

# Audio Ontologies for Intangible Cultural Heritage

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**Abstract.** Cultural heritage portals often contain intangible objects digitized as audio files. This paper presents and discusses the adaptation of existing audio ontologies intended for non-cultural heritage applications. The resulting alignment of the German Digital Library-Europeana Data Model (DDB-EDM) with Music Ontology (MO) and Audio Commons Ontology (ACO) is presented.

**Keywords:** Ontology · Digital Library · Digital Humanities · Cultural Heritage · Audio.

## 1 Introduction

Cultural heritage defines the identity of a community through its history, traditions, practices, and ideals. It fosters continuity between generations and connection among the members of a community. The role it plays in “education, research, creation and recreation”<sup>4</sup> is crucial, such that its preservation is of utmost importance. Digitization of cultural heritage objects (CHOs) ensures its preservation – a far-reaching initiative spearheaded by the Europeana, of which the German Digital Library or *Deutsche Digitale Bibliothek*<sup>5</sup> is a part.

The extensive collections of the DDB include CHOs from different memory institutions or sectors, such as libraries, archives, museums, as well as multimedia libraries, research institutions, and institutions preserving historical sites and monuments. Challenges common to digital libraries also exist in the DDB. Retrieval and exploration are further hampered by the sheer volume<sup>6</sup> and the highly heterogeneous nature of its collection. Some of these challenges are addressed using semantic web technologies, such as development and adaptation of sector-specific ontologies. Initial work focused on the alignment of library objects (Tan et al, 2021a) from the DDB-EDM<sup>7</sup> to FaBiO (Peroni and Shotton, 2012), an extension of FRBR (IFLA Study Group On The Functional Requirements For Bibliographic Records, 1998). In FRBR, the conceptual structure of bibliographical

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<sup>4</sup> Europeana, <https://www.europeana.eu>

<sup>5</sup> Deutsche Digitale Bibliothek, <https://www.deutsche-digitale-bibliothek.de>

<sup>6</sup> 41M unique objects as of April 2022

<sup>7</sup> a DDB-specific extension of the Europeana Data Model (EDM)

information resources is represented using several entities and their relationships to facilitate efficient access and retrieval. Objects from archives and museums undergo a similar alignment process using suitable ontologies, details of which are beyond the scope of this paper.

DDB's vast collection includes objects that the UNESCO cultural heritage hierarchy (Ronchi, 2009, Chapter 5) classified as intangible. Examples of intangible objects include musical works, natural heritage, oral traditions, to name a few. These are often digitized as audio or video. Semantic web studies in the field of cultural heritage are often skewed towards tangible objects. To help filling this gap, this paper presents and discusses the alignment of DDB-EDM to several audio-specific ontologies intended for non-cultural heritage applications.

## 2 Audio Ontologies in the DDB

Audio content in the DDB can be found across several sectors: audio books from libraries, interviews of significant German personalities from research institutions, commercial jingles from archives, recordings of animal sounds from natural museums and music from gramophone records often found in multimedia libraries. To be able to represent the semantics of these diverse objects, the selection of target ontologies is based on the following considerations: interoperability, suitability to the domain, and the application profile.

With audio content, adapting a FRBR-aligned ontology facilitates interoperability. A song in FRBR is composed of 4 entities: 1) its intellectual or creative content (*frbr:Work*); 2) how the content was conveyed, whether sound or text, (*frbr:Expression*); 3) how the sound materialized, as e.g., CD or Vinyl (*frbr:Manifestation*); and 4) the instance one finds in the library (*frbr:Item*).

Consequently, an audio book is considered an expression of its respective literary works. The same holds true for any musical composition and its text; for instance, a recording of Carl Orff's Carmina Burana is considered an expression of the 13<sup>th</sup> century manuscript<sup>8</sup> containing a collection of poems it was based on.

Although, FaBiO, as a FRBR-aligned bibliographic ontology, provides subclasses relating to musical works (*fabio:Song*, *fabio:MusicalComposition*) and their expression (*fabio:AudioDocument*), these subclasses cannot represent the full range of audio content described above. To address this limitation, ontologies aimed at representing the audio domain are considered.

**Music Ontology (MO<sup>9</sup>)** (Raimond et al, 2007). This ontology aims to model the semantics of music production workflows and their editorial metadata. FRBR plays a central role in the definition of its classes. Parallels can be drawn between the super-classes of MO (*mo:MusicalWork*, *mo:MusicalExpression*, *mo:MusicalManifestation*, and *mo:MusicalItem*) and the 4 conceptual layers of FRBR. Since the original intention of the authors is to model the different workflows, events

<sup>8</sup> Carmina Burana manuscript, <https://bit.ly/ddb-carmina-burana>

<sup>9</sup> MO Specifications, <http://musicontology.com/specification/>

are central to this ontology. Entities that are usually found as attributes of a *frbr:Endeavor* sub-class require intermediate events to link them to that endeavor: the attribution of an *mo:MusicalArtist* (Agent) to its *mo:MusicalWork* requires an instance of the *mo:Composition* event, in contrast to the widely-adopted convention of linking agents directly to the *frbr:Work*.

