation' will tend toward a 'normal distribution' defined by smoothly dropping off curves either side of a mean (the bell-curve).[10] Again, this is a theoretical device whose contemporary technological implementation brings many benefits in practical information processing terms; it is a model whose form of abstraction enables traction on the world (by cutting financial or computational costs for example), however as a technology there is also a performative effect of the model on the modelled by altering its behaviour, and a conservative bias towards equilibrium that tends either to bring 'deviants' into line, or to amplify the impact of those outliers that are not included in the model[11].

The science of economics as such is widely considered to begin with the free market thinkers of the Scottish Enlightenment at the onset of the industrial revolution, based on the principle that the aggregate effect of individual rational self-interest, acting autonomously in a free market milieu of fair competition, is to the benefit of the general public. Classical economic theory understands the competitive free market as exhibiting a statistical tendency towards fair

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[9] Cavaillès, J. (2014) p.77

[10] Sir Francis Galton, who would later develop the CLT in relation to evolutionary theory, declares 'The huger the mob, and the greater the apparent anarchy, the more perfect is its sway. It is the supreme law of Unreason. Whenever a large sample of chaotic elements are taken in hand and marshaled in the order of their magnitude, an unsuspected and most beautiful form of regularity proves to have been latent all along.' Galton, F. (1889) *Natural Inheritance*. Macmillan. p.66

price formation, efficient resource-allocation, and the reduction of unnecessary costs in production or distribution. As supply meets demand, prices should thus converge at an equilibrium point that is equally beneficial to both parties of the transaction, reflecting the 'true' value of the commodity. Moreover, this is done en masse with no need for costly external coordination. Nature's thrift in action. 'What could be more edifying than this equilibrium emerging from the Chaos of teeth and stomachs?'[12]

In contemporary terms we may see the invisible hand as a metaphor to describe the functional emergence of an effective self-organising mechanism in the market; it is based on a chain of causes and effects thought as *signals* that steer the market towards equilibrium. For example, a shortage of a certain commodity will be signalled by an increase in price, this will lead to a reduction in consumption that acts as a signal for cost reduction through increased production, hence the market supposedly acts as a negative feedback mechanism that dynamically finds equilibrium.

This conception of the market is thus an early example of what is now known as a complex adaptive system (CAS), and its theorisation is instrumental in catalysing a paradigm shift that cascades across many other disciplines. Systems (physical, biological and social) can no longer be explained by recourse to a transcendent and pre-existing design principle, but must be seen as emerging through the dynamic interaction of their constituent elements understood as random variables conforming to a statistical order. While Smith and the neoliberals who would champion his thought see this as benevolent and natural process of fair price formation, others would see it as the justification of a brutal regime of exploitation. '[The] Invisible Hand…dons

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[11] These effects are noticeable, for example, in 'predictive policing', targeted advertising and derivatives trading. These rely on a pro-cyclical conception of time (the future will behave as the past did), and have a positive feedback effect on the data that they use as inputs.

[12] Châtelet, G. (2014) p.33

no kid gloves in order to starve and crush silently, and…is invincible because it applies its pressure everywhere and nowhere.'[13] Significantly here, the functional integrity of this self-organising process is predicated on the symmetric transmissions of market signals without distortion by noise.

According to the logic of political economy, the industrial revolution had not only reduced the cost of production by grouping workers together and mechanising aspects of their labour, but had also reduced the individual worker's *risk* of producing for the market by aggregating production and sale under the control of an entrepreneur.[14] Reduction of risk through grouping is precisely the same effect as found in the management of gambling houses, in insurance and speculation, and in the emergence of stable equilibria due to the LLN. This is an exploitation of uncertainty through an operationalisation of the probability calculus, allowing for the pricing of risk according to the statistical probability distribution of a mass.

Classical political economy uses the metaphor of gravitational force to illustrate the tendency of the market to converge on the correct price (this is true of Smith, Ricardo and Marx, though they have different takes on what this means for political economy). The notion of correct or natural price is obviously defined in relation to deviations from appropriate prices, or more fundamentally the true price must be based on the exclusion of all falsity and noise. Classical political economy is thus engaged in a foundationalist search for the invariant scientific truth of value behind the veil of manifest appearances that is money and its exchange (all too contingent and variable to be true). This is illustrated by the frequent references made to money as a yardstick that is continually changing length; for the political economists the idea of a fixed objective measurement for distances was unquestionable since the axioms of Euclidean

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[13] Ibid. p.19

[14] Knight, F.H. (1964) p.279

geometry had stood unchallenged for millennia, however it is precisely at the time they are writing when this traditional edifice begins to crumble.[15]

In the nineteenth century, the equilibrium dynamics of the law of large numbers and the principle of least action are marshalled as a means for reducing the costs of the punitive maintenance of order. Though the actions of individuals and crowds may be hard to predict and control, certain regularities emerge from the analysis of the population taken as a statistical mass, enabling disciplinary supervision according to parameters. The feudal mode of direct dominion over the physical bodies of subjects and their fixed positions (geographical territory and social status) thus gives way to a modern mode of indirect command over the informational body of the population and their dynamic movements.

It is also at the same time that Lagrange applied differential calculus to the theory of probabilities resulting in the formulation of a calculus of variations that updates classical mechanics through the application of the principle of least action (the parsimony of nature) so that the dynamics of energy and momentum may be described. A further important development at this time was Laplace's generalisation of Bayesian probability theory, joining a mathematical system of inductive reasoning based on statistical probabilities to the differential calculus of mechanics, allowing for a much finer capacity for the prediction of complex systems according to a 'corpuscular-kinetic' world-view. The mechanics of necessity were thus wedded to the contingent dynamics of probability.

Laplace advocated an absolute causal determinism where he thought it was in principle possible to calculate a single equation describing the mechanistic trajectory of all reality such that the position of any body at any time could be probabilistically predicted with the accuracy and

[15] Mirowski, P. (1991) pp.186-188

necessity of a well-ordered mechanism. Hamilton later added to the formalisation of Lagrangian mechanics (using Leibnizian *vis viva* in his notation, and generalising the principle of least action), in effect completing the variational principle with such precision that it still forms the basis of quantum mechanical calculations. However, variation was just part of a wider dialectic that was yet to be realised: 'Hamilton's variational principle was only one side of a two-sided formalism; until the conservation principles were accorded equal status, it just was not clear what the Hamiltonian meant for physical theory.'[16]

As industrialisation ramps up in Britain following Watts' improvements to the steam engine, it is the French military engineer Carnot who catalyses the scientific revolution in the understanding of energy through his attempt to theorise an engine of maximal efficiency (1824). Carnot begins by presupposing the impossibility of a perpetual motion machine. In abstracting from the specifics of steam engines he produces an idealised model giving the upper bound for the efficiency of *any* engine. Such a 'universal motor'[17] would require not merely the elimination of friction between its moving parts, but also that of heat loss through conduction between parts of the engine with different temperatures.

The major innovation of Carnot is to show that 'caloric' flows from a hot to a cool body and that reversing this process cannot be achieved in an engine without a net increase in the work required. While the concept of irreversibility now naturally brings to mind the build-up of pollution and the tipping-points of global warming and mass extinction, the take home message of Carnot's imaginary device in the nineteenth century was the ineradicable cost and the unavoidable necessity of work: *nihil fit ex nihilo.*

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[16] Ibid. p.35

Twenty years later a flurry of independent scientists proclaim what retrospectively appear to be prototypical versions of the first law of thermodynamics. Indeed, this is Kuhn's major example of 'simultaneous discovery' typifying a 'paradigm shift', however, as Mirowski argues, it is not at all clear that they make a *discovery*, nor that they discover the same thing. The rhetoric of independent objective identification simplifies and reifies a complex process of collective scientific construction.[18] Without going into all the details here it is necessary to mention two points. Firstly, an important impetus for these developments comes from Joules' demonstration of the connection between mechanical power and heat, enabling their quantification under a single metric.[19] Secondly, of all those involved in the formulation of the concept of energy, the principle articulation is due to Helmholtz, who proposed a unified conception of *Arbeitskraft* (labour power or force) bringing together mechanics, heat, light, electricity, and magnetism.

More importantly, Helmholtz may be credited with synthesising the conservation principle describing the protean concept of energy with the variational principle predicting the motion of physical bodies (Lagrange, Hamilton) and understanding this together with the intrinsic directionality of irreversible processes (Carnot).[20] Condensing this double-sided formalism, Clausius would later coin the term *entropy*, rendering Carnot's insight as the second law of thermodynamics (where the essentially reversible principle of the conservation of energy is understood as its first law) and extending its scope to cosmic proportions. 'The energy of the universe is constant. The entropy of the universe tends to a maximum.'[21]

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17 Rabinbach, A. (1992) *The Human Motor: Energy, Fatigue and the Origins of Modernity*. University of California Press. p.45

18 Mirowski, P. (1991) pp.30-53

19 Ibid. p.43

20 Ibid. p.52

21 Clausius, R. (1879) *The Mechanical Theory of Heat – with its Applications to the Steam Engine and to Physical Properties of Bodies*. John van Voorst.

The quantification of labour power under the concept of Arbeitskraft made possible by the materialist conception of energy coincided with the beginnings of a radical critique of the political economy, most famously by Marx. Marx maintained, and even strengthened the claims of the labour theory of value, however he rejected the notion that the free action of economic actors tended towards the common interest. While Smith and Ricardo had understood political economy as a natural mechanism that tended to benefit the general populace, Marx drew on the dialectical method of Hegelian philosophy (though with the other 'young Hegelians' he rejected its idealist metaphysics) to argue that political economy is the ideology of the ruling class. Marx notes that while the principle of least action holds for the cost of production (i.e. it naturally tends towards parsimony) capitalist productivity is wasteful of human lives.[22]

In some sense, Carnot's proof of the ineliminable waste of any mechanism, and Clausius' cosmic generalisation of entropy maximisation, captured the nineteenth century zeitgeist, and ushered in a pervasive sense of irreversible social decline.[23] In another sense however, the limitation to absolute efficiency indexed by Carnot merely justified squeezing every last drop of energy from the exhausted proletariat in a push to maximise labour outputs, and the protean concept of energy rendered nature an immense 'standing reserve' ready for its conversion to work. These concerns would lead to the inauguration of a 'science of work' in France, which attempted to improve working conditions by reducing labour inefficiencies and the causes of fatigue. However, the program of waste elimination in the organisation of labour was most effectively executed by Taylor in the late nineteenth century resulting in the Fordist model of standardised production on a moving assembly line.

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22 Cohen, G.A. (2005) *Karl Marx's Theory Of History: A Defence*. Oxford Univ Pr (Sd); Expanded Edition.

23 Rabinbach, A. (1992)

As the laws of thermodynamics diffused into the scientific community, and the popular imagination, a new movement - *energetics* - arose that claimed the unlimited transformability of energy could unify *all* the sciences (including the new social sciences dealing with political economy) and dispense with the reliance on the ancient concept of matter by reducing it to energetic processes. Led by Ostwald, the energeticists elevated the conservation principle to absolute proportions, extenuating the variational principle and its mechanics (since this implies the collision of passive bodies composed of inert matter), and effectively dissolving the second law of thermodynamics.

Boltzmann and Planck are among the eminent scientists who castigate the incoherence of the energeticist assertions, in particular accusing them of failing to understand 'the distinction between a state function like energy and path-dependent quantities, such as physical work.'[24] Since the energeticists gave primacy to conservation principles, all processes appeared reversible, however it was beginning to become clear that it was the variational principle and the field of potential that would take primacy. Natural systems would be better modelled as having an intrinsic path-dependence or directionality.[25] The energeticist's timing couldn't be worse, since just as they were shouting about the substance theory of energy from the rooftops, down below in the labs the field theory of energy was quietly being assembled.

The mathematics behind the scientific concept of the field of potential can be traced back to Euler's work on fluid dynamics in 1743. Taking inspiration from Euler, Laplace then develops the formal structure in order to reduce the computational complexity of the Newtonian theory of gravitational mechanics, by treating gravity as a fluid field of potential rather than

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[24] Mirowski, P. (1991) p.56

[25] 'Ostwald wrote as though all irreversible physical phenomena…could be analytically interpreted as if they were composed of reversible phenomena; and he misunderstood the most basic attributes of the energy concept, namely, that energy must be a variable of state.' Ibid. p.56

balancing the accounts between point masses. However it is Faraday's application of fields to the understanding of magnetism that leads Maxwell to formulate his famous electromagnetic equations. In a surprising reversal of the usual order of influence, Maxwell claimed that his *statistical mechanics* had been motivated by the statistical framework of '*social physics*' promulgated by Quételet.[26]

The primary instrument for the empirical study of social physics was the method of least squares, which finds the best-fitting curve for a set of data points by minimising the sum of deviations from the norm (reducing the noise), yielding an error-minimized statistical mean (mathematics that had been developed by Legendre, Gauss and Laplace). Applying these tools of probability theory and statistics to sociological data (taking people as homogenous particles or as random variables to which a value may be assigned), Quételet was able to calculate the most 'correct' person; in the sense of the *expected value* we saw earlier, where for example 3.5 is the expected value of a dice throw.

According to Quételet, the average man is the centre of gravity of the nation, and the man who oscillates most closely to this mean is morally and intellectually superlative. 'For Quételet, there is a certain *excellence of the average as such,* whether in the order of the Good or the Beautiful: the most beautiful face is that obtained by taking the average features of the whole population, just as the wisest conduct is that which best approaches the set of behaviours of the average man.'[27] Effectively, the mean is the signal and everything else in noise.

As Mirowski argues, we may now retrospectively understand the classical substance theories of value as being a kind of 'proto-energetics', in the sense that they assert the

[26] Ibid. p.257

[27] Châtelet, G. (2014) p.42

mechanical production of value based on an entirely reversible equilibrium dynamics. Though Marx began his magnum opus at a time when conservation principles were ascendant and the concept of Arbeitskraft appeared to explain all phenomena, the field theoretical understanding of energy had already supplanted its substantialist interpretation by the time he had finished writing Capital. His labour theory of value displays this fracture at its core; for many this means that his economic theory is fatally flawed by inconsistencies, for others this is its great merit. The important point to realise here is that both Marx and Helmholtz were active in bringing the substantialist conception of value and energy to their respective nadirs, yet they also presided over the transition to one based on field theory.

Shortly after this transition, in the 1870's, there is again what is retrospectively conceived as independent 'simultaneous discoveries'; Walras, Jevons and Menger are most often credited as founders of what is now called neoclassical economics (after Veblen coined the term); again it is not clear that they *discovered* the same thing, however what unites them is the relinquishment of a theory of labour value based in the primacy of productivity and its replacement with a theory of use value (utility) based on scarcity and subjective preferences for consumption. 'Both energy and utility were based on large-scale prohibitions of "something for nothing": perpetual motion was banished in physics; natural scarcity was reified in economics (Brown 1987). Both elevated extremal principles to teleological research heuristics. And both proclaimed the dawn of a new era of unified science.'[28]

[28] Mirowski, P. (1991) p.218

3.3

Thermocratic Commodity Spaces and Groping Auctioneers

According to Walras, though utility preferences are subjectively held, they could be objectively gauged according to the maxima and minima of supply and demand curves, and this data could be plotted on a graph representing *commodity space* where forces and scarcities are vectors, and energies or utilities are scalar quantities.[1] The marginalist revolution builds on Walras' general equilibrium theory, further formalising the mathematics as marginal utility theory (Gossen and Marshall), where margins are considered infinitesimal differences in the gain or loss of utility. However, despite the complex mathematics and the use of field theory tools (vectors, scalars, fixed point theorem) neoclassical economic theory continues the proto-energetics stance of classical economics, it is merely dressed up in the garb of field potentials.

The system of forces is understood as essentially tractable to calculation according to a Laplacian vision of absolute predictability in plotting the dynamic trajectories of random variables (i.e. the classical dynamics of integrable systems). Technically speaking, the commodity space is an irrotational conservative vector field, where path-independency is taken as given (time is isotropic), supply is taken to equal demand, and prices are uniformly fair.[2] This fundamentally overlooks variational principles, the ubiquity of path-dependent irreversible processes, the non-equilibrium dynamics of risk and utility, and a non-denumerable quantity of other matter-energetic and informational asymmetries (such as negative and positive externalities).

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[1] Mirowski, P. (1991) p.220

[2] Ibid.

Just as classical physics is able to make exact predictions by discounting disturbing factors (noise) and making a number of simplifying assumptions, neoclassical economic theory is also founded on the assumption of certain simplifying conditions.[3] It assumes fully rational actors who have a set of choices and preferences by which they maximise their utility; commodity space assumes a state of perfect competition between traders; buyers and sellers innocently exchange in a state of perfect information symmetry (each knows as much as the other about the quality and cost of the product etc.); and, out of the chaos of the law of large numbers and the principle of least action, prices and utilities supposedly meet.

'Thus the Baroque Cauldron of chaotizing succeeds in incarnating the myth of auto-emergence, the myth of the i*nnocent transaction or operation*, forgetting that every such operation supposes - implicitly or explicitly - the putting in place of a (sometimes very brutal) apparatus of equivalence…Something has to be decided, then; there has to have been a *confrontation* - and perhaps struggle - and a symmetry that has been irreversibly broken.'[4]

Not long after the discovery of neoclassical economics, the scientific community received 'an abrupt awakening from the Laplacian Dream when Henri Poincaré demonstrated in 1889 that many of the most interesting problems in classical dynamics would never be converted into integrable systems [since]…certain well-defined problems, such as the generalised three-body problem, have no general Hamiltonian invariants that would facilitate their solution.'[5] Poincaré thus showed that the stability of the solar system, posited by Laplace as necessarily following from an analysis of its mechanics, was in fact a contingent effect of the chaotic

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3 These assumptions are confronted by later neoclassical theory, however, even in attempting to account for asymmetries the fundamental presuppositions of a Laplacian universe are kept intact. See for example: Knight, F.H. (1964) p.8

4 Châtelet, G. (2014) p.31

5 Mirowski, P. (1991) p.72

movements of the bodies that composed it. He discovered non-linear resonance effects in three-body orbits, whose 'complex irreducible spectral representation'[6] demonstrate the limits of the classical dynamics of trajectories and make possible a reconceptualisation of the laws of physics according to symmetry breaking or irreversibility.

The most important consequence of Poincaré's result was that the classical conception of physics, in which determinism was equated with predictability, and objective knowledge implied both, was shown to be false.[7] He proved the existence of fully deterministic systems whose evolutionary trajectory are incomputable. The three body problem can be determined by a relatively simple set of equations but that the output of the evolutions that this describes is non-linear or exponentially unpredictable due to the necessarily approximate nature of interval measurement in the physical continuum. He thus marks the origin of the 'geometricalization of physics', where geometry is to be understood as the measurement of bodies (whose basis must be 'manual'), by demonstrating the difference between 'the (low) equational complexity of the movement of celestial bodies and the (high) geometrical complexity of their evolutions, of their dynamics.'[8]

The computation of chaotic orbital complexity may often require a higher quantity of input data than its output describes, and since 'algorithmic information theory asserts that an output digit sequence is random if it cannot be computed by any algorithm (program) whose information content is less than that of the output…[then]…innate, irreducible, and incomputable randomness actually appears first in classical mechanics not quantum mechanics as

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[6] Petrosky, T. & Prigogine, I. (1993) Poincare resonances and the limits of trajectory dynamics. *Procedures of the National Academy of Science*, USA. Vol. 90, pp. 9393-9397, Oct. Physics.

[7] Longo, G. (2008)

[8] Ibid. p.23

popularly believed.'[9] Since only a small deviation below the threshold of measurement may magnify very quickly, and since the tools of measurement themselves must be understood as undergoing random fluctuations at the microphysical scale, 'the act of measurement introduces a small and uncontrollable error into the quantity being measured'.[10]

This 'universal noise level due to chaos' implies a 'generalized uncertainty principle',[11] however this uncertainty is far from constituting a critical impasse for speculative theories about the absolute, and on the contrary only serves to increase the discovery of invariants as rational tractabilities within this relativistic noise.[12]This inaugurated the study of non-equilibrium systems that would be later developed by Prigogine and Stengers in terms of the metastability of far-from-equilibrium systems, and to the establishment and popularisation of chaos theory after the discoveries of Lorenz and Mandelbrot.

However, the basic assumptions of neoclassical economics underwent no major revisions according to these revelations, and even within the scientific community classical dynamics was not generally seen as significantly compromised until the advent of chaos theory in the 1980's. These scientific discoveries have been frequently referred to, at least within the humanities, in a narrative about the collapse of determinism, the ineffectiveness of instrumental rationality, and the supposedly absolute, yet unpredictable, interconnectivity of all processes (the popular interpretation of the 'butterfly effect'). In fact, Poincaré's discovery was that of deterministic chaos, and the understanding of metastability and non-linearity that followed may be seen as

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9 Millican, P.J.R. & Clark, A. (Eds.) (1996) *Machines and Thought – The Legacy of Alan Turing Vol.1*. Clarendon Press. p.256

10 Ibid. p.259

11 Ibid.

12 Zalamea, F. (2012) p.166

triumphs of instrumental rationality, enabling the complexification of probabilistic reasoning and a heightened capacity for the modelling, modulation and control of risk.

Despite the tenacity of the core model of neoclassical theory, economics has certainly not stood still since the 1870's. For an understanding of noise in finance, it is necessary to refer to several important developments. Firstly, at the turn of the century Louis Bachelier published his seminal paper on the stochastic nature of the market,[13] where he showed that the random movements of prices on the stock exchange could be closely modelled by a Wiener process commonly known as Brownian motion; a random probability distribution corresponding to a specific *spectral density*: brown or red noise, which may be produced by integrating the offsets of white noise. However, Bachelier's work, like that of Poincaré's in classical dynamics, was largely ignored by practicing economists until the latter half of the twentieth century.

Since, as we have seen, economic theory borrows profligately from the hard sciences that it attempts to emulate, it should be noted that in the twentieth century there is a distinct shift away from the classical and neoclassical adoption of gravitational and energeticist images, towards new scientific hypotheses coming from psychology, information theory, cybernetics and AI. This turn towards a consideration of the finitude of systems is doubtless influenced by certain supposedly limiting results of modern science: Gödel's incompleteness theorem and the collapse of the Hilbertian project to secure the axiomatic foundations of mathematics in set theory, the extension of the incompleteness result by Turing to define the universal limits of computation, Heisenberg's uncertainty principle, Einstein's relativity theorem, and the rise of cognitive sciences.

[13] Drawing on the work of Jules Regnault who modelled the random character of stock prices as early as 1868. Bachelier, L. (1900) Théorie de la spéculation. *Annales Scientifiques de l'École Normale Supérieure* **3** (17): 21–86.

The Austrian school thus adapts the marginalist legacy of Menger, Böhm-Bawerk, and von Wieser, in arguing for a *subjective* theory of value (based on the maximization of utility) following from a premise of methodological individualism, where no individual has a totalized knowledge of the market. While von Mises' subjectivist praxeology leads him to reject all probability models in favour of *a priori* deduction, Hayek is more sympathetic to the neoclassical methodology of general equilibrium. Von Mises had been instrumental in developing a more sophisticated use of probability theory for economics, and took it as a founding axiom that a system could not be devised that would be capable of beating the market (equivalent to a martingale in the context of gambling), comparing it to the impossibility of perpetual motion[14] - as we have seen this allusion to the physics of energy is the most frequent metaphor undergirding classical economics, serving to entrench the dogma of the necessity of work as a natural law of economics.

For Hayek, though the individual financial actor faces uncertainty due to the local nature of their information supply and the finitude of their processing capacities, from the combined actions of all financial actors a superior form of collective intelligence emerges that he terms catallaxy. Catallaxy describes the way in which markets are able to aggregate information at a global scale. According to Hayek the aggregate output of the market effectively cannot be in error since there is no higher authority on prices than the market itself, no pricing mechanism external to it (this is its endogeneity).

Hayek enjoys some success in arguing that in a decentralised market, since economic actors are all acting on different information but nobody has access to the totality of that information, only the market price reflects all available information (i.e. the market *computes* the best price given all present knowledge). According to Hayek's argument, from this it followed

[14] Cavaillès, J. (2014) p.81

that no socialist form of centralized economic planning or control could achieve the optimality of the decentralized market, in terms of achieving the most efficient allocation of resources.

Neoclassical theory is predicated on the assumption that supply and demand curves will converge at equilibrium due to the stochastic effect of the independent identically distributed (iid) random variables composing the market. Of course, the random variables in question (i.e. persons) are neither independent nor identically distributed. The Great Depression and the massive unemployment that followed in its wake would seem to necessitate a reconsideration of the belief in the natural tendency to equilibrium. Indeed, the 1930's saw the rise of Keynesian economics, which was predicated on a much more fundamental uncertainty, and advocated state intervention (an active stabilization policy) of the market in order to control the non-equilibrium dynamics of aggregate demand (i.e. its excess or scarcity), whose structural imbalances would otherwise naturally lead to cycles of boom and bust.

There is uncertainty for Keynes firstly because we do not know all available information, or because that information has not yet been generated, and this means that price movements or economic actions must exceed rational calculation, being determined rather by mood or opinion. 'Both [Keynes and Simiand] reject the possibility of treating the relationship to the future in terms of an objective probabilistic calculus, both emphasize the inescapable subjectivity of individual expectations and, as a consequence, the social context in which opinions are formed.'[15] Secondly, there is uncertainty because the market is a self-referential system (or endogenous pricing mechanism); this is illustrated by his famous beauty contest analogy, where winning depends on judging the average opinion of others rather than the beauty of the contestants. The

[15] Orléan, A. (2014) p.136

important point here is that, in Keynes' analogy informed and uninformed actors; the latter of which Fischer Black will later call 'noise traders';[16] both equally determine the outcome.[17]

Over the course of the twentieth century the theory of general equilibrium (GET) gets challenged and modified numerous times to account for simplifying assumptions and inconsistencies. A shift in focus from the market to the firm reveals that profits are not maximized as they should be; this deficiency is accounted for by adjusting the assumption of perfect information. Coase, in particular, argues that the function of the firm is to minimize or reduce the costs of transaction, and that transaction costs arise because of imperfect information. This is another amendment to the strict model of general equilibrium, which assumes no transaction costs.

A further important development comes from Herbert Simon, who draws on the biological and computational sciences to argue for an informationally constrained form of rational optimization. According to this relaxation of the rigidity of GET, actors are not perfectly rational and no longer maximize utility, instead they are boundedly rational and *satisfice* utility preferences. That is, they make decisions concerning expectation or preference according to given constraints, which include the cost of gathering and processing information. Rather than exhaustively analysing the expected utilities of all commodities according to a formal calculus, agents use heuristics to reduce the computational complexity of the task, such as exploiting environmental regularities (identifiable patterns associated with quality, certifications, brand names and endorsements).

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[16] Black, F. (1986) Noise, in *Journal of Finance*, Vol. 41, Issue 3, Papers and Proceedings of the Forty-fourth Annual Meeting of the America Finance Association, New York, Dec 29-30, 1985 (Jul.), 529-543.

[17] Orléan, A. (2014) p.213

Though the theory of bounded rationality goes against many of the assumptions of GET (where there are no costs for information, utility is maximized, and rational decision is perfect up to an infinitesimal marginal difference), it effectively enables the modification of its structure to account for some of the complexities the inherited model could not. Its great merit was to achieve this in a way that is mathematically tractable, and moreover, amenable to computational simulation in a game theoretical form. Indeed, Simon's theory of bounded rationality was not only influential for economics; inspiring work in transaction cost economics, the theory of the firm, game theoretical or computational economics and evolutionary economics; and for biological science, from whose context it was originally drawn, again due to the practices of modelling and simulation it sets the constraints for; but furthermore it was also foundational for the discipline of AI.

Keynesian interventionism, and its assumptions of non-equilibrium dynamics and fundamental uncertainty, was countered by advocates of the free market such as members of the Mont Pelerin Society (Friedrich Hayek, Ludwig von Mises, Milton Friedman) and later of the Chicago school (including Eugene Fama and Frank Knight). While these theorists relinquish the dogma of general equilibrium theory and its complex mathematics, there is a cautious acceptance of partial equilibrium theories, and the broad outlook of neoclassical economics is resuscitated on the basis that the aggregate effect of *bounded* rational decisions by financial agents with imperfect information in the market leads to greater efficiency than any decisions taken by the bounded rationality of individuals within the state apparatus (e.g. meddling economic advisors like Keynes).

In the 60's Fama formulates this premise as the efficient market hypothesis (EMH), which states that any strategy taken by a financial agent cannot win in the long term against the stochastic efficiency of the free market's global information processing dynamics. Fama understood efficient markets as reacting instantly to new signals, and unproblematically reflecting all available information. Samuelson offered a final reinforcement to efficient market hypothesis by showing that stock prices follow a random walk, thus reviving and formalising the earlier claims of Regnault and Bachelier.

Samuelson's article 'Proof that Properly Anticipated Prices Fluctuate Randomly' showed that price changes are unpredictable and random if the market is truly efficient, since if all predictable price movements are discounted by arbitrage the only price movements left must be entirely random.[18] 'The efficient market hypothesis entails the random walk, because any predictable future price would by anticipation be traded in the present spot, leaving for the future only the unpredictable.'[19] In the eighties the static nature of general equilibrium theory was updated to account for temporal dynamics, yielding Dynamic Stochastic General Equilibrium theory (DSGE).

Despite the rhetoric of radical emancipatory politics, Attali's 'Noise: A Political Economy' should be read as an 'anarcho-mercantilist' endorsement rather than a critique of political economy, in the sense that, like the classical and neoclassical theorists before him, he considers that a beneficial world will emerge from the creative noise composed by the aggregate effect of social behaviour if only it is 'let be'. Certain telling remarks reveal the 'putrefaction of liberationist ideas'[20] that lies behind his discourse, for example he claims that the utopian overcoming of alienation (which he locates in usage rather than production) prophesied by

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[18] Farmer, D. and Lo, A. (1999) Frontiers of finance: evolution and efficient markets. *Proceedings of the National Academy of Sciences*. 96, 9991–2.

