FROM MUSIC ONTOLOGY TOWARDS ETHNO-MUSIC-ONTOLOGY

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ABSTRACT

This paper presents exploratory work investigating the suitability of the Music Ontology [33] - the most widely used formal specification of the music domain - for modelling non-Western musical traditions. Four contrasting case studies from a variety of musical cultures are analysed: Dutch folk song research, reconstructive performance of rural Russian traditions, contemporary performance and composition of Persian classical music, and recreational use of a personal world music collection. We propose semantic models describing the respective domains and examine the applications of the Music Ontology for these case studies: which concepts can be successfully reused, where they need adjustments, and which parts of the reality in these case studies are not covered by the Music Ontology. The variety of traditions, contexts and modelling goals covered by our case studies sheds light on the generality of the Music Ontology and on the limits of generalisation "for all musics" that could be aspired for on the Semantic Web.

1. INTRODUCTION

Non-Western musical traditions are of interest to MIR research for several reasons: firstly, alongside Western classical and popular music, which have been studied extensively in MIR, the musics of other cultures are analysed in their own right [6, 13, 16, 25]; secondly, other musical cultures often present difficult, non-standard datasets and examples, showing the limits of existing MIR approaches [22, 30, 39]; finally, including non-Western musical traditions allows for a broader view of music and leads to new, more generally applicable technical solutions [24, 28, 40]. In this paper, we explore the latter avenue with the view of generalising existing standards of semantic modelling in music to include non-Western musical traditions.

Ontology in computer science is commonly defined as an "explicit formal specification of a shared conceptualisation of a domain " [15]. An ontology represents consensual knowledge about the entities and their relationships in an area, preferably expressed using a machine-processable formal language that supports some form of inference [12]. This could be logic based, while more recently, ontologies found their use in machine learning as a mechanism to help structuring training data, formalise constraints, or become an integral part of the inference process [42].

The Music Ontology (MO) [32, 33] is among the most comprehensive ontologies for the music domain, with broad ranging applications [9, 38] from recommendation systems [49] to live performance [51], and numerous extensions covering music production [10, 11] and audio effects [53, 54], audio features [1], music theoretical concepts [34, 43, 46], smart instruments and more generic or other "Musical Things" [48]. The ontology is based upon several broadly accepted domain models (see Section 2) adopted to the music domain. Moreover, it has been applied successfully to model jazz [31], a tradition distinct from Western classical and pop music; and it was found to be beneficial for modelling Chinese musical tradition due to its flexibility and layered structure [45]. This makes it a primary candidate for our analyses.

The Music Ontology makes general claims about representing discographic information, music creation, performance, production and consumption. Yet it has so far mainly been applied to Western music. MIR researchers with expertise in ethnomusicology [29, 50] suggest that computational approaches to non-Western music should all be culture and use case specific. We therefore aim to answer the following questions: Is the Music Ontology capable of representing the domains of non-Western musical traditions? What are the gaps that the Music Ontology fails to model? Can or should the Music Ontology be generalised to encompass many (or all) musical traditions? What are the limits of such generalisation?

While political and geographic borders, language and religion play an important role in forming musical traditions, modelling the domain of such a tradition goes far beyond adding a geo location. For instance, Kurdish music in northern Iraq is different from Kurdish music in Iran and Turkey; Persian musics in Iran, Afghanistan and Tajikistan are also different, even though people speak in the same language (Persian); likewise Azerbaijan and Armenia have different religions and languages, but their musics are very close. Also, music of a diaspora sometimes adheres closely to the original traditions and sometimes fuses with the mu-

sic of the host community, importing new elements and establishing new trends.

In addition to differences in musical systems and repertoires, how people create, perform and listen to music varies between cultures. To account for this diversity, we chose four case studies from a variety of musical traditions. The use cases are representative of the chosen traditions, based on authors' expertise as practitioners, researchers and consumers of those musical cultures. While by no means exhaustive, this investigation employs a qualitative approach to test the usefulness and representativeness of the Music Ontology in a large variety of contexts outside of Western classical and popular music.