**Audio Commons Ontology (ACO)**<sup>10</sup> (Ceriani and Fazekas, 2018). As mentioned, not all audio content in the DDB possess intellectual or artistic content. Examples of these are natural sounds and field recordings. An ontology that provides classes and properties to allow representations of non-musical audio content exists in ACO. Being an upper-level ontology for audio content, the authors’ initial intention is to provide interoperability across repositories on the Web. The FRBR-aligned classes of ACO are generalizations of MO classes. However, a *frbr:Work* sub-class specific to ACO was not defined, since it does not generalize to all types of sounds. Similarly to MO, events also play a central role in ACO.

**Event- vs Object-Centric Modeling.** Cultural heritage object descriptions often follow either an event-centric, an object-centric or a combination of both modeling approaches. Event-centric modeling puts a premium on completeness by representing significant events relating to a CHO, such as creation, production, revision, enhancement, etc. In contrast, object-centric modeling opts for accessibility by relating the object to pertinent information that describe its context, such as agent, time, and place.

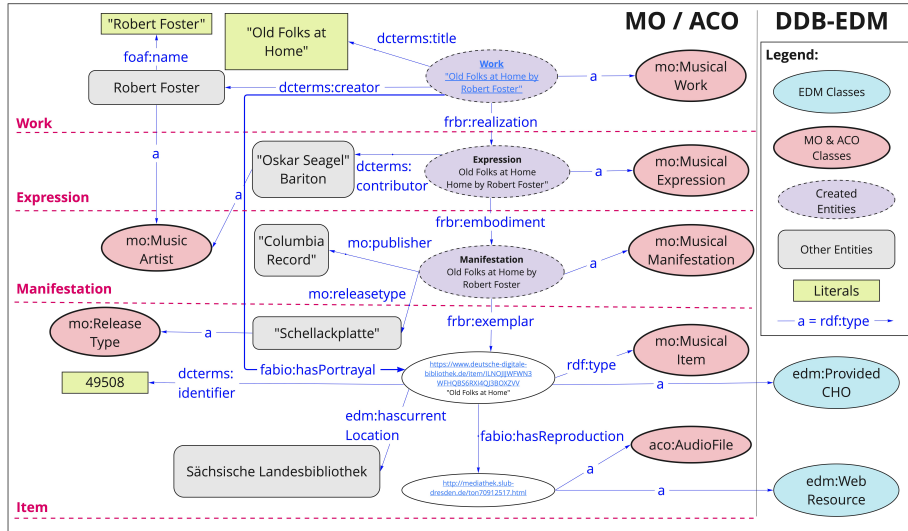
The primary application profile of the DDB is the publication of metadata that directly describes the CHOs. For instance, the description of a gramophone record includes the names of the composer, performer/s and publisher. However, details of the performance of this specific record which is crucial for modeling a music production workflow is not available.

For this reason, an object-centric approach is followed, by foregoing the usage of *event:Event* sub-classes, namely, *mo:Composition*, *mo:Performance*, and *mo:Recording*. Consequently, the generic property *dcterms:contributor* is used in lieu of *mo:performer*, since the latter strictly defines the domain to be of class *mo:Performance*, an event which is not utilized in the alignment.

**Alignment.** In Figure 1, a snapshot of the alignment for a gramophone record of Robert Foster’s “Old Folks at Home”<sup>11</sup> is shown. Similar to the work described by Tan et al., (2021) (Tan et al, 2021a), *edm:ProvidedCHO* is aligned to a specialization of *frbr:Item*. The original resource, an instance of *edm:WebResource*, is now an *aco:AudioFile*. The item and its reproduction are linked using the object property *fabio:hasReproduction*. Other FaBiO properties used to relate non-adjacent endeavors are also adapted, e.g. *fabio:hasPortrayal*, a relationship that exists between a Work and an Item. The main difference between audio

<sup>10</sup> ACO Specifications, <http://www.audiocommons.org/ac-ontology/aco>

<sup>11</sup> “Old Folks at Home” in the DDB, <https://bit.ly/3IJgJld>



**Fig. 1.** Alignment of “Old Folks at Home” from DDB-EDM to MO and ACO

content of a musical nature and some non-musical audio content is that only the instance of *mo:AudioManifestation* is created for the latter. For a detailed illustration and comparison, refer to this documentation page <sup>12</sup>.

### 3 Conclusion and Future Work

The diversity of CH objects in a portal such as the DDB requires domain-specific ontologies to represent their semantics. By putting emphasis on interoperability, efficiency of search and retrieval is not restricted by this form of specialization. Although MO and ACO were intended by the original authors for other applications, adopting an object-centric representation is shown to suit intangible CHOs for publication purposes. Hence, this work may serve as a reference for portals that utilize generic EDM classes. Using the proposed alignment, representative audio objects are made available in the DDB-KG (Tan et al, 2021b). Additionally, competency questions, sample SPARQL queries and dataset statistics are provided in the documentation page. The alignment activities will continue with the remaining CHOs: videos, research datasets, historical sites and monuments. Eventually, these changes will improve the organization, access and exploration of German Cultural Heritage.

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<sup>12</sup> DDB-KG Documentation Page, <https://ise-fizkarlsruhe.github.io/ddbkg/docs/alignment/audio/>

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