[19] Ayache, E. (2014) The Writing of the Market, in (Ed.) Mackay, R. *Collapse: Philosophical Research and Development.* Vol. VIII. Urbanomic. pp.584-585

[20] Châtelet, G. (2014) p.120

music requires the renunciation of all goals in favour of an aimless compositional twiddling, a 'doing for the sake of doing'[21] leading to a 'reconciliation between work and play'.[22]

Attali explicitly phrases this as a *reversal* of the usual order of labour, which traditionally begins with an aim and finishes with a product. Instead, he proclaims that from the aimless random productivity of free play the future will emerge like the equilibrium of the market from the aggregate of stochastic trades. It should come as no surprise then that Attali has been instrumental in the economic policy decisions of Mitterrand, Sarkozy, and Hollande, in the capacity of financial advisor. There is no better example for Châtelet's critique of the 'imposture of chaos' than Attali and his enthusiasm for the plugged-in switched-on nomads whose inane fluidity and 'elegant reversibilities' constitute the new regime of political economy.[23]

The presupposition behind Attali's championing of the 'coming world order' is precisely in line with the recommendations of the Club of Rome in assuming the cybernetic organisation of life to spring from a creative symmetry (after all, even the most wretched prole is *free to create*) and to work against the generalised diffusion towards disorder. Above all, the imposture of Attali's political economy is its 'aim to *mask a crucial dissymmetry* in the givens of a problem…in order to stage the Miracle of auto-emergence…Dissymmetry is given from the start, which vitiates the theses of the "Gardeners of Chaos" who would see in such examples a "refutation" of Boltzmann's principle of increasing entropy.'[24]

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[21] Attali, J. (2003) p.134

[22] Ibid. p.141

[23] Châtelet, G. (2014) p.121 Indeed, he explicitly refers to Attali as 'one of the most zealous acrobat-intellectuals of the future global neurocracy'. Ibid. p.115

[24] Ibid. p.32

Châtelet excoriates Attali's optimistic calls for a 'new civil society'[25], labelling it a 'thermocracy' that, with the help of the cybernetic optimisation of communication networks, quickly becomes a 'neurocracy'.[26] Published in 1998, Châtelet's 'To Live and Think Like Pigs' is a prescient critique of the contemporary neoliberal hegemony, led by Silicon Valley's mantra that 'information wants to be free', and by the 'ideology of transparency' that has solidified after the phenomenon of Wikileaks and other high-profile cases of whistleblowing. Since no amount of transparency can ever communicate everything, the culture of openness and sharing often has the reverse effect of further obscuring the violent asymmetries that have been hidden. As Châtelet remarks, 'to the paradox of the perfect market "no competition in a situation of perfect competition" - corresponds the paradox of the perfect communication: "Perfect communication communicates nothing!" [The rational anarchist or visionary executive] is merely fatuously aping Walras's favourite fiction of a perfect market with neither friction nor violence'.[27]

The communication of information and the exchange of commodities not only rest on asymmetries but also actively cause them, and this can be readily seen in the contemporary ICT revolution. The acceleration of communication flows and the freeing up of information, both ensuing from and culminating in an equilibration and homogenisation at a massively extended scale (online globalisation), has also resulted in colossal new asymmetries that remain entirely opaque to the 'cyber-Gideons' on their networked terminals. Moreover, the huge growth of these apparently negentropic data industries has not led to any reduction in entropic throughput, just as 'Jevon's paradox' predicts. Though 'the cloud' has an air of cool and tranquillity the server farms that make it possible devour energy and exude heat.

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[25] Attali, J. and Stourdze, Y. (1977) The birth of the telephone and economic crisis: the slow death of monologue in French society, in De Sola Poole, I. (Ed.) *Social Impact of the Telephone*. MIT Press.

[26] Châtelet, G. (2014) p.68

[27] Ibid. p.125-126

The first economist to really take the entropy law seriously was Georgescu-Roegen,[28] who repositioned it as the basis of the economy of life at all levels, thereby founding a heterodox perspective he called thermo-economics. This replaced the orthodox presupposition of equilibria and path independence with a fundamental directionality populated by imbalances and instabilities that were endemic, pervasive and inescapable. As such, he may be understood as a founding voice in contemporary heterodox accounts, such as evolutionary economics, bioeconomics, ecological economics, econophysics etc.[29] Georgescu-Roegen criticised mainstream economics for maintaining an approach based on classical Newtonian mechanics, where all processes are predictable, deterministic and essentially reversible.

Mirowski adds detail to this argument by showing that neoclassical economics is better described as a kind of proto-energetics that draws on certain field formalisms while sustaining an isotropic Laplacian image of time.[30] While post-industrial decline and climate change make it impossible to maintain such a viewpoint in *practical* terms (indeed this is clear even with Jevons' early preoccupation with resource depletion in 'The Coal Question'), economic *theory* is today still dominated by a presupposition of reversibility that puts aside all forms of friction and noise within the economic model, allowing the mechanism of the Invisible Hand to smoothly and silently determine its indifference curves without disturbance.

Evolutionary economics and bioeconomics are formulated in explicit rejection of the simplifying assumptions that are built into the orthodox picture of market objectivity. These include: general equilibrium theory, maximal utility theory and the convexity of preferences,

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28 Georgescu-Roegen, N. (1971) *The entropy law and the economic process*. Harvard University Press.

29 Bonaiuti, M. (2014) *The Great Transition*. Routledge.; Georgescu-Roegen & N., Bonaiuti, M. (Eds.) (2011) *From Bioeconomics to Degrowth: Georgescu-Roegen's "New Economics" in Eight Essays*. Routledge.; Farjoun, E. & Machover, M. (1983) *Laws of Chaos: a probabilistic approach to political economy*. Verso.

30 Mirowski, P. (1991) p.275

perfect information, the law of one price, linear time series, and passive price taking. The mathematical models presented by these postulates are not in question, neither is the concrete traction that such models provide for an analysis of financial systems; orthodox theory is not an entirely incorrect portrayal of the economic process, but it is an idealised image in which all the complexities, the friction and the noise have been expunged or smoothed over. Moreover, the model is not a neutral window onto the world but a technology with performative effects.

Standard neoclassical economics is a functionally adequate model but only when the actual conditions are abstracted to resemble what has been called the static state. Leaving aside for now the psychological and philosophical problems with the utilitarian postulate and the maximising efforts of the market isolated rational agent, the data from real economies simply doesn't fit. There are evolutionary and ecological dynamics, emergent properties, and entropic processes that cannot be accounted for by what amounts to a mechanical theory of reversible change in the classical image. It is precisely because the economy exhibits non-equilibrium dynamics, frequent positive feedback effects, and ubiquitous path-dependent irreversible change that standard neoclassical economics should be treated as a crude approximation at best, and mostly a gross ideology that conceals its violence in a rhetoric of freedom.

Georgescu-Roegen understands the economy as a process that facilitates the transformation of available free energy into unavailable bound energy. The former may be understood both as specific concentrations of low entropy material-energetic structures, such as oil or gold; while the latter is exemplified by waste, pollution, and highly diffuse forms of matter–energy such as heat. The true novelty of Georgescu-Roegen's formulation lies in his proposal for a fourth law of thermodynamics, where it is not only energy that is subject to decreasing returns, but also matter. This is evident in the depletion of various non-renewable material resources such as coal and the rare earth metals used in smartphones and laptops, but should also include resources like fresh water that can be renewed but at a significant cost (matter-energetic as well as financial).

Just as all energetic transformations entail a certain quantity of waste through the diffusion of heat and the friction of moving parts, so friction and diffusion expend the stock of available matter. While heat is the most entropic form of energy, a fine dust of well-mixed different molecular and atomic combinations has the highest entropy for matter (similar to the 'grey goo' of decomposed particles that Drexler famously thought unregulated nano-bots might cause[31]). Georgescu-Roegen thus identifies an ultimate supply limit of low entropy matter–energy: a source of absolute scarcity consisting of a terrestrial stock and a solar flow.[32]

Just like a biological process, the economic process can be thought as a modulation by which a certain dissipative system maintains itself by tapping a gradient, allowing it to 'input' available energy and 'output' bound energy, where the flow from input to output is termed throughput or metabolic rate. A gradient is a differential; such as that between hot and cold (an energy gradient), or between disparate prices (an information gradient); the value of which can be extracted. Tapping a gradient requires the expenditure of energy and results in a net increase in entropy.

In the case of information gradients this is not obvious. The tapping of a price differential on an electronic trading network produces negligible entropy in itself; however, it has an impact on material processes, and ultimately the aggregate effect of such arbitrage amplifies throughput at a global level. According to this view, although information processing is a low

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31 Drexler, E. (1988) *The Engines of Creation: The Coming Era of Nanotechnology*. Non Basic Stock Line.

32 Burkett, P. (2006) *Marxism and Ecological Economics: Toward a Red and Green Political Economy*. Brill.

entropy function, an organism or social institution engages in it in order to increase throughput and maximize its efficiency.

As more efficient methods are developed to exploit a certain resource, this can lead to an increase rather than a decrease in its exploitation. For Jevons this was a paradox that could only be explained by the tendency of supply and demand curves to approach equilibrium, so that an increase in supply would be met with an increase in demand. However, if we understand this effect within the wider picture of thermodynamics and evolutionary dynamics, there is no paradox and no formation of a stable equilibrium. According to such theories, the reasons for throughput amplification are deeper than economic and further than the biological drive to satisfy needs, they are driven by physics, depending upon the fact that humans, and the larger economic agencies that we create (corporations, banks, etc.), are dissipative structures.

3.4

The Voluminous Pit of Menard

There is a complex dialectic between the 'power of the multitude'[1] on the one hand and the fundamental (smallest) units of intelligent behaviour on the other (sapient rational agents engaged in inferential decision-making).[2] The former is engaged in a delirious process of (fetishistic) collective representation[3] and mimetic polarization[4] as well as the construction of institutions and the cumulative reasoning of the recognitive community.[5] Individual rational agents act within the constraints imposed by the social institutional framework, making inferential commitments and strategically employing mimetic behaviour according to cues and signals they are able to disentangle from the global information excess using a range of inferential strategies from implicit practical heuristics to explicit propositionally defined rules.

The price process does not reflect a 'true' value that lies behind price fluctuations like an invariant substance, but is rather the dynamic and contingent output of all these information processing strategies. Pricing is a measure of confidence or uncertainty in the double situation of information excess (information that is extraneous to the signal or misleading) and information scarcity (lack of information due to epistemic finitude or objective unpredictability). It is a process engaged in the self-referential (second-order) dynamics of risk assessment, which is both performative and counterperformative, rational and mimetic. Making decisions according to the

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1 Lordon, F. (2014) *Willing Slaves of Capital: Spinoza and Marx on Desire*. Verso Books.

2 Wolfendale, P. (2014) *Beauty, Justice, Acceleration*. Lecture at PAF, Get Reassembled. Accessible online: http://bit.ly/1IkF6EV

3 Orléan, A. (2014)

4 Following Girard's mimetic theory of desire, as developed by Orléan with regard to economics. Girard, R. 'Deceit, Desire and the novel: Self and Other in Literary Structure.' Freccero, Y. (trans.), Stanford University Press, 1961.; Orléan, A. (2014)

signals and cues of others (mimesis) is not opposed to reason because rational decision-making is bounded rather than global and strategic rather than parametric.

If we define noise as that which lies outside of expectations, or is not included in a probability model, then noise is relatively common, and is mostly unimportant. In the terms of information theory, noise is ubiquitous and ineradicable in every situation, channel or medium of communication, and is *insignificant* by definition (in opposition to the signal). In this sense, noise is generally made up of trivial details; they are not expected or not included in models because they pose no threat to the integrity of the system or the attainment of its ends.

Several humanities texts on noise have directly opposed this information theoretical definition by arguing for the significance of noise,[6] or by claiming that 'noise matters'.[7] While they generally mount no explicit critique of Shannon's work the argument at least implicitly suggests that the understanding of noise in information theory fails to account for meaning, is overly scientific in the reductive sense, as well as being an anthropocentrically imposed framework of measurement that material processes exceed.

Firstly, the success of information theory rests on its abstraction from meaning so this cannot be considered a shortcoming. Secondly, though we should agree that noise may often include significant data, as soon as it is understood as such it can no longer be thought as noise. Thirdly, that noise is caused by material processes including fluctuations below the threshold of measurement is hardly a revelation and in no way goes against the basic premises of information theory, certainly not against the ongoing synthesis of information theory, dynamic systems theory, complexity theory, etc.

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[5] Brandom, R. (2009) *Reason in Philosophy*. The Belknap Press of Harvard University Press, Cambridge, Mass.

[6] Kahn, D. (2001) *Noise, Water, Meat - A History of Sound in the Arts*. The MIT Press.

Information processing systems, particularly complex evolved information processing systems such as humans, must always discriminate between signal and noise, they cannot evade the necessity to abstract and compress information. The interesting questions concern what the criteria are for these decisions; at what cognitive levels are they occurring (unconscious pre-attentive neuro-computational, non-conceptual phenomenal, conscious semantically mediated thought and behaviour, and metacognitive processes involving all such levels); and how much traction is possible on these processes in terms of theoretical and practical reason. What is therefore required is an examination of the construction and revision of models and the derivation of expectations in accordance with them, rather than an affirmation of randomness or critique of rational modelling.

Understanding this means attending to the complex dialectics of scarcity and excess in the administrative economics of information processing systems. The higher the complexity of the information the greater is its processing, storage and retrieval cost; the more that this can be effectively compressed through abstraction, the cheaper it becomes to manipulate and coordinate this in connection with other information. As we have seen, the pertinent measure for the high cost of this informational excess is not Kolmogorov-Chaitin complexity (algorithmically incompressible randomness), but a statistical complexity that lies between randomness and order.[8]

We anticipate the unforeseen, make allowances for contingency, and continually alter our expectations according to new information. However, we do not know what we do not know, and sometimes these 'unknown unknowns' can completely transform the entire context in which

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[7] Hainge, G. (2013)

[8] Crutchfield, J.P. (1994)

we evaluate expectations. Following Nassim Taleb's popular account, these events are known as *black swans*. According to his definition they have three characteristics: they are outliers whose extreme improbability given past data leads us to ignore them, they are high impact phenomena that dramatically change our perspective on possibilities, and they are retrospectively incorporated into a narrative in which they are explained, leading to the feeling that we should have been more alert to their probability.

A black swan in this sense is the sudden emergence of significance from the noise of trivialised probabilities that have been discounted due to their presumed unlikelihood. The destruction of the twin towers is a prominent example for Taleb, as are the collapse of the Soviet Union, and the financial crashes of 1987, 2001 and 2007. In fact, Taleb claims that black swans are relatively rare for most of human (pre-)history, but that there is a marked upturn in such events after the industrial revolution, and an increase in their frequency and consequences since the ICT revolution.

He argues that the theoretical basis of this practical problem has a long history in philosophy (recall the Socratic question 'how do we know what we know?'), having been fundamental to the Pyrrhonian school of sceptical empiricism, taken up again by Al-Ghazali, resuscitated in a modern context by Hume, and coherently formulated in mathematical logic by Russell as the 'Problem of Inductive Knowledge'.[9] A classic example that Taleb draws on is of the turkey that associates the farmer with food until one fateful winter's day. The consequence of the insolubility of the problem of induction is that for any given regular sequence of events, rules of association may be derived, and explanations concerning causes and effects, however such rules and explanations do not constrain events from following another entirely unexpected course.

The epistemic opacity that follows from this has been successfully formulated across multiple disciplines (Taleb calls it the 'Berra-Hadamard-Poincaré-Hayek-Popper conjecture'),[10] but is widely ignored or misapprehended by institutions, corporations, and individuals in the finance sector.[11] Much of this reckless disregard can be explained by the necessity of concocting an optimistic sales pitch, however it is also a legacy of what has been called the 'autism' of mainstream economic theory.[12]

Taleb identifies several fallacies and biases that are the principle causes for this 'black swan blindness'. The *evolutionary adaptation* of our cognitive and sensory mechanisms is naturally geared toward guarding against probable rather than improbable threats; since the scale at which we interact with the world is usually linear (a small cause produces a small effect) we tend to think in linear terms. We tend to infer a rule from observation of a time series, and then act accordingly, thereby confirming our assumptions without checking alternative hypotheses. This leads to *confirmation bias*, where the inference is bolstered by successful action on its basis leading to the belief that it constitutes knowledge when it has not been systematically falsified (this is not to claim that all knowledge must be falsified).

There is a tendency to deal with unexpected events by embedding them in an explanatory story that reduces their improbability by retrospectively aligning the old context within the new one; Taleb calls this the *narrative fallacy*. Since failed strategies and assumptions are

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[9] Taleb, N. N. (2007) p.40

[10] Ibid. p.136

[11] Ibid. p.223

[12] Mainstream economics is characterised as autistic due to deficits of communication, social interaction with other disciplines, preoccupation with mathematical fantasy, language impairment limited vocabulary, an excessive attachment to certain objects, i.e. assumptions and models. Fullbrook, E. (Ed.) (2007) *Real World Economics: A Post Autistic Economics Reader*. Anthem Press. p.199

often unreported, there can be an undue focus on successful cases; he refers to this as distortion of information due to *silent evidence*. This is sometimes called *survivorship bias*, a kind of selection bias related to the '*self-sampling assumption*', which is the principle behind both the '*Casanova bias*' and the '*anthropic bias*' in cosmological probability models. Taleb calls the overestimation of known risks 'tunneling', meaning that other possibilities are overlooked because of the focus on 'well-defined sources of uncertainty'.[13]

There is also what he calls the 'round-trip fallacy', which is effectively the mistaking of a contingent inductive fact of observation (defeasible, non-monotonic) for a deductive fact with intersubstitutable terms (non-defeasible, monotonic). For example, a study that finds *no evidence* of sharks off the coast of Australia does not entail there is evidence that *no sharks* visit that area. In fact, though he makes little of this fallacy, it is what underlies the whole book and its central metaphor, the black swan. Before the discovery of black swans the proposition 'all swans are white' could be considered factually true, however this was a defeasible truth since, though they were unprecedented in experience, there was no a priori reason for the inexistence of different coloured swans.

If the seventeenth century discovery of black swans was such a shock to Europeans it was because they had mistaken contingency for necessity. Taleb's central complaint is with what he deems to be a 'Platonic' tendency to rely on the truth of categories (for example, the category swan with the attribute white). Passing over this misreading of Platonism, his argument is that since categories always produce a 'reduction in true complexity' they thereby *generate* black swans.[14] However, his recognition that black swans increase from modernity onwards does not prompt him to problematise his (apposite yet crude) attack on the dogmatic fixation on

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13 Taleb, N. N. (2007) p.50

14 Ibid. p.16

categories; he thus fails to acknowledge either the necessity of abstraction (complexity reduction) in a situation of increasing information saturation, or to adequately address the processes of second-order observation and mimetic contagion that lead to the generation of black swans in highly interconnected systems.

Before examining these shortcomings it is necessary to describe another category mistake that is central to the notion of the black swan, which Taleb calls the 'ludic fallacy'.[15] This is what underlies the widespread delusion leading to the treatment of the market as a closed system of possibilities from which certainties can be derived using a Gaussian framework. It is called 'ludic' because it follows from the misapprehension of the market as analogous to a game such as chess, in which the possibilities are large but finite and totalizable, and thus price variables are computable as statistical probabilities. As we have seen the Gaussian distribution enables the computation of variance from the square of the sigma, or 'standard deviation'[16], so that though price movements are stochastic, the degree of randomness can be calculated allowing risks to be offset.

According to Taleb there are several problems with this approach, the main issue being the way in which the mathematical certainty that it promises encourages traders to forget all those other fallacies and biases already mentioned. More specifically, Gaussian distributions just don't fit many real world situations, which are often dominated by very different probability distributions, and this is especially the case in the contemporary situation due to globalization and ICT.

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15 Ibid. p.127

16 Ibid. p.239

Some data sets, such as human height or weight distribution, can be successfully analysed using the Gaussian method, since individuals are closely correlated with the average emerging from the aggregation of all variables. However, other data-sets, notably those that function through networks and contagion, such as mobile phone sales, best-selling books, income distribution and internet hit rates, are scale-free and can only be approximated using power laws. The latter have many different, generally fractal, probability distributions, and can be modelled using Pareto-Zipf laws, Yule's law, Mandelbrotian algorithms, and Barabasi-Albert algorithms.[17]

These non-Gaussian probability distributions have been observed and formulated across many disciplinary contexts. This has been shown in biological systems by Willis and Yule,[18] in income distribution by Pareto, in sociology by Merton (the 'Matthew effect' of cumulative advantage),[19] in language by Zipf,[20] in finance by Mandelbrot and Hudson,[21] in network theory by Strogotz and Watts (small-world model), and by Barabasi and Albert (preferential attachment model). Though there are clear distinctions between these different distributions and their contexts, the underlying logic uniting all these phenomena is a generative mechanism of preferential attachment developing through cumulative advantage.

In fact it was Herbert Simon who first put forward a generalized conception of preferential attachment. As Taleb notes, in the case of commodities these probability distributions are significantly increased by industrial production, and massively exaggerated by the networked ubiquity of information. Though such scalable probability distributions have only

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[17] Ibid. p.37

[18] Yule, G. U. (1925) A Mathematical Theory of Evolution, based on the Conclusions of Dr. J. C. Willis, F.R.S. *Philosophical Transactions of the Royal Society B* **213** (402–410): 21–87. doi:10.1098/rstb.1925.0002

[19] Merton, R.K. (1968) The Matthew Effect in Science. *Science* 159 (3810), 56–63.

[20] Taleb, N. N. (2007) p.219

[21] Mandelbrot, B. & Hudson, R.L. (2004) *The (mis)behaviour of markets : a fractal view of risk, ruin, and reward.* Basic Books.

more recently flourished in certain anthropic contexts such as finance, they have a long natural history, being pervasive in biological and ecological systems. Amongst other natural processes, the reproduction of DNA follows power-laws that enable successful genes to asymmetrically dominate the fitness landscape.

A Gaussian distribution yields a bell curve where the rate drops away exponentially from the average, but Mandelbrotian distribution displays kurtosis, or 'fat tails'. While such kinds of scale-free networks are now well-modelled, it is still not possible to predict which nodes will suddenly benefit, or dramatically lose, in the dynamics of preferential attachment.[22] Their high-density composition makes them more robust to high frequency low impact events, however their extreme interconnectedness means that an unpredictable effect (low frequency) may cascade across the entire network (high impact). Beyond the alarm that Taleb sounds concerning the inadequacy of our standard probability measures, he also proclaims that the increasing dominance of non-Gaussian distributions in finance registers a generalised crisis of security brought on by globalization, where the appearance of robust stability masks an extreme 'interlocking fragility', or non-linear vulnerability.[23]

According to Taleb there is, moreover, an unavoidable circularity in the acquisition and analysis of data, meaning that there is a reductio ad absurdum in the methodology of employing probabilistic calculus in economics which finds its extreme in econometrics, but is equally present in any naïve attempt to solve the problem of inductive knowledge via probabilities. This is the called the statistical regress argument – 'we need data to tell us what the probability distribution is, and a probability distribution to tell us how much data we need.'[24] It is not then a question of merely replacing obsolete probability distributions with more contemporary

[22] Taleb, N. N. (2007) p.221

[23] Ibid. p.225

projections, since the scale at which the data should be analysed is not given in advance, nor certain at any stage in the time series.

Though mainstream economic theory obstinately clings to the Gaussian probability distribution, and it is still the ostensible backbone of the Black-Scholes-Merton (BSM) options pricing formula (in fact it is log-normal, following a maximum entropy probability distribution); as Taleb notes, at least since the 50's, following Mandelbrot, quantitative scientists have been applying more sophisticated methods of statistical physics to the market (i.e. non-Gaussian distributions). However, for Taleb this is still mistaking Knightian uncertainty for Knightian risk[25] (while the latter is computable, the former is a matter of judgment); or further, this is mistaking the real world contingency of the black swan for scientifically tractable randomness, in which one can only detect 'grey swans'.[26]

Elie Ayache argues that Taleb has misunderstood the black swan because he has failed to move beyond an epistemological concern with uncertainty and thereby avoided asking the *ontological* question of the market as such. Taleb's black swan is predicated on the epistemological gap between the model and the real, where the real is conceived as a random generator ('a big machine that generates events'),[27] and the discrepancy between the model and the real (the angle of deviation from expectation known as 'model risk') is generative of black swans. However, for Ayache the black and white swans are not opposed, since they are part of the same 'ex-ante' regime of possibility, probability and expectation.[28]

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[24] Ibid. p.269

[25] Ibid. p.127

[26] Ibid. p.37

[27] Ayache, E. (2010) *The Blank Swan: The End of Probability*. Wiley. p.11

[28] Ibid. p.xvi

While Taleb, on finding that we don't know all possibilities, ceases trading (he 'adopts a static buy and hold strategy')[29]; for Ayache it is *because* we don't know all possibilities that trading takes place, or it is because prices always diverge from their theoretical value that they are continually traded.[30] This does not leave the trader in the situation of radical scepticism that Taleb pronounces, but rather in the active position of taking risks (which, with the contemporary technology of the market is far from uncertain, according to Ayache) and making contingent claims.

For Ayache the significance of kurtosis is that the mode of production that it ensues from is 'the domain of the meta-model, not of the model'.[31] It is not the model that best represents reality that is successful in Extremistan,[32] but the model that models the other models most effectively, as we have seen (second order observation, self-referentiality of the market, Keynes' beauty contest, mimetic convergence, etc.). Ayache has a number of criticisms of Taleb's restricted conception, but the primary fault he finds is with the way in which Taleb both denounces the explicit scale-bindedness of probability models and at the same time maintains an implicitly scale-bound, frequentist approach to the event.[33]

For Taleb the black swan event is the unpredictable effect of a random generator, an exogenous noise with the potential to destabilize the system. Ayache rejects the notion of the

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[29] Ayache, E. (2014) p.537

[30] 'when all the prices will have converged to their theoretical values, there will be no point in the market' Ayache, E. (2007) The Next Question Concerning Technology. Part 1: The Significance of Dynamic Replication. *Wilmott*, March. 32-38.

[31] Ayache, E. (2007b) The Next Question Concerning Technology. Part II: A World Inverted. *Wilmott*, May. 42-48. p.46

[32] This is Taleb's name for the contemporary situation of pervasive scalable randomness, as opposed to Mediocristan, where everything is Gaussian. Taleb, N. N. (2007) p.32

[33] Ayache, E. (2014a) p.535

random generator and the 'ex-ante' attitude that it entails.[34] He argues that 'the ex-ante attitude depends on recognition of possible outcomes and totalization in a list'[35] while the ex-post trader merely follows the stochastic pathway of the underlying value, continually recalibrating the model in order to dynamically replicate the portfolio.

Ayache's assertion is that there is an implicit metaphysics embedded in the use of probability calculus (recall here the metaphysics of differential calculus that we discussed with regard to Deleuze and Leibniz), however, once theoretical abstractions are treated as components in the technology of the market this goes beyond the probabilistic framework that the instruments appear to rely on.[36] He therefore moves from the epistemic opacity of the black swan to the ontological question of the writing of contingency, which he calls the *blank swan*.

Ayache explains the blank swan by referring to the Deleuzian conceptualisation of the 'aleatory point', which Deleuze places great importance on, describing it variously as a quasi-causal operator, *atopon* (without place, endlessly displaced),[37] the 'paradoxical instance' of nonsense traversing the surface of sense (in which the synthesis of propositions and things takes place),[38] the throw of the dice once and for all time that determines the Idea, empty square and supernumerary object[39] (its two 'uneven faces').[40] Importantly in the case of derivatives, the aleatory point subdivides the singular points of the event ad infinitum along the straight line

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[34] Ayache, E. (2014b) A Formal Deduction of the Market, in (Ed.) Mackay, R. *Collapse: Philosophical Research and Development.* Vol. VIII. Urbanomic. p.981

[35] Ayache, E. (2014a) p.549

[36] Ibid. p.557

[37] Deleuze, G. (2004) p.190

[38] Ibid. p.138

[39] Ibid. p.75

[40] Ibid. p.199

labyrinth of the third synthesis of time (Aion)[41]; and according to Ayache this is precisely the virtualizing process performed by dynamic replication.

Another resource that Ayache draws on in describing the blank swan is a short story of Borges in which an author named Pierre Menard successfully *writes* Cervantes' 'Quixote'; it is word for word the same but he doesn't copy or rewrite it, he perfectly *replicates* it, he tracks its stochastic path without ever needing to refer to Cervantes text, his work not only *recontextualizes* the Quixote, but also transforms literature and makes history (i.e. it is an ontological event). Menard's writing is thus not without risk, and it may be thought as highly improbable, however it is in another sense beyond any probabilistic model since it marks a novelty or ontological difference not contained in any previous calculation of possibilities.[42] 'Menard's…special brand of 'future' had nothing to do with knowledge or representation and everything to do with writing and performativity'.[43] Menard does not copy the original or follow a model; according to Ayache it should be seen as an act of poesis,[44] in the Heideggarian sense of intransitive performativity.[45]

Going further than Taleb's epistemic uncertainty then, Ayache contends that the *event* of the market is beyond probability or improbability, since the pricing process involves changes of scale, or context, that can't be totalized as possibilities and computed[46]. Context is defined by the reading and writing of contingency, which is always a risk. Taleb disparages of the Gaussian assumptions of the Black-Scholes model, but Ayache, like the other traders isn't interested in

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[41] Ibid. p.74

[42] Ayache, E. (2010). p.4

[43] Ibid. p.9

[44] Ibid. p.10

[45] 'What is performed is performativity itself'. Ayache, E. (2008) 'The French Theory of Speculation. Part 1: Necessity of Contingency' *Wilmott*, pp. 20-23.

