A Showcase of New MEI Tools

Half-day pre-conference workshop proposal

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1 Introduction

The acceptance and success of a data format depends largely on the availability and effectiveness of tools for accessing, editing, processing, and presenting data encoded in that format. Over the last couple of years, the MEI data format has experienced an increasing adoption among musicologists and in Music Information Retrieval (MIR). Due to its open structure and versatility, MEI is suited for a large variety of tasks. Unfortunately, its ecosystem of tools is currently rather sparse compared to other symbolic music formats, but continuously growing thanks to several development projects that are mostly run by members of the MEI community. We are participating in this effort and would like to contribute a set of specialized tools for annotating measures in music scores, converting MEI to audio and other formats, and aligning audio to scores. This workshop aims at giving an introduction to these tools and impart a basic understanding of the technologies and concepts behind them. Furthermore, we want to open the stage for discussions and collect feedback, that we will incorporate into future development.

2 Measure Annotation

One of the first steps in the process of creating a digital critical music edition is the comparison of many different sources of the same musical work. To visually compare them measure-by-measure, it is beneficial to have the measures annotated in some way, allowing for executing commands such as "Show a measure and its correspondents from all sources side-by-side". For this purpose, we have developed a range of solutions: an AI-assisted measure recognition system, the Android app *Vertaktoid* [2] and the web-based app *Edirom Editor*. While the former is useful for generating a first draft, *Vertaktoid* and *Edirom Editor* can then be used to revise the draft. *Vertaktoid* is a pen-based annotation tool for Android tablets. It covers the need for a mobile, user-friendly, comfortable and quick annotation tool. To define the regions (or facsimile zones) of a measure, one

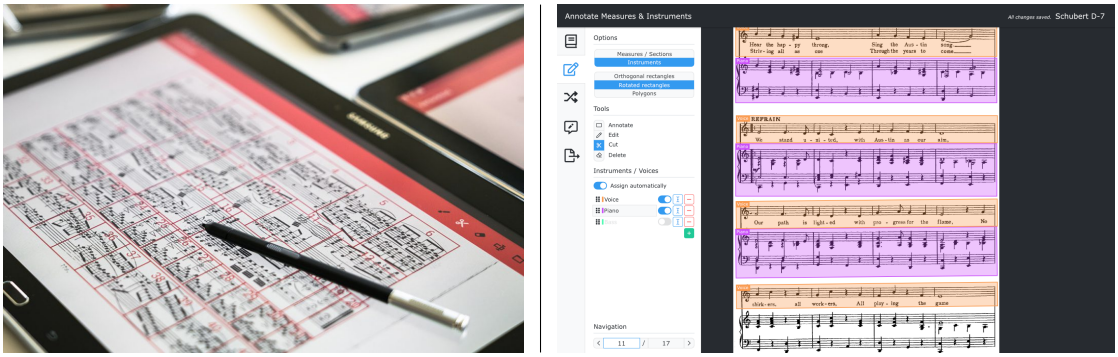

Figure 1: **Left:** *Vertaktoid* – A pen-based annotation application for Android tablets. **Right:** The *Edirom Editor* is an online suite for creating critical music editions.

intuitively draws bounding boxes (and even more general polygons) around bars and other elements in score images. Features like intelligent auto-numbering of measures and direct MEI output further support the annotation workflow. To evaluate the usability of *Vertaktoid* we performed a quantitative study based on the System Usability Scale (SUS). The usability of *Vertaktoid* as reported by the SUS was between "Good" and "Excellent".

After gathering extensive user feedback on *Vertaktoid*, we started developing an online version that extended it to a more general web suite for creating critical music editions. Although still in development, *Edirom Editor* already provides many helpful features that facilitate a typical workflow in edition creation and is completely centered around an intuitive user experience, leading to a very flat technological learning curve for "newcomers" into this field of research.

Transcribing music as well as annotating measures by hand are tedious tasks that invite automation. Optical Music Recognition investigates how to read music notation in documents. In our case, we are only interested in detecting measures, that represent the basic building blocks in scores while we can safely ignore the remaining details. Former work (see [4]) involved a substantial amount of human preprocessing thus was not entirely autonomous. Thanks to recent advances in the area of artificial neural networks, we were able to develop a deep learning model that is capable of detecting measures automatically in both handwritten and typeset music scores. We trained it on over 20.000 manually annotated score images and the first results are very promising (see Figure 2). While the neural network does not (yet) outperform humans in the recognition, it does already significantly improve the process of annotating measures by providing reasonable suggestions that the user can accept after a visual verification or in case of an error, correct directly in the application.

