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Tonalities' Collaborative Annotation Interface for Music Analysis

Thomas Bottini, Christophe Guillotel-Nothmann, Marco Gurrieri and Félix Pouillet-Pagès

IReMus (CNRS, Sorbonne Université, BnF, Culture), Bibliothèque Nationale de France, Quai François Mauriac, 75706 Paris

Abstract

This paper presents the alpha version of Tonalities' annotation interface. This interface leverages web technologies to grasp how distinct theoretical viewpoints bring to light different, sometimes conflicting, musical properties; to confront different analytical interpretations; and, ultimately, to provide reasoned, documented and authored statements on musical pieces. To this end, Tonalities (a) makes use of theoretical models, which (b) can be associated with arbitrary selections on the score and (c) lead to critical analyses through collaborative approaches. Three types of semantic data are used: MEI scores converted to RDF triples, music-theoretical knowledge formalized in the form of OWL ontologies, and semantic annotations expressed as CIDOC-CRM events.

Keywords

MEI, Music annotation, Music analysis, Collaborative approach, Modelling of musical theories

1. Introduction

As one of the ten pilots participating in the European project Polifonia: a Digital Harmoniser for Musical Heritage Knowledge (Horizon2020 - RIA)[1], Tonalities embraces the open linked data paradigm to reference large corpora of music made available in digital score libraries and to explore them through a specific approach. This approach consists of modeling different theories—historical or contemporary, specific or general—and applying them to musical works through a dedicated collaborative annotation interface. This interface helps to grasp how distinct theoretical viewpoints bring to light different, sometimes conflicting, musical properties; to confront different analytical interpretations; and, ultimately, to provide an reasoned, documented and authored modal-tonal classification of musical pieces.

2. State of the Art

Tonalities builds on previous studies that relate the musical system to its history[2], grant early music other conditions of truth than tonality [3], and utilize statistical methods[4]. The annotation interface, which is one of the cornerstones of the project, takes its cue from previous projects that use a score visualization interface to produce musical knowledge: The Josquin Research Project[5], which provides a large corpus of scores and

analytical routines for their exploration; The Lost Voices Project[6], which opens an avenue for collaborative analysis; and Dezrann[7], which provides ergonomic tools for score annotation. Tonalities complements these initiatives on several levels through leveraging the semantic annotation and open linked data paradigms: the modeling of music concepts into OWL ontologies to make analytical assumptions explicit and to permit choosing among different theoretical perspectives; the collaborative dimension to trace each critical annotation and to comment and compare it with others; the addressability of all resources: models, scores, analytical annotations, critical comments.

3. A Collaborative Annotation Interface that Draws on Knowledge Graphs Relating to Music, Music Theory, and Cultural Heritage

Through its annotation interface, Tonalities (a) makes use of theoretical models, which (b) can be associated with arbitrary selections on the score and (c) lead to critical analyses through collaborative approaches.

- (a) **Modelling different theories relating to the same knowledge domain.** The modelling of different theories relating to the same knowledge domain—i.e. modal-tonal organization—aims to avoid the limitations of a single “standard” or “global” theoretical perspective, arbitrarily chosen and applied mechanically despite its limited validity (belonging to a historical period, restricted to certain repertoires, conveying certain

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✉ thomas.bottini@cnrs.fr (T. Bottini);

christophe.guillotel-nothmann@cnrs.fr (C. Guillotel-Nothmann);

marco.gurrieri@cnrs.fr (M. Gurrieri); fpouillet@etu.utc.fr

(F. Pouillet-Pagès)