[46] Ayache, E. (2014a)

how its probability function has been *theorised*, but by what it achieves *practically*;[47] that is, the *capacity* of pricing derivatives, albeit by inverting the model against its theory.[48]

Ayache opposes the 'punctual domain' of possibility, which is always bound to a certain scale or context; to the generative capacity of the pricing *process* which takes place in the voluminous space of the trading pit[49], and to contingency, which is precisely the capacity for changes in context.[50] From the former perspective the black swan is a nasty shock resulting from epistemic finitude and the irreducible complexity of the market, from the latter it is 'simply a *case of change of context*'.[51]

In contrast with the conception of history as a branching succession of possible worlds with the present as its stochastic variable, Ayache claims that history is 'im-possible' and unprocessable.[52] The market is historical in the sense that it *produces* history, through its non-linearity and path dependency,[53] rather than being the *product* of socio-historical forces, or the result of equilibrium dynamics.[54] For Ayache, trading is not predicated on the ground of the probability formalism, does not proceed via prediction or rational expectation, but is a technology of *writing* contingent claims. What is contingent above all is the *scale* or *context* of the

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47 Ayache, E. (2010) p.19

48 'Nobody uses the Black-Scholes model in the direction that is provided by the theory. Everybody uses it in the inverse direction.' Ibid. p.73

49 Ayache, E. (2008)

50 Ayache distinguishes 'between possibility, as always defined relative to a fixed context, and contingency, as the capacity of changing the context', he argues that the market, or the writing of contingent claims, 'is a process of change of contexts (aka recalibration) not of possibilities. No probability can be applied to this process of change because probability can only choose among possibilities that fall in a single context.' Even more succinctly: 'contingency is another name for context change' and 'writing is its medium'. Ayache, E. (2010) pp.6-8

51 Ibid. p.7

52 Ibid. p.29

53 Ibid. p.88

54 Ibid. p.73

event, and according to Ayache, it is this that is incomputable and exceeds all probability models: 'the historical event is incalculable and unquantifiable because it precedes any scale'.[55]

However, Ayache does not advise the renunciation of the probabilistic calculus, or refraining from making contingent claims on this basis; this is because the action of the trader, in using that pricing technology in the medium of the market, is precisely what enables the '*quantification of that unquantifiability*. This is why the market is truly the technology of the future.'[56] Ayache's argument is that moving beyond the regime of expectation requires understanding the difference between gauging the movements of price in relation to a transcendent theory of value, and using the technology of the market in an immanent practice of pricing. Ayache explicitly draws on Deleuze (and Bergson) in understanding *possibility* as a derivative concept or 'backwards-looking narrative', where *contingency* is a generative process exceeding totalization as a list, following Deleuze's overturning of the hierarchal privilege accorded to identity over difference.

'The contingent state is not selected from a pre-existing list of possible states…[in which case] identity is recognized…before difference. In contrast, massive and absolute contingency, contingency as *matière première,* has to be recognized *before* state and identity.'[57]

Though insurance, and its theoretical basis in probability formalisms such as the law of large numbers, is apparently directed to the future, Ayache claims that what interests it is 'the ex-post accounting equation, rather than a certain ex-ante attitude towards future contingencies. It is the integrality and integrity of its financial account that allows it to reverse time and transform

55 Ayache, E. (2014a) p.531

56 Ibid. p.531

57 Ibid. p.541

into an ex-ante question what is only an ex-post equation.'[58] The function of the insurance company, and by extension the hedging strategy, is not then to predict the future, but to maintain a certain position with regard to the geometry of risk maintained by its liquidity network.

Rather than claiming that economic theory is idealistic and casting suspicion over the practice of speculation as Taleb does, Ayache takes up these formulae as performative instruments for the writing of future contingency, whilst maintaining that derivatives trading is enabled through an ex-post pricing process (dynamic replication). In order to understand this we must explain Ayache's argument with regard to market technologies. In Mackenzie's classic account of the performativity of markets he distinguishes four types of performativity: generic performativity is simply when economic theory is applied in financial practice, effective performativity occurs when the application of this theory alters the conditions for its practice, Barnesian performativity is where this alteration of the conditions serves to reinforce the effectiveness of the model in a positive feedback loop, and counter-performativity is where the use of a model, in altering its conditions, undermines its own validity.[59]

Let us explain how this relates to noise; the divergence between the model and the modelled is a source of exogenous noise to the system that implements the model or acts on its basis. When this exogenous noise is diminished in the case of Barnesian performativity, its self-reinforcing success is like an artefact (technologically induced distortion) that builds up endogenous noise through positive feedback. Mackenzie suggests that the '87 crash was an instance of counter-performativity, where portfolio insurance instruments based on the

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[58] Ayache, E. (2014b) p.983-4

[59] MacKenzie, Donald A. (2006) *An engine, not a camera : how financial models shape markets*. MIT Press. p.17

assumptions of the BSM provoked the collapse of the effectiveness of the BSM.[60] However, Ayache rejects this, claiming that while the sociology of finance has rightly focused on the technical networks and their functional relations, thus moving beyond thinking the economic model as a detached representation, this is not going far enough, and it has thus failed to understand the true (intransitive) performativity of the market as endogenous pricing mechanism.[61]

As Mackenzie explains, the BSM options pricing formula has three stages; in the first it is not a good fit to prices (generic performativity), in the second market prices are brought into line with it (Barnesian performativity), and in the third prices diverge from the projection (counterperformativity). The third stage begins with the '87 crash, after which a 'volatility smile' emerged (and still persists) that contrasted with the theoretical model; i.e. BSM and its Gaussian probability distribution. However it is precisely at this point, the ostensible breakdown of the model, that Ayache considers the derivatives market to be truly born, but not because of the failure to represent the value of the underlying (through whatever type of performative influence), but because of the decoupling of the derivatives pricing process, and its core technology of dynamic replication, from any consideration of value.

Thus, according to Ayache, the *conception* of the market was the '73 invention of the Black-Scholes formula, and its *inception* or delivery occurs in '87 with the crash: 'only with the 1987 crash does the derivatives market acquire its final truth, namely, that it shall always trade outside the given model and away from the reductive power of replication.'[62] For Ayache, the point is not to think the BSM as a model that beyond representing economic value also shapes it; this is still a substantialist conception of value. Like Orléan, Esposito, Mirowski, and other

[60] Ibid. p.259

[61] Ayache, E. (2007a)

heterodox economists, Ayache asserts the primacy of the pricing process and the secondary sense of value (the supplementary or derivative ontology of value). That is, value exists, but only as a result of the pricing process, which will always diverge from it positively. After the '87 crash the trader merely inverts the BSM to calculate the market-implied volatility; Ayache argues that this is neither knowledge nor forecast (the market neither predicts nor knows its own stochastic movements) but merely a vehicle by which to hedge or trade options.[63]

In most scientific endeavours, when there is a divergence between theory and data, the model is improved to account for the new information, but in economics there is a tendency to blame the real rather than the model for any discrepancies, by claiming for example that prices aren't behaving as they ought to. Taleb lambastes such a conceit, blaming instead the probabilistic model, whose finitude cannot account for the complexity of real price movements and the unpredictability of black swans. For Ayache this is a false opposition, based on a representationalist paradigm. Firstly, the model must be considered fully part of the real, as a technology operating within it; and secondly, any disparity is not a lack either on the part of the probability formalism or the contingent price movements. Thus, he argues we ought to understand the market as an instance of 'perfect contingency' rather than one of 'imperfect probability'.[64] It is because the market is absolutely contingent rather than imperfectly probabilistic that the trader is implicated in the dynamic pricing process, always by acting outside of the model:

'The trader's performance (and, here, performativity is the philosophical opposite of representation) literally exceeds the model from both sides. It expresses itself in the two

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62 Ayache, E. (2007b)

63 Ayache, E. (2007a)

64 Ayache, E. (2010) p.xvi

decisions that cannot be made part of the model, the decision to recalibrate and the decision to trade the newly priced instrument.'[65]

Though the sociology of finance correctly identifies many of the problems with the neoclassical conception of the market according to the utility maximizing behaviour of rational agents, and looks instead at the ways in which behaviour is embedded in social and technical institutions, Ayache agrees with Charles W. Smith's argument that this still remains within the allocative paradigm of neoclassical thought.[66] Smith therefore moves to an ontological, or definitional, conception of economic processes, and asks how the derivatives market has redefined risk and the ontology of value.

Smith considers the ontology of derivatives to be uncertain, or vanishing, for two reasons. Firstly, since the value of options are calculated statistically using a purely mathematical algorithmic process that bears no relation to traditional measures of value. Secondly, because the derivatives market consists overwhelmingly of future possibilities traded against each other without ever being realized as value. Smith's ontological diagnosis is a result of his substantialist conception of value however, and according to Ayache's argument it is precisely the relinquishment of this conception of value that the strategy of dynamic replication performs, and it is this that leads to the post '87 ontological inception of derivatives trading.

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[65] Ayache, E. (2007a)

[66] Ibid. p.37 Smith, C.W. (2003) *Markets as definitional mechanisms: a more radical sociological critique*. Paper presented at the Constance Conference on Social Studies of Finance, Konstanz, Germany, May, pp. 16-18.

3.5

The Deontologistics of Finance: A Synoptic Theory of Pricing

Felin et al.[1] and Koppl et al.,[2] make very similar arguments to Ayache, but in a notably different discursive context. Felin et al. recognise the importance of Simon's concept of bounded rationality and commend its use in ecological economics in so far as this moves beyond the dogmas of neoclassical economic theory (in particular, perfect information and global rationality). However, they argue that the understanding of economic activity according to computational finitude within an NK opportunity landscape (as an NP-complete problem) misses a fundamental difference between complex hierarchically nested systems such as biological and economic systems, and the kind of deterministically evolving trajectories of inert objects, which such phase spaces were originally developed to model.

An NK landscape is a mathematical model of the concept of a 'chreod' introduced by Waddington to describe the probabilities involved in pathways of genetic and epigenetic development. It is a combinatorial phase space with two parameters, which has been a fruitful tool in many areas of scientific inquiry, particularly with regard to optimisation studies, since it offers a relatively simple way of modelling an NP-complete problem. The latter is a problem for which a computable solution may exist, but finding it may take an exponential processing time.[3]

The mathematics for the construction of phase spaces comes from Boltzmann's statistical mechanics and was developed by Poincaré for modelling the evolution of cosmological trajectories. Koppl et al. note that general equilibrium theories and phase space construction are

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[1] Felin, T. et al. (2014)

[2] Koppl, R. et al. (2015)

both predicated on a comprehensive *a priori* delineation of all possible states of the system. They explain that the 'complete equational determination' for any dynamic system requires that the configuration space is pre-stated, so all possibilities of the system are known, and invariants are extracted that are transformed into a background space for calculation.[4]

Inert objects have geodesic trajectories within these spaces; they exhibit symmetries and invariants such as momentum and energy conservation, and invariant preserving transformations so that their trajectories can be predicted with precision.[5] However, this is not at all the case even at the level of biological complexity, let alone that of economic systems, the evolution of whose trajectories are continually altered by symmetry breaking transitions and the emergence of novel possibilities that could not have been predicted from the previous state of the system. Here, the extraction of invariants that would serve as pertinent parameters, and the enumeration of possible states just simply cannot be achieved since they are in perpetual context-dependent flux.

Though economic theory has long been influenced by information theory, dynamic systems theory, and complexity theory (e.g. Hayek, ecological economics, etc.), there is still a widespread acceptance of general equilibrium models, which 'represent economic dynamics as the unfolding of a process fully described, up to a stochastic error term, by a master set of equations or an evolution function.'[6] Such a model therefore erroneously assumes a fully mechanistic set of causes and effects with laws of entailment describing the dynamics of price trajectories.

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[3] Felin, T. et al. (2014)

[4] Koppl, R. et al. (2015)

[5] Felin, T. et al. (2014)

[6] Koppl, R. et al. (2015) p.2

As Koppl et al. state quite clearly, biological and economic systems are not governed by predictable causal laws. That is, even if we could precisely state the initial conditions of such a system - and this measurement in itself is susceptible to random fluctuations below the threshold of observability whose nonlinear amplification over a series of iterations lead to wild differences in trajectory - no 'laws of motion' could be formulated that would predict the evolution of its trajectory. This is not to suggest that biological or economic evolution is entirely unpredictable or random; complex systems such as these should display law-like *regularities* and reliable *tendencies* at certain scales of analysis.[7]

Koppl et al. recognise that the economic model, whether microeconomic general equilibrium or macroeconomic DSGE, is taken to be a low dimensional approximation to a high dimensional reality, and that this is its benefit as a mode of abstraction, since a representation with a higher information content may be intractable for practical analysis. However, they argue that since the phase space of the econosphere cannot be pre-stated, the low dimensional model may not even resemble let alone approximate the high dimensional reality. In the situation of biological or economic complexity, which may be thought in terms of extended creativity or criticality,[8] the configuration space is in such constant transformation that the pertinent observables cannot be identified in advance, and the possibilities cannot be exhaustively enumerated.

Economic activity cannot then be meaningfully modelled as an algorithmic behaviour of search within an NK opportunity or strategy landscape. According to Felin et al. modelling economic activity is therefore not a problem of computational finitude within a pre-given phase space, but that of a 'frame problem' within a continually transforming cascade of symmetry

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[7] Ibid. p.4

changes. The frame problem is a classic topic in cognitive science, AI and philosophy, which concerns the choice of parameters for the extraction of relevant details for a given situation. This means determining the situation and separating the salient signals from the background noise at the same time, something that AI has found very difficult to emulate.

As Koppl et al. explain, the frame problem was first discussed by McCarthy and Hughes, in relation to the necessity to recode any algorithmic form of AI for each new situation it encountered (there is thus a frame specificity to any algorithmic program), and was brought into the philosophical realm by Dennett, who was concerned with the way in which belief revision processes could maintain fidelity to their objects over changing contexts. In understanding the complexity of such processes of contextualization, we should recall here Taleb's statistical regress argument: the situation determines which details are salient, but the salient details determine which situation it is (or rather, which situation it should be taken as - determining the context is thus a salience choice itself).

Felin et al. also seem very close to Taleb when they explain the frame problem by saying that 'not only do we not know what will happen we typically don't know what *can* happen'.[9] However, the argument of Felin et al. is actually in line with Ayache, rather than Taleb, in that it claims that the problem of context change is not one of epistemic or computational finitude (an NP-complete problem), since the frame problem is not solvable algorithmically, and the economic activity of the market is essentially non-algorithmic.

Crucially, this does not mean a sceptical withdrawal from probabilistic modelling, as it does for Taleb, but rather a different approach to modelling economic activity. For Ayache this

[8] Longo, G. & Montévil, M. (2012b) The Inert vs. the Living State of Matter: Extended Criticality, Time Geometry, Anti-Entropy - an overview. Invited paper, special issue of *Frontiers in Physiology*, n. 3, 39.

means an ex-post recalibration according to contingent transformations of context instead of an ex-ante prediction according to ideal randomness. Koppl et al. also emphasize the generative capacity of economic hypothesis formation as opposed to the pro-cyclical probability model based on past performance or the assumption of ideal randomness. Unlike Walras' agents, who *take* prices and fill possibility spaces in an orderly fashion, economic agents *make* possibilities by engaging in a pricing process and acting outside of the probability model in an unpredictable way.

The frame problem is pertinent to the cognition of any arbitrarily chosen thing or process; there is no exhaustible list of functions, uses, or contexts that could define which different features of an object may be salient and which irrelevant.[10] If this seems close to object oriented ontology it should be noted that this inexhaustibility is not because the essence of the object withdraws from all sensual encounters,[11] but simply that its potential functionality or meaning with regard to an agent is not algorithmically definable. As Felin et al. argue, the frame problem cannot be answered by a closer investigation of the object or process, and does not refer to some essence that remains behind its appearances, but rather to the salient potentialities of its contextualization, and this demands a 'shift from exogenous environment to endogenous nature'.[12]

Biologically evolved cognition has a non-algorithmic 'solution' to the frame problem: the constrained randomness facilitated by the non-linear processing of neural assemblies, and their dynamic revisability in the ongoing feedback between sensors and effectors. For most objects we

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[9] Felin, T. et al. (2014) p.11

[10] Ibid.

[11] Harman, G. (2002) *Tool-Being – Heidegger and the Metaphysics of Objects*. Carus Publishing Company.
Wolfendale, P. (2014b) *Object-Oriented Philosophy: The Noumenon's New Clothes*. Urbanomic.

[12] Felin, T. et al. (2014) p.11

are able to extract the salient details from the noise apparently instantly, however for complex collective self-referential processes like the market (or social interactions in general) the frame problem is precisely the issue. In their discussion of the importance of the frame, Koppl et al. cite Witt's argument for the non-algorithmicity of the interpretative operation due to the nondenumerable possibilities involved, and extend this to learning.[13] This is very close to Ayache's argument for the active reading and writing of contingency.

Moreover, Felin et al. relate this non-algorithmic interpretative operation to the aleatory movement of an 'empty set' of adjacent possibles (possibilities not contained or entailed by the preceding dynamics), giving scientific rigour to Ayache's use of the Deleuzian notion of the aleatory point. Ayache's rambunctious claim that the derivatives trader has 'the future in his hands' or 'makes the future', is thus explainable as the generation of an adjacent possible and the exploitation of the gradient it opens up. Koppl et al. define the frame problem as 'the problem of modifying the system's implicit frame of analysis to adapt successfully to non-algorithmic change in the adjacent possible.'[14]

This reinforces the necessity for the 'meta-contextual predictive formalism [surpassing] classical Kolmogorovian probability' that Ayache calls for, in that the NP-complete problem concerns a measure of complexity defined by the algorithmic compressibility (or Kolmogorov complexity) of strings of code, however a meta-contextual measure of complexity would not follow this deterministic trajectory. Following the argument of Koppl et al., it should thus be stipulated that Ayache's 'regime-switching model' or any other solution to the frame problem cannot be algorithmic.

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[13] Witt, U. (2009)Novelty and the Bounds of Unknowledge in Economics, in *Journal of Economic Methodology*, 16(4): 361–375.

As we have seen in the case of biological systems, even though they are ultimately composed of the movement of particles according to the entailment laws of physics, the emergent properties of such evolutionary trajectories are not well described by this lower level causal mechanics. Biologically or economically evolved structures are better understood as 'enabling constraints' that allow for an open-ended range of possibilities.[15] When Koppl et al. claim that 'the economy is not a causal system',[16] this is not a repudiation of the causal structure of nature. Koppl et al. merely claim that the higher level dynamics of such complex systems are highly contingent and so cannot be accounted for by entailment laws.

One of the ways in which search in an NK landscape can be modelled is through assuming a random exploration that uniformly covers all possibilities over a series of iterations, yielding predictable behaviour on the aggregate. Note the similarities with probability distributions such as white noise where randomness covers all frequencies evenly, and with the neoclassical modelling of commodity space, in which uniformities emerge from idealized processes of randomness. A system exhibiting such dynamics is called ergodic, and Felin et al. note that Boltzmann, who introduced the term for the statistical mechanics of microphysical particles, argued that 'even highly complex non-reducible systems were "ergodic"'.[17]

It should be noted that for both Walrasian general equilibrium theory and the mathematics of phase space, time is isotropic in the sense that all transformations occur within a given space of possibilities.[18] Though the process of tatônnement can be considered a temporal factor in the evolution of Walrasian general equilibrium, and subsequent revisions of the theory

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[14] Koppl, R. et al. (2015) p.22

[15] Ibid. p.8

[16] Ibid. p.12

[17] Felin, T. et al. (2014) p.18

[18] Koppl, R. et al. (2015) p.7

have attempted to account for time constraints in search and learning through feedback, as well as uncertainty with regard to future prices, the emphasis on equilibrium dynamics within a pre-stated phase space simply cannot account for the irreversible, non-equilibrium dynamics of economic systems.[19]

Beyond this elision of time in economic dogma, both papers claim that ergodicity is not a valid assumption for economic systems; firstly, because the phase space cannot be specified, and secondly because the trajectories of evolutionary development are predicated on a 'highly canalized' form of randomness, 'poised for adaptations', rather than the kind of ideal randomness that systematically explores all possibilities.[20] There is thus a dynamically changing 'topology of the possible', or geometry of risk, across which the market's evolutionary trajectory irreversibly traverses.

Felin et al. argue that there has been too much emphasis on selection rather than the other side of Darwin's first principle, which refers to variability: descent with *modification* and selection. In order to explain the 'radical emergent heterogeneity' of the biosphere or econosphere it is therefore necessary to shift from thinking exclusively in terms of survival of the fittest, to consider the generative processes behind the emergence of novelty, or to the 'arrival of the fittest'.[21] As we have seen, evolutionary variation involves randomness at many different hierarchically nested scales of complexity.

However, this is not a pure randomness, since the enabling constraints at each level favour the development of further enabling constraints through opening up new 'adjacent possibles' (i.e. a non-prestatable opportunity), and this leads to an asymmetric diffusion towards

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[19] Ibid. p.7

[20] Felin, T. et al. (2014) p.19

complexity.[22] Variation occurs through many different selection-independent processes that cannot be analysed within a single measure or frame of randomness, such as ontogeny, morphogenesis and epigenetics, retroviral gene insertion, inter-specific hybridization, speciation and punctuated equilibria, exaptation and niche construction.[23] Felin et al. claim that randomness in biological or economic systems cannot be considered as noise because it is a functional aspect of evolutionary dynamics that facilitates and enhances the generation of novelty, and does not conform to any probability formalism such as LLN or CLT.[24]

With regard to the asymmetric diffusion towards complexity, Koppl et al. note a similar law-like regularity in the econosphere both in the increasing specialization enabled by division of labour, and here they claim Adam Smith as a precursor to this theory; and in the growing quantity of available commodities, which they call cambiodiversity. While the asymmetric diffusion towards entropy is a universal tendency, the constraints embodied in chemical structures such as autocatalytic loops or genetic replication mechanisms, allow for a locally circumscribed contragrade movement - the asymmetric diffusion towards complexity - that is anti-entropic.[25] Increasing complexity is not selected for but enabled as a novel possibility by its preceding dynamics. It follows that, in contrast to analyses such as Hermman-Pillath,[26] strict limitation to the doctrines of MaxEnt and the maximum entropy production principle (MEPP) in the economical (or biological) domain is therefore a globally incompetent overextension of a model based on extremal principles drawn from the physics of inert particles.

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21 Ibid. p.14

22 Koppl, R. et al. (2015) p.9

23 Felin, T. et al. (2014) p.14 n.6

24 Ibid. p.17

25 Bailly, F. & Longo, G. (2009)

26 Herrmann-Pillath, C. (2010) *The Evolutionary Approach to Entropy: Reconciling Georgescu-Roegen's Natural Philosophy with the Maximum Entropy Framework*. Frankfurt School, Working Paper Series.

Though Koppl et al. put forward a 'creative economics' that might superficially resemble the hegemony of neoliberal political economy, theirs is a very different proposal than that suggested by Attali's new world order. Firstly, it does not assume that market forces will distribute resources in the most efficient way or neutrally find an equilibrium that is beneficial to all, but suggests the necessity for actively transforming the economic system so that the generative capacity of enabling constraints are amplified. Secondly, it does not argue for any scarcity driven negentropic deceleration of the metabolism of capital (throughput) such as we find in the recommendations of the Club of Rome.

Lastly, it warns against the autocatalysis of power as a self-reinforcing mechanism that can have positive feedback effects on the evolutionary development of social and economic systems.[27] This last point suggests the possibility for an identification and analysis of power structures with a degree of scientific objectivity not freighted with moral condemnation, and this may lead to capacities to transform them. In fact, we can understand the self-reinforcing autocatalysis of power in terms of generative entrenchment. As Benedict Singleton argues, understanding the platform logic of GE can allow us to repurpose generatively entrenched structures towards different ends.

We have seen then how, over the history of economic theory and financial practice, scientific concepts from physics have consistently been imported to explain the workings of the economy, and how this is tied to a substantialist conception of value. While the discourse of classical economics was motivated by the dialectic between essence and appearance, and grounded in the labour power theory of value; neoclassical economics shifted to a more immanent field-theoretical approach grounded in a utility theory of value, in which the tension between order and disorder could be modelled within a vector or phase space. Both present a scientific image of economic man, in the Sellarsian sense that they treat individuals as particles or random variables of a statistical system organised by natural laws.

The scientific image performs a drastic abstraction, however this is does not amount to a criticism in itself since abstraction is precisely what gives the model tractability and efficacy. The manifest image is dramatically distorted as a result however, and sociological critiques of the political economy (such as found in Marx, Orléan, etc.) have attempted to redress this both by pointing to the invalidity and ideological character of the assumptions of this scientific image, and by maintaining in contrast the essentially normative character of economic relations.

We have furthermore seen how, while classical and neoclassical theory are wedded to an equilibrium dynamics and consider price to be exogenously determined, contemporary heterodox economic theory replaces this with non-equilibrium dynamics and the endogeneity of the pricing process. Nevertheless, in as much as it wants to calculate the non-equilibrium trajectories of price movements according to the 'laws of motion' of economic theory, even such heterodox accounts present a specious scientific image (e.g. the NK modelling of opportunity space).

There are two reasons for this resistance of persons as conceived within the manifest image to the description given according to the natural laws of the scientific image of economic man. Firstly, the evolutionary complexity of biological and economical systems are highly contingent and do not follow laws of entailment in the same way as inert matter; secondly, there is an unavoidable normative aspect to economics, which is again not explained by the invocation of any supposed natural laws of economics such as fundamental scarcity.

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[27] Koppl, R. et al. (2015)

Indeed, as we saw, economic theory must surrender its foundationalist search for the true substance of value, and instead understand pricing as a primary process that can only be understood as an irremediably social normative act. However, in arguing this we should be careful not to fall into a social constructivism that would be a distorted use of the manifest image. We must therefore be able to give a naturalistic account of the capacity for normative behaviour in general, and more specifically in contemporary finance. Moreover, we must also navigate the complex synoptic fusion of these images without reducing one to the other.

This argument for the irremediable normativity of finance is in contrast with Malik, who also draws on Esposito and Ayache (as well as Nitzan and Bichler) to argue for the primacy of the pricing process, but claims that derivatives trade is nonnormative. He makes this claim within the context of a criticism of neorationalism, in particular its use of Robert Brandom's deontological conception of inferential reason as the freedom to make and revise commitments. Malik provides a rigorous and thorough account of the ontology of finance, that is fully consistent with the one put forward here; however, the philosophical argument that he derives from this deserves critical scrutiny.

He begins by asserting that 'if neorationalism contends that subjective norms can be progressively transformed by the pragmatic universalism of self-revising rational norms, that contention supposes both the authority of reason not only over conceptual thought but also over social norms'.[28] This is a valid premise, though we should be careful not to reify reason as something that *has* authority. Reason has the capacity to influence behaviour but this is not *given* and instead requires an ongoing struggle in various practical and theoretical discursive contexts. Authority, on Brandom's account derives from both the reliable regularity in which authority is

[28] Malik, S. (2014) p.640-641

practiced (i.e. the *naturalistic* capacity of an expert to 'get it right') and the endorsement of the recognitive community (i.e. according to valid *normative* claims within the space of reason).[29]

Malik then goes on to claim that 'capital-power, though certainly not directed by theoretical reason, revises social norms to the point at which [they] lose efficacy altogether',[30] and that therefore the neorationalist project of revising social norms is impotent in the face of the constitution of the risk order, which occurs through the primacy of the pricing process. This is a mistaken understanding of the relation between the market and its normative constitution and consequences. Money, and the financial system it supports, is a normative construction predicated on the socially constituted conventions that define it. Finance relies on the prior existence of these social norms. Economic transactions clearly have normative consequences since changes in the flow of capital inform the normative decisions that financial agents make. However, capital-power itself cannot be said to revise social norms because the market is an information processing system that does not *reason* and cannot operate at the level of normative discourse within the space of reason.[31]

It is certainly true that in the neoliberal hegemony of financialized capitalism, the information processing dynamics of the market come to supplant normative prescriptions of social organization. For example, the normative principle that everyone should have access to free healthcare comes to be replaced by a variable degree of healthcare subject to market forces. Nevertheless, this does not entail the 'vitiation of normativity', as Malik claims. It is helpful here to look at how Brandom treats the distinction between the normative and nonnormative. He identifies two broad discourses stemming from the Enlightenment project: a vector of

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[29] Brandom, R. (1994)

[30] Ibid. p.641

[31] Brassier, R. (2015) Reason is Inconsolable. Conversation with Malik, S. in (Eds.) Cox, C. et al. *Realism, Materialism, Art.* Sternberg Press. p.218

disenchantment that would describe the normative in terms of the nonnormative movement of physical particles; and a humanistic impulse that evacuates the natural world of any value but those normatively ascribed by subjective judgment, thereby reducing all differences in normative status to differences in normative attitude (all values are the projection of human desires).[32] The former leads to a distorted scientific image of economic man evident in mainstream economic theory, the latter results in a distorted manifest image evident in mainstream sociological accounts.