First, we look at a Dutch state institution collecting folk songs of a tradition now largely extinct and how research on this collection is conducted (Sec. 3). Secondly, contemporary performance and composition in Iranian music are explored, encompassing Persian classical art music, folk music of many Iranian population groups and Western influences (Sec. 4). Thirdly, we take the genre of world music into consideration, where recording and consumption are broadly in line with Western popular music (Sec. 5). Additionally, we turn to Russian village music and how it is being actively revived through field research and performance (see Supplement [1]).

Dutch folk songs are a representative of folk music traditions of Western Europe and North America in our study; Russian village music is a polyphonic vocal tradition, which are common throughout Eastern Europe, and are found in other parts of the world. Iranian music is a maqamic tradition, strongly connected to the modal traditions encompassing the Near East, North Africa, and South Asia. The world music genre does not represent any particular culture and can include all kinds of musical content from around the world.

To illustrate how the Music Ontology (MO) classes and properties can or cannot be used to model our case studies, we introduced a consistent form- and colour coding throughout this paper: MO classes and their subclasses have solid line borders while other classes have dashed line borders; MO properties are thick blue arrows with straight heads; properties not present in the Music Ontology are thin red.

2. PREVIOUS WORK

The main standard for semantic modelling in cultural heritage is FRBR (Functional Requirements for Bibliographic Records). It is a conceptual model for describing entities and relationships in libraries, museums, and archives [47]. FRBR was developed by the International Federation of Library Associations and Institutions (IFLA) and is widely used by cultural institutions around the world, in particular for electronic cataloguing of physical and digital objects. It provides the basis for interoperability between holdings, collections, and datasets [3].

FRBR Group 1 defines four main entities to represent the products of intellectual or artistic endeavour: "Work (a distinct intellectual or artistic creation) and expression (the intellectual or artistic realisation of a work) reflect intellectual or artistic content. Manifestation (the physical embodiment of an expression) and item (a single exemplar of a manifestation) reflect physical form." Group 2 includes persons and corporate bodies responsible for the custodianship of Group 1 intellectual or artistic endeavours (e. g., creators, consumers). Group 3 includes events and places [17] (Fig. 1).

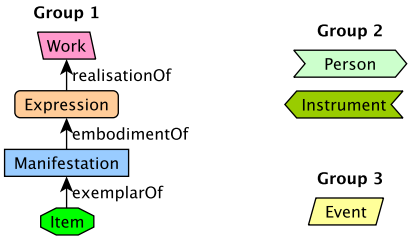

Figure 1. FRBR conceptual model. The shape and colour coding exemplified here is used throughout this paper to indicate classes implementing FRBR concepts

The Music Ontology [32] provides a vocabulary for publishing and linking a wide range of music-related data on the Web [2] . It builds on four main ontologies: FRBR Ontology [3] (Fig. 1), the Timeline Ontology [4] , the Event Ontology [5] and FOAF [6] . Fig. 2 illustrates how the Music Ontology classes implement FRBR. It has been extended to describe a variety of musical domains, such as audio content (Audio Features Ontology [7] [1]), recording sessions (Studio Ontology [8] [10]) and exploration, transformation and redistribution of audio content (AudioCommons Ontology [9] [4]). The Jazz Ontology [31] is a semantic model successfully developed on the basis of MO. It illustrates how the Music Ontology requires "tweaking" with shortcuts, new or qualified properties and some additional concepts to describe a musical tradition other than Western popular or classical music.

MusicBrainz [10] is the largest crowd-sourced collection of music metadata online. It has its own semantic model [18], focused on discographic information about published CDs, therefore less suitable to musical traditions which are not centred around published products.

