ANNOTATIONS FOR MIR WITH *VEROVIO* AND *MEI-FRIEND*

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ABSTRACT

Digital annotations can be used by MIR systems to record, contextualise, and visualise analytical outputs, or to encode and structure ground truth for processing as an input. We present two related recent developments for the annotation of digital music scores. The first concerns *Verovio*, a popular music engraving software embedded within many web-based notation tools, previously lacking the capability to flexibly process and display annotations. We describe a new implementation for handling Music Encoding Initiative (MEI) XML `<annot>` elements in *Verovio*, providing default visualisations alongside identification of annotated elements in SVG graphical output for extensible customisation. Secondly, we introduce *mei-friend*, an interactive editor for MEI with an embedded *Verovio* notation viewer, with additional interface support for the creation and editing of `<annot>` annotations.

1. INTRODUCTION

In the general case, digital annotations offer affordances to highlight, bound, reference, or link, from selections made on digital documents, such as scores, to other relevant information or interpretive context.

Deployed in combination with Music Information Retrieval (MIR) approaches, annotations offer a mechanism by which the results of a computational process can be attached to musical elements within an encoded notation, which is often the source (or a related source) used as input to the analysis. Standardised annotation frameworks can also provide for streamlined structuring of machine-readable human annotated ground-truth data.

In this paper we review a basic structure for annotations (section 2). We then present two recent developments adding support for the annotation of digital music scores: first an extension of the *Verovio* music engraving library (section 3); and second the *mei-friend* editor (section 4).

2. BACKGROUND: ANNOTATION COMPONENTS

The Web Annotation Data Model is a W3C standard [1], derived from the Open Annotation Data Model [2], which defines an annotation **Target** as the area of interest to which the annotation applied (which in this model can be anything referred to by a URI); and an annotation **Body** as the information to be associated with that target by the annotation (which can be in any format, including arbitrary text). Annotations can also include information about their motivation, and who or what created them.

Beyond music-specific applications, annotation facilities within the International Image Interoperability Framework (IIIF), used by library collections worldwide for online access to their digital images, implements annotations according to the Web Annotation Data Model.

The Web Annotation Data Model has also been directly and indirectly incorporated in earlier MIR research and tooling, in particular the Music Encoding and Linked Data (MELD) [3] and subsequent applications implemented using this framework. The MELD-based Beethoven in the House annotator [4] notably supports combining MIR analysis tools in support of musicological investigation, via the Music Annotation Model [5].

These earlier approaches layer annotations over symbolic music representations (e.g. scores) using bespoke interactions and visualisations, manipulating already-engraved notation as purely graphical objects. The next section introduces a new implementation extending engraving tools (in our case *Verovio*) to be 'annotation aware', processing annotations embedded in the native symbolic encoding (in our case MEI) and persisting these through to the rendered graphical output (in our case SVG).

3. IMPLEMENTING ANNOTATIONS IN *VEROVIO*

In other work we have compared existing implementations of annotations in digital systems in detail, and surveyed users for use cases [6]. Here, we focus more narrowly on the annotation of symbolic scores encoded using the MEI format. In this context, annotation Targets can be assumed to be XML elements defined by the MEI schema (and therefore URI addressable as required by the Web Annotation Data Model). Annotation Bodies will, necessarily, be application specific–the information and corresponding visualisation of ground truth annotations describ-

ing audience reaction will have differing requirements to those reporting computational chord estimation–and so we have implemented annotation processing functionality to provide a generic and foundational visual scaffold, upon which further customisation can be added.

Verovio [7] is an open-source software library designed for engraving and displaying symbolic music notation in a digital format. Verovio begins by parsing the MEI XML to use as its internal data format, then interprets the structural elements of the encoded music, before performing layout calculations to arrange the elements on a musical staff or system according to predefined and customizable formatting rules. Verovio then generates a graphical representation of the music notation, with its most powerful graphical output being SVG, a W3C standard through which Verovio can preserve the addressability of notation elements between symbolic and graphical encodings.

We add a `type=score` attribute value to `<annot>` elements in MEI, and corresponding functionality in *Verovio* to process and represent three types of annotation in the SVG output:

Element enumeration. Elements which are the annotation Target are explicitly and individually included by entering their `xml:ids` as values of a `plist` attribute in the `<annot>`. *Verovio* identifies the individual elements within the engraving SVG, which can then be customised and manipulated via CSS.