Therefore, we must be careful to specify what kind of nonnormative behaviour is happening in derivatives trading, and how this relates to the normative structures it is embedded in. The information processing dynamics of the market are nonnormative in the sense that they do not reason, but the market is a socially instituted normative structure and every decision made by the financial agents that populate it is a normative decision. Malik's argument for the nonnormativity of derivatives trade has two premises: Firstly, traders do not repel incompatible commitments because they offset the risk of an option with another option correlated with the inverse risk. Secondly, traders make and dynamically revise commitments but since this activity is counterperformative it prescribes no 'ought', only an endless series of insufficiently determining alternatives.[33]

The latter premise of counterperformativity is ruled out, as we saw earlier, by Ayache's argument concerning the ultimate performativity of the market as endogenous pricing mechanism. The self-referentiality of the market means that counterperformativity is a form of intransitive performativity. With regard to the endless series of commitment deferrals that the trader enters into, Malik argues that '[i]n formulating the basic unit of judgement not in the

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[32] Brandom, R. (1994) p.47

[33] Malik, S. (2014) p.784-785

predicative form of <If p then q> but in the contingent formulation <If p then q or r or s or…where p is insufficient to determine q, r, s…> the risk-order vitiates reason qua the positive freedom and authority of normative constraints'.[34]

However, this contingent formulation is a pervasive aspect of sapient rational behaviour according to Brandom, since most inferences involve a potentially endless series of defeasors and are thus non-monotonic. This does not in the least vitiate the positive freedom of reason, and on the contrary, is key to its generatively extensible, and hence emancipatory nature. It should be remembered here that we can think of defeasors as noise the program of a logical system, but that abductive reasoning, dynamic revisability, creative hypothesis generation, and strategic mimesis are so intrinsic to rational cognition that defeasors are fully functional and therefore not noise.

The former premise does not hold up either, as traders have not made incompatible commitments but have rather made two conditional commitments; the options contracts they enter into refer to incompatible outcomes but are not incompatible themselves since they are contingent claims. And these are subordinated to a more fundamental commitment (to make a risk free profit by straddling contingencies) within the context of a web of other commitments (to the normative conventions of trading etc.). Brandom states 'two claims are incompatible if commitment to one precludes entitlement to another'; in the case of the derivatives contracts the two contingent claims are not incompatible because traders are entitled to hold both. This entitlement is normatively prescribed: explicitly in the form of financial legislation and other rules, and implicitly in the practices and procedures of the recognitive community of financial agents.

[34] Ibid. p.785

Making incompatible commitments are all too common place, for example I can commit to getting some work done at the same time as making the incompatible commitment to going out to a party: 'the laws of nature do not forbid making contradictory judgments'.[35] Furthermore, as Brandom argues, contradiction is an aspect of normative judgments rather than natural relations; therefore the two incompatible commitments that Malik thinks the traders enter into are either not nonnormative or not incompatible. In fact I think they are normatively structured entitlements that are not normative claims in themselves, and therefore not incompatible. The neorationalist argument is that following the emancipatory vector of reason requires the labour of tracing the ramified pathways of these commitments, and repelling any incompatibilities through a process of construction and revision.

We are capable of making incompatible commitments and contradictory judgments because we are sapient agents with the normative capacity to revise them according to reasons. When Malik claims that 'the deontic-alethic modalities of incompatibility-repelling synthetic unity postulated by SSI are undone by the risk order of capitalisation',[36] it is difficult to know in what sense, since the very existence of the risk order is predicated on the social normative institutions of finance, and these are obviously not without normative conventions or consequences. Malik's argument appears to be that the pricing process is nonnormative because it makes no inferential commitment, but is rather the constitution of the risk order and the distribution of its power relations. Therefore 'pricing and the risk order of capitalization are not rational but the conditions of unfreedom'.[37]

Effectively Malik is saying that the risk order cannot be overcome, or even addressed, within the space of reasons, since the risk order is unreasonable and lies outside it. Beyond the

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[35] Brandom, R. (1994) p.12

[36] Malik, S. (2014) p.785

choice between paralysing defeatism and violent struggle that this seems to lead to, it is simply not the case that economic activity is immune to normative prescriptions as to how it should be, or to possible transformations to a post-capitalist form according to rational discourse. However, to change normative statuses it is not enough to merely change normative attitudes, this is the social constructivist fallacy. Moving beyond the risk order of capitalization would require top-down and bottom-up structural and functional transformations, massive social organizational change that includes but certainly is not limited to normative commitments.

As Negarestani says 'any political project aimed at genuine change must understand and adapt to the logic of nested hierarchies which is the distinctive feature of complex systems.'[38] In contrast with Malik's assertion, power is both rational and submissable to rational analysis and transformation. Power is a complex system that must be decomposed so that its functions and mechanisms are revealed; political transformation requires 'the explanatory differentiation of levels and cross-level manipulations'.[39] A large part of this explanatory differentiation is concerned with maintaining the capacity to explain normative behaviour according to natural processes (the scientific image of invisible particles) while at the same time arguing for the logical or explanatory distinction between inferential reason and the information processing capacities of self-organising systems and computers.

Negarestani argues that forming a synoptic image means navigating between an overemphasis of the manifest image, in the emergentist argument for the causal irreducibility of normative behaviour; and the distortions of the scientific image, in eliminative reductionism. We can also add on the former side, the sociological critique of the political economy, and on the latter, econometrics and the neoclassical doctrine of general equilibrium. Navigating this

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[37] Ibid. p.785

[38] Negarestani, R. (2014) p.461

synthesis, which is a task of functional decomposition, intervening at the normative level of the space of reasons and the naturalistic level of the space of causes, is what Negarestani calls 'the revisionary-constructive loop of engineering. Bypassing inadequacies of both emergentism and eliminative reductionism, the engineering loop is a perspectival schema and a map of synthesis.'[40]

We have seen the pervasiveness of randomness operating at several different scales and how noise enters the system in many different structural-functional configurations. Indeed, randomness is so intrinsic to the evolutionary stability of biological and economic systems that it can be argued there is no noise for such systems.[41] There are two reasons why noise is inadequate as a description for such systems: firstly, there is no calculable probability distribution because the system is constantly undergoing symmetry breaking transitions, and secondly the system does not therefore display robustness to perturbation but resilience and an anti-entropic increase in complexity. This means we must not just move beyond the equilibrium dynamics of classical and neoclassical economics, but also beyond the path dependency and far from equilibrium dynamics of ecological economics.

The political consequences of this argument are far from suggesting a submission to the caprice of chance: we cannot expect a beneficial order to emerge from randomness, nor hope for a contingent event to disrupt the cruelty of the current regime. It is highly unlikely for a resilient system to be transformed by acts of resistance; it simply will not be perturbed. Instead, the system can only be changed through the social institution of new normative rules of self-determination. Randomness must be accounted for rather than hypostatised, and this demands ongoing processes of decomposition, localization, local to global and global to local transits,

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39 Ibid. p.462

40 Ibid. p.462

41 Felin, T. et al. (2014)

reintegration, synthesis, inter-level manipulation, abstraction, and hypothesis generation.[42] It is this process, intrinsic to the elaboration of reason, that unleashes an emancipatory vector for the bootstrapping of intelligence.[43]

This chapter has been focused on randomness, unpredictability, and noise within the domain of economic theory and practice, where those concepts are understood in the abstract terms of information theory, probability distributions, and computational modelling. In order to bring the analysis up to its full multi-level complexity the next chapter will examine sonic noise and the use of randomness and aperiodicity in music, which demands the specification and elaboration of several descriptive levels beyond those we've encountered in economics. In particular, the phenomenological experience of temporal objects and the semiotic and semantic content of sound and music.

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[42] Zalamea, F. (2012)

[43] Negarestani, R. (2015) Where is the Concept? in (Ed.) Mackay, R. *When Site Lost the Plot*. Urbanomic.

4.0

Sonic Noise: The Complex Texture of Sound

4.1

The Phenomenal Sound Mass

Over the course of this thesis we've seen how the concept of noise is developed in various scientific contexts, including information theory, cybernetics, thermodynamics, evolutionary theory, dynamic systems theory, and economics. We've also engaged with some of the philosophical problematics surrounding the elaboration of the concept of noise; in particular, the focus has been on the discrepancy between the manifest and scientific images of noise, and the different ways in which Deleuze and Sellars have drawn out the philosophical consequences of this problematic. We shall now examine more closely the specifically sonic dimension of noise, its use in music, and the problems associated with its description at the level of phenomenological experience.

The opposition between music and noise in European tradition is based on a longstanding veneration of harmony over discord with its basis in the physical and mathematical attributes of periodic sound, as well as an underlying philosophical prioritisation of order over disorder. This musical tendency is deeply rooted in the ancient Greek conception of reason, the guiding ideals of which - goodness, truth, and beauty - are framed in terms of ratio, balance, and proportion. This understanding of reason is also bound up with the conception of causality as an orderly progression from cause to effect, most evidently in the principle of sufficient reason (PSR), which was a founding presupposition of ancient philosophy.

Not only is this philosophical assumption of good order as balance expressed in musical composition, it is also profoundly entrenched in modern conceptions of political economy. This bias continues to dominate contemporary economic theory despite having been critically dismantled from a number of different angles. As we saw, the PSR was transformed by Deleuze according to dynamic systems theory and his cosmic vision of differential calculus, which reverses the prioritisation of identity over difference, so that order and disorder are no longer opposed but dialectically interpenetrating terms. As Iannis Xenakis argues, the breakdown of this classical opposition in nineteenth century statistical physics (primarily in thermodynamics, then in DST) is further developed over the course of the twentieth century, finding expression in art and music as well as philosophy and science.[1]

In order to understand the concept of noise within the field of sound and music, it is necessary to examine several different aspects: the physical properties of soundwaves, how these vibrations are analysed by the auditory system and the brain, the phenomenological experience that results from this, and the ways in which the conceptualisation of noise has altered the composition and analysis of music. This not only requires an elaboration of both the scientific and manifest images of noise, but also demands the construction of a synoptic image able to integrate these two dimensions without collapsing one onto the other.

Plucking the strings of a tuned guitar produces periodic vibrations, which we perceive as musical tones because they have a locatable pitch defined by the dominant frequency, as well as a certain duration, amplitude, and characteristic timbre. By vibrating a plate or membrane covered with a thin layer of material (fine particles, liquid, or both) we can see the shape of the soundwave as a pattern; the study of such phenomena is now referred to as *cymatics*[2]. Periodic soundwaves form a variety of distinctive shapes resembling mandalas with 'geometric

[1] Xenakis, I. (1992) *Formalized Music: Though and Mathematics in Composition*. Pendragon Press.

[2] Jenny, H. (2001) *Cymatics: a study of wave phenomena and vibration*. Macromedia.; Lowe, A. & Schaffer, S. (2000) *N01se: universal language, pattern recognition, data synaesthetics*. Kettle's Yard.

tessellations…sequencing gracefully through time'.[3] Most other sound generating activities result in aperiodic soundwaves, the modal vibrations of which are like a rugged landscape or turbulent ocean filled with chaotically intersecting peaks and troughs.

For centuries, Western musical tradition admitted only those periodic vibrations with a fixed and identifiable pitch as musical - a tiny subset of all possible sound - excluding all other more complex, dissonant, and even rhythmic sounds as noise.[4] In this sense the defining characteristic of twentieth century music is the collapse of the opposition between music and noise; that is, the expansion of the space of music beyond its restriction to tonic organisation, and the increasing significance of rhythm, timbre, and dynamics. A description of soundwaves in terms of frequency, amplitude, and other spectromorphological characteristics is however neither sufficient for the manifest experience of noise, nor its significance at the level of semiotics and semantics.

Since we are interested in a naturalized account of the manifest experience of noise this will require delving into its neuroscientific explanation. Lets begin by examining the basis for its phenomenological description. In order to do this I shall start by analysing the relevance of Husserl's philosophy in the context of the contemporary concept of noise. Husserl's project should first of all be understood as motivated, like Hilbert's, by the need to secure the foundations of mathematical knowledge against scepticism and psychological relativism. Nevertheless, it is based on a fundamental opposition between the mathematics pertaining to

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[3] Mathieu, W.A. (1997) *Harmonic Experience: Tonal Harmony from its Natural Origins to its Modern Expression*. Inner Traditions International.

[4] Chion, M. (2009) *Guide To Sound Objects: Pierre Schaeffer and Musical Research*. (Trans. Dack, J. & North, C.). Accessible online: http://bit.ly/1IzjW0Q p.43

material things (which he characterised as axiomatic) and the purely descriptive eidetic method of intuition in phenomenology.[5]

Just as physics axiomatically defines the essence of natural or material things (*Naturwissenschaften)*, Husserl's phenomenology is intended to be an equivalently rigorous 'eidetic science' that describes the essential features of pure consciousness, and these are considered to be non-natural (*Geisteswissenschaften)*.[6] It should be noted that the Sellarsian distinction between the manifest and scientific images represents a different approach to the same problem that is indicated by Husserl's opposition between the non-natural objects of *Geisteswissenschaften* and the natural objects of *Naturwissenschaften*.

It can be argued that, from a Sellarsian perspective, the phenomenological approach is fundamentally prey to the myth of the given in the sense that to be aware of an object as having categorial status *c* is mediated by an implicit form of inferential language entry-exit transition even if it phenomenologically appears to be immediately available to consciousness. However, the Sellarsian critique of the myth of the given does not diminish the need for a naturalised account of phenomenological experience. A synoptic elaboration of the concept of noise in the sonic sense requires an explanation that is capable of both differentiating and reintegrating the naturalistic and normative dimensions of phenomenal experience. This account should specify the ways in which randomness operates at the physical level of neuronal pattern formation, and how this is functionally integral to biological cognition and rational agency.

[5] Petitot, J. et al. (1999) p.37

[6] Ibid. p.31

As a philosopher of the flux Husserl is particularly interested in sonic phenomena, which he designates 'temporal objects.'[7] It is against the British empiricist tradition's postulation of the elementary nature of sense perception (its sceptical focus on the actual or factual content of experience) that Husserl takes up the example of listening to music and argues that such kinds of experience must presuppose the presentation of a 'temporally extended present' composed of retentions and protentions.

While for Husserl the axiomatic basis of mathematics could exactly specify the discrete natural objects under its purview in the causal mechanical terms of ideal point particles and their calculable trajectories, the essences grasped in the regional ontology of pure lived experience are vague and inexact precisely because the temporal flow of lived experience presents a continuum that is irreducible to discrete representation.[8] Similarly, the *causal level of explanation* is not pertinent to the phenomenological analysis of pure consciousness and is replaced with a *motivational level of description*. Husserl's basic premise is that the ideal forms of geometry are abstracted from the 'Heraclitean flux of sensible morphologies', and that the 'inexact proto-geometrical forms' of perception fundamentally resist axiomatic mathematisation.[9]

This theoretical position, and its accompanying practical methodology, would later be a crucial inspiration to Pierre Schaeffer's development of *musique concrète* (or 'noise music'),[10] in the taxonomy of sound objects he develops, and in his analysis and manipulation of sound using electro-acoustic techniques. Schaeffer draws heavily on Husserl's practice of 'eidetic reduction' in constructing his guide to sound objects and in conceptualizing his own radiophonic work, which

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7 Husserl, E. (1992) *On the Phenomenology of the Consciousness of Internal Time* (1893-1917) (trans. Brough, J.B.) Kluwer Academic Publishers.

8 Petitot, J. et al. (1999) pp.34-40

9 Ibid. p.40

10 Chion, M. (2009) p.12

he saw as performing 'acousmatic reductions'.[11] In order to describe the phenomenological characteristics of noise we need to turn to Schaeffer's investigations before returning to the question of a naturalised description of the processes underlying its phenomenological experience.

Firstly, it should be understood that the sound object is a phenomenon of auditory experience and is distinguished from the physical properties of mechanical vibrations measurable in terms of frequency, amplitude, and chronometric time. Schaeffer, and Chion, argue that the experience of sound has certain correlations with the physical pressure waves, however these correlations are characterised by anamorphoses and distortions resulting from physiological and psychological particularities.[12] This means the relationship between the pressure waves received by the body and the experience of sound cannot be reduced to a linear mechanical chain of cause and effect. The conscious sensation of sound is the result of the non-linear processing power of the auditory system and is thus quite different from the physical vibrations.

For example, pitch is not a property of the vibration itself but the outcome of a frequency calculation carried out by the fast sub-personal information processing mechanism embedded in the structure of the auditory system.[13] Rather than passively receiving an impression of external pressure waves, the auditory system actively constructs a picture of the environment, for example by supplying fundamentals when they are not there. There are also temporal anamorphoses, for example unpredictable sound appears longer than predictable sounds of the same length.

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[11] Kane, B. (2014) *Sound Unseen: Acousmatic Sound in Theory and Practice.* Oxford University Press.

[12] Chion, M. (2009) pp.15-18

[13] Schnupp, J. et al. (2011) *Auditory Neuroscience: Making Sense of Sound.* The MIT Press. pp.93-138

More interestingly, the dynamics of the whole sound object can affect the perception of the attack; thus constituting a retroactive effect that propagates backward in time. In general this non-linear processing serves to enhance signal detection, both reducing noise and computational load. This active capacity of the auditory system to fill in missing detail is exploited by some forms of digital audio compression.

In place of the traditional forms of musical analysis, which are directed to the organisation of periodic tones (with criteria such as key, scale, pitch, harmony, duration, etc.), Schaeffer introduces detailed 'sound identification criteria', constituting an elaborate taxonomy for the description of sound objects, including several genres, classes, types and registers at every level of analysis.[14] While previous methods of musicological analysis had been based on the identification of pre-defined individuals, Schaeffer maps the dynamic individuation of sound objects within three perceptual fields: the pitch field, the intensity field, and the duration field. The transition from the organisation and analysis of music according to individual tones to the individuation of sound objects within perceptual fields is analogous to the transition from the substantialist to the field theoretical conception that we saw in energetics and economics.

The main criteria for the typological classification of the morphological characteristics of sound objects are Mass and Facture. Mass is gauged by occupation of the pitch field, constituting a sound *matter*; and Facture describes the *form* of the sound, its dynamics in the fields of intensity and duration.[15] Forms are perceived in a dynamic field as masses are in a pitch field.[16] Homogenous sounds, such as white noise or continuously held organ tones, have 'a non-existent *form* and fixed matter'.[17] In the experience of homogenous sound, there can be a sensation of

[14] Chion, M. (2009) p.126

[15] Ibid. p.135

[16] Ibid. p.66

[17] Ibid. p.144

temporal vertigo, or a sublime discord of the senses that makes time reel. Schaeffer describes white noise thus:

'It is indeed a homogeneous sound, and the exact opposite of the tonic sound (since it occupies the whole tessitura): every moment of listening is, for statistical reasons, like the preceding moment. These circumstances are to some extent found in applause, poured gravel or water, indeed agglomerates of any sounds, provided they are varied enough and their distribution in the tessitura and in time obeys the laws of chance.'[18]

Chion argues that sound mass is a crossroads concept, allowing for the collapse of the distinction between music and noise. Chion explains Schaeffer's use of the term thus: '*mass* is a generalisation of the concept of pitch, including sounds whose pitch is not precisely locatable by the ear (complex or varying sounds)…the mass of a sound object is its *way of occupying the pitch-field*. - whether it allows one or several distinct and locatable pitches ("tonic" masses) to be heard.'[19] The sound *matter* is both the sound mass and its harmonic timbre, which is the relatively 'diffuse halo' of sound surrounding the mass within the pitch field. Harmonic timbre is most easily identified in tonic sounds, and the more complex the sound, the less harmonic timbre can be distinguished from mass. Because sine tones are restricted to a single frequency with no mass and white noise covers all frequencies (maximum mass) these extremes both have non-existent harmonic timbres.[20]

Sound mass is further distinguished into seven classes: pure sound, tonic, tonic group, channelled sound, nodal group, nodal sound, and white noise.[21] Examples going from pure

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[18] Ibid. p.167

[19] Ibid. p.162

[20] Ibid. p.168

[21] Ibid. p.164

sound to noise are: a sine tone, a note played on a piano, a chord on a piano, the sound of several different cymbals ringing, cymbals clashing; and lastly white noise, which, like the sine tone, is an ideal function generated by electronic synthesis.[22] Music in the European tradition was restricted to the classes of tonic and tonic groups for a long time, later expanding to the class of nodal group and nodal sound, and avant-garde and popular movements use of sine tones, channelled sound, and white noise has now been accepted into the contemporary musical establishment. In some senses it could be argued that, after the determinate negations of the twentieth century, the space of music is now open to the full spectrum of sound possibilities. However, most music continues to be characterised by predictable rhythmic and melodic sequences with locatable pitch and harmonic organisation.

Having outlined some criteria for the phenomenological description of complex sound and noise, let us now return to the question of a naturalised account of those anamorphoses. This should preserve the Sellarsian claim that the relationship between perceptual contents and the aspects of the world they refer to is one of functional isomorphism. However, Schaeffer's phenomenological account of sound objects is not sufficient for a full understanding of noise for two reasons. Firstly, it only describes the manifest level of the appearance of sound objects. It is based on a suspension of the 'natural attitude', and thus brackets the question of a naturalised explanation of the physical properties and neurophysiological mechanisms underlying the generation of this appearance. Secondly, in suspending the natural attitude it also forgoes any description of the semantic content of sound and noise. This is a fundamental limitation of both Husserlian phenomenology and Schaeffer's application of it to the domain of sound. It is also a deficiency of a purely information theoretical approach, or one that does not clearly distinguish

[22] Ibid. p.166

between self-organising systems and rational inference. As Mazzola argues, 'classification of musical sounds is arbitrary without reference to their semantic potential'.[23]

In order to understand the full scope of sonic noise, beyond its phenomenological description, it is necessary to give both a naturalised explanation of sonic experience, and to analyse noise at the level of representation and semantics. Husserl's phenomenology is anti-naturalist at base, in the sense that it rejects 'philosophical naturalism' and starts from the presupposition that thought is not amenable to an analysis according to natural laws and the structure of causality.[24] It is also clearly prey to the myth of the given, in claiming to have immediate knowledge of categorial contents of perception.

However, this does not prevent the formulation of a naturalized account of phenomenological experience. In fact, Husserl even thought a mathematical (axiomatic) science of phenomenological experience might at some future point be possible.[25] Roy et al. argue that such a description of 'vague morphological essences' is now capable of mathematisation, and hence naturalisation, through various physico-mathematical theories that are based on the topological analysis of dynamic systems, including: 'catastrophes, attractors and bifurcations of nonlinear dynamical systems, critical phenomena and symmetry breakings, self-organization and critical self-organizing states, nonlinear thermodynamics and dissipative structures'.[26]

The contemporary scientific image of complex hierarchically nested nonequilibrium thermodynamic systems allows for a bottom-up explanatory description both of the qualitative manifestation of macroscopic phenomena in terms of the emergent functional properties at

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[23] Mazzola, G. & Cherlin, P.B. (2009) p.11

[24] Petitot, J. et al. (1999) p.38

[25] Ibid. p.49

[26] Ibid. p.55

different scales of their structural components down to the postulated entities at the microscopic scale (atomic and sub-atomic); and of the causal structure that *enables* the top-down higher level dynamics involved in phenomenal perception. Let us now look at how the phenomenal experience of time and intentionality can be given just such a description.

4.2

Nonlinearity, Multistability, and the Phase Space of Perception

Varela argues that the phenomenal experience of the lived present is irreducible to the sequentialist model of computation posed by the read/write-head of the 'Universal Turing Machine' (UTM).[1] This is because the textured 'nowness' of lived experience is what William James called a 'specious present',[2] consisting of an integrated model of the present state in its relation to the retentions and protentions it elicits. The lived present is specious or textured because it allows for the appearance of the past and the future in the present, a seeming paradox that Husserl acknowledges when he refers to past perception with the oxymoron 'wooden iron'.[3]

Contemporary neuroscience further allows us to describe the specious present as being constituted in a 'window of simultaneity', whose capacity is determined by the functional information processing characteristics of the neural substrate.[4] The global integration of neural information processing takes a certain amount of time such that the present cannot appear instantly and there is a minimum gap between two phenomenal events under which they appear simultaneously.

Since the biological organism must be capable of responding to stimuli in the instant of its occurrence it employs two strategies: firstly there are a large collection of phylogenetically ancient reflex arcs related to potentially dangerous affects such as intense heat or noise (i.e. retentions); and secondly the system must project and seek out the indeterminate threats and

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[1] Varela F.J. (1999) p. 168

[2] James, W. 'The principles of psychology'. H. Holt and Company, 1893. p.609.

[3] Gelder, T. Van, (1999) Wooden Iron? Husserlian Phenomenology Meets Cognitive Science, in Petitot, J. et al. *Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science*. Stanford University Press. p.55

opportunities of the future based on a probabilistic assessment of signs and cues available in the present (i.e. protentions). Beyond these largely unconscious tendencies, animals capable of higher cognition have more developed capacities for memory, planning, and social intelligence such as 'theory of mind' and strategic deception. Rational agents have the further capacity to engage in linguistically enabled inferential activity and explicit logical reasoning, allowing for a higher degree of behavioural flexibility and a more complex anticipation of contingencies. Inference that is consciously controlled and explicitly formulated in language is bound to be more costly both in terms of time and computational resources; however the payoff is a greater capacity for problem solving and the generation of novel behaviour.

Information processing resolution across different sensory modalities is similarly varied in terms of the economic administration of computational resources, with the auditory cortex displaying a far higher capacity for temporal discrimination and the visual cortex, which is primed for spatial coordination. The temporally heterogeneous operationality of sensory information processing must be dynamically integrated into a coherent, globally available model. Thus, in contrast to the sequential processing of symbols according to a linear flow from input to output, biological cognition presents time in a temporally extended window (analogous to what Husserl called the halo of time) according to non-linear neural processes involving dynamic networks of reciprocal determinations that Varela argues are 'incompressible'.[5]

Varela proposes two hypotheses concerning the neurophenomenology of intentionality: firstly, for every cognitive or intentional act a specific cell assembly (CA) is activated; and secondly, 'a specific CA is selected through fast transient phase-locking of activated neurons

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[4] Metzinger, T. (2004)

[5] Varela F.J. (1999) p.270

belonging to sub-threshold competing CA's'.[6] Most perception is so quickly and accurately processed that we appear to be in direct contact with its reality. This fast selection process is effected by the harnessing of stochastic randomness and non-linearity by the biological information processing system. CA's are transient emergent patterns composed of 'large arrays of neural groups that because of their intrinsic cellular properties qualify as complex non-linear oscillators'.[7] The functionality of this randomness disqualifies it from description as noise, just as we argued regarding the analysis of complex systems in biological evolution and finance.

According to Varela, there are three levels of functional emergence discernable in neuronal activation, corresponding to three temporal scales; there is the component level scale composed of single neural oscillators and their intrinsic group relations; then there is the collective scale of competitive synchronisations determined by the relaxation time of large-scale integrations; and finally the global level where the percept becomes available for cognition and descriptive-narrative assessments. Since there is a functional delay in processing the neural system must operate by constantly updating a model of the external environment that includes its differentiation from the past instant and its expected progress in the future. This is fully explainable in terms of the functional characteristics of neural assemblies as coupled non-linear oscillators, since 'each emergence bifurcates from previous ones given its initial and boundary conditions thus each emergence is present in its successor'.[8] The neuro-biological system is able to navigate the dynamically unstable environment by maintaining itself in a state of dynamic metastability.

Emergence at the global level is particularly noticeable in cases of multistable phenomena such as the Necker cube. The time it takes to switch from one state to another is generic, and

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[6] Ibid. p.275

[7] Varela F.J. (1999) pp.266-329

commensurate with the third scale of temporality defined by the relaxation time of CA's.[9] In fact, varying *rates of apparent change* (RAC) correspond to different attractor dynamics in the neural substrate, and may be an indicator of changes in dopamine activity or schizophrenia.[10] Varela refers to Tim van Gelder's discussion of Anderson and Port's connectionist network for auditory pattern recognition in arguing that heuristically trained attractor neural networks (ANNs), which are based on 'dissipating dynamical processes governed by point attractors and limit cycles',[11] cannot replicate either the speed or the dynamic instability of enactive cognition (in particular that of mammalian auditory perception).

'In this class of dynamical systems, the geometry of phase space needs to be characterized by an infinity of unstable regions, and the system flows between them spontaneously even in the absence of external driving forces. There are no attractor regions in phase space, but rather ongoing sequences of transient visits in a complex pattern of motion, modulated only by external coupling.'[12]

Paolo Chagas argues that Varela's focus on visual multistability is to the detriment of his analysis of internal time consciousness since, unlike the rather contrived visual examples; multistable auditory phenomena are both intrinsically temporally extended and relatively common.[13] He identifies the window of simultaneity as the decisive factor in the neurophenomenological description of 'sound objects-events'. However, in order to fully

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8 Ibid. pp.282-283

9 Ibid. p.285

10 Kruse, P. et al. (1995) The Significance of Perceptual Multistability for Research on Cognitive Self-Organization, in Kruse, P. & Stadler, M. (Eds.) *Ambiguity in Mind and Nature: Multistable Cognitive Phenomena*. Springer.

11 Varela F.J. (1999) p.287

12 Ibid. p.285

understand the phenomenal experience of sound and noise in music we must move beyond the focus on the dynamics of complex adaptive systems, and examine how these processes relate to the representational capacity of cognition. We shall begin by outlining the unconscious processes of perceptual 'inference' that are more or less well explained by such systems dynamics, before proceeding to semiotic and semantic aspects which require a properly inferential level of description.

As Husserl recognized, phenomenal perception is a paradoxical composite of multiple nested temporal hierarchies – for example that of a single note, within a phrase, within a melody, within a song, within a historically constituted musical style, etc. This convolved structure is further complicated when we take into account the nine scales of music that Curtis Roads identifies: infinite (ideal/sine waves), supra (beyond individual composition), macro (overall compositional form), meso (groups of sound objects), sound object (basic unit), micro (sound particles down to threshold of auditory perception, millisecond time scale), sample (atomic level of digital sample, microsound time scale), subsample (fluctuations below recording sensitivity, nanosecond time scale), infinitesimal (ideal mathematical durations such as infinitely brief delta functions).[14] Metzinger argues that the thickness of presentative content is constitutively bound up with the hierarchal nesting of representative content such that the phenomenal appearance of the former is generated by the non-phenomenal simulatory dynamics of the latter.[15]

Although the ear is sensitive to sounds with a duration of milliseconds, the 'sensation of tone happens when human perception reaches attentional limits where microevents occur too

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[13] Chagas, P.C. (2010) Spectral Semiotics: Sound as Enacted Experience: A phenomenological Approach to Temporality in Sound and Music. *Before and after Music: Proceedings from the 10th International Congress of the International Project on Musical Signification. Acta Semiotica Fennica XXXVII*, ed. L. Navickaite-Martinelli (Vilnius), 117–26.