Tian et al. [45] presented a detailed analysis of metadata standards in existence in 2013, including the Music Ontology, and their ability to model the domain of Chinese traditional music. They identified several aspects which were not covered by existing standards: function (purpose of creation, occasion of performance), performance practice (vocal style, stage performance, cosmetics and props, per-

[1] Supplementary material: https://osf.io/5qxdb/

[2] http://musicontology.com
[3] http://vocab.org/frbr/core.html
[4] http://purl.org/NET/c4dm/timeline.owl
[5] http://purl.org/NET/c4dm/event.owl
[6] Friend of a Friend ontology, describing relationships between persons:http://xmlns.com/foaf/spec/
[7] https://w3id.org/afo/onto/
[8] http://isophonics.net/content/studio-ontology
[9] https://w3id.org/ac-ontology/aco
[10] https://musicbrainz.org

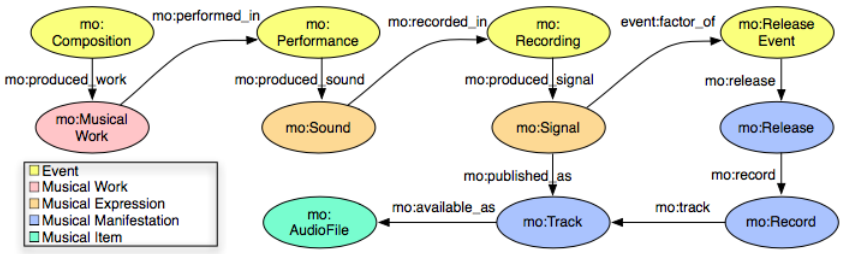

Figure 2. A fragment of the Music Ontology: key concepts and selected properties describing the music production workflow, showing the FRBR layers [12]

forming skills), musical characteristics (intonation, temperament), historical context, ethnic group, etc.

Further to cultural heritage sector, Coladangelo [5] provides a comprehensive description of contemporary (2020) semantic frameworks representing cultural heritage, including those related to music. Goienetxea et al. [14] describe an ontology representing Basque folk songs based on CIDOC Conceptual Reference Model (CIDOC CRM) - a complimentary standard for cultural heritage used primarily in the context of architecture and museum collections. FRBRoo is an object oriented model harmonising FRBR and CIDOC CRM [36]. Strle and Marolt [41] modelled Slovenian folk songs and chimes music based on FRBRoo. DOing REusable MUSical (DoReMus) Project [23] developed a model, also based on FRBRoo, describing varied collections from three French cultural institutions.

In this paper we conduct four diverse case studies originating from different musical traditions, analysing the ability of the Music Ontology to model their domains. The following sections describe the case studies: the cultural context, the musical content to be modelled, specific domain characteristics, providing diagrams of semantics models. We wrap up with a discussion of commonalities and differences displayed by the case studies and their application of the Music Ontology, the advantages and the limits of a generalised Ethno-Music-Ontology.

3. CASE STUDY: FOLK SONG RESEARCH ON THE DUTCH FOLK SONG ARCHIVE

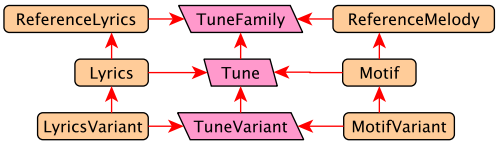

Figure 3. The oral transmission (songs learnt and passed on through listening and participation) introduced continuous changes, giving rise to the coexistence of *TuneVariants*

The history of Western European folk song collection and research stretches back centuries: before the emergence of audio recording, folklorists wrote down folk songs performed by their informants or encountered in the field, which were then released in printed collections. Songbooks would often only contain the lyrics; later, more research oriented editions would include a notated melody transcription. The idea of *TuneFamilies* (Fig. 3) – clusters of tunes descending from a common "ancestor" - was in line with other disciplines such as linguistics [2,7]. This line of inquiry was strengthened by the requirements of the medium – the book – used to publish the songs: usually only one representative of a tune family would be included in a print collection to avoid repetition (Fig. 4).

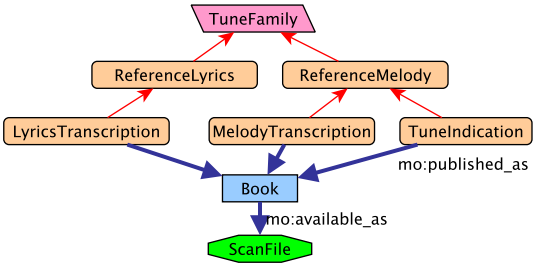

Figure 4. A *TuneFamily* was represented in a print book collection by only one of its member tunes.