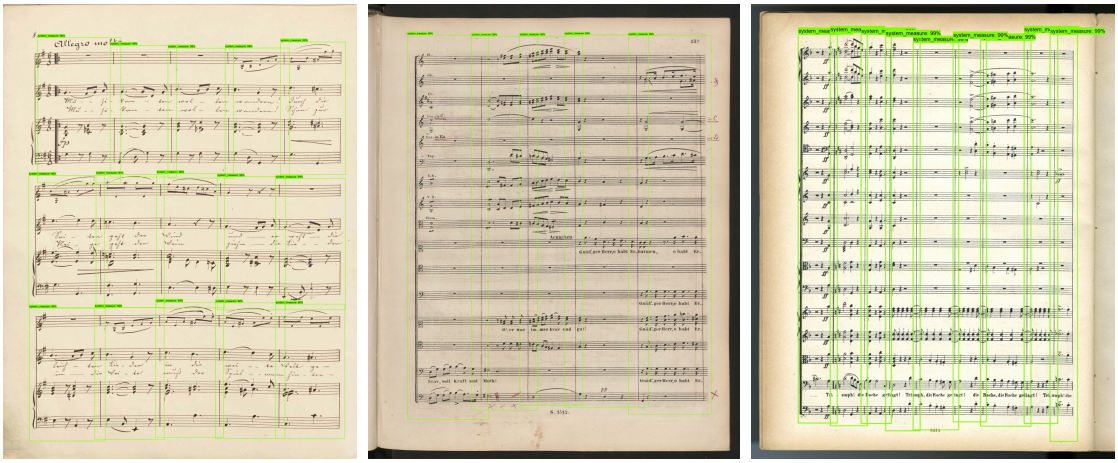

Figure 2: Example outputs of our AI-assisted measure recognition system.

3 Multimedia Presentation & Interaction

The second emphasis of the workshop is on a "transformative digital intermedia studies" perspective of MEI encoded music. Tools to transform MEI into other media formats and representations exploit different ways of presenting music editions and make them accessible to a wide range of users and use cases. This is complemented by tools to link between different representations of a musical work that enable even new research methods.

Meico: MEI Converter

MEI encoded music has a variety of potential use cases such as music engraving, music production, digital music stands, MIR, or simply music listening. The problem is that the corresponding software rarely supports the MEI format. This situation motivated the development of *meico*, the MEI converter framework [1]. Initially meant as a programming library to help software developers in processing MEI data, we also added a graphical user interface to run *meico* as a standalone application and utilize its various functions. It converts MEI to MIDI, WAV, and MP3, thus, making it possible to listen to the encoded music. This is very useful for proof-reading in combination with the integrated *Verovio* score renderer as some errors are far easier to hear than to see. Soundfonts can be added for high-quality instrumental sounds. Chroma features can be generated and exported in JSON format—useful for several MIR applications. *Meico* is also a convenient XSL transformation tool and it offers a hand full of MEI processing functions such as validation, generation of XML IDs, and resolution of expansions into "through-composed form". Figure 3 shows an impression of *meico*'s graphical user interface.