[14] Roads, C. (2004) *Microsound*. The MIT Press. pp.3-4

[15] Metzinger, T. (2004) p.154

quickly in succession to be heard as discrete events'.[16] It is this cortically generated 'thickened present' that allows for the phenomenal experience of timbre to which the auditory cortex has a very high degree of discriminatory sensitivity – an adaptive evolutionary trait shared with many animals. As the auditory information from the event is processed a multimodal sensory-motor image emerges from multistability according to the fast phase locking of neuronal activations that are sensitive to pitch, timbre and spatial location; transient cell assemblies that show marked interdependency.[17]

The timbre of a sound in the specious present appears as a spectral texture that is dynamically updated according to the retentions and protentions it elicits, for example the distinctive sound of percussion is 'shaped by transient aggregates that briefly occur at attack phase'.[18] Altering the envelope of a sound may generate alien acoustic phenomena that bear little relation to the original sample, or even to any 'normal' modes of sound production. For example, the sound of an oboe recorded in a small room may be given the reverb of a large concert hall, and the timbre can also be manipulated using filters or by changing the speed. Furthermore, this may be submitted to granular synthesis techniques so that its sonic profile can be altered at the level of microsonic grains.

Normal experience seamlessly presents us with unambiguous content, but because perceptual illusions reveal active processes of image construction and disambiguation they offer important insights into the unconscious neurophysiological functions that underlie this apparent

[16] Roads, C. (2004) p.23

[17] Bizley, J.K. et al. (2009) Interdependent Encoding of Pitch, Timbre, and Spatial Location in Auditory Cortex. *Journal of Neuroscience*.Vol. 29, Issue: 7, Soc Neuroscience, pp.2064-2075 PubMed: 19228960

[18] Chagas, P.C. (2010)

seamlessness.[19] Though many of the well-known examples of bistable and multistable phenomena are visual and rather contrived (such as the 'Rubin vase', the 'Necker cube' and the 'Rabbit and Duck' illusion), perceptual ambiguity in general and multistability in particular is not an exceptional case. Rather they are a fundamental feature of regular perception, and especially auditory cognition. Rather than revealing a malfunction of perception; or indicating the untrustworthiness and falseness of sensory content (as many philosophers have held); such illusions demonstrate that sensory experience is not a passive registration of information but an active construction. Without this active process of disambiguation through hypothesis generation or modelling, which Helmholtz speculated to be the result of 'unconscious inferences', sensory content would be much more 'false' and confusing.[20]

This is clearly shown in the 'Ponzi illusion', where two oval shapes of the same size appear to be different due to perspective lines. The information received at the retina is of two identically sized ovals, this is the 'proximal' size, and the 'distal' size of the object is a speculative hypothesis about its actual size based on contextual cues. The distal sizes of the ovals are different because perception has learned to interpret visual information in this way, through an unconscious analysis of accumulated associations according to a dynamic Bayesian framework of statistical probabilities, very much as Hume thought.[21]

The active disambiguation of sonic information, which is called 'auditory scene analysis' (ASA), presents several cognitive challenges that are specific to the medium of sound. Sound is a one-dimensional mechanical pressure wave registered on the tympanic membrane as a variable degree of pushing or pulling. The value of this proximal variable, at any one time or over a

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[19] Pressnitzer, D. et al. (2011) Auditory Scene Analysis: The Sweet Music of Ambiguity. *Frontiers in Human Neuroscience*, Dec. doi: 10.3389/fnhum.2011.00158

[20] Ibid. p.2

[21] Ibid.

certain duration, may be represented as a real number between 0 and 1; however the distal sound sources that it refers to may be multiple, distributed in space, and travelling at various speeds.[22] As Pressnitzer et al. point out, unlike in the visual field 'there is no occlusion between acoustic waves originating from different sources: as waves propagate through the air, they sum linearly at each point'.[23]

Because there are a high number of different possible distal configurations, the proximal sound information *must* be actively interpreted. Pressnitzer et al. explain that this underdetermined situation is what in mathematics is called as an 'ill-defined problem'. This means it is not possible for the auditory system to simply register and pass on information; it must project hypotheses and make a bet according to their probability. 'An exact solution being impossible, perceptual gambling must begin.'[24] As bistable phenomena show, because we cannot simultaneously hear or see two different distal projections, and we do not generate an average between two choices, a decision must therefore be taken. For many living organisms interpreting the information one way or the other can be a matter of life or death, so this unconscious compulsive perceptual gambling habit is a really high stakes game.

According to Pressnitzer et al. the problem that ASA confronts can be analysed according to two axes or dimensions: the vertical analysis of frequency distribution, and the horizontal analysis of temporal organisation.[25] From the discussion of Schaeffer's typology of sound objects above we know that a dimension of intensity should be added, and that the three perceptual fields (pitch field, intensity field, and duration field) are inseparable in practice. As we saw earlier, this is further demonstrated by the concept of 'specious present' that Husserl

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22 Ibid.

23 Ibid.

24 Ibid. p.3

25 Ibid. p.4

introduced, and which we can now give neurological explanations in terms of attractor dynamics and coupled non-linear oscillators.

From the proximal reception of the linearly summed soundwave at the tympanic membrane, the signal is broken into frequency sub-bands as a result of the distinctive biophysiological structure of the cochlear. This tonotopic organisation of sound can be understood as the first stage of the modelling process. It reveals patterns of correspondence between frequency distributions that would be difficult to detect without tonotopic organisation. For example, the periodicities and harmonic cues that indicate the presence of pure tones. As situations in which all the information is available are uncommon, the auditory system regularly fills in the missing details to complete the 'inferentially' detected patterns.

As Pressnitzer et al note, tonotopic organisation presents its own challenges for ASA, since sound from a single source will most likely be spread across several frequency bands, and this may overlap with sound from other sources.[26] Other vertical cues they mention relate to onset and synchrony, location, and spectral regularity. All of these cues are signals whose detection must be extracted from surrounding noise. This process is always susceptible to interference and has a certain probability distribution with regard to false positives. As we saw earlier, the discrimination between signal and noise can be modelled according to the Bayesian calibration of a decision criterion on a probability distribution, known in signal detection theory as the 'receiver operating characteristic'.

The main problem of ASA in the temporal axis is again related to the individuation of distal sources, called 'streams', from the continuous variation of proximal pressure waves. Since the dynamics of most sound producing events do not suddenly jump from one frequency to another across large intervals, the perceptual recognition of a stream is most stable when it moves up and down in small pitch steps. This tendency is exploited in Western polyphonic music; 'voice leading' presents a method for the control of streaming phenomena, while the deliberate manipulation of this bias can be found in 'implied polyphony' and in Bach's 'ambiguous canons'.[27] As Pressnitzer et al. argue, bistability for streaming is a common feature of perception, and musical composition appears to demonstrate not just an implicit knowledge of the workings of ASA, but an incessant exploration of the probability fields of perception. They analyse two pieces by Ligeti using a computational model of ASA that defines a coherence matrix, showing how the pieces explore the space of vertical and horizontal perceptual ambiguities.[28]

Composers such as Scelsi and Ligeti emphasised the timbral qualities of sound, and explored the microtonal structure underlying the dynamics of sound mass transformations. This careful attention to the acoustic properties of sound and to the phenomenological characteristics of ASA is further extended by the school of 'spectral music'.[29] Spectral music follows from the historical expansion of the space of music that occurred over the twentieth century. This can be understood as a series of determinate negations of the parochial limits of established musical tradition. Serial music was the determinate negation of the organisation of music according to key signature and harmony, but it only achieved this by supplanting traditional composition with a highly constrained, rigid and dogmatic form. Post-serialism extended this abstract formalism to other elements of sound, such as rhythm, duration, and dynamics.

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[26] Ibid. p.3

[27] Ibid. p.7

[28] Ibid. p.9

[29] Anderson, J. (2000) A Provisional History of Spectral Music. *Contemporary Music Review*, 19:2.

The increasing importance of timbre and sound dynamics, as well as the technological developments in composition and synthesis, led to the concept of sound-mass. This is the determinate negation of the definition of music as the organisation of individual tones with locatable pitch. Spectral music extends this trajectory; effecting a determinate negation of harmony, melody, rhythm and form; by introducing alternative constraints it defines a much larger possibility space than traditional composition, taking up the whole spectrum of sound.[30] These musical elements (harmony, rhythm, etc.) are not entirely absent but the emphasis has shifted to the spectral dynamics of their emergence, transformation and dissipation.

Spectral music draws on the computational and mathematical modelling of sound spectra in order to take the compositional control of sound to another level. Instead of a macrostructural organisation of tones according to harmony there is an evolution of timbre-chords and sound masses according to the microstructural development of harmonic spectra. There is careful attention to the acoustic dynamics of the changing relationships between different masses in the pitch field. Spectral music displays many of the characteristics of contemporary mathematics that Zalamea outlines.[31] In particular, a complex pendular motion between pairs of dialectically interpenetrating terms such as the one and the many, the discrete and continuous, the local and global, etc.

Finally, returning to the discussion of perceptual illusion, Pressnitzer et al. refer to the phenomenon of 'verbal transformations': when a word is repeated for some time the brain begins to extract new information or produce new hypotheses about the distal source. This results in the appearance of phantom words and phrases; some are reliable bistable figures analogous to reversible figure-ground visual illusions such as the 'Rubin vase', for example 'fly,

[30] Ibid.

[31] Zalamea, F. (2012)

fly, fly' can switch to 'life, life, life'. Pressnitzer et al. note that this effect extends to the repetition of small musical segments, and this is used to great effect in the work of Steve Reich and other minimalist composers, and in popular sample-based music (they mention Carl Craig). It is certainly true that bistable perceptual illusions and verbal transformations are highly common in popular sample-based electronic music. This is perhaps most evident in recent music inspired by the 'footwork' scene in Chicago.[32]

The discovery of patterns in random auditory or visual noise is a phenomenon called pareidolia, which is part of a wider class of probability estimation fallacies called apophenia (including the gambler's fallacy, overfitting of statistics, etc.). In a more deliberate and explicit exploration of this feature of auditory perception Roc Jiménez de Cisneros, of EVOL, screened a film entitled 'Pareidolia' at the ICA, using synthetically generated voices whose spectral dynamics were imperceptibly modulated over repetitions producing both pareidolia and bistable switching.[33]

Evol have explored auditory illusion in other work, for example in the split cassette with Mark Fell entitled 'Each Absolute End Point of an Atriodic Irreducible Continuum is an End Point', Evol present an extended study on the 'Shephard tone' illusion, which appears as an infinitely ascending or descending series of tones. In order to fully understand what is happening in the experience of a piece of music such as this we should not only give a description of its phenomenological characteristics, this must also be supplemented by a neurophenomenological explanation, but furthermore a semiotic and semantic description is necessary that is not well explained by self-organising systems.

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[32] Such as DJ Rashad's *Slip Away* remix of DVA's *Walk it Out*, or *I'm Too Hi* by DJ Rashad (feat. Earl) both on Hyperdub 2013

[33] At an event called 'Do Blow it on the Vector', curated by Richard Sides, and featuring performances from Theo Burt, EVOL, Mark Fell, and Lorenzo Senni. Held at the ICA, London, on the 6th September 2014.

In a reversal of the 50's attempt to synthesise natural sounds using algorithms, Evol have experimented with the acoustic production of sounds developed in computer music.[34] Fifteen players equipped with a latex balloon and a hexagonal stainless steel nut, emitting short bursts of sound at different distances and speeds, were able to create sounds very like the saw-tooth wave, a non-sinusoidal waveform that is characteristically recognisable of computer music, as well as supersaw and hoover sounds, which were the iconic sounds of rave music in the late 80's and 90's. The auditory content is thus non-distinguishable from a generic synthesiser preset; however the conceptual content is quite different.

It is interesting to note the similarities and differences between the strategies of artists such as Evol, Mark Fell, and Lorenzo Senni, and those employed by the bands Brassier mentions. The latter produce a noise that is not 'noise' (in the merely physical sense) by colliding incomplete idiomatic fragments, synthesising incompatible genres and generating semantic overload; the former also produce a noise that is not 'noise', but by subjecting a generically identifiable idiom to an extended treatment at a scale that utterly transforms its semantic and phenomenological content.

The music of Mark Fell presents an especially interesting case with regard to multistability and to genre. On the one hand he dismisses the 'canonical works of electroacoustic, modernist algorithmic composition, and contemporary classical musical practices (including aesthetics, ideologies, materials and processes)' and is principally influenced by house and techno music, in particular the 'super slick smooth productions' coming out of New York in the early nineties.[35] On the other hand, though his music uses a sound palette drawn from house

[34] Evol *Three hundred grams of latex and steel in one day* (ALKU 111, 2011, 7" balloon-pink vinyl). http://bit.ly/1O0iTsy

[35] Fell, M. (2015) Patterns in Radical Spectra. *Divergence*. Issue 4, Feb. DOI: 10.5920/divp.2015.44

and techno, its rhythmic fragmentation is inspired by the likes of Yasunao Tone and Autechre,[36] and so it is far from being dance music. Fell accepts that his music can be described as 'post-techno' in the sense that it extends rather than refutes the insights of techno, however he prefers to classify it as 'Unusual Electronic Music Typically Without Academic Affiliation'.[37]

A central aspect of his musical practice is the exploration of the phenomenological experience of temporality. Against Varèse's description of music as 'organised sound', Fell argues that 'organised paint' does not sufficiently describe the lines painted on the floor of a car park.[38] Fell's point is that the painted lines organise behaviour in space and time. Likewise, at the very least, music can be thought as providing various contexts for the experience of time and space, and organising the possibilities of movement within this paradigm. Further than this however, what Fell is alluding to can better be understood in topological terms as the gestural or diagrammatic constitution of the spatial and temporal coordinates of cognition. The gestural constitution of space and time has been discussed by mathematicians and philosophers such as Deleuze and Gilles Châtelet,[39] developed in phenomenological terms by Merleau Ponty,[40] and applied to music via a category theoretical approach by Guerino Mazzola.[41] For Mazzola, music is the prime means for the 'creation of autonomous time beyond the physical "tyranny" of real time'.[42]

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[36] 'Yasunao Tone (particularly 'Musica Iconologos', Lovely Music, 1993), Autechre ('Chiastic Slide', Warp Records, 1997 and the later 'Draft 7.30', Warp Records, 2003)' See: Fell, M. (2015)

[37] Fell, M. (2015)

[38] Doran, J. (2013) The Sound Of Rain: Mark Fell And The Quietest Room In Europe. *Quietus,* May 28.

[39] Châtelet, G. (2000) 'Figuring Space: Philosophy, Mathematics and Physics'. Kluwer Academic Publishers.

[40] Merleau-Ponty, M. (2002) *Phenomenology of Perception*. Routledge.

[41] Mazzola, G. (2002)

[42] Ibid. p.933

In some sense, as we have seen, the temporality of experience is never 'real' time, since it is a simulation within a window of presence that is determined by the contingent physiological structure and information processing dynamics of the brain. However, most waking experience is governed by the more or less implicit knowledge of causal laws, so from a given sensory input (e.g. ball rolling across table) we can project the likely trajectory (ball falls off table). Because this online information is *about* the world, it is fully transparent and maximally integrated into the causal structure of the global meta-model or world zero. As we saw, conscious experience is continually filled with counterfactual simulations or hypotheses, which are evaluated on the basis of the apparent immediacy of the meta-model.

In listening to music, the sensory information is no longer *about* the world, it is freed from the causal regime of regular events, and enters into the production of an 'antiworld'.[43] According to Mazzola, music is semiotic and has a syntax but, unlike linguistic communication, there are no external references to the discourse of music, and all meaning is produced by its internal organisation.[44] It is this immanent character of music, the unification of form and content which modernist art aspired to, which makes its analysis particularly amenable to topological description. Since music cannot refer to time in the way that a linguistically communicated story can does, musical time is determined by its syntagmatic organisation alone, which, together with paradigmatic choices, constitutes an internal narrative structure.[45] In fact, this is precisely why the description of music at the level of physical sound, sensory content, or phenomenological experience is not enough, since the capacity of music to structure time and space is a feature of its internal geometry (symmetries, the topological organisation of Gestalts) and its semiotic and semantic content.[46] In particular, Mazzola argues, following Michael Leyton,

[43] Ibid.

[44] Ibid. p.938

[45] Ibid. p.934

[46] Ibid. p.933

that time is constituted by symmetry breaking, and musical time can also be topologically analysed in terms of its internal symmetry breaking relations.[47] The analysis of music according to topology will be further discussed in the final section.

Fell contends that 'music is a technology for constructing an experience of time', and draws on, but moves beyond Husserl in explaining this.[48] He argues that Husserl's phenomenology is based on an infinitely contracted now point where time moves in an orderly linear fashion, and claims that this is an ideological image of time that does not account for alternative forms of experience. As we've seen, Husserl's position is in fact more complex since he acknowledges the specious nature of the present. Nevertheless, Fell's point stands in the sense that phenomenological analysis tends to follow a linear organisation, where topological tools and a consideration of feedbacks and non-linearities gives a more complex picture of temporal and spatial organisation. According to Mazzola's further specification, musical time can be modelled according to catastrophe points and symmetry breaking transitions.[49] Fell emphasises the role that technologies play as constraints for composition, and argues that the software used for most computer based composition (sequencers such as Logic) are intrinsically linear in comparison with the open environments of MaxMSP and Supercollider, which allow for a topological treatment of temporality.[50]

Fell is particularly interested in what he considers to be a kind of 'a-temporal transcendence' that is typically associated with meditative slowly evolving drones such as La Monte Young and Eliane Radigue, but which he thinks is just as attributable to techno tracks

[47] Ibid. pp.933-938

[48] Fell, M. (2014) *Music Of The Eternal Now: Post-Husserlian Temporality, Pattern Cyclic Time-Consciousness And Computer Music*. Silent film with text, screened at ICA London Sep 6.

[49] Mazzola, G. (2002) p.933

[50] Doran, J. (2013)

such as Mike Ink's 'Polka Trax'.[51] He refers to Laurie Spiegel's discussion of 'slow change music', where she argues that the reduced density of change allows for an increased sensitivity to subtle details and a sense of temporal relaxation or decontraction.[52] However, Fell rejects the mystification of music that surrounds the listening experience of Young and Pauline Oliveros, as much as he scorns the intellectualism of electroacoustic music, the experimental avant-garde, and 'intelligent dance music'.

Several of Fell's compositions are interesting with regard to this focus on temporality as well as perceptual multistability and the transformation of identifiable generic musical idioms. The first, 'Psycho Neural Alignment Study 5', was composed for radio broadcast, and was accompanied by a downloadable image of two brightly coloured circles, which the audience were asked to stare at cross-eyed so the two circles appeared as one for the short duration of the piece. The sound component is a spectral integration of two conflicting recognisable musical idioms via the 'linear interpolation between the frequencies of the eleven loudest sinusoidal waveshapes'.[53] The two idiomatic auditory contexts are the spiritualist a-temporal transcendence of the Tibetan singing bowl; and the functionalist, technologically enabled a-temporal transcendence of the 'mind lock sequence' composed by Walter Murch for the film *THX1138*. This is a different methodology for the synthesis of incompatible genres, with both a sensory and semantic overload. The second piece pertinent to the discussion is an installation piece, called *64 Beautiful Phase Violations*, which was presented in an anechoic chamber and is based on the manipulation of the phase and frequency of 64 oscillators. The violations produce bizarre

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[51] Fell's examples are: 'Mike Ink's 'Polka Trax' (Warp Records, 1996), Thomas Brinkmann's 'Studio 1 - Variationen' (Profan, 1997), or even Jeff Mills' 'Growth' (Axis, 1994)' Fell, M. (2015)

[52] Ibid.

[53] Ibid.

source-location ambiguities, morphing the spatio-temporal configuration of experience like melted plastic.[54]

Lastly, Fell produced an album entitled *Multistability*, which features paired tracks that are like the two different perspectives of a bistable image. However, what is really interesting about this album is the different levels of multistability at work. Each piece presents a short burst of percussive or synth sound extracted from the idiom of house or techno music and iterated according to non-standard timing or fragmented rhythms. The duration, envelope and spectral content are modulated over iteration. This recapitulates the slow-change a-temporal transcendence of techno in a completely alien and atonal register, it is almost like the application of post-serialist formalism to the sound palette of dance music (but without the dogmatic framework or 'high art' avant-garde intellectualism). The durations of the sounds typically range between 1 microsecond and 3 seconds, and since this is the zone of certain thresholds in auditory experience; between the perception of beat, pitch, and timbre; the iterated sound object appears to move through the different dimensions of audibility. This means there is multistability within the specious present as well as across the fragmented rhythmic groups, and at the level of semantic content as a result of the transformation of the generic idiom.

All three of these examples of Fell's work not only explore the 'sweet spot' of perceptual illusion, but present an active engineering of spatial and temporal experience that forces the listener to consciously confront the unconscious mechanisms underlying the seamless presentation of auditory content. The next section will further examine the discrepancy between the phenomenological experience of the person and its neurophysiological explanation, and show how this relates to noise.

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[54] Doran, J. (2013)

4.3

Neurocomputational Illusion: The Ultrasmooth Limit

The apparent irreducibility of phenomenal experience to neurobiological descriptions of material processes in the brain cannot be dismissed simply by asserting a naturalist ontology. This is just dogmatism unless there is a sufficient explanatory hypothesis that demonstrates the integration of the different levels of descriptive analysis in a unifying framework. That is, an explanation of the brain as a complex dynamic system, detailing the structural features of its hierarchically nested organisation and how this gives rise to functional properties such as phenomenal experience and conscious control of behaviour.[1]

The argument put forward here will be that Thomas Metzinger's neurocomputational account[2] of the experience of selfhood as the result of a transparent phenomenal self model (PSM) is able to overcome the antimony between the reductive approach of eliminative materialism espoused by theorists such as Paul Churchland, and the folk psychological notion of the self that is the basis of the manifest image.[3] For Metzinger, the self is an 'epistemically unjustified representational fiction', but one that is structurally and functionally adequate for higher cognition. That is, the self-model satisfies the requisite structural constraints for consciousness, and can be given a functional explanation in terms of computational load reduction and evolutionary advantage. Metzinger likens the illusion of selfhood caused by the

[1] Petitot, J. et al. (1999) p.45

[2] Metzinger, T. (2004)

[3] Brassier, R. (2011b) The View from Nowhere, in *Identities: Journal for Politics, Gender, and Culture*, Vol. 8, No.2.; Brassier, R. & Ieven, B. (2009) *Against an Aesthetics of Noise*, interview, published online: http://bit.ly/21rxTtc

functional transparency of the neurobiological system to Kant's postulation of the transcendental unity of apperception.[4]

Metzinger's argument is primarily based on a representationalist and functionalist understanding of cognition as a system that generates a model of the external environment and the system's own states; a self-model. There are three components to the representational relationship; the representing system, the representational state of the system, and the represented object the system refers to. As Metzinger notes, this bypasses the familiar problems of correspondence by assuming only a functionally mediating state as the relation between representing and represented.[5] This follows an approach called *teleofunctionalism* in evolutionary biology that understands mental representation in terms of its instrumental or practical ramifications. The content of a representation is then just the use to which the representing system puts it, including the set of simulated motor-behaviours it corresponds to and any enacted response. This is fully in line with Sellars' naturalised account of Humean impressions as isomorphisms defined by their functional role.

This representational relationship can also be understood according to the Piercean triadic conception of semiotics that was outlined earlier. Triadic semiotic relations can be instantiated in many systems, and occur in many organisms without the need for conscious phenomenal awareness. To specify the phenomenal experience of noise we must first distinguish between conscious and unconscious representational states. According to Metzinger's account, there are varying degrees of consciousness related to the structural and functional characteristics of the system. The homeostatic regulation of temperature and the coordination of the immune system are examples of automatic processes that amount to unconscious representational states.

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[4] Metzinger, T. (2004) p.58

[5] Ibid. p.29

A self-model constitutes a first-order intentional system, while a PSM wielding a phenomenal model of the intentionality relation (PMIR) is a second-order intentional system; it has intentions about its intentions and the intentions of other systems.[6]

Furthermore, we must distinguish representational content (triadic) from phenomenal content, which is a two-place relation between system and content (intransitive).[7] Phenomenal content is determined by the internal characteristics of the information processing system.[8] The truth of a phenomenal description of noise does not depend on the real physical existence of noise, however the former may be an indication of pathology if the latter does not hold (for example in the case of amusia that Oliver Sacks describes).[9] Many simple organisms do not need to generate conscious phenomenal content; other more complex organisms fulfil these criteria but do not model the self. A system that generates a phenomenal model has the immediate conscious experience of a world, and has a greater flexibility and control of behavioural response as a result.

However, most animals do not generate a phenomenal model of the *self* because it is computationally expensive and not necessarily evolutionarily advantageous. A PSM is a model of the self within a model of the world, both of which emerge from a modelling process that is not included in the nested models. The transparency of conscious experience may be understood as a functionally underdetermined mechanism, or platform, for the fast disambiguation of signals, the reduction of computational load,[10] and the flexible top-down control of complex behaviour.[11]

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6 Ibid. pp. 113-114

7 Ibid. p.28

8 Ibid. p.13

9 Sacks, O. (2007) *Musicophilia: Tales of Music and the Brain*. Knopf Publishing Group.

10 Metzinger, T. (2004) p.136

Metzinger acknowledges that since phenomenal experience is not an objectively observable substantial thing in the world, but the emergent functional property of a multitude of interacting material components, there is an unbridgeable gap between the personal and the subpersonal levels of description.[12] In particular, the temporally extended quality of experience is an emergent property of the neural dynamics that generate phenomenal content. The neurocomputational architecture of the brain supports a complex dynamic state space. Lower level cognition merely revises or reinforces a pattern and relates to a relatively stable dynamics, while a trajectory in the state space of higher level cognition often transforms the very landscape it operates in.[13]

It is important to note that though conscious experience is the weakly emergent[14] property of a globally integrated picture of the world, phenomenal state space is only a subset of the physical state space of the brain.[15] In Sellarsian terms, the impasse between these two levels of description is a particularly stubborn aspect of the clash between the manifest and scientific images. However, the chasm separating subjective experience from the objective physical and biological reality of the brain is only evident from a first-person perspective that neuroscientists have determined as naïve,[16] illusory,[17] and contingent on the computational ecology of phenomenal experience in the biological evolution of certain organisms in a particular milieu.[18] As Brassier argues, phenomenal transparency is not a necessary feature of all higher cognition

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[11] Ibid. p.121 and p.200

[12] Ibid. p.18

[13] Ibid. p.59

[14] Weak emergence asserts that emergent properties are explainable in terms of lower level material components but cannot be predicted without a full simulation of the system. Bedau, M.A., & Humphreys, P. (Eds.) (2008) *Emergence: Contemporary Readings in Philosophy and Science*. Bradford Books, The MIT Press.

[15] Metzinger, T. (2004) p.59

[16] Ibid. p.16

[17] Ibid. p.23

[18] Ibid. .p.127

but merely 'a cheap way of minimizing the neurocomputationally exorbitant cost of representational opacity.'[19]

Metzinger argues that the analysis of conscious phenomenal states requires at least two interdisciplinary levels of description that cannot be reduced to each other: representationalist and functionalist. He proposes three other levels of description necessary for the specification of the 'representational deep structure of phenomenal experience': phenomenological, information-computational, and physical-neurobiological.[20] It is important that none of these levels of description can be reductively eliminated, but that all representational processes can ultimately be explained in terms of the underlying neuronal activation patterns. He then proposes eleven constraints for distinguishing conscious phenomenal representations from the wider class of representational states, and submits each to a systematic multi-level description according to the five criteria.

In order to understand the pertinence of noise to cognition, and to give a neurological explanation of the phenomenological experience of noise, it is necessary to give a brief overview of the relevant constraints. The first constraint pertains to the phenomenal appearance of a world in which information has the status of *global availability* for deliberately guided attention, cognitive reference, and control of action. The second constraint is presentationality, or *activation within a window of presence,* which refers to the fact that phenomenal content is always presented as occurring 'now'. The third constraint, *integration into a global coherent state*, relates to the functional coherence of the global image, and the fact that this level of representation cannot be represented by the system *as* a representation, which Metzinger refers to as 'auto-epistemic closure'. Both presentative and representative content are integrated into a global representative

[19] Brassier, R. (2011b)

[20] Metzinger, T. (2004) p.110

medium, which Metzinger calls a world zero; this is a reference model that is 'given not constructed', thus enabling a stable point for discrimination between counterfactual simulations and competing models.[21] This is closely connected with the seventh constraint, *transparency*, which refers to the degree to which information from earlier stages of processing is made available to attention and introspection.[22]

Metzinger argues that satisfaction of constraints two, three, and seven (presentationality, globality, and transparency) constitute a minimal concept for the appearance of any phenomena to consciousness. So, conscious experience (of noise or any other phenomena), at the very least 'consists in the activation of a coherent and transparent world-model within a window of presence.'[23] Adding constraint four, *convolved holism,* allows for the construction of a nested hierarchy in the content of perception, the individuation of objects, scene segmentation, and the foregrounding of salient characteristics crucial to signal detection and communication but also to the definition of noise. The fifth constraint, *dynamicity*, refers to the coherent representation of temporal change, without which consciousness can only be a snapshot reality. The addition of constraint six, *perspectivalness*, describes the minimal conditions for a conscious first person perspective.