The assignment of a tune to a family is performed manually by experts. An annotation experiment [52] has shown that the most salient feature for experts to assign songs to the same tune family was the presence of common melodic *Motifs*. It also confirmed the emergence of a prototypic *ReferenceMelody* representing a tune family (Fig. 3).

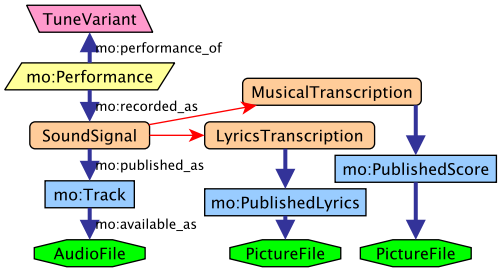

Figure 5. Audio field recordings capture real-life performances of folk songs and are stored in digital files.

When audio recordings of Dutch folk songs and digital processing were introduced, there was no need to limit the publication to just one representative of a family. A

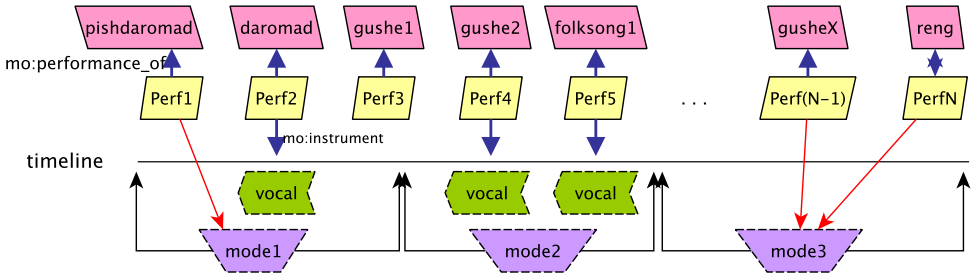

Figure 6. Traditional Iranian performance: The daràmad (opening section) comes at or near the beginning of the performance, and the following gushés are organised according to a gradually ascending pitch scheme, until a forud (cadence) leads a return to the original mode. During the modulations, the modal tonic gradually moves upwards. Usually, metered gushés are played between non-metered gushés. [55]

contemporary database of the Dutch folk songs (the Dutch Song Database [21]) contains metadata on 173K song occurrences from song books, manuscripts and field recordings from the 12th century to the present day. Songs from the earlier printed collections are linked to audio *Recordings* of their *Performances*, the *Lyrics*, the *Scans* of the book pages and *Transcriptions* in digital notation (Fig. 5). The songs are linked to other songs with the same lyrics, or the same *ReferenceMelody*, or the same *MelodicIncipit*. A general melodic similarity search on the whole database is a new tool that facilitates song relationship discovery.

The diagrams in Figs. 3, 4 and 5 show that all the instances can be represented by MO classes or their subclasses (solid borders). Often MO properties (thick blue arrows) can be used. Yet connections between *Tunes* and *TuneVariants* from a *TuneFamily* (Fig. 3), which are paramount in folk song research, are not represented in the Music Ontology (red arrows). The relationships between primary and derivative kinds of *MusicalExpressions*, e.g. a melody and its transcription (Figs. 4 and 5), could be modeled via an event of transcription, analogously to *Sound* -> *RecordingEvent* -> *Signal* connections in the Music Ontology (Fig. 2) . In contrast, the relationship between a *MusicalWork* and its *Expression*, which is similarly represented via a composition event in the Music Ontology (Fig. 2), cannot be used in the context of folk songs or traditional music more generally: there is usually no composer and no single event in which a song is created.

