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Modelling a bibliographic ontology of imperial diplomas: updates from the OntoVE Knowledge Base

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1. Abstract

This paper presents updates on the OntoVE_WrittenRecords Semantic Web Ontology in the OWL language presented during the annual AIUCD Conference in 2023. The ontology was conceived within the OntoVE project, which aims to collect Germanic Cultural Heritage (CH) items related to Veneto; more specifically, the ontology presented in this contribution conceptualizes the description of imperial diplomas issued by rulers of Germanic origin and related to Veneto. The ontology reused initially FRBRoo and was updated to LRMoo; it furthermore merges the LRMoo ontology with Bibframe. Moreover, a User Interface for the visualization and exploration of the dataset has been implemented. The main contribution of the paper consists in the alignment between domain ontologies and in the conceptualization of a model that makes explicit the connections between the contents, the places and the actors involved in imperial diplomas.

Questo contributo presenta gli aggiornamenti relativi all'ontologia del Web Semantico in linguaggio OWL OntoVE_WrittenRecords presentata durante il convegno annuale AIUCD nel 2023. L'ontologia è stata concepita all'interno del progetto OntoVE, che mette a sistema elementi del patrimonio culturale germanico relativi al Veneto. Nel dettaglio, l'ontologia presentata in questo contributo modella la descrizione di diplomi imperiali promulgati da regnanti di origine germanica e relativi al Veneto. Inizialmente, l'ontologia riusava FRBRoo ed è stata aggiornata a LRMoo; inoltre, unisce l'ontologia LRMoo con Bibframe. Infine, è stata implementata un'interfaccia utente per la visualizzazione e l'esplorazione del dataset. Il contributo principale del saggio consiste nell'allineamento tra ontologie di dominio e nella concettualizzazione di un modello che rende esplicite le connessioni tra i contenuti, i luoghi e gli attori coinvolti nei diplomi imperiali.

Keywords: Bibliographic ontology – LRMoo – Bibframe -- imperial diplomas -- #AIUCD2023

2. Introduction

This paper describes the OntoVE_WrittenRecords Semantic Web Ontology in the OWL language, which models the metadata and the contents of imperial diplomas issued by rulers of

Germanic origin related to the Veneto region. The ontology was first presented in [12] during the AIUCD23 annual conference and has been updated since then. Aim of this paper is to present the modifications to the ontology and to discuss the relevance of the modelling for the OntoVE project and for the realm of bibliographic ontologies. The ontology in fact aligns LRMoo [7] and Bibframe [18] and could be potentially employed in other projects, since it maximizes reuse of established ontologies.

The OntoVE project, *Ontologies for the description of Germanic cultural heritage in Veneto within the perspective of the European Open Science Cloud (EOSC)*,[1] aims to describe cultural heritage items of Germanic origin left by the Germanic populations that transited through the Veneto region or had an impact on it. The individuals that populate the Knowledge Base are of diverse nature, ranging from archaeological to bibliographic items, and are described in different repositories online; two ontologies were developed to describe these items, both of which reuse Cultural Heritage (CH) and bibliographic ontologies.[2] The classes and properties declarations and named individuals described in the OntoVE Knowledge Base (KB) can be retrieved here: https://w3id.org/ontove/ontology. The architecture of the ontologies and the general aims and principles of the project are described in [12] and [13].

The ontology presented in this paper was conceived to describe imperial diplomas issued by rulers of Germanic origin and linked to the Veneto region, but I will argue that it can be applied to any bibliographic items. The diplomas are of specific interest within the OntoVE project, since they shed light on the political development of the region after the conquest of the Lombard reign in Italy by Charlemagne and up to charters issued by the emperors of the Carolingian and Holy Roman Empire. These bibliographic records can be moreover linked to archaeological items of the same origin retrieved in the region and described in the OntoVE Knowledge Base. The ontology OntoVE_WrittenRecords reuses the LRMoo v. 0.9.6 ontology [7] and aligns it to relevant classes of Bibframe [18]; furthermore, also classes and properties from the BIBO ontology [10] are reused.[3] In the initial stage of modelling, the ontology reused FRBRoo [6]; in light of then ongoing developments of the LRMoo model, the ontology presented in 2023 was updated to the now released LRMoo model. This constitutes an advantage for the modelling of the metadata of the items populating the OntoVE Knowledge Base, since the ontology for the description of archaeological items reuses CIDOC-CRM v. 7.1.2 [5], to which the LRMoo model v. 0.9.6 is already aligned; moreover, the ontology reflects recent developments in the standards used by the international DH community. The paper furthermore

[1] A reviewer wonders what "within the perspective of the European Open Science Cloud (EOSC)" means. This addition belongs to the official denomination of the project, which strives to align to practices and models adopted in the wider European context of Open Data.

[2] The OntoVE_WrittenRecords and the OntoVE_Archeo ontologies are archived respectively here: https://github.com/ChiDeBa/ontove_writtenrecords and https://github.com/ChiDeBa/ontove_archeo. The two ontologies were conceived separately: the ontology described here refers to bibliographic items, while the OntoVE_Archeo ontology was conceived to describe archaeological artefacts. Both ontologies can be used separately, they were however merged in the OntoVE Ontology Specification.

[3] The BIBO ontology was reused to model bibliographic information tied to the references to the works or the historical artefacts belonging to the OntoVE KB. BIBO classes are modelled as subclass of the context-description:Bibliography class from the ArCo [8] ontologies, which conceptualizes the bibliographic references referring to an historical artefact. BIBO classes and properties will only be discussed when relevant for the OntoVE_WrittenRecords module.

discusses a User Interface (UI) that provides access to the data and provides visualization outputs that reflect the modelling of the ontology and the competency questions we aim to address.

This paper is structured as follows: Section 3 discusses the imperial diplomas at the center of the modelling and databases containing them; Section 4 discusses the state of the art relative to bibliographic ontologies employed in projects similar to OntoVE. Section 5 discusses the competency questions related to the OntoVE_WrittenRecords module and the methodology adopted in its conceptualization. Section 6 gives an outlook on the visualization outputs for the bibliographic items described in the OntoVE KB, Section 7 concludes the paper.