Finally, constraints eight to eleven define further individuating characteristics of normal human consciousness: *offline activation*, *representation of intensities*, *ultrasmoothness*, and *adaptivity*. Dreaming is a 'global offline state' that maximally satisfies constraint eight, however there are degrees of offline activation in normal waking consciousness, for example unintentional simulations, fantasies and daydreams.[24] Constraint nine refers to a feature of the transparency of

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[21] Ibid. p.96

[22] Ibid. p.165

[23] Ibid. p.204

[24] Ibid. pp.179-184

presentative content whereby the intensity of a signal is represented as an analogue continuum whose resolution exceeds conceptual discrimination.[25] Metzinger explicitly relates the tenth constraint (ultrasmoothness) with Sellar's discussion of 'the grain problem'; according to Metzinger, this is again a constitutive structural feature of neurobiological systems dynamics. He argues that the 'ultimate homogeneity' of the pinkly sensed continuum that Sellars refers to (or the immersive bassoonly duration) may be 'another paradigmatic example of ineffability'.[26]

On this account ineffability is caused by the phenomenal transparency of earlier processing stages and the excess of attentional availability over conceptual discrimination. The homogeneity of simple sensory experience is the result of the maximal transparency of presentative content. Many aspects of phenomenal experience, both of the external environment and of the PSM, are characterised by this kind of *ultrasmooth* 'structureless density'.[27] Qualities such as the timbre of a bassoon cannot be decomposed into simpler parts; no grain is detectable, and no edges to perception can be found. This is because the earlier processing stages are completely unavailable to introspection.

Rather than demonstrating the continuity of perception down to the infinitesimal differential, as Leibniz and Deleuze have it, the ultrasmoothness of presentative content demonstrates 'a fundamental level of representational atomicity'.[28] This means, paradoxically, that the apparently limitless continuity of perception is actually the result of a discontinuity and a limit to perception. The phenomenal experience of homogeneity presents us with 'the closedness of our own user surface in a maximally concrete way'.[29] It is because of this fundamental limit to

[25] Ibid. pp.184-189

[26] Ibid. p.190

[27] Ibid. p.192

[28] Ibid. p.346

[29] Ibid. p.194

the introspective methods of phenomenological investigation that Metzinger claims, at least in the context of the analysis of fine-grained perceptual discriminations: 'Neurophenomenology is possible; phenomenology is impossible'.[30]

Presentational content is what is given to experience via very fast sub-personal neuro-computational processes, it is 'the paradigm example of transparent phenomenal content'.[31] Whatever is given as presentational content appears to refer to a substantial cause, it thus operates as an 'existential quantifier' indicating the existence of something.[32] The development of presentational content is accompanied by increased 'output decoupling'; i.e. a drop in automatic stimulus reflexes, with a higher variety of behavioural responses available for selective motor control.[33] The generation of a genuinely 'inner world' is related to a further transition toward 'input decoupling', characterised by a greater variety and complexity of counterfactual simulations, and allowing for detailed memory and planning.[34] The experience of music is profoundly characterised by input decoupling.

Metzinger argues that the fundamental architecture of phenomenal experience is characterised by a 'structurally anchored deficit' that he refers to as 'autoepistemic closure'.[35] This is not a defect but a functionally necessary attribute that stops the infinite recursion of self-reflexivity. Autoepistemic closure is not the same as bounded rationality; it is not a matter of information scarcity or excess and the necessity for heuristic procedures; rather, it is a structural

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30 Ibid. p.83

31 Ibid. p.98

32 Ibid. p.98

33 Ibid. p.47

34 Ibid. p.48

35 Ibid. p.57

feature of phenomenal experience that refers to 'closure of attentional processing with regard to one's own internal representational dynamics'.[36]

Phenomenal content is never an actual now but a virtual reconstruction, or simulation, which for humans takes place in a window of simultaneity with a minima of 30 microseconds and a maxima of 3 seconds.[37] Alluding to the common conception of intentionality as problematic for cognitive science, Metzinger argues that it is *phenomenal* content rather than intentional content that is scientifically intractable, and that this is due to the principle of local supervenience.[38] That is, while intentional content can in principle be explained and located in a specific pattern of neural activity, first hand phenomenal reports of experience cannot be eliminated from scientific inquiry. This is not just because they are the result of a global process of information integration that cannot be localised in a specific region of the brain, but also because this level of description is irreducible to the lower levels on which it supervenes.

Metzinger claims that Brentano's influential concept of intentionale inexistenz is best understood as the virtual content of an actual object emulator existing in a neural state. For Metzinger the problematic of intentionality is overcome by the teleofunctionalist integration of the intentional and functional content of mental states. Metzinger's hypothesis is that mental states are virtual organs with computational properties that are relatively advantageous to the information processing of the system and thus the survival rate of the organism. According to Metzinger, mental states are real objects in the world with causal properties, analogous to tools or weapons 'used to optimize sensorimotor integration of the information flow within a biosystem'[39]

[36] Ibid. p.57
[37] Ibid. p.25
[38] Ibid. p.30
[39] Ibid. p.201

There is a relative degree of opacity or manipulability in the functioning of intentional content at the level of *representation*, however the phenomenal introspection of *presentative* content is a fully transparent system, phylogenetically ancient, and able to process and retroactively simulate reality with such speed and precision that it appears no process has occurred. The transparency of presentative content (its 'ultimate homogeneity') is compounded by a far greater discrimination of differentials across analogue spectrums such as sound (pitch) or light (colour) than we are able to describe using language.[40]

A striking feature of presentational content is its dual indexicality.[41] In contrast to representational content, what it refers to is not just an object, but an object existing *now*. Metzinger argues that the qualitative content of presented objects, such as the 'redness' of a tomato, are the result of nonconceptual analogue indicators, leading him to reject the existence of 'qualia' (or 'sense-data') as elementary units of phenomenal content that are available for behavioural control and cognition.[42] All phenomenal objects, such as the distinctive timbre of an oboe, or the colour blue are, in the words of G.E. Moore, 'diaphonous'; the non-conceptual quality of blue is given to introspective attention whilst the neuro-computational processes that condition the possibility of such a phenomenon are not.

It should be remembered that while the sound of an oboe or the colour of a clear sky is non-conceptual presentative content, and thus constitutes non-inferential knowledge, the awareness of it *as* an oboe is conceptually mediated, depending on a language entry-exit transition that is more or less transparent to awareness. That is, even when human thought is not explicitly formulated in language, it implicitly relies on the linguistic coordination of features and

[40] Ibid. p.69 and p.118

[41] Ibid.p.97

objects. The unconscious nature of 'inner languagings' that Sellars pointed to is analogous to the variable degrees of transparency of the PSM that Metzinger highlights.

It is important to note that Metzinger's account allows for a naturalised explanation of the manifest image that upholds the logical irreducibility of the personal level of description, and the normative freedom of linguistically enabled rational subjectivity, while resisting the emergentist fallacy indicated by the first of Sellars' three choices.[43] The question as to whether manifest objects exist is given an emphatically negative answer; the world of coloured facing objects and temporally extended sound objects that we experience does not exist in any substantialist sense: 'neither phenomenal properties, nor phenomenal individuals – if real or intentionally inexistent – exist. What do exist are holistic, functionally integrated complexions of subcategorical content, active feature detectors episodically bound into a coherent microfunctional whole through synchronization processes in the brain.'[44]

Metzinger characterises the self as a neuro-computationally generated illusion - that is, he pronounces the scientific image of unobservable neuro-computational processes to be the true image and considers the manifest image of the person and its phenomenological experience as a phantasm. He argues that the actual existence of the present moment is only a neurologically generated simulation, and that 'the physical world is "nowless," as well as futureless and pastless.'[45] It should be remembered that Sellars also argued that manifest appearances must, in an important sense, be false; and that the 'thing-in-itself' of space and time are defined by the scientific image (in the 'long-run'). Sellars argument was that the particulate paradigm of the

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[42] Ibid. p.611

[43] i.e. Manifest objects are identical with systems of imperceptible particles in that simple sense in which a forest is identical with a number of trees. Sellars, W. (1963) p.27

[44] Metzinger, T. (2004) p.67

[45] Ibid. p.127

scientific image could not account either for the continuity of perception or the causal structure allowing for the normative freedom of the rational subject.

In fact, we do not need to move beyond the particulate foundation to explain the continuity of perception, however we do need a multi-level account drawing in particular on the transparency of phenomenal experience, as well the homogeneity constraint defining the ultrasmoothness of simple sensory contents. Explaining the causal efficacy of conscious thought and the normative freedom of rational subjectivity also requires a multi-scale account of the complex hierarchically nested dynamics that are its basic structural enabling conditions. As we have argued throughout this thesis, randomness and noise are intrinsic functional components of such systems; their internal order is not from passive resistance to noise, but active resilience.[46]

[46] As we saw with Longo in the context of biological systems. Bravi, B. & Longo, G. (2015)

4.4

Generic Aesthetics and Multi-Level Overload

In order to understand the semantic content of noise it is necessary to situate it in the discursive context of contemporary art and music. Part of the problem of contemporary art is the pervasive opinion that creative expression transcends any explanatory account that could be made of it, or that it is irreducible to the teleological framework of instrumental rationality. This conceit is bound up with several themes that run through Continental theory in general and Deleuze's philosophy in particular: the rejection of representation, essentialism, and rationality; the prioritisation of difference over identity; and the definition of art in terms of the capture of affects and percepts. As we saw, Deleuze's rejection of the form of judgment is bound up with his theory of aesthetics and his philosophy of art; in particular, his reconceptualisation of the Kantian sublime and corresponding glorification of noise. This philosophical framework is implicit in the mainstream conception of art, and manifests in various chance procedures.

We can understand the fetishization of indeterminacy that Malik has identified as the defining hegemony of contemporary art[1] as proceeding from the undermining of key aspects of both the manifest and the scientific image. On the one hand, the causal-mechanical framework of the scientific image is denounced as an idealistic determinism grounded in the illusion of representation, good sense and common sense (even worse it is vilified as 'scientism' by the acolytes of Derrida and Deleuze),[2] while on the other hand, the self-sufficiency of the suffering-thinking-acting subject that is the basis of the manifest image is overthrown on the premise that

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[1] Malik, S. (2015) p.191

[2] E.g. Prevost, E. (2009) Free Improvisation in Music and Capitalism: Resisting Authority and the Cults of Scientism and Celebrity, in Iles, A. & Mattin (Eds.) *Noise & Capitalism*. Arteleku.

sub-representational differences, impersonal forces, and pre-individual singularities precede the constitution of subjectivity and the (propositional) form of judgment.

Both of these objections must to some extent be accepted but not in the way in which Deleuze proposes. Rather than constituting a fundamental limit to the scientific image, the discovery of non-linearities and continuous variations below the threshold of discrete representation should be understood as a refinement or stratified extension of the scientific image. Rather than overthrowing the representative regime that was the basis for the critical autonomy of subjective judgement, the basis of the manifest image as the normative freedom of the judging subject must be upheld not discredited, and *explained by* the sub-personal forces and pre-individual singularities that constitute it. The attempted stereoscopic fusion that Deleuze presents is distorted beyond all recognition. The capacity for judgment, a central assumption of the manifest image, is replaced with a philosophy of affirmation; and entropy, a key component of the scientific image, is denounced as transcendental illusion.

Deleuze overcomes the opposition of thought and thing by flattening it onto material information processes, and this is just as true of Varela; his vitalism is not the prioritisation of living over inert matter, but a vibrant conception of material processes. It is important to acknowledge and understand the continuity between purely physical information processing systems and biological forms of cognition, however it is also necessary to emphasise the discontinuity between inert and living processes, and the distinctiveness of rational thought. It is the normative freedom of the latter that Deleuze subverts with formless micro-processes and aleatory forces. Even more problematic is the (retrograde) development of this line in thinking in the apostles of Deleuze, and in 'new materialism'. Unfortunately, recent discussions of noise in the sonic culture literature are dominated by such approaches.[3]

Christoph Cox, for example, argues that recent cultural developments have seen a shift in the privilege accorded to music over sound.[4] He then asserts that this transformation is paralleled by 'an ontological shift from *being* to *becoming* and a temporal shift from *time (le temps)* to *duration (la durée)*.'[5] If the shift from being to becoming entails the neo-animistic reconception of matter as vibrant, the foreclosure of scientific representation to the lived experience of time and the spiritual transcendence of the law of entropy, then it should be countered at every turn. However, we need not succumb to mysticism; becoming should rather to be understood according to a multi-level approach able to specify the hierarchically nested non-equilibrium dynamics of complex systems in terms of entropy, negentropy, and anti-entropy.

Cox correctly identifies the historical transition leading to the contemporary situation of sound art: it emerges in the context of the determinate negation of Greenbergian medium-specificity (modernism) by post-Minimalist artists who challenge visual dominance with multi-modal art engaging all the senses. They subvert the alienation of the art consumer with immersive installations, and overturn the hierarchal prioritisation of product over process, or obliterate the distinction between score and performance. A bifurcation then ensues, with a trajectory of dematerialisation exploring the discursive-linguistic possibilities of art on the one hand (favoured by conceptual art), while on the other hand (the path that practically all sound art

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3 For new materialism see: Connolly, W. (2011) *A World of Becoming*. Duke University Press; Bennett, J. (2010) *Vibrant Matter – A Political Ecology of Things*. Duke University Press.; for its application to sound and noise see: Hainge, G. (2013); Trower, S. (2012) *Senses of Vibration: A History of the Pleasure and Pain of Sound*. Continuum.

4 Cox, C. (2011) From Music to Sound: Being as Time in the Sonic Arts, in Kelly, C. (Ed.) *Sound – Documents of Contemporary Art*. MIT Press.

5 Ibid. p.80

follows) there is a hyper-materialisation of art following an expanded conception of matter as 'a profusion of energetic fluxes'.[6]

Cox is right to castigate the conceptual path in as much as it disbars any talk of an extra-discursive reality (i.e. Derridean post-structuralist post-modernism), though inaccurate to assume that all conceptual art expresses this, and deluded to insinuate the possibility of a non-philosophical (i.e. Laruellian) mode of 'sonic thought' not mediated by its inferential articulation within a discursive context. However, his valorisation of the path of expanded materialism is even more problematic since he fails to differentiate between various strata of materiality, and implicitly falls into the myth of the given by invoking the experience of music and sound art as a nondiscursive perception of the metaphysics of flux and event.

Following Brassier, a basic premise of Sellars' inferentialist account of thought is that it is fundamentally propositionally structured and thus discursive even if it is not explicitly articulated in language.[7] The activities of composers, musicians, and listeners are part of a discourse concerning what music is and *should* be, just as Kant argued. This means that an act of (noise) music is non-linguistic yet discursive, it is a semiotic communication that cannot be true or false since it produces a world rather than referring to something within the world, nevertheless it may express an implicitly propositionally structured normative commitment.

In order to understand the possibility space of music and how this relates to noise we need a multi-level description accounting for the physical properties of soundwaves, the neurophysiological processes underlying sonic experience, and the semiotic and semantic content

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6 Cox, C. (2015) Sonic Thought, in Cox, C. et al. (Eds.) *Realism, Materialism, Art.* Sternberg Press. p.125

7 Brassier, R. (2014) Interview with Glass Bead on March 5, http://glass-bead.org/

of musical expression. Let us now examine how these three descriptive levels are implicated in the recognition of patterns.

A cognitive agent can be modelled as a stochastic dynamic system that simulates the surrounding environment by correlating sensory inputs with patterns of neuronal activity leading to behavioural responses. In organisms of lower complexity, in the simplest case, an environmental stimulus elicits a pattern of neural activity leading to a behavioural response whose correlation with the stimuli is either reinforced or weakened according to feedback received. However, most pattern governed behaviour does not operate in a situation of complete information, for example a pattern may have a large number of individuating characteristics only some of which will be available to sensory perception at any one time. Moreover, the pattern must be extracted from the surrounding information, and this may involve grasping the relationship between several different transient features of the perceptual field, and binding the features into a whole. This is known as the binding problem, covering questions of perceptual grouping, first investigated by Gestalt theorists.[8]

The ideality of the object of perception is a basic claim of Husserl's philosophy. Since sensation only ever receives parts (adumbrations) of the object, the whole or Gestalt is given to perception in an eidetic act of projection. Pattern governed behaviour, even in organisms of lower complexity, requires not just recognition, but the predictive *completion* of patterns. Organisms of higher complexity generate a higher number of patterns and have a certain degree of top-down control of behaviour, increased by communication and learning. This not only affords a higher variety and flexibility both in the number of features bound and the range of responses, but also generates counterfactuals enabling greater prediction, manipulation and

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[8] Wagemans, J. et al. (2012) A Century of Gestalt Psychology in Visual Perception I. Perceptual Grouping and Figure-Ground Organization. *Psychol Bull.* Nov; 138(6): 1172–1217.

control of the environment. In fact, conscious phenomenal experience is always counterfactual since it is a constructive hypothesis projected within a simulated temporal window; a 'now' that does not exist.[9]

This is why Metzinger refers to waking experience as an online hallucination, as opposed to the dreaming state, which is an offline hallucination.[10] Human intelligence is predicated on the coordination of this complex pattern governed stream of bottom-up information processing (presentation) with top-down control related to an inferentially articulated conceptual picture of the world (representation). In order to successfully navigate this now-less vectorial continuum of excessive information, the neurobiological organism must reduce the high dimensional noise of external events through correlating them with the subpersonal 'noise' of functionally integrated competing cell assemblies. However, as we have consistently maintained, following Thom, randomness is relative to the scale of analysis and the language of description, and the stochastic processes of the brain are no exception.

Metzinger argues that what has previously been understood as neural noise is likely to be just this entirely functional two-way dynamic projection of counterfactual possibilities, only a portion of which are given to phenomenal experience.[11] It is important to stress therefore that this is therefore *not* noise, but a highly canalized randomness continually modulated by bottom-up and top-down processes of coordinated constraint maintenance and propagation.[12] Deleuze and Guattari thus overextend and fetishize the concept of noise when they define the brain as the junction of three chaoid planes (art, science, and philosophy) as well as the site of their

[9] Metzinger, T. (2004) p.57

[10] Ibid. p.51

[11] Ibid. p.51

[12] This is the argument put forward by Longo in the context of the complexity of biological phase space, which is here extended to the brain. Bravi, B. & Longo, G. (2015)

interference, and when they claim that the brain 'plunges into chaos'.[13] The emphasis should rather be inverted, so that it is not randomness and noise that is glorified, but the structural resilience of the system to noise, and its functional integration of randomness that is appreciated.

If the self is an illusion and the colours and timbres it perceives in some sense do not exist, as Metzinger maintains, how can a synoptic image that preserves the central features of the manifest image be upheld?[14] Firstly, we should define more clearly what is meant by the self here. Effectively, what Metzinger means by self is the tendency to take the phenomenal experience of selfhood to refer to a substantial entity whose presence is given to experience. The representationalist conception of the transparent self-model functions like what Sellars called the scientific successor image, by postulating a hypothesis based on the behaviour of micro-physical processes invisible to manifest experience that *explains* and predicts various phenomena that could not be accounted for in the previous (phenomenological) model.[15]

Just as the kinetic theory of gases does not refute Boyle's law, the neurophenomenological explanation of the self does not invalidate the manifest experience of selfhood, it merely accounts for it at a different level of analysis. However, while the truth of Boyle's law holds for any gas, the manifest experience of the self as transparently given to consciousness is not a necessary feature of all phenomenal self-models. Metzinger's theory just states that the self is a contingent evolutionary solution to a problem that can be posed at several different descriptive levels;[16] it is not the only solution, and certainly not a law.

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[13] Deleuze, G. & Guattari, F. (1994) pp.201-218

[14] The central features are perception, conception and action at the macroscopic scale, and correspondingly, the normative freedom of the rational subject.

[15] Brassier, R. (2011b) refers to Metzinger, T. (2004) p.337

[16] Phenomenal, representational, functional, information-computational, and physical-neurobiological.

Metzinger predicts that it would be impossible for a system such as us (a PSM) to transcend the transparency of presentative content without losing the sense of self; the experience of selfhood depends on this transparency. However, Metzinger argues that it is possible to conceive of a system operating under 'completely opaque, phenomenal processes of self-modelling'.[17] Such a system, while remaining functionally egocentric, would have a 'nemocentric reality model' since the experience would belong to nobody at the phenomenological level of description.[18] Brassier explains that a nemocentric system 'would experience its own phenomenal self-model not only as a represented but also and simultaneously as a representing'.[19] The more that earlier processing stages are made available the less that the self appears as given. The obliteration of the self does not entail the termination of the normative freedom of the subject however. Brassier argues that it is necessary to distinguish the self and the transparent phenomenal consciousness that accompanies it from rational subjectivity, which is only strengthened by the further objectification of experience.

The nemocentric reality model thus represents a thoroughly objectified understanding of the PSM, which Metzinger refers to as a 'first-object' rather than first-person perspective. Metzinger's own self-model theory of subjectivity is such an objectification of experience, and as neuroscience progresses in explaining and controlling various aspects of cognition, more of the transparent processes of the phenomenal self could become manipulable and thus relatively opaque (through drugs, technologies, genetic modification, etc.). Brassier argues that the sensory and cognitive assault unleashed by noise music performs a similar form of alienation as the neurological objectification of experience does. Because it exceeds the 'familiar cognitive-classificatory sluice-gates' that bind the features of regular sensory content, noise lays bare, to a

[17] Metzinger, T. (2004) p.336

[18] Ibid. p.336

[19] Brassier, R. (2011b)

certain extent, the mechanisms underlying the givenness of phenomenal experience.[20] To understand this claim, a brief excursion is necessary in order situate it with regard to philosophy of art and its relation to aesthetics.

According to Brassier, noise music forces us to register an interference between the simultaneously represented and representing functions of cognition, and thus foreshadows the ways in which subjectivity must come to terms with its own objectification. His argument is effectively a reconception of Kant's theory of the sublime, according to a neurocomputational understanding of informational density, and marked by a discrepancy or friction between phenomenal processing power (sensation) and rational subjectivity (conception).[21] This is very different from Deleuze's reclamation of the Kantian conception of the sublime, which glorifies the aesthetic basis of the 'free indeterminate accord of the faculties', and argues that history, and the necessarily historical realization of the concept of freedom, is 'a web of madness' woven by sensible nature rather than individual rational purpose.[22]

In contrast, Brassier claims that, 'noise as I understand it would be the destitution of the aesthetic, specifically in its post-Kantian, transcendental register. Noise exacerbates the rift between knowing and feeling by splitting experience, forcing conception against sensation'.[23] The specifically post-Kantian transcendental register of aesthetics that Brassier refers to is condensed in claims to the 'autonomy of art' that was the legacy of the Jena romantics: the purification of art from any representationalist or instrumental function, and hence its inviolability to rational explanation. Peter Osborne explains that this autonomy is 'not of a type of judgment (Kant), nor merely at the level of appearance, the illusion of self-determination (Schiller), but of a certain

[20] Brassier, R. & Ieven, B. (2009)

[21] Ibid.

[22] Deleuze, G. (1995) pp.46-75

[23] Brassier, R. & Ieven, B. (2009)

kind of production of meaning in the object, an autopoiesis, distinct from both *techné* and mimesis (Novalis, Schlegel). This is not an "aesthetic regime of art" but a *supra-aesthetic regime of truth*.'[24]

This is why Osborne unequivocally rejects Rancière's definition of contemporary art in terms of an 'aesthetic regime', as well as Badiou's 'inaesthetics', which, while railing against Rancière's theorisation and the 'didacto-romantic' regime of twentieth century avant-garde,[25] merely reproduces the 'radically singularizing vision of aesthetic as the truth of art'.[26] Deleuze and Guattari are even more culpable in this regard, having famously proclaimed that 'the work of art is a being of sensation and nothing else'.[27]

As Peter Osborne argues, the twentieth century is witness to a series of determinate negations in the theory and practice of art that radically alters its ontology.[28] Conceptual art in particular, can be understood as the determinate negation of the sufficiency of aesthetics as criteria for the composition and analysis of the artwork. Arthur Danto gives the example of Warhol's reproduction of Steve Harvey's 'Brillo' box design, which is identical with its non-art counterpart.[29] Osborne sets out a number of insights from conceptual art that form the conditions of possibility for what he calls 'post-conceptual' art; the first three are relevant to the discussion here: '1. Art's necessary conceptuality. 2. Art's ineliminable – but radically insufficient – aesthetic dimension. 3. The critical necessity of an anti-aestheticist use of aesthetic materials.'[30]

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24 Osborne, P. (2013) *Anywhere or not at all: Philosophy of Contemporary Art*. Verso. p.44

25 Badiou, A. (2005) *Handbook of Inaesthetics*. Stanford University Press.

26 Osborne, P. (2013) p.9

27 Deleuze, G. & Guattari, F. (1994) p.164

28 Osborne, P. (2013)

29 Danto, A.C. (2004) Kalliphobia in Contemporary Art. *Art Journal.* Vol. 63, No. 2 College Art Association. pp. 24-35

30 Osborne, P. (2013) p.48

The same criteria are applicable to music in the latter half of the twentieth century. For example, Osborne comments on Le Witt's negation of artistic 'will', and its replacement with the conjunction of formal necessity and chance. Just as with Cage and his cohorts, this parallels the industrialisation of labour, and thus appears anti-romantic, however it is in fact the appropriation of 'mechanization as means of romanticization'.[31] The use of noise in such works is based on a fetishisation of indeterminacy, and a glorification of artistic genius and aesthetic sensibility even in its apparent withdrawal. The formidable power of noise that Brassier refers to has little to do with Cage's 'redefinition of the percept'[32], and refers instead to the popular (i.e. non-academic) use of noise in bands such as 'To Live and Shave in L.A.' and 'Runzelstirn & Gurgelstock'.[33]

While serialist and post-serialist composition was based on a highly constrained dogmatic formalism, for the Black Mountain experimentalists all sound and noise can be music. This means that the constraints imposed by composition appear to be the arbitrary combination of formal necessity and chance. In contrast, the noise music that Brassier refers to establishes itself within already existing constraints (generic forms) but radically transforms them by the forced amalgamation of incompatible sets of constraints into monstrous chimeras; this is not fusion but the synthetic construction of 'generic anomaly'.[34] Rather than romanticising noise in an anti-anthropocentric gesture by which it is embraced as spiritualised nature, these bands perform an all out attack on every form of reconciliation or domestication of noise, revelling in the grotesque and abject but with a level of humour that refuses its romanticisation.

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31 Ibid. p.66

32 Deleuze, G. & Guattari, F. (1994) p.195

33 Brassier, R. (2009) Genre is Obsolete, in Iles, A. & Mattin (Eds.) *Noise & Capitalism*. Arteleku.

34 Ibid.

The use of noise in both American minimalism and the maximalist compositions that Brassier refers to cannot be understood in terms of sensibility alone precisely because such practices follow from the three conditions of possibility mentioned above. However, unlike the former, the latter are not conceptual art but properly post-conceptual noise music. The post-conceptual is not anti-conceptual; on the contrary, it follows from the condition of art's necessary conceptuality, but rather than opposing this to sensibility it operates within a complex dialectic between the aesthetic and the conceptual.[35] When Brassier defines noise in terms of information density it is important to stress that this is not to be conceived in purely physical terms, and goes beyond the Deleuzo-Guattarian analysis of art in terms of affect and percept. Noise is routinely theorised in terms of excess, often drawing on Bataille's reconceptualisation of Kant's theory of the sublime as the inundation of reason by the positive forces of desire.[36] However, unless this excessiveness is specified at several different levels of description; in particular, at the level of intelligibility; it falls back onto a narrowly aesthetic understanding.

To understand what Brassier means when he argues that the informational density of noise prefigures the cognitive predicament incurred by the objectification of experience, information excess must be given a multi-level explanation according to at least three forms of description: the spectromorphological complexity of the purely physical soundwaves (described in terms of amplitude and frequency characteristics within a framework of Boltzmann entropy), the computational task this entails for auditory information processing (described in terms of Shannon entropy), and the inferential work that is necessary at the semiotic and semantic level of intelligibility (a mathematical description of the semiotic content can be given using topology, however the semantic content must be interpreted conceptually).[37]

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[35] Osborne, P. (2013) p.109

[36] For example: Crowley, P. et al. (Eds.) (2005)

[37] In Brassier, R. (2014), Brassier explains that his reference to information density in 'Genre is Obsolete' was equivocal, and specified that he meant semantic overload as well as or beyond the physical dimensions of noise.

Brassier criticises the way in which the use of noise in various forms of para-musical, anti-musical, and post-musical experimentation has become a generically identifiable cliché. It is precisely because such forms stay at the physical level of information excess that they hold little interest, and only serve to romanticise alienation and fetishize indeterminacy. The bands that Brassier describes as exemplars of a more interesting form of noise are involved in 'ruthlessly identifying and pulverising those generic tropes and gestures through which confrontation so quickly atrophies into convention'.[38] Brassier also discusses the music of Derek Bailey in this regard; Bailey has perhaps taken the systematic avoidance of hackneyed gesture to its limit, and this is why he rejects the classification of his practice as either experimental or noise music, preferring instead the term non-idiomatic music.[39]

For Brassier, it is because such non-idiomatic or anomalous noise music 'interferes with default cognitive schemas and perceptual Gestalts' that it augurs a future form of subjectivity in which the givenness of experience is systematically dismantled. This is certainly a compelling argument, however, some considerations should be borne in mind before committing to the concerted destruction of genre and the future annihilation of the self. Firstly, it should be stressed that Brassier's argument is not against genre, but against the tiresome reproduction of accumulated stock gestures within a genre. He does not advocate the destruction of genre but the discovery and invention of new parameters that would transform existing genres and give rise to new ones.

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[38] Brassier, R. (2009)

[39] Brassier, R. et al. (2010) *Idioms and Idiots*. Access online: http://bit.ly/1Ti1Kyo; Watson, B. (2004) *Derek Bailey and the Story of Free Improvisation*. Verso.

Crucially, the transformations that Brassier calls for cannot simply come from the sort of 'vacuous indeterminate negation' that so much noise music is guilty of.[40] This is also the problem with Deleuze and Guattari's overly positive emphasis on anarchistic creativity and their call for a 'permanent revolution'.[41] Art and music, complicit with the prevailing neoliberal hegemony, quickly become novelty for the sake of novelty. A determinate negation only follows from the introduction of new constraints, not the jettisoning of all constraint.