4. CASE STUDY: PERSIAN MUSIC - CONTEMPORARY COMPOSITION AND PERFORMANCE

Music in Iran is categorised, according to a scheme devised by Farhat, into urban, ethnic and pop [8]. Urban music, prevalently heard in the larger cities, includes both classical art music and pop music. Classical Persian music consists of free-rhythmic pieces (àvàz) and rhythmic pieces, typically in 2/4, 4/4, or 6/8. Ethnic music, which is in an Iranian form of maqàm, is that of the various ethnic groups living in towns, villages, deserts, and in the mountains. In addition to pieces in free and simple rhythms, irregular rhythms such as 5/8 and 7/8 are more often encountered in ethnic music. Classical Persian music uses more ornaments, complex melodies and free rhythms than ethnic music. Iranian pop music, which has dominated the music scene in Iran since the mid-twentieth century [8], draws on either or both of the classical and ethnic traditions; it tends to simplify them and to reflect influences from other cultures, notably Western pop music.

The process of creative performance, called bedàhe navàzi (improvisation), which is at the heart of Persian music, is different from improvisation in Western music, as it involves both composition and new ways of rendering classical pieces (gushés); thus, there is no distinction between the role of the performer and the composer [27]. A performance is usually centred on a set of important gushés, whose order is conventionally accepted (Fig. 6). The texture of Persian ensemble music is heterophonic, meaning that the members of the ensemble play the melodic scheme simultaneously in different ways, characterised by a high degree of improvisation and ornamentation.

4.1 Persian modes and repertoire

Persian music is based on a modal system of seven main modes and their five derivatives that are collectively called the twelve dastgàhs [8, 16]. In a maqàm performance, different pieces are played in a single mode, while the performance in a dastgàh comprises a certain sequence of modulations from an opening section in the main mode of a dastgàh (daràmad), to derivative modes (àvàz) and finally a return to the starting mode. (Fig. 6).

A student of Persian music studies a Radif - a body of classical repertoire created by a Grandmaster (Fig. 7) - to form the basis of their performance and composition. In the past the transmission took place orally in a teacher-student relationship that would last for many years; nowadays musicians refer to scores and recordings of classical pieces performed by outstanding masters (Fig. 8).

In Fig. 6 a traditional Iranian performance is represented on a timeline (black line) using the Timeline Ontology (black arrows). The modes are specific to Iranian music and are not part of the Music Ontology, which only provides a concept of a Western-centric major/minor *Key*, though these could potentially be added and the concept generalised to represent modes. Alongside mode the gushe type also has to be documented (Fig. 7, for which there is

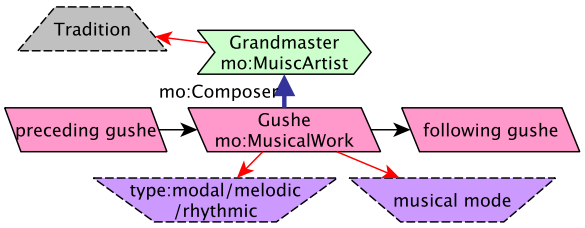

Figure 7. Radif - the core repertoire of Iranian classical music, a body of compositions by a *Grandmaster* from a particular regional tradition.

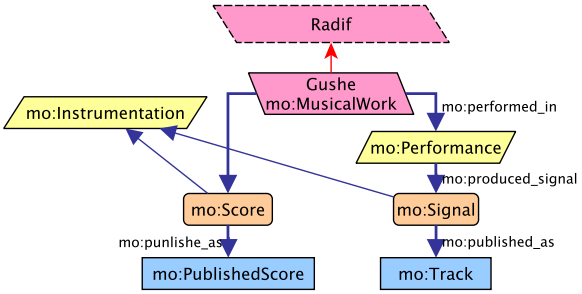

Figure 8. Documenting Radif

no correspondence in the Music Ontology. A Grandmaster is part of a Tradition, which provides the musical and cultural context (grey trapezoid) to the performance - see discussion to Fig. 1 of the Russian case study in the Supplementary Material. In Fig. 8 all relationships can be represented including the creation of a Score, with one exception: the belonging of a gushe to a particular radif. This is similar to the within-repertoire relationships discussed in Section 3 in relation to Dutch folk songs.