Element range. Annotation Targets are identified as those between a starting element (passed by `xml:id` as a value to the `startid` attribute) and an ending element (passed via the `endid` attribute). *Vevorio* draws a bar over the stave as a child of the annotation's group element, which can similarly be customised via CSS.

Metrical range. Annotation Targets are identified as those encompassed in a range between a start point (a metrical value to the `tstamp` attribute) and an end point (passed via the `tstamp2` attribute). Although the semantics of its definition are distinct, visually this is presented as for the element range.

As with other rendered elements in *Verovio*, annotation bars span systems and lines gracefully and avoid clashing with each other or with other symbols by expanding upwards in vertical space above their stave.

4. EDITING AND ANNOTATING IN *MEI-FRIEND*

mei-friend [8] is a browser-based editor for music encodings. It is capable of opening a variety of formats, including MusicXML, but converts these to MEI for editing. The editor incorporates two main panels – an XML code editor and an interactive digital score dynamically rendered using an embedded Verovio instance – and synchronises these into a synoptic view of the encoding, such that a selection or modification in one panel is immediately reflected in the other. Graphical menus with associated keyboard shortcuts provide access to a host of score manipulation and element insertion functionalities, and a set of additional features – MEI validation and schema-informed auto-completion, an integrated facsimile panel providing views of aligned

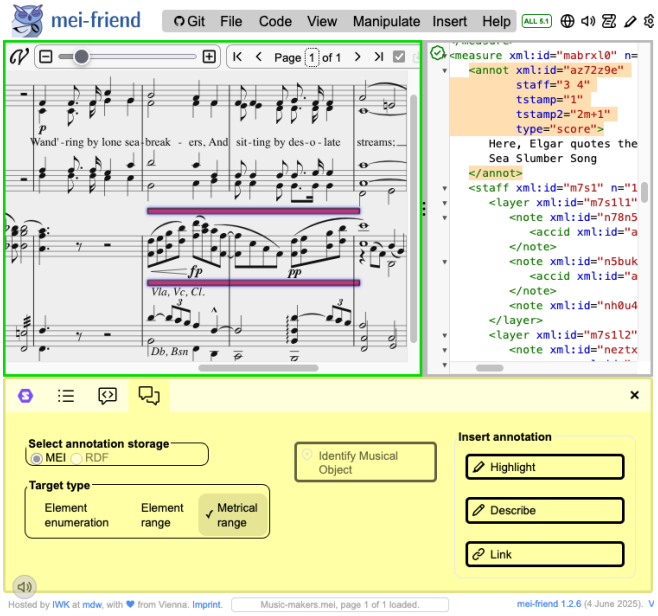

Figure 1. A metrical range annotation is created to describe a short melodic quotation of Elgar's *Sea Slumber Song* within *The Music Makers* (op. 69) using *mei-friend's* enrichment panel, with the score and range indicator (over two staves) rendered by *Verovio*.

images of source documents, support for MIDI playback, a GitHub integration for collaborative encoding, among others – are available. The editor's interface is translated into a growing set of languages, and extensive documentation and support for targeted consultation of the MEI Guidelines are provided.

The editor's enrichment panel exposes an interface supporting the creation and display of editorial mark-up and annotation. Annotations can be authored in-line, using `<annot>`, or as stand-off Linked Data structures adhering to the Web Annotation Data Model [1] or the Music Annotation Model [5]. Whereas mei-friend has previously rendered annotations targeting element enumerations using CSS styling applied to the corresponding SVG elements in the digital score panel, *Verovio*'s new capabilities for rendering element and metrical range annotations are now explicitly supported.

To create an annotation, the user selects relevant elements using a click-and-drag selector. In the enrichment panel's 'Annotation tools' tab (figure 1), the user chooses a 'storage type' (MEI for in-line, RDF for stand-off) [1] and a 'target type' (as per section 3). The user may then insert an annotation using one of the provided tools, currently 'highlight' (an annotation without a body), 'describe' (associating a textual body), and 'link' (associating a pointer targeting a Web resource's URI as the body, using the `<ptr>` MEI element). Annotations are rendered in the digital score and become available within mei-friend's enrichment list (alongside other editorial mark-up).

[1] mei-friend currently supports only element enumerations for stand-off annotations, as defining Linked Data selectors for element and metrical ranges remains a desideratum.

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