Nevertheless, Brassier's emphasis on exhaustion and extinction can also be overly negative. He claims that 'all genres have a finite lifespan', and that a point of saturation is inevitable where no further variations are possible.[42] A more positive image of genre can understand it as an instrument in its own right, with a functionality that can be continuously revised and reconstructed. We can think of genre according to Wimsatt's conception of generative entrenchment,[43] and Singleton's transference of this philosophy to the field of design and technology according to the notion of 'platform dynamics'.[44]

That is, a genre is composed of more or less implicit constraints allowing for an unprestatable range of behaviours, some of which may be highly predictable according to the 'rules' of the genre, while other compositions may open up a context-changing 'adjacent possible' that could not be predicted (see 3.5 sic). A platform is a bounded space with a certain degree of latitude that allows for contingent variables to take place on its surface. These 'adaptations' may provide further platforms, thus generatively entrenching the developmental pathway. The big genres that defined the twentieth century (jazz, rock, techno, etc.) are

[40] Brassier, R. (2014)

[41] Deleuze, G. & Guattari, F. (1990)

[42] Brassier, R. (2014)

[43] See 1.5 within. Wimsatt, W. (2007)

generatively entrenched in music, and not in any danger of exhaustion since sub-genres are continually proliferating on their surfaces.

Brassier's discussion of noise focuses on the critique of indeterminate negation and the paradoxical way in which the relinquishment of conventional musical constraints leads to the establishment of a genre against genre, saturated with generic gestures (white noise, screaming, feedback). This misses the wider cross-genre context of noise in the evolution of musical forms, the way in which noise music is part of a historical expansion from periodic tones to more complex sound and noise has been instrumental in the development and transformation of many genres.

The rejection of genre is not necessarily the defining feature or essential drive behind noise music, even if many noise musicians may think it is. It can just as well be understood as the determinate negation of the restriction of music to the organisation of periodic tones. Furthermore, noise music, as a non-paradoxical genre whose determinate parameters are defined by the exploration of the further edges of non-periodicity, has its own platform dynamics and the generative capacity for further transformations.

Finally, with regard to the objectification of the self, as both Metzinger and Brassier point out, in order to function, a nemocentric system would have to overcome several potentially intractable difficulties, principally at the information-computational level, but also at the other levels of description that Metzinger specifies. Computationally, a huge amount of processing power would be necessary; phenomenologically, a way of superposing earlier processing stages over constructed appearances must be discovered; representationally, infinite recursion must be

[44] Singleton, B. (2015) Plots, Platforms, and Sinister Designs. Talk on Urbanomic's *Yarncast* series. Access online: http://bit.ly/1YES8Bf

avoided; functionally, besides prevailing over the 'special form of darkness' that the transparency of the PSM envelops us in, the causal role of an opaque PSM is not clear; lastly, this must be either technologically integrated into or realized on a neurobiological substrate that may not support such a transformation.

Brassier follows Metzinger in emphasising the illusory quality of the self resulting from the transparency of the PSM, and the negative consequences of this are painfully evident in many of the pathological conditions that Metzinger refers to in demonstrating his argument. However, Metzinger also considers self-models to be 'neurocognitive tool which can be discovered and sharpened, which can function in isolation, or, like instruments in a large orchestra, form coherent ensembles'.[45] An alternative way of thinking about the self is described by Negarestani, who understands it as the primary form of alienation from nature, and the most useful instrument in the process of bootstrapping intelligence.[46] The discrepancy between the phenomenal self and its rational understanding can be harnessed as a vector of transformation engaged in a process of continual deracination from local exigencies and contingent parochial constraints.

[45] Metzinger, T. (2004) p.344

[46] Negarestani, R. (2015b) Talk given at PAF Get Reassembled, Aug.

4.5

Breaking Symmetries

Xenakis points out that incantatory music can be described as the minimisation of entropy coupled with the maximisation of tension.[1] This description can be extended to some forms of minimalist composition and drone music, such as the work of La Monte Young or Phillip Glass. White noise represents the inverse situation (maximum entropy, minimum tension), explored by artists such as Zbigniew Karkowski and Hijokaidan. Xenakis considers white noise to be the richest possible sound since it has a maximum of partials (from the perspective of Fourier analysis it has the highest number of sinoidal constituents), and argues that the human auditory system simply isn't evolved enough to appreciate this.[2] Nevertheless, he finds music that *stays* at either extreme to be uninteresting, and his particular focus is instead on the evolutionary dynamics of sound as it travels across the continuum from periodicity ('frozen tones') to aperiodicity ('perfect noise').

In his discussion of the relevance of the concept of entropy to the analysis of music Xenakis refers to Ravel's Bolero as having virtually zero entropy after the first few repetitions of the refrain. Noting that all the variation is in the dynamics, he argues that aesthetic interest only increases over time as a result of the immobility of the fundamental idea. He therefore denies the possibility of a correspondence between aesthetic value and a certain measure of entropy. Nevertheless, he maintains that 'sonic discourse is nothing but a perpetual fluctuation of entropy in all its forms'.[3] If the scale and context of the measure of randomness is specified, this gives a

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[1] Xenakis, I. (1992) pp.76-77

[2] Hoffman, P. (2009) *Music Out of Nothing? A Rigorous Approach to Algorithmic Composition by Iannis Xenakis*. PhD diss., Technische Universität Berlin. Accessible online: http://bit.ly/1lshsfc p.51

[3] Xenakis, I. (1992) p.76

more or less useful description of the music. What is important here is that rather than taking entropy as a given, which is to hypostatise chance, we must stress the multiple, scale-relative and context-dependent forms of randomness.

The twentieth century shift from periodic tone to sound mass expresses a transition in ontological framework that crosses all domains of knowledge and has immense philosophical, scientific, political and artistic implications. The transition is from the static order of well defined discrete possibilities, to a multi-scale conception of the dynamic processes involved in continuous and discontinuous transformations within probability fields; from the substantialist conception of being to the field theoretical conception of becoming. Much of this thesis has been dedicated to examining the development of this shift and the way it impacted those different domains. I shall now briefly recall some of the key ideas before showing how they apply to the domain of music.

As we have seen, this transition can be traced back to the formalisation of probability theory, in particular the law of large numbers (LLN), which formed the basis for statistical physics, the development of conservation and variation principles, and the formulation of the thermodynamic concept of entropy. We saw how this move was also fundamental to theories of biological evolution and political economy. We saw philosophical and scientific critiques of the classical mechanistic model of the scientific image in both biological and economic contexts. We discussed narratives about the collapse of classical determinism into a paradigm of relativity and indeterminacy, drawing on dynamic systems theory, second-order cybernetics, chaos theory, quantum mechanics, etc.

However, we also put forward an understanding of this shift in terms of the development of a probabilistic ontology that extends rather than refutes the mechanistic paradigm. This can be understood according to what Sellar's calls a 'successor image', and what Catren refers to as the 'stratified extension of science'.[4] Finally, we saw how statistical probability is bound up with a number of problems going back to ancient Greek philosophy and still central to the development of contemporary mathematics; the dialectic between the one and the many, continuity and discontinuity, invariants and variables, and the local and global.

For Xenakis, statistical probability, or *stochastics*, overcomes these aporia, by enabling a mathematical description of continuous and discontinuous transformations, the individuation of a unified sound mass from the compositional dynamics of its multiple parts, and the topological mapping of variables and invariants in vector space.[5] Effectively, he presents stochastic synthesis as a 'solution' to the problem of the one and the many, in a compositional methodology that immediately recalls the Leibnizian theory of *petites perceptions*. To understand the importance of this we should first recall the distinction between the manifest qualitative experience of sound at the macro-scale, and the scientific image of sound as a mechanical pressure wave composed of micro-scale vibrations that are quantifiable according to amplitude and frequency.

Fourier long ago showed that in theory any sound could be built up by a combination of simple sine tones, and most composition and electronic sound synthesis works on this principle. However, Gabor also showed that sound could be decomposed into micro-sonic grains lying below the threshold of hearing.[6] While the ideal tones of traditional musical composition can be simply represented as periodic functions, Xenakis claims that the *exhaustive* representation and synthesis of a concrete sound with complex aperiodic waveforms would be a computationally exorbitant task for standard (Fourier) synthesis.[7] Xenakis compares this with the excessively

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[4] Catren, G. (2011) p.341

[5] Topological modelling can reveal singularities, tendencies and structure preserving transformations.

[6] Roads, C. (2004)

[7] Of course, this is regularly achieved at a certain scale of abstraction and compression

complex calculations involved in the classical (Laplacean) mechanical description of a gaseous mass before the development of statistical physics, and argues that this is a false problem since what is required is the specification of a pertinent scale of analysis.[8]

Xenakis refers to Meyer-Eppler's studies in the spectral analysis of orchestral sounds, which present tiny second-order variations in spectral lines plotted according to amplitude and frequency, so that the simulation of their trajectories exceeded then-available computational power; this is as true today as it was in 1963 when Xenakis first published this. This means the timbre of the bassoon that we discussed in relation to Sellars' example of the continuity of perception would require an incredibly complex mathematical description, subject to variations below the threshold of measurement. This sub-representational difference can clearly be conceived in terms of Deleuzian metaphysics. The lectures of Meyer-Eppler were heavily influential on Cage and his followers, and there is a certain resonance with the Deleuzian approach in their reaction to this sub-representational difference as a liberation from top-down control. Aleatory composition is designed to embrace this difference by freeing the material of sound to speak for itself.

However, as we have argued, beyond this emphasis on material systems, it is necessary to supplement or modify the metaphysics of difference with an account of inferential rationality that maintains the force of normative claims within a naturalised explanation. That is, we should give a causal-naturalistic description of thought in terms of complex hierarchically nested dynamics that makes a clear distinction between different levels and types of information processing, including an explanation of the logical autonomy of the normative-linguistic level of inference in the space of reasons. Longo's account of the limits of computation is more positive about the capacity of mathematical description, and gives criteria for distinguishing between

[8] Xenakis, I. (1992) p.49

different levels of organisation and scales of analysis according to which randomness may be specified.[9]

Xenakis is also explicitly concerned with different levels and scales of randomness, and is inspired in the opposite direction by Meyer-Eppler's findings, not to withdraw compositional control but to extend it right down to the sub-audible micro-sonic grain. In contrast with the American experimental avant-garde, which he regards as the banal glorification of chance, he does not merely allow for chance but rigorously constructs it. Rather than introducing chance procedures, Xenakis' work is engaged in a constant attempt to formalize composition and to attain complex sonorities according to rules. This is a rationalisation of randomness rather than a fetishisation of indeterminacy.

Xenakis' argument requires some unpacking. If the organisation of sound according to periodic tones was a given of traditional European theory, its composition from the combination of elementary sine tones has been a given of twentieth century composition, in particular analogue and digital forms of additive and subtractive electronic synthesis. Xenakis argues that both modes of composition (traditional notation and standard Fourier based synthesis) begin with an ordered plane - a blank canvas, as it were - and arrange a given discontinuous unit element such as a tone or combination of sine tones in a more or less regular order by processes of iteration.

Xenakis berates serial music in particular, which, because it is based on the formal organisation of twelve-tone rows, is constrained to discrete representation and unable to explore continuity and discontinuity, an area of vast mathematical, conceptual and aesthetic significance. Most post-serialist composition can be understood as an expansion from the pitch versus time

[9] Longo, G. (2009)

domain following from a renewed focus on the material qualities of sound beyond its tonal organisation, and towards more complex use of timbre, rhythm and dynamics.

Fourier's theorem can be stated as 'every periodic function is a unique sum of sinoidal components'; this means that, in principle, every sound can be broken down into pure sine waves.[10] As such, it provides rigorous mathematical criteria for quantifying the degree of periodicity of any sound. However, as Mazzola points out, this does not mean that sound '"is" composed of "pure" sinoidal partials'.[11] According to Xenakis, the more that the timbral qualities of the sound material are accentuated, and the further this approaches noise, there is a greater importance of transients; high-amplitude short-duration sounds often with non-periodic components.

The synthesis of complex sounds such as this using sine-waves (a procedure of trigonometric calculation invented by Fourier) is highly computationally demanding, and Xenakis compares it to the difficulty of representing a jagged landscape using small circular sections.[12] The tendency to think of sound as composed of sine waves bears a close resemblance to the presupposition of equilibrium dynamics in finance; both are based on the assumption of infinite length runs (i.e. the LLN) that are ideal functions and do not exist as such in nature.[13]

Rather than beginning with a simple pre-given unit of sound (the sinoidal waveform) Xenakis developed an electroacoustic compositional practice based on the statistical treatment of micro-sonic *grains*. This is called 'non-standard synthesis' in distinction with Fourier based synthesis. It is important to note that the granular components that Xenakis uses are neither

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[10] Mazzola, G. & Cherlin, P.B. (2009) p.10

[11] Ibid p.10

[12] Xenakis, I. (1992) p.244

[13] Ibid.

simple nor pre-given (not independent identically distributed random variables) but the result of a compositional decision. According to Xenakis' formalised description, any sound (down to the smallest possible element) or piece of music can be mapped over three axes: duration, frequency, and intensity.

The grain is neither a point nor a line;[14] although its duration is very short it is not a sine wave but a pressure versus time *curve* that acts like a very small glissandi.[15] Grains are vectors then, rather than particles; and are modelled in a probabilistic vector space (as we saw with commodities in maximum utility theory). Since the elements Xenakis uses are not audible in themselves, composition occurs at the macro-level treatment of populations. In musical terms, a continuous sound can be produced by a multitude of continuous or discontinuous elements at a given scale, for example sine tones or sample-length grains of sound, the dynamics of which can be controlled using probability theory.[16]

The traditional compositional process, based on Fourier analysis, begins with simple wave forms and attempts to build complex structures by combining them. Xenakis' methodology turns this procedure on its head by beginning with disorder; a random walk, or Brownian motion; and imposing constraints in the form of mathematical functions that generate continuous transformations at the sub-audible micro-sonic scale of the grain. This mode of synthesis uses 'not periodic functions, but quite the opposite, non-recurring, non-linear functions'.[17]

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[14] Hoffman, P. (2009) p.177

[15] Varga, B. A. (1996) *Conversations with Iannis Xenakis*. Faber and Faber, London. quoted in Mackay, R. (2009) Blackest Ever Black; Haswell & Hecker; Rediscovering the Polyagogy of Abstract Matter, in *Collapse III*, Urbanomic.

[16] Xenakis, I. (1992) p.9

[17] Ibid. p.295

It is important to note that composition using standard Fourier synthesis naturally emphasises the vertical dimension of frequency and harmonics, while non-standard synthesis, which Xenakis pioneered, 'naturally leads to time-variant spectra, i.e. time evolution is an integral part in Granular Synthesis compositions, and not a secondary control issue, as it tends to be in the Fourier paradigm'.[18] Xenakis varies the level and rate of periodicities and symmetries introduced to a random process, so that at the macro-scale of qualitative auditory experience, a complex sound mass evolves over the three axes.[19]

A lower number of periodicities and symmetries generates a sound at the white noise extreme of the auditory spectrum (frequency and intensity), while a higher number approaches a simple tone. Xenakis takes absolute compositional control of all structurally definable sonic variables; by specifying pitch, duration and intensity values as real numbers. However timbre is the unpredictable outcome of the topological dynamics of these variables, inhabiting 'vague zones of indiscernibility' constituted by movements below the threshold of audition.[20] Timbre is not a structural element but a highly complex functional property, whose calculation as a real number is computationally exorbitant, as the Meyer-Eppler studies showed.

If a certain duration of grain is specified, sound can be represented on a series of 'screens' with frequency and intensity as the two axes. The composition can then be analysed as an evolving pattern in the distribution of grains over successive screens, according to three criteria: density, topography, and ataxy (a measure of disorder). The LLN can be used to model continuous transformations across any of the axes and within any of the criteria; all of which imply specific entropies at different scales and contexts of description.[21] In principle,

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[18] Hoffman, P. (2009) p.121

[19] Xenakis, I. (1992) p.289

[20] Mackay, R. (2009)

[21] Xenakis, I. (1992) p.16

composition at this level allows the processes of continuous transformation to be reversible, just as the micro-scale laws of physics were for Boltzmann. However, Xenakis finds that the most aesthetically pleasing results come from the use of probability distributions with nested functions that vary over time, embodying the non-equilibrium dynamics of dissipative systems and the irreversibility of time.[22]

Xenakis invented two electroacoustic compositional tools based on computation: a device for composition using stochastic synthesis, called GENDYN, and a synthesizer and sequencer with graphical control, called UPIC. Both systems are designed to generate complex sonorities rich in partials and closer to the noise end of the periodic-aperiodic continuum. UPIC achieves this spectral complexity by using jagged wave forms, while GENDYN obtains its rich spectra by the deliberate inclusion of 'step-wise signals full of digital artifacts'.[23]

Unlike other contemporary research into computer generated sound, Xenakis' tools have outputs that are far from any 'natural' method of sound production. They do not attempt to reproduce known musical sounds and are not based on the received ideas of musicology and acoustics. Rather, they are intended for the composition of genuinely artificial music, and realise a computational idiom that could not be produced by other means.[24]

The exploration of the continuum of periodicity is a fundamental characteristic of GENDYN since it is based on a procedure of algorithmic iteration that loops through a wave form with different degrees of periodicity encompassing the whole spectrum from sine tone to

[22] Ibid. p.255-256

[23] Hoffman, P. (2009) p.52

[24] Ibid. p.65

noise.[25] With *Gendy3,* composed on GENDYN, Xenakis finally achieved a goal he had been working towards his entire career: a fully automated composition using stochastic synthesis.

Both UPIC and GENDYN have had extensive use by more contemporary composers in their hardware form, and software versions of each are now available. Several of these composers may rightly be called 'post-Xenakian' since they have not only further explored the rich possibilities that Xenakis' pioneering design facilitated, but have extended the tools by reprogramming the system for real time composition and interactive performance.[26] Notably, Alberto de Campo updated UPIC for real time performance on the request of Florian Hecker and Russell Haswell, who have used this system for their 'UPIC diffusion sessions' often held in club venues.[27]

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[25] Ibid. p.52

[26] Hoffman, P. (2011) Xenakis Alive!: Explorations and extensions of Xenakis' electroacoustic thought by selected artists. Proceedings of the *Xenakis International Symposium* Southbank Centre, London, 1-3 April. Accessible online: http://bit.ly/1Otn0lm

[27] Hoffman, P. (2012) Forum "Post-Xenakians" Interactive, Collaborative, Explorative, Visual, Immediate: Alberto de Campo, Russell Haswell, Florian Hecker, in Makis Solomos, (ed.), Proceedings of the international Symposium *Xenakis. La Musique Électroacoustique / Xenakis. The Electroacoustic Music* (Université Paris 8, May)

4.6

The Pointer Scheme Continuum

Many of the concepts introduced and arguments put forward over the previous chapters are useful tools for an analysis of noise in the context of music. I shall now recapitulate the relevant points and address them to music. Firstly, it should be recalled that randomness, which is key to the definition of noise, is relative to descriptive choices regarding scale and language or context, and that there are two main forms of description neither of which can be directly reduced to each other or eliminated: mathematics and natural language. However, the logical irreducibility of natural language to mathematics does not mean that linguistically enabled normative thought is irreducible to a naturalistic explanation in terms of neuronal activity. Following the 'right' Sellarsian account (rather than the left) means that normative-linguistic conceptual content is ultimately explainable in terms of the naturalistic isomorphisms between neuronal patterns and patterns in the world, and in terms of the practical dispositions that this brain activity corresponds to.[1]

Therefore, the concept of harmony, for example, does not refer to an abstract Platonic form or substantial entity to which the question of existence can be posed, but rather to the way in which the concept organises practical activity and allows for navigation.[2] We can give a causal-naturalistic description of harmony or noise by plotting the mathematical relations between different frequencies, however this does not adequately describe the normative-linguistic concepts or their generatively extensible rules of use. This is because the concepts have entered

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[1] O'Shea, J.R. (2010) Conceptual Thinking and Nonconceptual Content: A Sellarsian Divide, in (Eds.) O'Shea, J.R. & Rubenstein, E.M. *Self, Language, and World: Problems from Kant, Sellars, and Rosenberg*. Ridgeview Publishing Company.

[2] Mazzola, G. (2002) p.39

into the theoretical and practical elaboration of music, which is an open process constituting a revisionary-constructive engineering loop within the space of reasons. Nevertheless, the normative-linguistic capacity of embodied cognition is also in principle, 'in the long run of science', fully describable in causal-naturalistic terms, so there is nothing supernatural about any concept such as noise.

Mazzola refers to Nobuo Yoneda's lemma as completing a paradigm shift in contemporary mathematics that began with the development of category theory, where the foundational problems associated with the presupposition of objects is overcome by a functorial approach that is 'recurrent pointing' all the way down.[3] When the distinction between concept and object is posed in terms of isomorphisms there is no longer a mystery gap. The concept is a navigational aid, or mode of address, that perturbs the informational homogeneity of the universal.[4]

As Mazzola argues, since concepts are a foundationless and generative category of pointers, they are essentially topological in nature.[5] For Mazzola, understanding a concept just means the capacity for 'navigating on its recursive ramification tree'.[6] He likens the computational economy of the 'pointer scheme' of concepts to the encapsulation of data in object oriented programming languages. This is because the ramified pathways of the concept are embedded in its structure (i.e. relatively transparent) and only unpacked in their conscious use.[7] This accords with the Sellarsian claim that perception is suffused with conceptual content

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[3] Ibid. p.177

[4] Negarestani, R. (2015)

[5] Mazzola, G. (2002) p.43

[6] Ibid. p.55

[7] Ibid.

and that the apparent immediacy of experience is mediated by implicit (unconscious or transparent) language entry-exit transitions.[8]

Of course, the concept refers to an object in the world, but this reference is mediated by the theoretical and practical activities that the concept is bound up in. This is just as Sellars argued with the functional role account of meaning or conceptual content; 'meaning is not a relation', the concept never comes into contact with the external world, it is a tool for the coordination of behaviour.[9] This is one reason why Hainge is misguided to assume noise can be sufficiently described as having a 'relational ontology'.[10] It is important to stress here that the traditional opposition between reason and noise; where rationality is construed as detached and ordering while the 'real' world continually overflows its categories and disrupts its organisation; is turned on its head. It is the concept that unsettles; it is reason that provokes and disturbs the equilibrium. Randomness just leads to randomness unless a constraint is introduced.

We saw earlier that there are various different quantifiable measures of disorder and mathematical descriptions of randomness on the one hand, and multiple semantic pathways within natural language on the other hand, the latter generally referring to the qualitative aspects of noise at the manifest level of experience and in the semiotic processing of information. The same distinctions can be applied to the understanding of noise in the situation of music; there are two forms of description specifying the degree of noise in music (maths and language), and within these two descriptive forms there are implicit and explicit rules according to which plural measures of disorder and complexity can be gauged. There are explicit rules for the formal quantification of noise according to certain well defined parameters, and there are more or less

[8] Sellars, W. (2007)

[9] Ibid. pp.81-100

[10] Hainge, G. (2013)

implicit rules for its qualitative judgement embedded in linguistically structured norms and social discursive practical reason.

This means that there can be no single simple definition of noise in music. The degree of disorder can be given by a number of different mathematical formalisms, as can the degree of complexity, but there are also context-sensitive normative-linguistic determinations of sonic noise. In contrast with Hegarty, this does not mean that noise is relative to subjective judgment; and contrary to Hainge it is not sufficient to claim that noise demands a 'relational ontology'. Such accounts miss the dialectical tension and generative extensibility of the development of the concept along both the naturalistic and normative axes.

The necessity for a multi-level account of music is underscored by Mazzola; who argues that music is fundamentally an act of communication, and that its analysis can first of all be thought according to a basic distinction between production, reception, and documentation.[11] Production refers to the process of *making* music, which necessarily entails the physical generation of sound. Reception refers to the activity of *taking* something from music (which of course implies taking something *as* music), whether by listening to the sound, analysing the score, or by submitting either to computational analysis. Documentation refers to the *storage* of a 'musical fact' on a relatively durable medium or sign system, for example musical notation, digitally encoded information, or sustained in folk repertoires.

Mazzola represents these fundamental aspects of music on the faces of a tetrahedron, with communication as the fourth face.

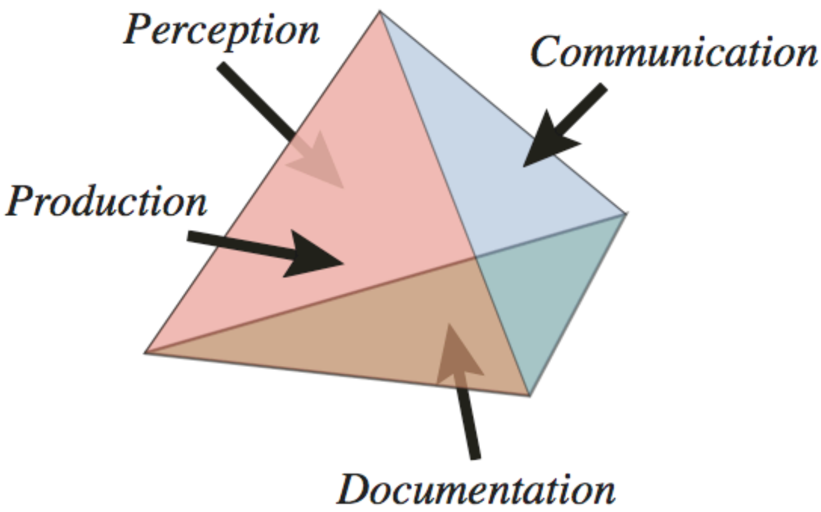

Figure 4. The tetrahedron of musical activity[12]

Mazzola proposes that musical communication occurs when any of these three basic activities are put in relation to one another. It might be noticed that the relationship between production, reception, and document bears a resemblance to that between sender, receiver, and channel. And of course, according to Shannon's famous law of information theory, there is no communication without a certain quantity of noise. However, it is not this kind of banal unintentional noise that is of interest here. Rather, it is the deliberate use of noise in music, which can only be properly described by considering it as an act of communication and addressing each of the criteria that Mazzola specifies. Furthermore, while sender, receiver, and channel are abstract functions, conceived in relatively stable and neutral terms; production, reception, and document are far more dynamically conceived.

Mazzola is opposed to intuitivist arguments that claim music to be ineffable, or without concepts, and to anti-reductionist arguments claiming music to be beyond any mathematical

[11] Mazzola, G. (2002) pp.3-5

[12] Mazzola, G. (2002) p.4

description.[13] To be clear, Mazzola argues against reductionism in the sense that he thinks music cannot be reduced to a single descriptive level (i.e. the particulate conception). However, he criticises the naive view that sees mathematical description as purely quantifying and ruthlessly mechanical. He demonstrates how contemporary mathematical developments such as topology and group theory allow for a sophisticated description of the qualitative properties of music that is not possible within natural language. To claim that something is definitively ineffable is just as problematic as claiming something is totally random; it is meaningless unless the scale and language are first specified.

Mazzola argues that many aspects of music that are ineffable in natural language are fully describable in the languages of contemporary mathematics, in particular topology and category theory. As an example he shows that the performance nuances that were 'one of Raffman's advanced arguments for ineffability of music, can be perfectly formulated in the mathematical language of vector fields.'[14] Mazzola then argues that analysing how a piece of music relates to the three aspects of communication requires crossing at least four fundamental sciences, each with their own descriptive level: semiotics, physics, mathematics, and psychology. As a preliminary definition of music and its multi-level ontology, Mazzola proposes:

'Music is a system of signs composed of complex forms which may be represented by physical sounds, and which in this way mediate between mental and psychic contents. To deal with such a system, semiotics are naturally evoked. To describe these forms, mathematics is the adequate language. To represent these forms on the physical level, physics are indispensable. And to understand the psychic contents, psychology is the predestined science.'[15]

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[13] Ibid. pp.195-196

[14] Ibid. p.25

[15] Ibid. p.20

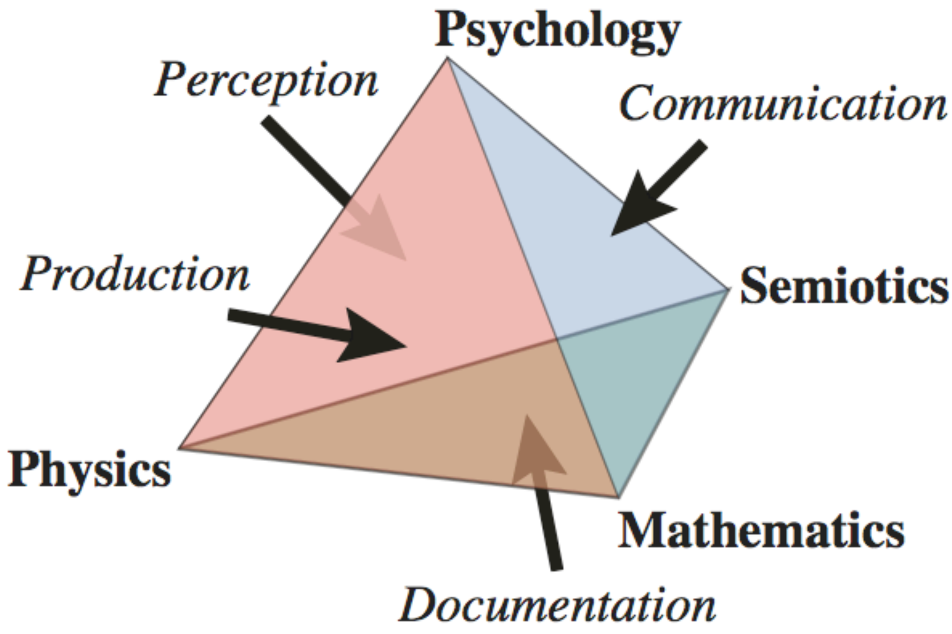

Figure 5. The tetrahedron of musical activity and its different descriptive levels[16]

There are two highly prevalent tendencies that oppose music to any form of rational explanation; on the one hand music is considered beyond mathematical description, on the other hand it is posed as beyond natural language description. These two propensities are combined and amplified in Deleuzo-Guattarian philosophy, where intensive difference and the affective qualities of sound are beyond quantification and below the threshold of conscious articulation, and where the work of art is considered to be 'a being of sensation and nothing else'.[17]

In contrast, Mazzola mounts a stringent defence of music as a fully describable form of reason. Traditional accounts oppose the hard sciences such as physics; which are concerned with objective a-historical truths of nature and properly addressed in the language of mathematics; to soft sciences such as musicology, which are considered to be dependent on socio-historical frameworks for subjective interpretation. Mazzola firstly notes that physics is no less susceptible

[16] Ibid. p.7

[17] Deleuze, G. & Guattari, F. (1994) p.164

to irreversible historical transformations that alter the context for the interpretation of scientific facts (for example, the way in which special relativity necessitated a reconceptualisation of the reference frame).[18]

The difference between physics and music is that such context-changing events (which Ayache called blank swans,[19] and which Felin et al.[20] described in terms of the non-constructible dynamics of complex phase spaces such as biological ecologies or economic systems) are pervasive and incessantly transform the space of musical meaning. Mazzola thus rejects this hard-soft opposition, claiming that music is no less describable than physics; his argument is just that 'dynamical concept and theory handling is much more vital to musicology than to physics', and that the description of music requires a complex multi-level explanation, including a diachronic and synchronic analysis.[21]

Against Deleuze and Guattari, non-human animals do not make art or music, and this is not just an anthropocentric conceit but a true discontinuity in the same sense that is marked by the distinction between sentience and sapience. Animals certainly engage in aesthetic activities and even make practical inferences regarding design or display choices, however this is a pattern governed activity. They certainly communicate however they do not have a linguistically organised social recognitive community in which behavioural choices may be evaluated according to reasons.