5. CASE STUDY: PERSONAL WORLD MUSIC COLLECTION

Personal world music [44] collections are ubiquitous and the exact specifics of their usage will differ between users. They are put together for enjoyment, to create playlists, share music with others, to have an overview of a variety of genres and traditions. The difference to other case studies is that the owner of the collection is not an expert in the majority of the styles represented in the collection. Moreover, a world music collection would be heterogeneous and include a large variety of cultures, genres, languages, instruments, contexts, etc. The authority of the sources and the authenticity/expertise of the performers are not always clearly documented or known; all kinds of cultural and stylistic mixtures can occur: for instance, a piece can originate from one culture but be performed in a different style; the musicians might have their roots in more than one culture, including diasporas; music can be performed using instruments not present in the culture of its origin; a mixture of styles can be deliberate or accidental.

Because the consumer is not an expert, the artwork, liner notes and other textual information play an important role (Fig. 9). Tracks are commonly compiled into playlists which can be devoted to a particular theme (love songs), reflect or create a certain mood (chill out) or serve a function (music for exercise) (Fig. 10).

Fig. 9 shows that, apart from the cultural context, the Music Ontology is perfectly suitable to represent discographic information about world music collections. Yet we observe in Fig. 10 that factors determining the content of a playlist - aspects of cultural context or musical characteristics - are beyond the domain of the Music Ontology.

6. DISCUSSION

The Music Ontology captures FRBR group 1 concepts in all case studies, modelling the process of performance documentation from *Expressions* over *Manifestations* to *Items* (Figs. 4, 5, 8, 9). It is also well suited, in combination with the Timeline and the Event Ontologies, to document musical events (Figs. 6, 10). We identified three areas where the Music Ontology lacks descriptions: cultural contexts, musical characteristics and relationships within or between repertoires.

Our case studies demonstrate how varied cultural contexts (grey downward trapezoid in the diagrams) can be: function, social group and performance practice (Fig. 1 in Supplement [11]) in Russian traditional music; regional tradition in Persian Music (Fig. 7); culture, function, mood and theme in world music (Fig. 10). This is a very complex area, which is often described and discussed differently depending on the language, organisation or school of thought. It is not practical to construct a single taxonomy to describe pagan rituals and music for exercise; wedding songs alongside remembering sunrise; an Easter Vesper as well as indecent humorous couplets. Therefore, Broad categories could be offered like *SocialFunction*, *PerformancePractice*, *Mood*, whereas more detailed modelling should be culture- and use case specific.

Musical characteristics (magenta upwards trapezoid in the diagrams) are specific for each culture: traditions and repertoires can differ greatly in the complexity and variation in modality, rhythm, harmony, ornamentation. Case studies vary in which musical characteristics are important: mode and rhythm type are crucial in Persian music (Figs.6, 7) but are less important in other case studies. Therefore, it seems most viable to model musical characteristics separately for each musical tradition, choosing a subset of the model relevant for the use case. MusicOWL [19] and the Music Theory Ontology [34] offer a model for Western music. Modelling for other traditions should be conducted in collaboration with ethnomusicologists and tradition experts. It is important to keep in mind the gap between theory and practice [16]. Related musical cultures, such as maqamic traditions or Eastern European polyphonic vocal styles, could possibly benefit from a systemic view and a more generic modelling, which would facilitate cross-cultural interoperability of the models.

Relationships within repertoires are crucial in some cultures and contexts: the order and modulations of gushes in

[11] Supplementary material: `https://osf.io/5qxdb/`

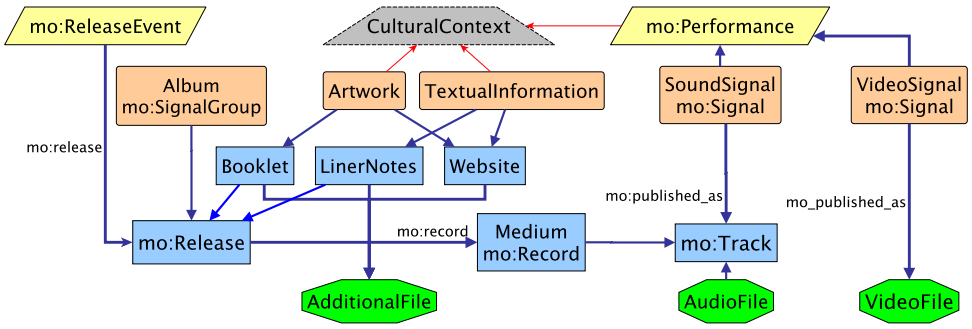

Figure 9. A world music collection: *TextualInformation* captures the cultural affiliations and the social context of the song/work performed as well as of the performance itself