3. Imperial diplomas and databases hosting them

Within the context of the OntoVE project, diplomas and charters issued by rulers of Germanic origin and related to the territory of Veneto are of special prominence. The OntoVE dataset brings together CH items of Germanic origin that are already digitized in different repositories and whose metadata are openly accessible, in order to adhere to the FAIR (Findable, Accessible, Interoperable, Reusable, [25]) principles and provide a dataset that is open to anyone interested in exploring it. These materials are of diverse nature and are catalogued with different metadata standards. Following the history of Veneto, and generally the Germanic migrations to the Italian peninsula, we first witness the Gothic and Lombard occupation of Italy, and then the conquest of the Lombard reign by Charlemagne (cf. for example [15]). Since the OntoVE project aims to collect the items left by these populations in the Veneto region that are already described in online repositories, the first phase of the project consisted in the collection of data through the querying of online catalogues and databases. Whereas for the Gothic and Lombard populations we collected mostly archaeological artefacts,[4] from the conquest of the Lombard reign by Charlemagne, also diplomas can be found. It is from these documents that we started modelling our bibliographic ontology. Imperial diplomas offer in fact precious insights into the relationship between rulers of Germanic origin and the Veneto territories subjected to them. Starting from the time when Charlemagne was reorganizing the Italian reign after conquering it from the Lombards, diplomas witness the different administrative acts that help scholars gain insights into the relationship between the rulers of the Holy Roman Empire and the overthrown Lombard rulers and their successors in Veneto.

Regarding imperial diplomas, we started our research from the collection provided by the *Digital Monumenta Germaniae Historica* (dMGH, https://www.dmgh.de/). This consists in the digitization of the volumes edited in the course of the 19th and 20th centuries and curated by the homonymous research institution. The research started from these editions, since each diploma is accompanied by introductory information relevant for the OntoVE project. In fact, the (d)MGH volumes provide a short description of each diploma, which briefly summarises its contents, contains references to the copies of the diplomas and the institutions hosting them, references to other works citing the diplomas and references to interpolations of alleged falsifications of the diplomas or parts of them. Then, the place and date of issuance are given,

[4] This does not mean that there are no documents containing Lombard or Gothic texts at all; within the context of our project, which aims to collect items that are already digitized in some form and related to Veneto, we did not find any documents meeting these requirements for the Gothic and Lombard periods.

followed by the transcription of the documents.[5] These pieces of information are essential for our project design; in fact, we not only aim to highlight the relationship between rulers of Germanic origin and the Veneto region, but we also want our dataset to record pieces of information about these works that are the product of scholarly assessment, in order to present the users with complete information about the diplomas. The (d)MGH volumes are therefore our prime source of information, and we decided to prioritise the modelling of the instances of the bibliographic module from here.

The availability of the volumes in digitised form constitutes an advantage for the open circulation of the documents, but there are some limits. One can in fact browse the dMGH and search for text-strings. This way, we could locate the documents related to cities and territories of Veneto. However, the results obtained needed manual filtering out of the documents. The MGH institution is moreover working to offer an XML/TEI encoding of the documents edited by the institution, which are not limited to the imperial diplomas. The encoded files, collected under the *openMGH* section (https://www.mgh.de/en/digital-mgh/openmgh) represent a further step for a wider dissemination and accessibility of the documents; however, at the time of writing, the charters of interest to us do not seem to have been encoded already, since the encoding process is still ongoing. Furthermore, some texts of the MGH series will also be available through external corpora, such as the *Latin Text Archive* (https://lta.bbaw.de/) and the *Corpus Corporum* (https://mlat.uzh.ch/browser?path=/index.php). At the moment, the texts of the diploma series are not present, but their addition to the corpora would also allow us to enrich our KB with further open data.

There are other projects and initiatives that collect digital facsimiles of the diplomas relevant for the OntoVE project. For example, the *Cartae Europae Medii Aevi* project (https://cema.lamop.fr/) or the *Abbildungsverzeichnis der europäischen Kaiser- und Königsurkunden* (http://www.hgw-online.net/abbildungsverzeichnis/) provide further metadata about the diplomas. The latter project collects diplomas produced by Frankish rulers starting from the Early Middle Ages to 1265 circa and provides links to the digital facsimiles, when present, and links to the relevant diplomas in the dMGH series. Similarly to the dMGH project, this project also presents information about falsifications or interpolations. The *Corpus der altdeutschen Originalurkunden bis zum Jahr 1300* (https://tcdh01.uni-trier.de/cgi-bin/iCorpus/CorpusIndex.tcl) also offers diplomatic digital editions of the documents, starting from the year 1200. Finally, information about the diplomas relevant for the history of Veneto can be found by browsing the SIUSA (*Sistema informativo unificato per le Soprintendenze Archivistiche*) of the Veneto region, under the path *Ecclesiae Venetae*. The following link provides information about one of the charters collected in the OntoVE project in the SIUSA portal: https://siusa-archivi.cultura.gov.it/cgi-bin/siusa/pagina.pl?TipoPag=unita&Chiave=348406&RicDimF=2&RicProgetto=evtv. As can be noticed, a few bibliographic indications are present, and a summary for the text is given, but the text cannot be consulted in its entirety.

The resources cited above all provide different digitization practices and search protocols. In some cases, the data are still under collection, in other cases, such as the *Virtuelles deutsches Urkundennetzwerk* (www.vdu.uni-koeln.de), the projects are closed and the data are not open anymore. For the SIUSA of Veneto, the sections relevant to certain dioceses allow to consult

[5] An example of an edition of a diploma can be consulted here: https://www.dmgh.de/mgh_dd_karol_i/index.htm#page/402/mode/1up

and find information about documents, but there are no clear indications on how to find them and not all dioceses present the same amount of information.

From this brief overview, it is clear that the objects of our research are processed in different ways, through different repositories that follow different protocols. Moreover, searching for the relevant information is not always possible, as some resources are still under construction, or no clear documentation about the metadata and the digitization or encoding of the texts is given. As the authors of the IRNERIO [4] or STOLE [1] projects argue, Semantic Web technologies can overcome these limits by providing formalized descriptions of the dataset chosen, and by making the data searchable through dedicated SPARQL endpoints or through dedicated user interfaces. The present contribution therefore presents our methodology to design an ontology of such documents, describe the documents according to the established module and present the documents to the users in an appropriate way. This will add further value to the resources, since the connections between the documents are explicitly modelled and thus searchable.