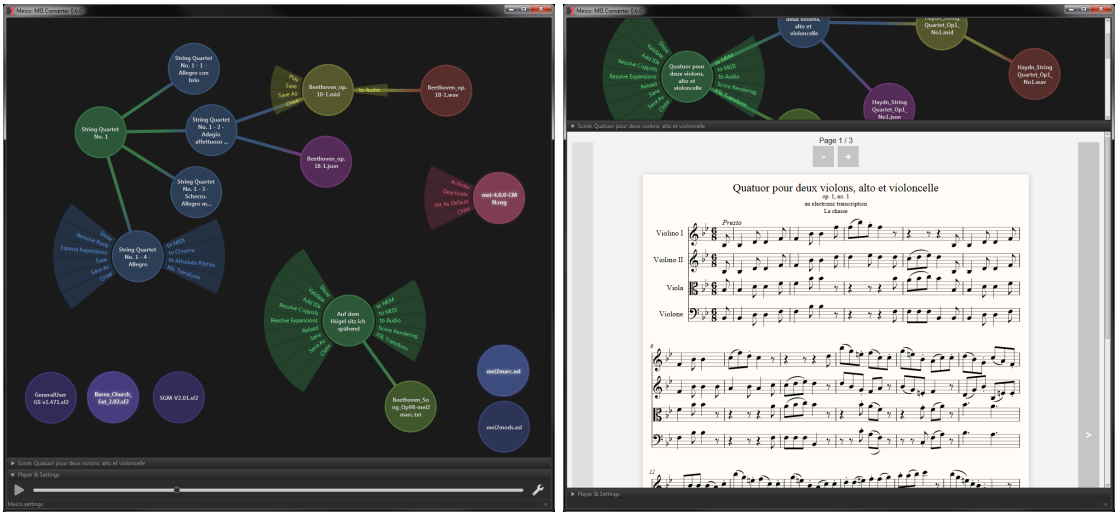

Figure 3: The user interface of *meico* with with its graphical representation of conversion paths, an integrated audio and MIDI player, and Verovio score rendering.

Exploration of Music Performances

Based on the core features of *meico* and *Verovio* [3] we have developed an audio-to-score alignment algorithm that computes the position of each score note within an audio recording. The alignment is highly flexible in case of varying tempo, mistakes in the MEI score or audio recording, transpositions, and even pitch drift over time as it may occur in a cappella singing. Theoretical background and a discussion of related work in the research field are given in [5]. An overview of the state of the art will be given also during the workshop. On top of the audio alignment, we added the ability to align YouTube videos by automatically extracting the audio track and calculating the alignment. The interface, called *ScoreTube*, is completely web-based.

Furthermore, we developed a web-based interface called *MuPEx* [6] that combines

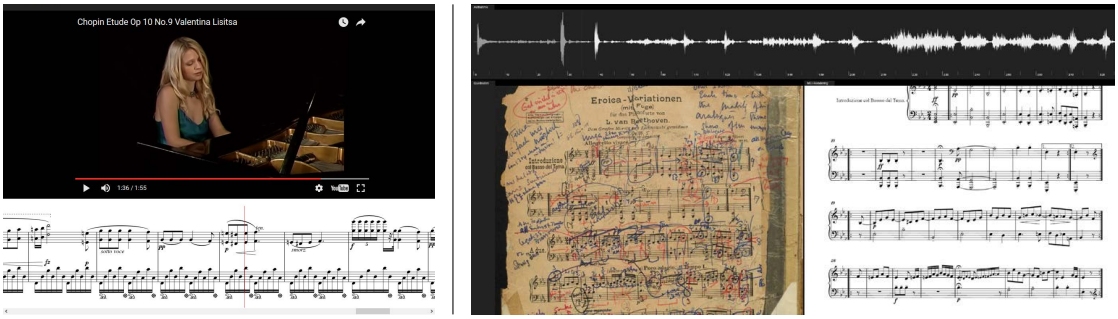

Figure 4: **Left:** *ScoreTube* is a video-to-score alignment solution based on MEI input and YouTube links. **Right:** A multimedia interface that allows different views upon a recorded music track.

music recordings with their corresponding score, similar to *ScoreTube*. By computing the alignment between audio files, scans of the scores used during production and clean renderings of the MEI scores, the interface allows for multimodal navigation and annotation. Clicking in either one of the three views moves the playback cursor in all other views to the corresponding positions. Annotations can, therefore, be made in the view that has the strongest relation to its content, e.g., timbre-related annotations can be made directly in the waveform while the (written) reason for the specific change in timbre is highlighted in the scan. This is particularly interesting to examine and analyze interpretations if the performer's hand-written markings are visible on the scan of the score.

Workshop Requirements

This is a half-day workshop of 3 hours length. Our target audience comprises everyone who encodes MEI or works with MEI encodings such as musicologists, music editors, music theorists and analysts, and digital librarians. Our tools are open source, hence the workshop could also be relevant to software developers who process MEI data. We require a projector and a speaker system to play music from laptops. Participants should bring their own laptops to follow along and can bring their own MEI and image data to experiment and get support by the workshop tutors.

References

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