ABSTRACT

Integration between different data formats, and between data belonging to different collections, is an ongoing challenge in the MIR field. Semantic Web tools have proved to be promising resources for making different types of music information interoperable. However, the use of these technologies has so far been limited and scattered in the field. To address this, the Polifonia project¹ is developing an ontological ecosystem that can cover a wide variety of musical aspects (musical features, instruments, emotions, performances). In this paper, we present the Polifonia Ontology Network, an ecosystem that enables and fosters the transition towards Semantic MIR.

1. INTRODUCTION

During the last 20 years, the field of Music Information Retrieval (MIR) has seen the introduction of an increasing number of music datasets, enabling researchers to train and evaluate algorithms for several tasks, from chord recognition and beat detection, to source separation and mood detection. However, the availability of audio data is still limited, and two overlooked issues remain: (i) music datasets are commonly provided as independent and isolated collections, with little or no alignment at the metadata and annotation level; (ii) even when tracks/compositions are annotated, SW technologies greatly facilitate effective data access and integration, resource discovery, semantic reasoning and knowledge extraction, while also promoting interoperability among resources, information models, data providers and consumers. As such, they have been adopted by both large corporations, such as Oracle, IBM, Google²), and many domains dealing with vast quantities of data gathered with different encoding formats, such as health care, life sciences, and cultural heritage³. A wealth of recent research is dedicated to the adoption of SW knowledge bases as references for enhancing Information Extraction tasks [6].

In light of this, SW technologies and principles are ideal for MIR, as they could easily address the disconnection and the low level of linkage of music collections. Nonetheless, despite the numerous music ontologies to date, high fragmentation and poor maintenance of these contributions are currently hindering the transition to Semantic MIR (see Section 2). To fill this gap, we are developing an ontological ecosystem providing a standard, flexible and expressive schema to represent and describe/annotate heterogeneous musical data of different formats, genres, and provenance. By leveraging the different sets of skills and expertise of music scholars in Polifonia, we aim at unifying views and identifying requirements across different disciplines to guide the ontology design activities, while following state of the art methodologies for data engineering.

¹ https://polifonia-project.eu
² https://schema.org
2. MUSIC ONTOLOGIES

In the last two decades several ontologies have been developed for diverse music-related applications, dealing with both symbolic notations and audio signals at different levels of specificity. Some ontologies have been designed for describing high-level music-related information, such as the The Music Ontology [7] and the DOREMUS Ontology [8]. Other ontologies describe musical notation, both from scores and symbolic representations. For example, the MIDI Linked Data Cloud [9] proposes the interconnection of symbolic music descriptions encoded in MIDI format, and the CHARM ontology [10] aims to describe musical structures based on the CHARM specifications. The Music Theory Ontology (MTO) [11] describes theoretical concepts related to a music composition, while the Music Score Ontology [12] represents similar concepts with a focus on music sheet notation. Finally, the Music Notation Ontology [13] focuses on the core “semantic” information present in a score. Other ontologies aim to describe specific aspects of the musical domain, such as the Chord Ontology, the Tonality Ontology, the Temperament Ontology [14], and the Segment Ontology [15]. The Audio Features Ontology [16], the Studio Ontology [17], and the Audio Effects Ontology [18] describe audio signals and production procedures. Others have also been used to model listening habits and music tastes [19], music-induced emotions [20], and to describe musical similarities [21].

The focus of these ontologies is generally specific, covering only particular aspects of musical content. However, music consists of a dense connected network of heterogeneous elements that concert with each other. Furthermore, many of these ontologies were developed as stand-alone projects, with little or no alignment to other relevant ontologies within the same domain.

3. THE POLIFONIA ONTOLOGY NETWORK

Besides the expressive and modular design, allowing to represent a wide range of music-related concepts and relations, the Polifonia ontology network (ON) also brings a wide range of music-related concepts and relations, the Polifonia ontology network (ON) also brings two key assets desirable for the whole ecosystem. First, the Polifonia has the same semantics as the concept of the Music Ontology [7] and the DOREMUS Ontology [8]. Other ontologies describe musical notation, both from scores and symbolic representations. For example, the MIDI Linked Data Cloud [9] proposes the interconnection of symbolic music descriptions encoded in MIDI format, and the CHARM ontology [10] aims to describe musical structures based on the CHARM specifications. The Music Theory Ontology (MTO) [11] describes theoretical concepts related to a music composition, while the Music Score Ontology [12] represents similar concepts with a focus on music sheet notation. Finally, the Music Notation Ontology [13] focuses on the core “semantic” information present in a score. Other ontologies aim to describe specific aspects of the musical domain, such as the Chord Ontology, the Tonality Ontology, the Temperament Ontology [14], and the Segment Ontology [15]. The Audio Features Ontology [16], the Studio Ontology [17], and the Audio Effects Ontology [18] describe audio signals and production procedures. Others have also been used to model listening habits and music tastes [19], music-induced emotions [20], and to describe musical similarities [21].

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The identification of the 11 ontology modules emerged from the investigation, and thematic classification, of all the CQs from the 19 stories recorded so far. The Full module is the entry point of the whole network. The Core module models general-purpose concepts and relationships (e.g. place, time). The Musical Composition and Musical Performance modules represent musical performances and events, and musical compositions respectively. The Musical Feature module provides a model to describe a musical object in regard to the musical properties that can be objectively attributed or subjectively identified from it. The Source module represents sources of music-related information. The Instrument module proposes a taxonomy of instruments and their technical properties, whereas Bell focuses on bells. The Music emotion module provides a model to describe emotions both perceived and induced by a composition wrt the musical features. A module named Comparative Measure defines ODPs describing observations and measures applied to comparative analysis, such as similarities between musical pieces. Lastly, the Metadata module aims at supporting the representation of metadata about musical resources. The Polifonia ON is being populated by data from various existing datasets.

4. CONCLUSIONS AND FUTURE WORK

In this paper, we addressed the recurring problem of integration and linkage of MIR datasets. By means of SW technologies and best practices, we are laying the foundations and providing the infrastructure for Semantic MIR. Not only will this support computational music analysis, but the KGs resulting from the interconnection of MIR datasets and their integration with other sources can be explored through symbolic reasoning to derive novel musical knowledge and test musico-logical hypotheses. We are currently developing a first version of the Polifonia ontology network, and future work will iteratively extend the ecosystem as a result of continuous expert feedback.

4 https://github.com/polifonia-project/

5 E.g. an alignment axiom could assert that the concept of Person in Polifonia has the same semantics as the concept of Person in FOAF.
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5. REFERENCES