The activity of *music* makes sense only from within the normatively constructed space of reasons, and this is profoundly true for noise music, not because it breaks the rules and does

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18 Mazzola, G. (2002) p.399

19 See 3.4 within. Ayache, E. (2010)

20 See 3.4 within. Felin, T. et al. (2014)

21 Mazzola, G. (2002) p.399

away with reason but because it revises the rules and expands the definition of music just as it enlarges the space of reasons. This doesn't take away its awesome affective power, or the non-inferential knowledge we may have of the immediate sensation of noise. Rather, it forces us to confront our own physicality in the causal-naturalistic sense of the scientific image, while filling us with delight and dread at the normative-linguistic level of the manifest image.

There are also numerous musical pieces and works of sound art that are directly concerned not just with thermodynamic degradation and information theoretic entropy, but with their combination in the breakdown of cybernetic systems. This both derives from the ambiguity of noise and amplifies the confusion and misunderstanding concerning the mathematisation of disorder in the two different formal descriptions of entropy. The use of noise in such works have been well documented by several theorists, however they are mostly conceived in terms of disruption to order, and the materiality of systems beyond their intelligibility or rational control (i.e. their susceptibility to disintegration, and the ineradicable interference that derives from the 'relationality' of material media).[22] Alvin Lucier's 'I am sitting in a room…' is a classic example of this bimodal sonification of entropic noise; that is, Boltzmann entropy leads to and is expressed in Shannon entropy. Another well-known example is Steve Reich's phase-shifting tape-loops in 'Its Gonna Rain' and 'Come Out'.[23] The anti-rationalist fetishization of indeterminacy is most evident in Caleb Kelly's apotheosis of malfunction,[24] and in Kim Cascone's aesthetics of failure.[25]

In contrast with this theoretical stance, which is also widely observable in many music and sound art practices, we should understand the investigation of a system's limits, the

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[22] Kelly, C. (2009) *Cracked Media: The Sound of Malfunction*. MIT Press.; Hainge, G. (2013); Kahn, D. (2013)

[23] Christensen, E. (2004) Overt and Hidden Processes in Twentieth Century Music, in (Ed.) Seibt, J. *Process Theories: Crossdisciplinary Studies in Dynamic Categories*. Springer.

[24] Kelly, C. (2009)

[25] Ibid.; Cascone, K. (2000)

discovery of critical points of breakdown, and the accelerated dissipation of systems, as the elaboration of models within the wider 'self-correcting' enterprise of reason.[26] Musical composition and performance involve deductive and inductive reasoning, however they can usefully be understood according to Simon's bounded rationality model, where retroductive and abductive forms of reasoning are more common.

This is especially the case in live performance and improvised music. In particular, there are plentiful examples of theoretical abduction in the interaction of improvising musicians, as well as manipulative abductions in the exploration of their instruments. The work of an artist such as Fred Frith abounds in theoretical and manipulative abductions, the whole performance being structured round a careful avoidance of hackneyed idiomatic gestures and an elaboration of the sound-making capacities of the instrument beyond its traditional functioning (i.e. 'extended technique'). These performances may be highly unpredictable and non-repeatable, however this does not make them inviolable to science or to capital, as Prevost seems to think.[27]

There have been several attempts at applying the concept of entropy to the analysis of art and music,[28] however unless the criteria for analysis are rigorously specified this remains an unsatisfactory approach on a number of levels. Xenakis also excoriates the information theoretic treatment of music in favour of a multi-level analysis according to the criteria of topology,

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[26] Wimsatt, W. (2007); Bechtel, W. (2010) p.xxvi

[27] Prevost, E. (2009)

[28] Arnheim, R. (1971) *Entropy and Art: An Essay on Order and Disorder*. University Of California Press; Freund, J. (1980) Entropy and Composition. *College English* Vol. 41, No. 5 (Jan.), pp. 493-516. National Council of Teachers of English DOI: 10.2307/375719, http://www.jstor.org/stable/375719;Neeman, S. & Maharshak, A. (2006) *Order and Disorder, Entropy in Math, Science, Nature and the Arts*. Engineering Studies Faculty Publications and Creative Works 2: 198-202.; Shaw, D. & Davis, C.H. (1983) The Concept of Entropy in the Arts and Humanities. *Journal of Library and Information Science*; 9(2).

density and ataxy, as we saw.[29] Furthermore, he recognises that at the other end of the scale from information theoretical dogma, there is an equally malignant belief espoused by those intuitionists who pronounce the purely unquantifiable nature of aesthetic value, and who thus glorify chance effects in their composition. Xenakis levels this charge at aleatory music and graphic notation, for example John Cage and Morton Feldman; and at music with extra-musical spectacle such as in the 'happenings', it seems Xenakis has La Monte Young in mind here. This intuitionist creed, the polar opposite of the doctrine of information theoretic quantification, is also evident in aesthetic theorists such as Clement Greenburg, and in Arnheim's account of art and entropy.

According to Arnheim's argument, thermodynamics is not only unable to account for structure, but also confuses two tendencies that he distinguishes with his own terms: the *catabolic tendency* towards the destruction of order, and the *tension reduction tendency,* which gravitates towards simplicity by increasing orderliness and hence reducing superfluous information or order.[30] To describe structure he claims a 'shape-building cosmic principle' is required, which he calls the *anabolic tendency*, noting that in thermodynamics and information theory this is known as negative entropy.[31] He correctly points to the way in which the understanding of tension reduction in Freudian psychology was related to the principle of least action taken from physics.[32]

Arnheim understands tension reduction as directed towards maximum entropy, and extends this to the 'structural theme' of the work of art. He is careful to distinguish this from the mechanistic or energeticist proclivities of previous aesthetic theories drawing on entropy, which

[29] Xenakis, I. (1992) p. 180

[30] Arnheim, R. (1971) pp.43-44

[31] Ibid. p.27

[32] Ibid. p.37

have argued for the quantification of artistic value according to gratification, or the capacity of art to produce maximum aesthetic stimulation for the minimum of effort or detail.[33] He distinguishes between orderliness, which is defined by the *degree* of tension reduction and thus the extremal principle of maximum entropy; and order, which he understands as the *level* of structural organisation imposed by the constraints embodied in the system.

This principle of tension reduction has already been discussed in the previous chapter where we saw the scientific and philosophical conception of the parsimony of nature, and how this is applied in the context of finance. There, we argued that the use of extremal principles such as maximum entropy in the econosphere was an unwarranted overextension of the principle. While Arnheim specifies that in the work of art parsimony is achieved by labour rather than relaxation, he proceeds to illegitimately import conceptions derived from physics to the realm of aesthetics, presuming the tension reduction principle to give purchase at the global level of description both in terms of composition and perception.

Furthermore, he draws on Gestalt theorist Wolfgang Köhler's 'law of simplicity' or 'law of dynamic direction' to understand the artwork as a reciprocal determination of the whole and its parts, at a stable equilibrium formed through tension reduction. In such a system the position of all parts are necessary, including those features that would be quantified as redundant in information theory, and altering any part would alter the properties of the whole.

Finally he argues that further than this economic aspect of aesthetics, the anabolic counter-tendency leads to the development of a 'structural theme'. He describes the structural theme as the skeleton key of an object's meaning, 'which establishes "what the thing is about," be it a crystal or a solar system, a society or a machine, a statement of thoughts or a work of

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[33] Ibid. p.36

art'.[34] This is clearly a problematic global overextension of the concept; the various systems he mentions have different dynamics at different levels of complexity and scales of analysis. Furthermore, they must primarily be distinguished according to the distinction between inert and living matter, and between sentient cognitive systems and sapient rational agents, only the latter of which can inferentially establish 'what the thing is about' through conceptually mediated acts of reference.

Arnheim's analysis must be rejected for multiple reasons that have been developed throughout this thesis: it is prey to the myth of the given in assuming structure to be revealed in immediate perception, it wrongfully attributes concepts taken from physics to contexts of a higher order of complexity where they are no longer binding, it entrenches a conservative description of art in the language of science whilst simultaneously rejecting the purchase of science on the phenomenon of art (by denouncing the mechanistic basis of the scientific image), and it substitutes an intuitionist dogma of Gestalt structure for the information theoretical dogma that it is supposed to critically overcome.

The analysis of aesthetics according to entropy shows that a work of art or music is likely to be far from the maximally constrained regularity of deterministic order, and far from the absolutely unconstrained irregularity of deterministic randomness. This is hardly surprising and is unhelpful on two counts. Firstly, since most real-world phenomena have a structure that lies somewhere between these two extreme poles, it does not provide any kind of exclusive criteria for the identification of music as opposed to non-music.[35] It is somewhat like asking someone where they live and receiving the answer 'between antarctica and the arctic'. While most good music lies within a region of statistical complexity this does not mean that all organisations of

[34] Ibid. p.41

[35] Crutchfield, J.P. (1994)

sound at this degree of complexity will yield anything like good music, nor does it account for the distribution of outliers beyond this standard deviation.

Mazzola demonstrates that the classical conception of musical Gestalt according to transposability and super-summativity, which was originally put forward by Christian von Ehrenfel, is not sufficient since it does not take into account the conservation of gestalt under small deformations.[36] Ehrenfel's argument is that a melodic gestalt is preserved under various transformations, such as pitch transposition, and that since this invariance is not attributable to any one of its parts or any particular organisation of its parts, the gestalt is 'more than the sum of its parts' (super-summativity).

However, as Mazzola argues, the relation between a melodic gestalt played at two different pitches on an actual piano will yield minor deformations that do not fall under any transformation rule.[37] The analysis of gestalt therefore needs to be extended beyond super-summativity and transformational invariance, to a topological consideration of the neighbourhood of small deformations under which stability is preserved.[38] The neighbourhood of a point is a topological conception,[39] where the point is no longer the non-extended ideal point of classical geometry but has its own local space, a feature that is especially pertinent when the points are semiotic denotators.[40]

Mazzola explains that the mathematical conception of musical gestalts stems from Eduard Hanslick's (1854) description of the unity of the composition in terms of a manifold. He

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[36] Mazzola, G. (2002) pp.203-276

[37] Ibid. p.276

[38] Ibid.

[39] Ibid. p.277

[40] Ibid. p.50

notes that in the same year Bernard Riemann 'conceived a far reaching generalization of the mathematical concept of space to so-called manifolds. These are understood as being patchworks of locally cartesian charts, similar to geographic atlases.'[41] Mazzola's argument is that the performance of music is the construction of a global composition through a procedure of patching together 'local charts' according to 'gluing transformations'. A local chart may be for example a melody or a chord, the order of their combination is structured by syntagmatic rules, and the local chart is selected according to the possible paradigmatic options.[42]

Of course, interesting composition does not merely follow existing syntagmatic rules and select already available paradigms, but constructs unprecedented combinations and selections. A genre can be thought as a category of syntagmatic rules and paradigmatic choices. However, this does not mean that to be interesting a composition must defy generic conventions. A great composition can satisfy the individuating criteria of a genre without revisiting well-known formulas and hackneyed gestures. Furthermore, as Mazzola argues, 'locally trivial structures can add up to esthetically valid configurations if glued together in a non-trivial way. A simple and well-known example of such a global shape is the Möbius strip.'[43]

Like Arnheim, who talks of the structural theme of a composition as the skeleton key that unlocks 'what its about', Mazzola refers to the guiding coordinates of a composition's narrative structure as its 'nerve'. However, while for Arnheim the structural theme is given, Mazzola emphasises the *process* of extracting the nerve as an active exploration of the composition's pathways.[44] Moreover, for Mazzola, exposing the nerve is a process of abstraction

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41 Ibid. p.307

42 Ibid. p.939

43 Ibid. p.307

44 Ibid. p.937

analogous to the 'problem of curvilinear reduction of high-dimensional objects'.[45] When the process of abstraction is non-trivial there will likely be a number of different 'solutions' or perspectives with various benefits and drawbacks. For example, the reduction of the three-dimensional surface of the globe onto the two-dimensional surface of a world map admits of many different projections, each of which foregrounds some aspects of the geography at the expense of distorting other parts.

There are two extremal situations in the performance of this abstraction according to Mazzola; a 'discrete' interpretation isolates all local charts and imputes a trivial connectivity to the global composition, while an 'indiscrete' perspective includes the entire composition in a single local chart revealing no local groups, symmetries, or variations. Neither extreme is useful; it is somewhat like asking what the ingredients of a cake are and receiving on the one hand a list of its atomic constituents, and on the other hand simply the word 'cake'. Discovering the nerve of a composition lying between these two extrema is then a matter of specifying the appropriate scale for the analysis of its structure, and cutting it at its joints.

While the melody appears as an immediately grasped whole, it is the result of a multilevel, nested process of interpretative abstraction 'involving several non-automatic parameter choices'.[46] In particular, the melodic gestalt is a derivative construct obtained through a process of abstraction at the level of motif structure.[47] Motives themselves can only be apprehended in a further level of abstraction.[48] As we've already seen, pitch recognition derives from a further two-stage process of abstraction carried out by the physiology of the inner ear and the neurological mechanisms for auditory scene analysis. According to Mazzola,

[45] Ibid. p.937

[46] Ibid. p.473

[47] Ibid. p.332

[48] Ibid. p.466

understanding the global structure of a composition at these three nested levels of analysis - thematic, melodic, motivic - is a problem with three principal components that demand interpretative choices: semantic depth, formal complexity, and ill-defined aspects.[49]

The semantic depth of a composition refers to the complex way in which meaning is constructed through the hierarchal nesting of its motivic, melodic, and thematic levels of organisation. The operation of gauging the semantic depth of a composition is more like the formation of a crystal than the construction of a house, since it is the motif that acts as 'a germ of a structural hierarchy, unfolding into its most diversified ramifications, variations, and fragmentations.'[50] The problem of defining the formal complexity of the composition is related to the description of local charts and their gluing transformations, including the identification of symmetries and transformations (group-theoretical complexity), and the structural variations and invariants at each level of organisation revealed by shape deformation (topological complexity). Lastly, the ill-defined aspects are the result of the necessity for abstraction at any level of analysis, and the multiple possibilities that exist for this procedure.

The framework for analysis that Mazzola elaborates is universally applicable to any work of art, however it is not appropriate or sufficient for all forms of music. In particular, although its scope encompasses classical composition as well as contemporary computer-generated music, it is primarily directed to the ontological localisation of musical facts. He associates this factual ontology with the early Wittgenstein notion of 'what is the case', and notes that steps have been taken within Mathematical Music Theory to move beyond this Cartesian perspective towards an analysis of the processual production of facts.[51] Indeed, even in his own approach in 'Topos of Music' he had moved beyond the 'classic paradigm of sets and their functional relations' towards

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[49] Ibid. p.465

[50] Ibid. p.465

a topos-theoretical description of processual transformations and diagrams of spaces. However, his study of free jazz reveals that even 'processes are also an abstraction from a more basic layer, namely the gestural layer' of music making.[52]

He thus finds it necessary to add a further dimension to his cube of musical ontology[53] in order to account for the gestural dynamics involved in the constitution of musical facts (yielding a hyper-cube or 'oniontology' of music).[54] This categorical division should not be understood as a dogmatic schema subsuming all analysis, but as an abstract model enabling traction on a complex problem. The addition of the fourth dimension underscores the gestural basis of communication and knowledge production, and should be taken to include all generative semiotic activity at the level of icon, index or symbol. This is highly important for an understanding of the use of noise in music, since a large proportion of it involves elements of improvisation, and much noise music proper is even ideologically opposed to rehearsal.[55]

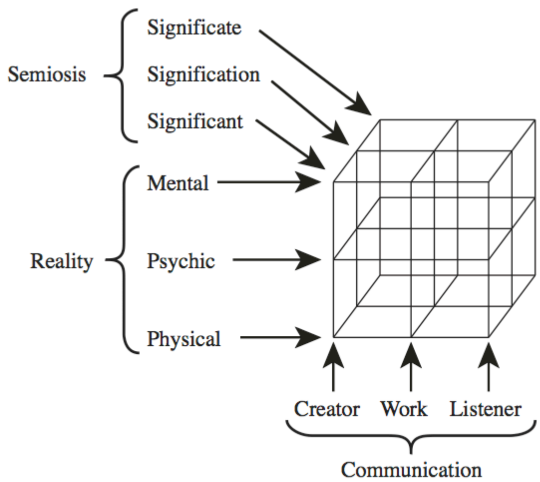

Figure 6. The Cube of Local Topography[56]

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51 Mazzola, G. & Cherlin, P.B. (2009) p.32

52 Ibid. p.33

53 Mazzola, G. (2002) p.20

54 Mazzola, G. & Cherlin, P.B. (2009)

55 Haswell, R. (2012) *Oscillographics: the search for unusual images on a Stereo-Phase Scope*, liner notes accessible online: http://bit.ly/1QbcA9W

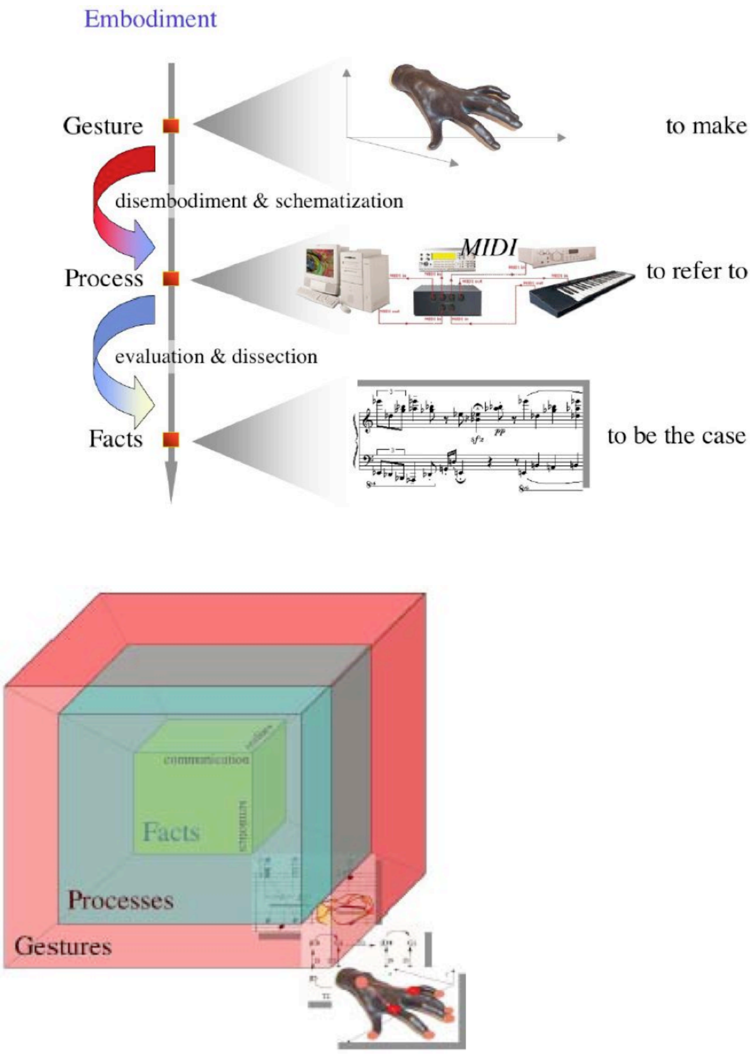

Figure 7. The Fourth Dimension of Embodiment[57]

For many noise musicians and enthusiasts the rejection of rehearsal is synonymous with the abolition of traditional musical conventions, and expresses a more general embrace of freedom and hostility to rational control. This attitude merely regurgitates a popular and anarchistic version of the ideological fantasy of the autonomy of art that was the legacy of the Jena romantics. The basis of this standpoint is the widely held belief that creative acts are opposed to rational decisions. This is a mischaracterisation of the relationship between reason and creativity that has a long and illustrious history. When reasoning is understood as embedded

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[56] Mazzola, G. (2002) p.20
[57] Mazzola, G. & Cherlin, P.B. (2009) p.33

in social discursive practices, and when it is extended beyond deduction and induction to include the abductive generation of hypotheses, this opposition collapses.

Despite the proclamations of noise musicians themselves then, the repudiation of rehearsal is therefore not bound to the fetishization of indeterminacy. Though it may seem like the improvisation of noise artists is free from all inhibition, any decent performance is the result of the accumulation of implicit constraints over years of practice (not rehearsal). The decisions that the musician takes may appear, even to herself, to be the immediate manipulation of non-conceptual sensory contents and the intuitive exploration of their instrument, however they are generally abductive inferences whose implicit propositional structure is relatively transparent to conscious experience.

In conclusion, the phenomenal description of sonic noise is defined by the maximal occupation of the pitch field. Phenomenal experience is an active unconscious construction within a specious present. Sound objects are anamorphoses, distal projections based on the probabilistic extrapolation of proximal information. A neurophenomenological explanation of auditory experience can be given, from the tonotopic analysis of mechanical pressure waves received at the tympanic membrane to the attractor dynamics of competing neural cell assemblies. However, pointing to the 'incompressible' non-linear dynamics of cell assemblies does not furnish a sufficient description either of the experience of music, which requires semiotic and semantic levels of description, or of the freedom of rational agency, which is not rooted in sub-representational fluctuations but in normative self-determination.

Music cannot be thought simply as organised sound for two reasons. Firstly, the organisation of sound only qualifies as music when some identifiable generic markers serve as the signifying conditions for its reception as music, even if these conventions are distorted beyond all recognition. Music is thus fundamentally normative, and only makes sense in the context of rule governed behaviour and the revisionary-constructive elaboration of freedom. Secondly, the organisation of sound implies a pre-given spatial and temporal frame in which the sounds are distributed. Music should rather be understood as a technology for the gestural constitution of space and time in the medium of sound.

5.0

Conclusion

Noise is relative to the analytic scale and descriptive formalism of a cognitive or information processing system. When noise takes on a functional role it can no longer be considered noise. We have seen how randomness and model deviation play a functional role by stimulating variability and diversity in evolution, by concealing signals or deceiving signal detection, by increasing sensitivity in signal detection, and by becoming significant. Biological organisms and ecologies are complex hierarchically nested systems in which multi-level randomness is so intrinsic to their stability that noise is not a pertinent concept in explaining their dynamics. Entropy and negentropy are insufficient to describe such systems since their increasing complexity is the result of an asymmetric diffusion that can be modelled as anti-entropy.

From the beginnings of the modern scientific understanding of mechanistic determinism, philosophy has struggled to preserve the apparent freedom of thought within the structure of causal necessity. Descartes formulated a dualistic conception that safeguarded cognitive freedom from brute mechanism, while Spinoza posited a monistic ontology affirming the coexistence of freedom and determinacy. Since the latter part of the nineteenth century many scientific developments complicated this mechanistic image of predictable order (non-linearity, deterministic chaos, self-organising systems, quantum indeterminacy, etc.), making possible a materialist conception of the freedom of thought. However, certain attempts to overcome the dualism led to a hypostatisation of chance and glorification of noise; a 'botched dialectic' in which inorganic material processes express a vital becoming and thought is flattened onto self-organising systems.

Against this failed stereoscopic image, it is necessary to give a multi-scale explanation of complex systems that distinguishes between different levels of organisation and specifies the appropriate formalisms for a description of their dynamics. In particular, accounting for the freedom of cognitive agency requires a return to the Kantian understanding of rational autonomy as normative self-determination. Above all, freedom should neither be understood in terms of the indeterminacy of the *clinamen* nor an immediate experience of duration whose continuity exceeds measure or representation.

We saw how classical and neoclassical economic theory is also based on a fetishisation of randomness and self-organising systems, though with a completely different rhetoric to that of Continental philosophy. Mainstream economics is a substantialist ideology in which prices are thought to reflect the true value of commodities through the attainment of equilibria within the competitive exchange environment of the 'free market'. This dogma rests on a number of simplifying assumptions, including parametric rationality, market isolation, utility maximisation, the convexity of preferences, and the treatment of price formation by the application of statistical probability theories such as the LLN and the CLT.

Heterodox economic theories counter this fundamentally reversible picture of exchange by acknowledging bounded rationality, information asymmetries, the importance of mimesis in strategic decision-making, non-linear and non-equilibrium price movements, and the thermodynamic drivers of the metabolic rate of capitalism. However, it was argued that this still maintains various simplifying assumptions so that a further level of complexity must be added. In particular, economic activity does not conform to extremal principles such as maximum entropy, and cannot be modelled as an opportunity landscape since it is continually undergoing symmetry breaking transitions so that its phase space cannot be constructed. Lastly, it was proposed that in order to account for the full complexity of finance, and to have any chance of transforming it, a multi-level explanation is required that is able to encompass not just the naturalistic dynamics of entropy, negentropy, and anti-entropy, but also the essentially normative character of economic transactions.

The final chapter focused on giving an explanation of sonic noise and its use in music. Firstly, we saw how sound can be treated as a temporal object whose experience relies on the projection of retentions and protentions within a specious present. A neurophenomenological account of the non-linear dynamics of perception was then given, and it was argued that multistable phenomena render this active construction noticeable. Though the switch between different distal projections is apparent, the earlier processing stages are not made available due to the fundamental transparency of presentative content in phenomenal experience. We saw how the lived experience of duration, and the homogeneity of sensory experience - both of which have been held up as irreducible to the scientific image of discrete particle interactions, the former by Bergson and Deleuze, the latter by Sellars - are effectively neurocomputationally generated illusions that can be fully explained at several different descriptive levels, and without moving beyond the 'particulate framework'.

It was argued that contemporary art is characterised by a fetishisation of indeterminacy that is complicit with the neoliberal hegemony that was critiqued in the third chapter. Against this flattening of thought onto self-organising systems it was claimed that music can only be accounted for at the normative level of giving and asking for reasons. Noise music often deliberately breaks the normative conventions of generic music. However, the use of noise in music is not necessarily against generic convention. Though certain practices have become stock gestures of transgression, there are many musicians who have discovered and invented new conventions. Rather than fetishising indeterminacy, such practices can be understood as the rational exploration of the further reaches of aperiodicity through the correlation and propagation of new constraints within an expanded space of musical possibility emancipated from its parochial limitations. Finally, the multi-level account of noise in music was supplemented by a topological description of the functorial transformations constituting the nerve of the composition.

Randomness and noise cannot be treated as if they are the same thing everywhere. This thesis has attempted to clarify the necessary distinctions. Quantum randomness must be distinguished from unpredictability and deterministic chaos in macroscopic physical systems; moreover, the dynamics of randomness in living systems, in logical machines (computers), and in rational agents must also be differentiated. Unlike computers, living systems are not Laplacian machines. The functional integrity of computational systems is predicated on their robustness to noise in the form of random variability and sensitivity to initial conditions, while the latter are intrinsic to the stability and 'extended criticality'[1] of living systems. Nevertheless, randomness is not the source of freedom. Rather freedom is the labour of rational agency, the complex dialectic between variables and invariants, the dynamic correlation and propagation of constraints in the ongoing interplay between chance and necessity. We are not free by chance but through the revisionary-constructive imposition of constraints.

[1] Longo, G. & Montévil, M. (2012b)

6.0

Acronyms and Abbreviations

ANN - Attractor Neural Networks

ASA - Auditory Scene Analysis

CA - Cell Assembly

CAS - Complex Adaptive System

DSM - Discrete State Machine

DSGE - Dynamic Stochastic General Equilibrium

DST - Dynamic Systems Theory

ECH - Environmental Complexity Hypothesis

EMH - Efficient Markets Hypotheis

GDP - Gross Domestic Product

GET - General Equilibrium Theory

MaxEnt - Maximum Entropy

MEPP - Maximum Entropy Production Principle

PCA - Principle of Causality

PCO - Principle of Continuity

PI - Principle of Identity

PII - Principle of Identity of Indiscernibles

PIM - Principle of Immanence

PSR - Principle of Sufficient Reason

PUB - Principle of the Univocity of Being

RAC - Rate of Apparent Change

RDRD - Reliable Differential Responsive Disposition

TOTE - Test Operate Test Exit

7.0

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