4. State of the Art

As has become evident in Section 3, there has been no attempts to uniform and standardize metadata about diplomas of Germanic rulers and the territories these diplomas had an impact on. Digitizations and metadata about the diplomas are present in different repositories online, but the standards and search protocols used are heterogeneous. The OntoVE project aggregates these documents, together with other kinds of artefacts, and describes them through shared metadata standards. While the dataset described is unique to the OntoVE project, the methodologies and standards employed are shared by the scholarly community. In this paragraph, I will discuss different projects that apply Semantic Web technologies for the description of specific sets of documents, since they share similar goals with the OntoVE project, and constitute a starting point for the methodological reflections presented in Section 5.

The IMAGO project aims to produce a KB of Medieval and Renaissance geographic works [2], [3]. Based on the observation that the documents object of the KB have not been studied using digital methods, the authors of the KB present their methodology to apply Semantic Web Standards on their dataset. The ontology produced for the project maximizes reuse of established ontologies, in fact, CIDOC-CRM and FRBRoo were reused, and only a few classes were added when these had to describe concepts that did not correspond to the concepts present in the reused ontologies. These methodological choices allow the IMAGO data to be interoperable with similar projects and to integrate information from other KBs, in light of the Linked Open Data (LOD) principles. The choice of reusing CIDOC-CRM and FRBRoo is moreover tied to the descriptive power of these models, which have been widely used in different fields. FRBRoo was conceived as an extension of the CIDOC-CRM and should moreover act as an "interlingua to bridge the divide between the heterogeneous metadata formats of libraries and museums to achieve ontology-based metadata integration of various art collections" ([9]: 625).

The authors of the IRNERIO project argue instead for a different approach, basing their methodology on the observation that CIDOC-CRM provides primitives that have high-level semantics and are difficult to implement concretely ([4]:122). Similarly to the IMAGO project, also the IRNERIO project aims to describe several pieces of information contained in and about medieval manuscripts, for example glosses or commentaries. They decide to reuse two ontologies that are based on FRBR, namely FaBiO and CiTO [20]; these ontologies expand the FRBR ontology with subclasses that represent members of the four layers of the Work

Expression Manifestation and Item (WEMI) scheme of FRBR (cf. also Section 5), thus easing the descriptive burden for the user ([4]: 128).

The STOLE ontology developed by [1] is based on the reuse several ontologies; the KB has as its center journal articles published between the end of the 19th century and the beginning of the 20th century in Italy. The authors observe that historical documents are usually interconnected with each other, and that different websites allows browsing their digitized versions, but the connections between the documents and their contents is usually lost and better tackled by describing these data through ontologies. The STOLE ontology reuses standard vocabularies and thesauri, such as Dublin Core (https://www.dublincore.org/), FOAF (https://www.dublincore.org/collaborations/foaf/) and the Bibliographic Ontology (https://writeanessayfor.me/bibliontology-com) in order to capture the features relevant for the construction of their KB.

Some of the projects mentioned in this section make use of a set of bibliographic ontologies known as the SPAR suite [21]. The SPAR ontologies were designed to describe different aspects of the publishing domain; each of the ontologies focuses on a specific domain within the realm of publishing. The FaBiO ontology, for example, describes entities that are "published or potentially publishable" [21] and is aligned to FRBR (cf. Section 5), but expands it by providing more granular classes in order to adequately describe different types of publications, for example books and journals, but also datasets and algorithms. It moreover imports and reuses different entities from established standards in bibliographic descriptions. The SPAR ontology suite provides moreover modules that allow capturing citations, e.g. CiTO and C4O, and bibliographic references (BiRO); these ontologies conceptualize the different kinds of scholarly practices that involve citing or referencing other scholarly works in different ways.

These ontologies provide a model that is reusable and interoperable, since several standards and Ontology Design Patterns were reused. Moreover, they expand these standards with a fine-grained conceptualization of the realm of published works. However, while the SPAR ontologies provide a comprehensive description of the publishing domain, they were not reused in the OntoVE KB for two reasons; the first relies on the domain of the ontologies, which is comprehensive enough to describe different published or publishable documents and the references to them. However, the focus of the FaBiO ontology for example seems to be tied primarily to modern texts, while OntoVE collects historical texts.[6] The second reason lies in the recent update from the FRBRoo to the LRMoo model. Since the SPAR ontologies are aligned to FRBR, and the OntoVE_WrittenRecords module was updated to LRMoo (cf. Section 5.1), a possible alignment between the OntoVE_WrittenRecords ontology and the ontologies in the SPAR suite deserves careful consideration.

The approach undertaken in the OntoVE KB consists in maximizing the reuse of established ontologies in order to make our KB interoperable with similar initiatives and avoid "reinventing the wheel" [24]. Archaeological artefacts collected in the KB are described with the CIDOC-CRM and ArCo [8] ontologies; as mentioned above, CIDOC-CRM is a standard widely used in different fields, and is moreover constantly maintained and reviewed by the Special Interest Group (SIG). As [4] contends, however, the concepts it defines present a high level of abstraction and are in need of finer grained classes and properties, which the OntoVE project supplemented from ArCo for the description of archaeological items. Similarly, for the description of bibliographic items we decided to reuse an extension of the CIDOC-CRM. We

[6] Cf. for example the definition for the fabio:manuscript class: https://sparontologies.github.io/fabio/current/fabio.html#d4e4043

aligned LRMoo with a finer-grained vocabulary, Bibframe, which translates the MARC 21 standard into a Linked Data model [26]. On the basis of the research by [27], the alignment between these two models requires careful reflections but is possible provided that the semantics of the models are preserved. The reused ontologies, their alignment and the description of a resource of the OntoVE_WrittenRecords ontology are given in Section 5.

5. The OntoVE_WrittenRecords module

5.1 Modelling choices

The OntoVE_WrittenRecords ontology aims to shed light on the acts promulgated by rulers of Germanic origin and the territories of Veneto affected by them. The competency questions at the basis of the modelling of the present ontology are the following: *In which area are cultural heritage objects pertaining to the cultural scope x mostly found? Which written sources can be found for the chronologic period A-B? In which period or in which area is written production mostly found? Which events are linked to the documents? Which areas are mentioned in the documents? Which rulers or actors are mentioned in the documents?*

These competency questions were formulated in the first conception of the project, by the actors involved directly in it.[7] They were utilized in order to define the conceptualization of the OntoVE_WrittenRecords ontology and in the first rounds of testing of the ontology. Our goal is to highlight how Germanic populations impacted over the history of the Veneto region, by investigating which areas were mostly affected by political decisions, and which acts were promulgated by which rulers. The competency questions illustrated here only refer to the OntoVE_WrittenRecords module. For the modelling of the conceptualization of archaeological artefacts, other competency questions were formulated.