Persian music (Figs. 6, 7) or the relationship between tunes in a folk music tune family (Fig. 3); they are less important in other cultures, like Russian village music. Cross-repertoire relationships, such as between tune families or Radifs, are of interest for comparative research. Such relationships will differ between cultures, yet there might be scope for generalisation within larger musical regions.

We also noticed that modelling musical instruments (Fig. 1 of supplement, Fig. 10) will represent a challenge, due to their variety and linguistic barriers. While a general instrument classification has long been established [37] and the Music Ontology refers to an instrument taxonomy [20], constructing a cross-cultural taxonomy of musical instruments is a long-term task. Alongside instruments, an addition of approximate dates (e.g. Figs. 1, 2 of supplement) as it was done in the Jazz Ontology [31] would be beneficial, since references to periods of the past and absence of exact dates are a common phenomenon in many traditional musics.

Caution must be exercised when using the FRBR/MO concept of *MusicalWork*. As Riley [35] noted, it is less well suited to describe traditional and folk music. It is often difficult to delineate works: are highly similar tunes one work or two? If a song has changed through oral transmission, or has been transformed through improvisation, is it still the same work? It is related to the problem of labelling works, when titles, lyrics and incipits vary between localities or through improvisation, such as instrumental tunes in our Russian example [26].

We conclude that the Music Ontology is a very useful standard to implement for the domains of musical cultures other than Western classical and popular music. However, its further generalisation seems to offer few advantages, since cultural contexts, musical characteristics, intra- and inter-repertoire relationships are mostly culture specific: small domain specific extensions would be more useful than trying to build one big generic ontology.

In future work we suggest to investigate CIDOC Concept Reference Model as a way to provide generalised categories for cultural context, to interface with the Music Ontology. One option would be to adjust the Music Ontology to implement FRBRoo, the object-oriented model harmonising FRBR and CIDOC-CRM. This might allow to blend the advantages of FRBR for modelling music creation and consumption with the modelling of cultural contexts to some extent, though the simplicity and transparency of the Music Ontology's current version would suffer. Similarly, the usefulness of Hornbostel-Sachs categories to generalise musical instruments should be explored critically through case studies.

This generalisation approach could be taken further in relation to cross-cultural comparative research. We suggest to concentrate on two or three loosely related repertoires from a broad cultural area, for instance a Persian Radif, a Turkish Makam and an Indian Raga. Modelling similar use cases for such repertoires would allow to evaluate generalisation opportunities and advantages (or the lack thereof) in cultural context, musical characteristics, relationships within and between repertoires and musical instruments.

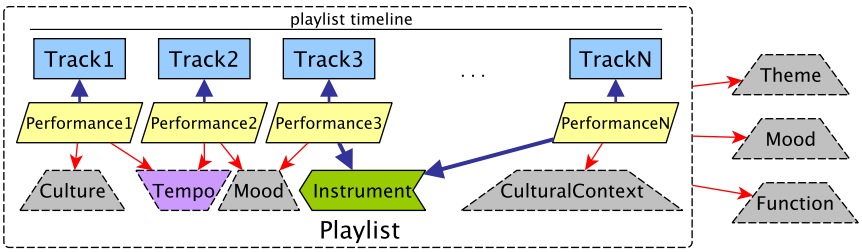

Figure 10. World music playlists are often compiled for variety, each track from a new culture, with different instrumentation and texture. Tempo and mood may be kept constant or raised gradually, depending on the aim of the playlist.

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