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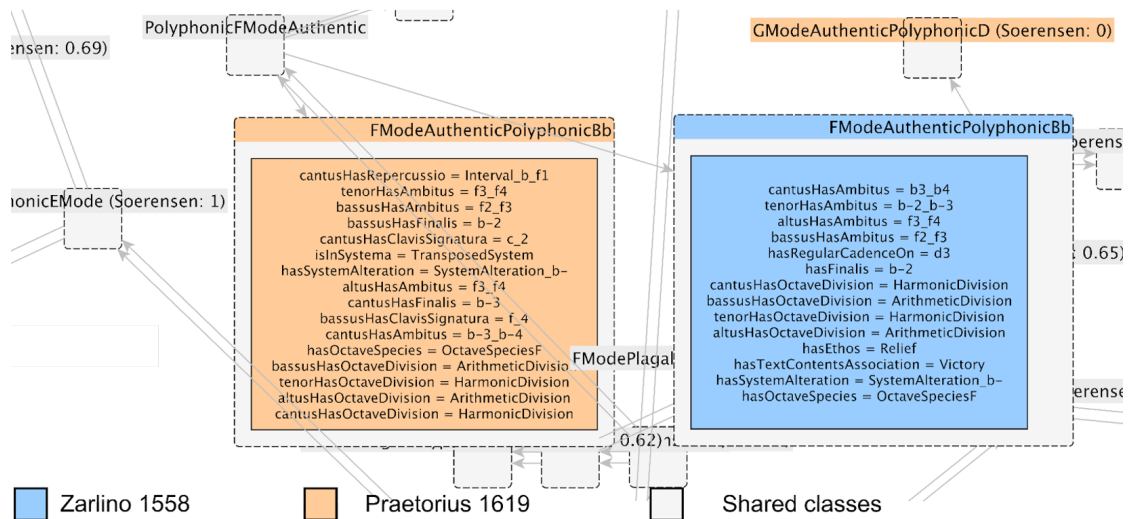


Figure 1: Models for the historical theories of Zarlino and Praetorius.

ideologies, etc.). Instead, Tonalities applies different models—corresponding to distinct theoretical viewpoints—to a single musical work, allowing the user to observe how these perspectives affect its modal-tonal structure. Further, this multifaceted approach allows for the confrontation of models in order to grasp how theoretical concepts evolve over time and space. The alignment of these ontologies then shows how concepts (such as “mode”, “D Ionian”, “transposition”, “cadence”, “chord”, etc.) evolve while the terms to denote them remain constant and, conversely, how certain concepts remain identical while their signifiers change. At the present stage of development, two historical theories are operational: Zarlino 1558[8] and Praetorius 1619[9] (each with circa 2500 axioms, 500 classes, and 100 object properties)[10, 11]. The Praetorius model has been presented[12] and applied[13, 14] in former studies. Initial tests have been undertaken over the last 12 months to infer the mode of individual works from these models. Further, a set of functions has been developed to allow the comparison of the models, both at the class level and at the property level, and to measure their differences and similarities (see Figure 1);

- (b) **Selecting arbitrary selections in the score and associating them with concepts.** Once a musical element—ranging from a single note to complex segments (i.e. not contiguous or nested)—has been selected, it can be associated with an analytical property and/or concept from

a theoretical model. This association is fully recursive: a parent concept, corresponding to a main selection, can itself contain child concepts that refer to subsets. The linking of concepts with selections can be done manually and/or via knowledge extraction routines either based on deep learning (for root and cadence analysis) or formalized approaches (for voice range and key analysis, etc.);

- (c) **Commenting analytical annotations in the context of collaborative approaches.** Analytical annotations can give rise to critical comments. These comments are signed and addressable. Their purpose is to correct and qualify and/or contextualize the analytical information, particularly in the context of collaborative approaches. This collaborative dimension is at the heart of the interface’s methodological ambitions. First, Tonalities aims to rely on collaborative work for the annotation and analytical exploration of large corpora. The aim is to overcome isolated studies on individual musical works in favour of team projects predisposed to discern properties and trends of the musical language in large collections. Second, the collaborative work aims to contextualize analytical statements through argumentation, refutation, and comparison. The challenge is to go beyond agnostic or positivist postures that would see in a musical analysis objective and universally valid facts in favour of a dialectical activity which places at its centre the context-dependent viewpoint of analysts. The Tonal-