As illustrated in Sections 3 and 4, digital data and metadata are often siloed, and the connections between the documents is not always automatically retrievable. As a further requirement for our modelling, we decided to model the connections between the documents, the territories and the people mentioned, and the different acts promulgated. The conceptualization proposed is tied moreover to visualization outputs targeted at different kinds of audience, as will be explained in Section 6.

In the initial conception of the project, we decided to reuse first FRBRoo, and then update to LRMoo, because these are extensions of the CIDOC-CRM model. We furthermore decided to integrate the general and abstract classes and properties provided by the CIDOC-CRM model and its compatible extensions with classes and properties of finer-grained ontologies. We decided for this reason to align classes and properties of the FRBRoo and then LRMoo model with classes and properties of Bibframe. The alignment was performed manually and actuated with the Protégé Editor [19]. Since Bibframe classes foresee their own properties and these are stable, we decided to align them directly as subclasses or equivalent classes of the LRMoo model. The same strategy was adopted within the project for the archaeological module; therefore, we did

[7] In the future, they could be further expanded by consulting domain experts, in order to refine the model.

not only reuse the established taxonomies, but we merged the models to maximize their descriptive power.[8]

Since initially we decided to reuse the FRBRoo model, a few remarks about its structure will be provided, since the basic conceptualization of a work is maintained also in the updated LRMoo model. The FRBRoo model, and the FRBR family of conceptual models in general, adopts the Work, Expression, Manifestation, Item (WEMI) scheme, which is relevant to describe an intellectual work and its different embodiments. Similarly to the conceptualization of text proposed by [23], in fact, the abstract idea contained in a *Work* is embodied in different *Expressions* (e.g. translations or critical editions), and is represented through different textual *Manifestations*, reflecting e.g. the *mise en page* of a specific expression. Finally, the actual copy of a Manifestation (*Item*) can be identified through e.g. the shelfmark number of an institution hosting it. In our modelling, we wanted to keep this quadripartite conceptualization of a creative work, as it allows to model pieces of information related to a work on different levels of the conceptualization. At the same time, the FRBRoo and LRMoo models do not foresee specific classes that further specify the type of work or the type of manifestation.[9] A more refined conceptualization of types of documents is represented by the Bibframe model. For example, the class *Instance*, which reflects material embodiments of a text, has the following subclasses: *Print, Archival, Tactile, Electronic, Microform*. Moreover, the Bibframe model also allows conceptualizing information about the content of a work or its publishing at different levels of modelling. These pieces of information are not modelled explicitly in FRBRoo or LRMoo. However, the Bibframe model foresees three levels of abstraction, instead of the four provided by the WEMI model. These are *Work*, *Instance* and *Item*. A careful examination of the conceptualization provided by the two models to be reused was necessary in order to align the two models and not modify the intension of the relevant classes.

Before illustrating how the OntoVE_WrittenRecords module merges the LRMoo and Bibframe models, a few words about the shift from the FRBRoo and the LRMoo model are in order here. As mentioned in the Introduction, we first conceived our model via reuse of FRBRoo and aligned it with the relevant Bibframe classes and properties, as illustrated in [12]. When LRMoo was published, we decided to reuse the new version of the model and performed the alignment with Bibframe anew; this step might have not been necessary, since there are still FRBR(oo) aligned ontologies in use, like FaBiO or CiTO [20], [21]. However, the update from FRBRoo to LRMoo has modelling advantages. Since LRMoo is conceived as an extension of CIDOC-CRM, it cannot be implemented without reusing CIDOC-CRM classes and properties; this means that FRBRoo specific classes that are semantically equivalent to CIDOC-CRM classes, such as F8_Event, were deprecated. This constitutes an advantage for our modelling, since the OntoVE_Archeo ontology already reuses CIDOC-CRM, v. 7.1.2, and this version is compatible with LRMoo v. 0.9.6, presently adopted in OntoVE_WrittenRecords. This also meant however that the concepts we modelled with deprecated FRBRoo classes had to be remodeled reusing CIDOC-CRM classes and properties, but these classes and properties were already adopted in the project, thus making the two ontologies devised within OntoVE intraoperable without

[8] CIDOC-CRM foresees essentially two ways of extending it: (i) by using the E55_Type class as an interface for thesauri or other ontologies, or (ii) by expanding its classes with subclasses, provided these are stable and foresee their own properties [5]. Cf. the MPEG-7 ontology for an example of the second strategy [16].

[9] Similarly to the CIDOC-CRM model, these pieces of information could be represented through instances of the E55_Type class. Given the reasons illustrated above, we decided to merge the LRMoo and Bibframe models instead.

additional alignment steps. Moreover, the LRMoo model reflects changes due to the experience of the CIDOC-CRM SIG in the actual implementation of some concepts, i.e. the F4_Manifestation_Singleton class, which is deprecated in the LRMoo model. Given that the changes undertaken by the SIG constitute improvements of the model, the choice to remodel our ontology was inevitable.[10]

Given the reasons illustrated above, in the remainder of the paper the discussion revolves around the merging of the LRMoo and Bibframe ontologies, which concerns the layers reflecting the conceptualization of a *Work* and their related properties. Returning to the conceptualization of a *Work*, it is apparent that the Bibframe model needs to be carefully examined in order to align it with the LRMoo model. The *Instance* and *Item* classes correspond respectively to the material embodiment of a *Work* and to an actual copy of an *Instance*. These were declared as equal to the classes lrmoo:F3_Manifestation and lrmoo:F5_Item respectively, as their association is straightforward, as noted moreover by [27]. However, the *Work* level in the Bibframe model "reflects the conceptual essence of the cataloged resource: authors, languages, and what it is about (subjects)" (https://www.loc.gov/bibframe/docs/bibframe2-model.html). In the previous conceptualization of the ontology, we equated the frbroo:F1_Work class with the bf:Work class;[11] however, [27] notice that the bf:Work class actually represents both a work in its abstract idea and its expression. In fact, the language in which a work is redacted is reflected in the modelling of the bf:Work level; the same content can be however expressed through different linguistic codes, and this would be reflected in the lrmoo:F2_Expression layer within the WEMI model. Moreover, the subclasses of the bf:Work level also conceptualize different forms in which a content may be carried, which are more adequately described as instances of lrmoo:F2_Expressions in the WEMI model. For these reasons, we stated in our modelling that the bf:Work class is equivalent to lrmoo:F1_Work OR lrmoo:F2_Expression; this way, we state that the bf:Work class is the union of the lrmoo:F1_Work and lrmoo:F2_Expression classes. The modelling was tested through the Hermit reasoner plugin in Protégé (http://www.hermit-reasoner.com/) and no undesired inferences were produced.

