Creative Computers, Improvisation and Intimacy

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1. Introduction

Freely improvised music provides both an amenable and a challenging setting for autonomous, creative computer systems. The laptop, user-controlled, is a familiar participant in contemporary improvisation; the sonic vocabulary of real-time computing, and the capacity for live engagement (e.g. by recording and manipulating live audio on-the-fly) accord well with the longstanding aims and characteristics of non-electronic, experimental improvisation. A well-established performance practice – associated with the customisation of software such as Max/MSP, PD, Supercollider – explores the expressive potential of interfaces, conventional screen/mouse control, etc., and, consequently, technical issues about parameterisation and mapping. But audiences may find the laptop musician's inscrutable actions, while dealing with this relatively new performance practice, compare poorly to the expressive information conveyed by, for example, a live percussionist. Would any musical *effect* necessarily be lost if those apparently ineffectual laptop-focussed actions are substituted by the machinations of a 'creative' algorithm?

On the other hand, free improvisation disavows expressible rules and local 'top-down' control and seeks to avoid implicit rules (in the form of stylistic, formal or behavioural constraints). A musical language where 'anything goes' presents a particular challenge for a participating algorithm, if sounds are contingent only on the recent past and the unpredictable behaviour of others. The freedom 'to' in free improvisation is also a freedom 'from' helpful procedures for musical organisation that might readily be encoded; e.g. the rules of harmonic progression and melodic formulae in jazz. Without such rules, which would also function as evaluative criteria, how do we know if the result is any good? Autonomy, or the effective impression of autonomy might be one measure: ie. the extent to which a software designer / composer is present *in proxy* whenever a system is used, and the extent to which the sonic behaviours of a system accord with our expectations of group interaction between humans.

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The two terms discussed below, adaptability and intimacy, might be characteristics of this dual autonomy, and reflect this author's recent interests as a composer and improviser in developing the *_prosthesis* 'compositions' and other related work.

2. Adaptability and Intimacy

The term *live algorithm* has been coined to describe the theoretical notion of a computational system able to collaborate effectively with human performers; i.e. participate in music-making on an equal footing [1]. It is the focus of the Live Algorithms for Music (LAM) network, established since 2004 with UK EPSRC support [2]. There are potentially many requirements of a successful LAM system in practice.

If live, improvised sound is thought of as a shared environment, **adaptability** is the ability to acclimatise, demonstrable in changes of behaviour, offering an inference that the behaviour may in turn modify the sonic environment. The unfolding temporal structure of a musical event (performance, composition) could be interpreted as a process of adaptation in the most abstract terms, i.e. without reference to a composer's or interpreter's intention. Sonic materials might be heard as agents that present, modify and re-present according to the emergent environment context; an autonomous 'living' music responding to its own environment. Perhaps computer music can be heard like this too, without reference to the computer's imagined 'intention', and without reference the now absent human laptop operator.

Computer models of adaptation are well established and successful in computer-based creativity, including music [3]. But it is readily arguable that a neo-Darwinian model of biological and environmental change fundamentally redefines our idea of the creative process; it does not emulate it. Adaptation is a useful concept in free improvisation with autonomous computers because it evades the potential pitfalls of anthropomorphism. If all performers adapt to sound (the environment), rather than trying to adapt to one another, this is comparable to the biological process of stigmergy [4] [5]. Interaction only occurs between performer and the environment and, separately, between the machine and its environment, so the products of adaptation can be regarded as equivalent, and equally significant, and the difficulties and paradoxes raised by supposed human/machine mutual interaction are avoided. It is then inconsequential whether the interactions depend on a machine algorithm or human cognition (but the process of adaptation itself does not need to be offered as intrinsically interesting or creative).

Nevertheless, many human performers like to communicate, and express, in a personal, direct, way or at least believe that they do at the time. They may also wish to respond ('adapt') to an earlier, remembered state of the sonic environment, not the current state. But, although performers may wish to communicate directly with a machine as an equivalent participant, they clearly cannot. George Lewis's term 'emotional transduction', defined as a 'bi-directional transfer of intentionality through sound' [6] established that communications should occur in and of the medium itself, not directly and intrusively (i.e. via controllers, laptop screens, etc). However, his definition suggests that a performer's original intentions are preserved and reflected in a machine's response. This assertion demands a leap of faith, but illustrates the very significant need for performers to develop an empathetic relationship with fellow musicians, so this is an essential, if passive, property of a live algorithm.

Improvisation is widely understood as a social as well as cognitive process, which involves continuous social interaction based on mutual listening and multiple, simultaneous strands of monitoring, comprehension and action. A social, rather than biological, discourse might help us design and understand live algorithms that can be used in real life.

Understood as a structured social process, human improvisation (jazz, free etc.). can be analysed in a similar way to other task-orientated social experiences: Goals are identified by group members – who actively assume and cast roles – in order to adapt to the changing environment. Goals might be attributable to 'supra-personal' social facts, (such as norms of acceptable behaviour, actions consistent with expectations or requirements). Even so, an entirely new, shared history evolves as the cooperative experience develops. Players become aware of the appropriateness of their response to others' contributions and appraise their own ability to initiate behaviour from others, by proxy in the shared environment. Any computer system attempting to engage in such a complex network of behaviours would need capacities for both transparency and opacity.