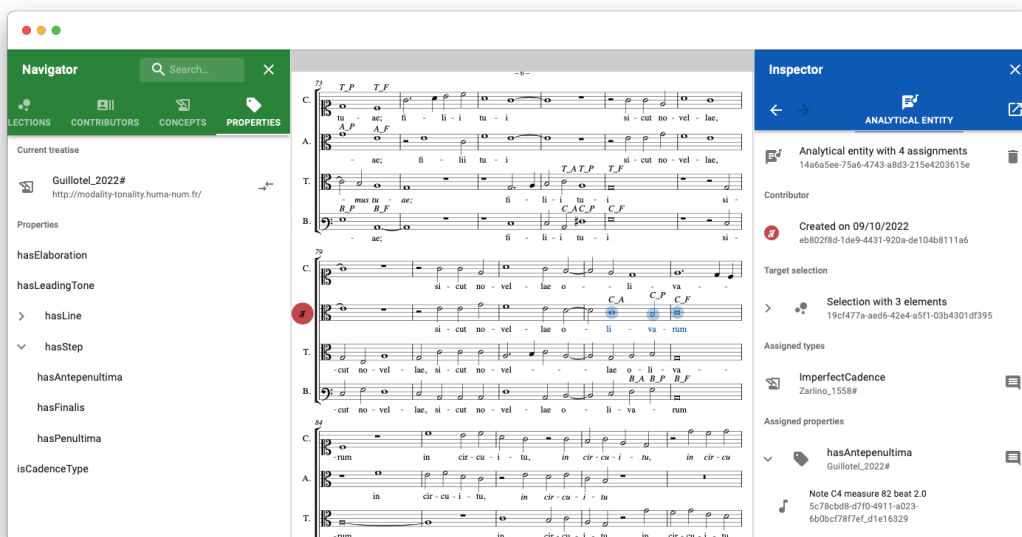


Figure 2: Excerpt of the Tonalities' annotation interface.

ities interface has therefore also been designed in view of identifying and applying methodological paradigms in which AI and manual (collaborative) annotation are articulated in approaches that remain sensitive to the challenges within the humanities and social sciences, in particular those of music analysis[15].

To uphold this practice, Tonalities consumes three types of semantic data:

1. MEI scores are fully converted to RDF triples: each XML element receives a unique IRI; each XML attribute gives birth to an RDF triple; and basic CIDOC-CRM patterns are used to express the type (note, rest, verse, etc.), the id (reflected in the IRI of the corresponding semantic data), and the nesting of each element. However, some analytical tasks assume the ability to address observables that are not represented by musical signs, such as (a) score offsets (verticalities), (b) note offsets, and (c) arbitrary selections of MEI elements. Score and note offsets are extracted with Music21 libraries, and free selections are modeled as basic CIDOC-CRM patterns. Each non-MEI observable also receives a unique IRI.
2. The project formalizes theoretical knowledge (either historical sources or contemporary theory) in the form of OWL ontologies. These ontologies provide concepts and properties which, imported

into the Tonalities application, provide an analytical vocabulary to annotate scores.

3. Tonalities allows to display and compare two types of semantic annotations linking together analytical observables and theoretical concepts: those created manually in the interface and those generated by programs relying on machine learning and formalized knowledge production rules algorithms. Each annotation is expressed as a CIDOC-CRM event, is thus dated and signed (by a human musicologist or by a specific algorithm), and takes the form of a reification of a RDF triple. An annotation may be simple, in which case the object/body is a single value (such as a dissonance type associated to a subject/target representing a note). Annotations may also be complex, for example when an analyst describes the inner structure of a cadence. In such cases, a macro-selection may be annotated with cadence types ("DiminishedCadence", "PerfectCadence", etc.) and may contain sub-selections annotated through the attribution of properties ("hasAltizans", "hasCantizans", etc). Within each of these sub-selections, each note may in turn be annotated with its own properties ("hasAntepenultima", "hasPenultima", etc.).

4. Challenges and Working Perspectives

Tonalities' interface is currently available in an alpha version. Several improvements and developments are in progress, including ergonomics, metadata treatment, musical queries, download/upload options for end users, etc. In the medium-term, the interface will provide means for the fine-grained comparison of concurrent annotations made on a score. Diagrams will also be implemented for the diachronic and synchronic analysis of different musical features, including pitch collections, harmonic progressions, cadences, etc. The long-term goal is to supply an extended palette of analytical symbols for score annotation, notably for the purpose of harmonic analysis (Roman numerals, Riemannian functions, or harmonic vectors[4]).

5. Tonalities' Video Teaser

<https://www.dropbox.com/s/ufjcc4i9kj5mfyx/Tonalities%27%20Teaser%20Video.mp4?dl=0>

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