The bf:Work level allows however to state which content is subject of a *Work* through the property bf:Subject. A subject of a work could correspond to places, actors or events; this is relevant for our modelling, since we aim to make the relationship between rulers of Germanic origin and the territories of Veneto searchable. To this aim, the property bf:Subject and its inverse bf:SubjectOf were adopted and attached to the topmost layer of the conceptualization, since these represent the abstract contents of a work, independently of the language or carrier.

5.2 The description of one diploma

In the following, a modelling of one diploma is presented through the ontology specification published at https://w3id.org/ontove/ontology, which also contains the named individuals described in the KB. The KB was populated by external linking of the relevant individuals, and their description is done manually in Protégé Editor [19]. This is due to the fact that the dMGH

[10] We thank an anonymous reviewer of the conference paper presented in 2023 for pointing this out. As mentioned in [12], the LRMoo model was not already stable at that time. As the stable release was published shortly afterwards, we started to remodel our module reflecting the most recent changes.

[11] In the remainder of the paper, I will use the following prefixes to express classes and properties in the ontologies discussed: *lrmoo*, *bf*, *bibo*, *context-description, ontove* and *cidoc-crm* for LRMoo, Bibframe, BIBO, the Context-Description module of the ArCo ontologies, OntoVE and CIDOC-CRM respectively.

resource does not provide an exact set of metadata that could be extracted and automatically mapped to our ontology.[12]

Figure 1 - The description of one diploma, Work layer

In Figure 1, we see the main properties attributed to an individual of the bf:Work class. The person responsible for the promulgation of the diploma is modelled with the BIBO class bibo:issuer. Then, the language of the diploma is declared, together with its originPlace and originDate. The bf:originPlace property is linked to an instance of the cidoc-crm:E53_Place class. Instances of this class are defined through the property cidoc-crm:P168_place_is_defined_by and the property ontove:externalLink, which respectively provide their geographical coordinates and a link to an authority record with a unique identifier for the place:

Figure 2 - The description of an E53_Place individual

The content of a diploma is modelled through the bf:Subject property, which refers to places, events or agents. An example of an event is given in Figure 3:

[12] Cf. for example the possible functions performed via the dMGH API and REST interface: https://www.mgh.de/en/digital-mgh/dmgh/api-and-rest-interface.

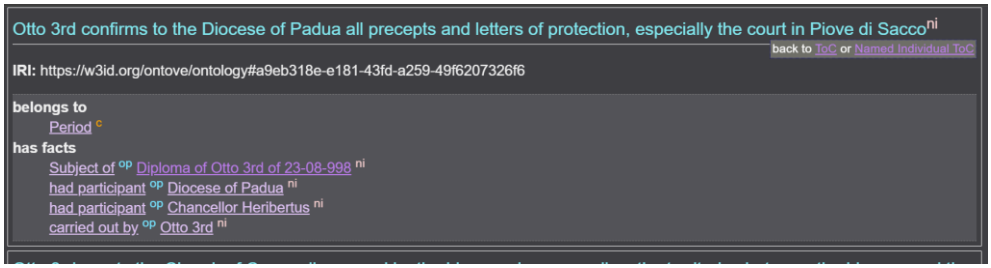

Figure 3 - The description of an E4_Period individual

In the former version of the ontology, the events were modelled through the frbroo: F8_Event class; this class has been deprecated in the shift from FRBRoo to LRMoo. The LRMoo specification suggests to use the class cidoc-crm:E4_Period instead, as can be seen in Figure 3. Each event related to a diploma is modelled in this way, and the agents and participants are defined through the properties cidoc-crm:P14_carried_out_by and cidoc-crm:P11_had_participant. Each agent is defined through an ontove:externalLink pointing to an authority record, such as VIAF, or Wikidata (Figure 4):

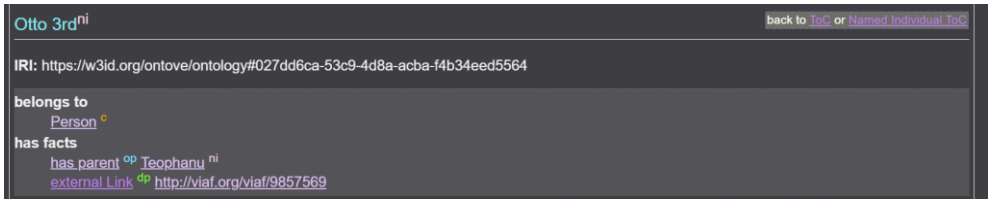

Figure 4 - The description of an E21_Person individual

The Work layer is then further defined by linking it to its relevant Expression and Instance. By exploiting both the LRM and Bibframe schemas, a Work is related to its Expression via the property lrmoo:R3i_is_realised_in and to its Instance (which in our ontology is aligned to lrmoo:F3_Manifestation) through the property bf:has_Instance. This direct association between a Work and one of its Manifestations is only possible thanks to the alignment between the LRMoo and Bibframe schemas.[13]

In Figure 5 a Work is related to one of its Expressions :

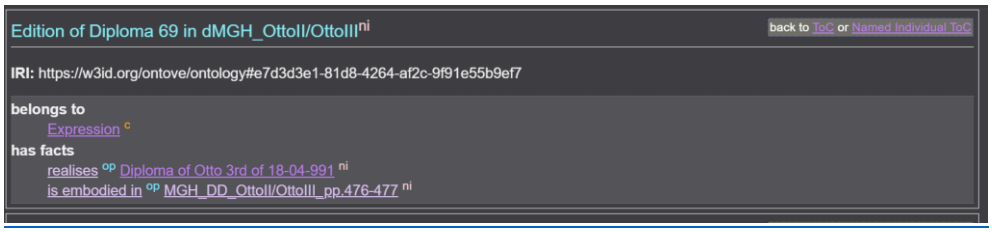

Figure 5 - Description of the Expression layer

[13] As a reviewer justly notices, this strategy is also adopted in the FaBiO ontology, through the property Fabio:hasManifestation.