Intimacy is a key measure of social interaction. In music technology, 'intimacy' is equated with notions of immediacy or physical sensitivity, and is accepted as a value measure in the design of tactile or visual controllers [7] [8]. In this context – for instance performing with a custom-designed, sensitive device – intimacy is identified with the extension of the self; the musical device becomes a prosthetic. Tactile feedback, responsiveness, a close relation between action and sonic outcome; these and other factors are recognised as attributes of this 'control intimacy', just as they might be with a conventional musical instrument. But no matter how successful this intimacy, it is an experience hard to share with an audience, and the processes enjoyed by the performer could potentially be entirely opaque and incomprehensible to others.

Intimacy, as more commonly understood, refers not to an experience of technological embodiment, but to a social experience shared between individuals. It might also be an experience clearly evident to others. Social intimacy has been explored systematically in social science and psychology. Intimacy between two partners is described as a interactional process in which, for instance, revelatory self-disclosure finds validation through the other partner's response [9]; this is interpreted as evidence of an emergent and binding understanding. Intimacy is learned over time, through a series of transactions and negotiations; it cannot be designed or pre-arranged. Real intimacies are synonymous with trust, cohesiveness and psychological proximity [10]; trust that a partner will provide what is expected, (or more to the point, what is of benefit rather than harm), and cohesive in the sharing of experiences and aims.

Intimacy in musical performance – a sense of dialogue and exchange – might be evident to the listener/viewer either through sound alone or in some other form in performance. This could apply in composed and notated ensemble music as much as improvised music and might be taken as a profound measure of musical interaction (as explored for instance by Benson [11]. Could an autonomous computer performer participate in this 'social' process? Intimacy might be achieved if a machine were able to attend to all aspects of the sonic experience, in all its complexity, nuance and higher level characteristics, as a human might. Real-time audio analysis might allow this. Intimacy might be achieved if human and machine performers could adapt to each other and, especially, learn from one another.

Playing a certain phrase, sound event, gesture, or by electing to do nothing: these could all be interpreted as acts of self-disclosure that may produce a response that seems like a validation, or not. In any case, real-time learning, and an ability to act upon prior learning, seems absolutely essential. Such music could still be witnessed by others almost as a social process, and could still be developed and heard purely in terms of the medium itself, music, rather than through any other experience (e.g. visual) or subsequent spoken explanation.

These possibilities have been explored in a number of 'compositions' of mine (2006-present) for solo instrumentalist and a computer that employs real-time learning – a would-be live algorithm. These works include *au(or)a, piano_prosthesis, oboe_prosthesis, flute-prosthesis* and *cello-aura*.

3. Composition/improvisation systems

The pieces listed above are in truth computer systems developed in Max/MSP; each has a distinct corpus of pre-recorded sound materials that are the basis for computer-originator sound, and each has a library of potential initial behaviours ; the analysis functions are also tailored to the instrument used. They are explored in more depth in other papers [12] [13] and recordings are available on the author's website [14]. In all these pieces the soloist's improvisation is analysed, encoded and used to train a neural network that can subsequently identify improvised musical materials if they recur. The network expresses its growing knowledge by producing, and modifying, its own musical behaviours; intermittently and covertly devising connections between the human music and its own repertory of sounds and gestures. As the machine learns, adapts and 'communicates', the player is invited to reciprocate. Through this quasi-social endeavour, a coherent musical structure may emerge, as the performance develops in complexity and intimacy.

A feed-forward neural network allows unsupervised sub-symbolic learning and classification. The multilayer perceptron neural network is trained using a back-propagation error algorithm. This type of network benefits from a capacity for generalisation and tolerance to apparently unpredictable or contradictory data; consequently it is well suited to classifying analysis of improvised music.

There are two analysis functions. The first focuses on pitch; the implied harmonic characteristics of the improvisation (rather than just step-by-step note progression) and executes a harmonic function to extend the characteristics logically, providing a related, wider pitch resource for subsequent synthensis. The second analysis is independent of this, and measures characteristics of the performance based on various audio descriptors (loudness, brightness, duration between events, sustained-ness, frequency etc.), calculated as moving average and standard deviation over a fixed period (usually 5 or 10 seconds); this data is used as inputs to the neural network. Rather than observing a simple stream of events, the analysis attempts to represent a musical behaviour in such broad terms: this is relevant to the exigencies of freely improvised music, although the analysis is, in itself, only indicative. It is adaptable however, as the individual descriptors in themselves are of less significance than the composite representation offered.

The purpose of the network is to classify novel performance behaviours, in order to acquire a library of learned states for future reference. This learning is applied – while the improvisation continues and the network runs – to assess incoming states in comparison to those already known: the aim being to identify musical behaviours that are well defined and contrasting, so the network can respond effectively to a broad range of subsequent musical activity. To achieve this, retraining only occurs if a fitness function is satisfied, a measure of the similarity of the current state to those previously learned.

The effect desired is a system that displays attributes of adaptability and intimacy; able to respond and provoke in an effective, musical way. Some players who have worked regularly with the system have found it is possible to engage with it as if there is another, thinking, participant. Flautist Anne Le Berge (*flute_prosthesis*) writes:

> *"... I am using a form of free association ...which is more and more guided and influenced by the responses of the computer....feels like I'm exposing or revealing more of myself than I have previously. That comes from trusting the patch and probably the audience... it.works best when the performer enters into a fantasy world that includes the Max/MSP patch as a truly creatively responding being. Even though this fantasy is still somewhat a leap of faith, it does allow the computer and the performer the opportunity to create an atmosphere of invention / interaction / respect."*

Many composers and performers are looking for opportunities to re-think creative methodologies and compositional techniques, and consider how rapidly developing technologies impact on musicians' thinking about identity, performance practice, authorship and autonomy. Live algorithms might offer genuine creative innovation, and of course be amenable and challenging for performers, too.

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