The lrmoo:F2_Expression class is then related to its lrmoo:F3_Manifestation individual via the property lrmoo:R4i_is_embodied_in. Thanks to the WEMI scheme, therefore, more than one expression for the same work and the relevant manifestation can be conceptualized in this layer. At the moment, our KB only collects the diplomas as presented in the Digital Monumenta Germaniae Historica editions, as illustrated in Section 3, but in the future further expressions and manifestations for the same diplomas can be conceptualized here.

The lrmoo:F3_Manifestation layer is equated to the bf:Instance class, which is a superclass for finer-grained classes that allow to state the type of instance; in our case, Electronic (Figure 6):

Figure 6 - Description of the Manifestation/Instance layer

Since we are conceptualizing the diplomas as the versions of the work published by the dMGH, our Instance classes would correspond to the relevant interval of pages in a specific volume presenting the diplomas of a given ruler. The pages interval for the volume containing the diplomas of Otto 2nd and Otto 3rd are presented in Figure 6; as can be noticed, this level also provides the information about the volume the page interval belongs to, through the property bf:partOf.[14] It is moreover at this level that information about other items conveying the same text or events noted in the introductory section accompanying every diploma are conceptualized. Figure 7 shows how the OntoVE property citesEvent is used to conceptualize scholarly information about the dating of the diploma:

[14] The bf:hasPart property is used to link resources that are logically or physically contained within another resource. It can be used with all the three Work, Instance and Item layers. The LRMoo scheme has conceptually similar properties, which however are specified at the Work, Expression and Manifestation levels; for example, the lrmoo:R71_has_part property links an instance of Manifestation with a structural part which is itself another instance of Manifestation forming part of a Manifestation instance containing both. Since the domain and range of the bf:hasPart property is wider, it was not equated or aligned with other lrmoo properties which have a narrower scope. However, the strategy of assigning different Instances to an Instance containing them is compliant with the LRM scheme. The decision of creating an Instance of the edition of the diplomas is due to the fact that the population of the OntoVE KB started from the volumes of the dMGH, which present the diplomas in a specific order. I thank a reviewer for noticing that the relevant dMGH edition did not have a corresponding Work and Expression layer. Correction of this and similar shortcomings is undergoing and will be featured in a successive release of the Ontology Specification.

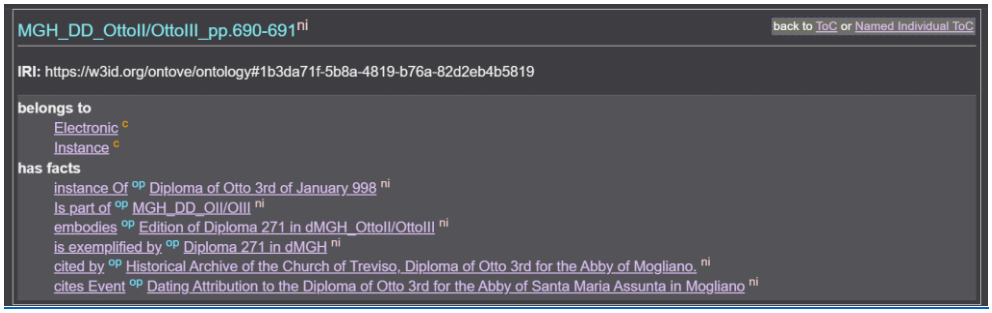

Figure 7 - An Instance citing a specific Event

The Dating Attribution event is modelled as a cidoc-crm:E13_Attribute_Assignment instance. One could argue that these pieces of information must have formed part of the Expression level already; however, since we can see how they are actually presented at the Manifestation level, we decided to record these pieces of information here. This level is moreover directly linked to the bf:Work layer for each diploma through the inverse property bf:instanceOf. This property links a work with one or more of its manifestations in the Bibframe schema. As also mentioned above, we are therefore employing both the WEMI scheme, linking a Work to its Expression(s) and the relevant Manifestation(s) and the Bibframe scheme, linking the Work layer with its Instance(s). This second passage might not be necessary, as each Expression is linked to the relevant bf:Instance in our conceptualization, and the class is equated to lrmoo:F3_Manifestation. This decision is actually due to pragmatic reasons, since it allows writing a shorter path in the relevant SPARQL query at the basis of the visualization interface (cf. Section 6) and as argued above, this conceptualization is only possible thanks to the alignment between the LRMoo and Bibframe schemas.

Finally, a bf:Instance/lrmoo:F3_Manifestation individual is then related to its Item via the property lrmoo:R7_exemplifies (Figure 8):

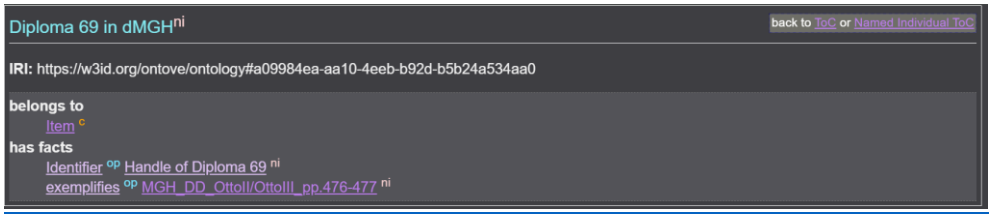

Figure 8 - The Item layer

The lrmoo:R7_exemplifies property is moreover equated to the bf:ItemOf property. In our KB, the relevant item label carries the diploma number in the dMGH and is further identified by a bf:Handle individual defined by the bibo:handle data property (Figure 9):

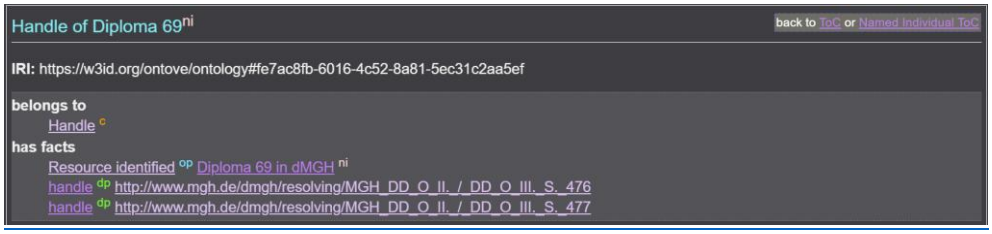

Figure 9 - The handle for a diploma

Finally, a context-description: CulturalScopeAttribution instance is attributed to each diploma,[15] thus making the information about the diplomas comparable to the historical artefacts retrieved in Veneto and belonging to the same cultural scope (Figure 10):

Figure 10 - Cultural Scope Attribution to the diplomas

The modelling choices allow answering the competency questions presented above[16] and make explicit the relationships between rulers of Germanic origins and the territories of Veneto subjected to them. The conceptualization of actors, events and places as subjects of a diploma helps answering competency questions introduced in 5.1 seeking to determine which events, actors or places are mentioned in a diploma. Furthermore, one can discover which rulers promulgated which acts thanks to the conceptualization of the carriers and participants in a given event, linked to the diploma of which it is subject thanks to the bf:SubjectOf property. The assignment of a Cultural Scope to diplomas can help retrieve the archeological items and the written works belonging to the same cultural scope relevant to the Veneto region. Finally, even though the modelling started from the conceptualization of the diplomas, this module can be used to model information about any kinds of bibliographic items.

[15] This class is reused from the ArCo ontologies network [8] and employed to describe the cultural scope attribution to the items collected in the OntoVE KB.

[16] Given that the bf:originDate property is defined as a Data Property in the Bibframe scheme requiring a literal as value, the relevant strategies to formulate a SPARQL query to isolate specific dates need to be applied.

6. Visualization

The OntoVE project aims to make the dataset open to both an academic and a non-academic audience; to this end, it will provide a SPARQL Endpoint[17] and it provides a user interface, based on the Sampo Model [17], [22]. The UI reuses the model developed by the Semantic Computing Research Group (SeCo), which has been building semantic portals on top of different RDF triplestores; the model developed by the SeCo group has been tested therefore on several portals and the code is being maintained. The model is highly customizable and is domain-agnostic. For these reasons, we decided to employ it for the OntoVE dataset.

The dataset is presented through seven so called "search perspectives", i.e. aggregation of specific classes in the KB and selected properties that can be filtered by the users. The search perspectives are based each on a SPARQL query, whereas the selection of the properties that can be filtered by the users are configured in a .json file for each perspective. The interface is in English and Italian. The interface can be accessed here: https://ontove-ui.chitontove.it/en, and the code is published in [11]. The advantage of this UI is that it allows users not necessarily conversant with SPARQL to explore the dataset; instructions on how to use the UI and the different filters are provided, making the UI user-friendly and potentially open to a non-expert audience.

The relevant perspectives for the texts collected in OntoVE are "Texts" (https://ontove-ui.chitontove.it/en/Texts/faceted-search/table?page=0), "Events" (https://ontove-ui.chitontove.it/en/Events/faceted-search/table?page=0), "Places" (https://ontove-ui.chitontove.it/en/Places/faceted-search/table?page=0) and "Cultural Scope"(https://ontove-ui.chitontove.it/en/CulturalScope/faceted-search/table?page=0). They gather information on the texts, namely who issued or produced the text, the contents of the texts and the edition(s) (i.e. the Instances for a text, as mentioned in Section 5.2), or about the events or the places mentioned in the texts. Finally, the Cultural Scope perspective allows to inspect all the Cultural Scope attributions in the KB, included the attributions of Cultural Scope to the texts and the relevant criteria.[18] For each search perspective, a selection of filters the users can employ is presented. At the moment, only a table view is provided; however, since each geographic location is defined through its geographical coordinates, as mentioned in Section 5.2, we aim to implement the perspectives with maps detailing which parts of Veneto are most cited in the documents, or where the documents were mostly produced. The OntoVE-Sampo-UI offers a first insight into the relevant data, which could be of interest to scholars not necessarily willing to use SPARQL, but also to students or citizens and tourists interested in the history of the area. Figure 11 presents the Events perspective, where users can filter the agent responsible for the events related to the documents and the participants:

[17] At the time of writing, the OntoVE SPARQL Endpoint can be found at the following URI: https://ontove-endpoint.chitontove.it/. However, the Endpoint has not been opened to all users, for web security reasons independent of our will. We are however planning to provide an open SPARQL Endpoint.

[18] The UI has been released at the beginning of 2025, but the refinement of the perspectives is still ongoing.

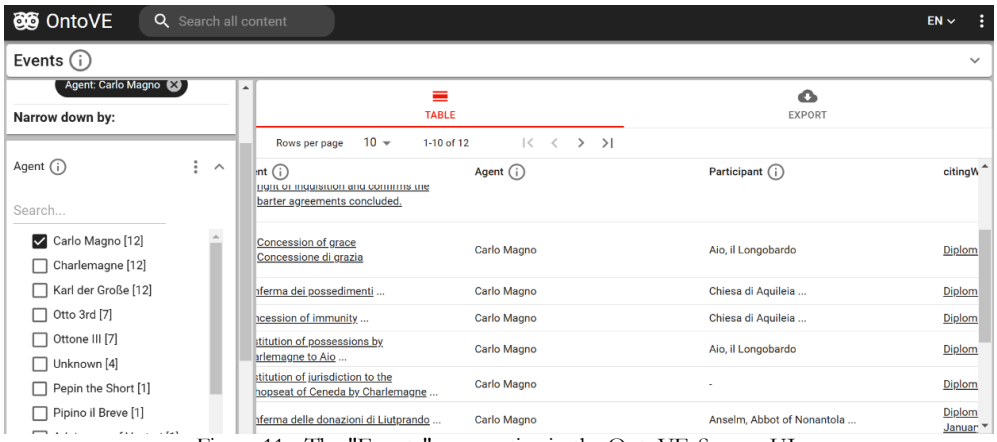

Figure 11 - The "Events" perspective in the OntoVE-Sampo-UI

Figure 12 shows the "Texts" perspective, where e.g. information about the subjects of a text can be consulted:

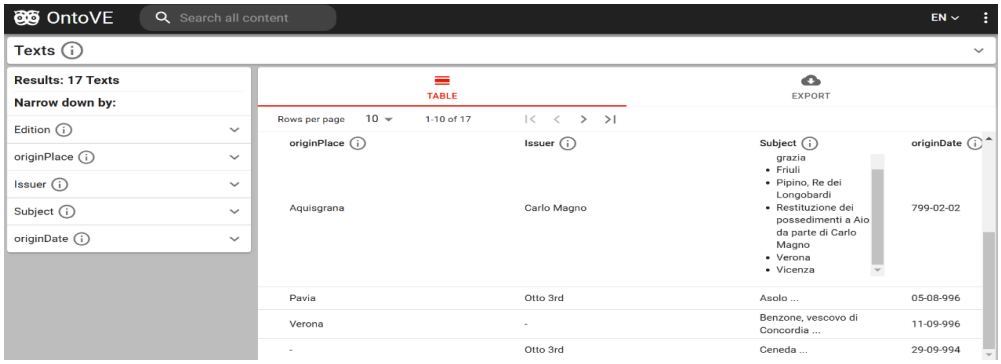

Figure 12 - The "Texts" perspective in the OntoVE-Sampo-UI

For a subset of the OntoVE dataset, a further visualization through the CHIt portal is provided (https://chit.chitontove.it/, [14]); now, the CHIt portal only aggregates metadata about the archaeological artefacts described in the OntoVE KB, but we plan to include also metadata about bibliographic items. The CHIt portal in fact aggregates data about Italian CH and allows creating thematic paths that collect data with a similar provenance. The OntoVE data are therefore put in relation to similar objects produced outside of Veneto, and the metadata can be further enriched through the tool Pundit (https://www.netseven.it/pundit/). In light of these observations, we plan to make also the bibliographic items of the OntoVE KB searchable through CHIt. The OntoVE-Sampo-UI and the visualization of the data through CHIt need to be tested with different users to effectively prove their usability.

7. Discussion and Conclusions

This paper presented the OntoVE_WrittenRecords ontology, which is part of the OntoVE project, seeking to highlight the relationship between Germanic peoples and the Veneto region. The OntoVE_WrittenRecords ontology conceptualizes historical documents, primarily imperial diplomas issued by rulers of Germanic origin that had an impact on the region, but can be employed to conceptualize other historical documents. As argued for in Section 3, there are different initiatives that present digitized and digital editions of the diplomas of interest to the OntoVE project. The digital resources examined in Section 3 follow different digitization and search protocols; the OntoVE project aggregates and describes the specific dataset relevant to the project thanks to interoperable models. At the time of writing, we are in fact not aware of projects that focus on this specific CH domain related to the Veneto region. The OntoVE project constitutes therefore an example of aggregation of diverse resources that highlight the history of a given region.

In order to devise an adequate description of the items included in the OntoVE dataset, the alignment of domain ontologies was performed. This also allows to maximize interoperability and reusability. The LRMoo and Bibframe schemas differ in the granularity of their description, as highlighted for instance by [4], [26], and [27]. The advantage of reusing LRMoo lies in its alignment with CIDOC-CRM, an ontology widely used in the field of museum description; moreover, it provides a high-level conceptualization of a Work, since it adopts the WEMI scheme introduced by the FRBR family of ontologies. As argued in Sections 4 and 5, however, LRMoo classes and properties are abstract and in need of finer-grained conceptualizations. Finer-grained taxonomies for bibliographic classes are provided by Bibframe, which provides a three-layered abstraction for a Work. The alignment between these schemas involved therefore careful consideration, especially since they conceptualize a creative Work in different layers. The result of the operation is an interoperable ontology, which makes use of the abstract conceptualization provided by LRMoo, aligned to CIDOC-CRM, and of the granular description provided by Bibframe. This alignment proved adequate to describe the items included in the OntoVE KB. Aligning the LRMoo and the Bibframe schema allowed for example to conceptualize the contents of a diploma at the topmost layer, exploiting the bf:Subject property. A knot which needs to be refined regards the topmost layer of the conceptualization, which is constituted by Work in Bibframe, but divided into Work and Expression in LRMoo. The strategy undertaken in OntoVE_WrittenRecords does not generate undesired inferences, but the conceptualization could be refined further. Moreover, the effort of aligning two already established standards helps avoiding reinventing the wheel and the creation of *ad hoc* ontologies, which could hinder interoperability and data interchange. The model proposed can be certainly refined and enriched with other ontologies; for example, the reference to other works and to papers citing a particular event related to the diplomas could be refined by reusing the ontologies in the SPAR suite.

Regarding the population of the KB, since the KB was populated through external linking and the individuals described manually in the Protégé editor, there is still work to be done to populate it so that the investigation into connections between Veneto and Germanic peoples can benefit from insightful data. However, we believe that the ontology and the visualization output proposed adequately describe the resources and allow discovering connections between the data presented. More work is needed in the future to enrich the KB and to model information about different expressions and manifestations for the diplomas and texts of interest for the project. As long as these are openly accessible, we aim to include them in the KB, in order to give the users a complete view of the texts included. In fact, whereas the dMGH editions provide a wealth of information about the diplomas, they do not reproduce a facsimile for them, which is however

retrievable from other databases, such as the *Abbildungsverzeichnis der europäischen Kaiser- und Königsurkunden* (http://www.hgw-online.net/abbildungsverzeichnis/). Given that a facsimile embodies a different Expression for the same text, these pieces of information are easily modelled in our KB, enabling to describe the textual transmission of a diploma fully. The aggregation and description of the metadata of the historical documents could be moreover enriched with a new edition of the texts, e.g. in XML/TEI format.

Finally, the visualization of the dataset via the reuse of the Sampo Model proved adequate for the goals of the project and constitutes another case of reuse of stable and open tools. Even though the scope of the OntoVE project is limited to a specific portion of CH, the strategies adopted and the ontologies produced could be applied to projects dealing with a different CH domain.

8. Acknowledgements

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