From Digital to Computational Humanities: The VAST Project Vision

Silvana Castano[1], Alfio Ferrara[1], Stefano Montanelli[1] and Francesco Periti[1]

[1]*Università degli Studi di Milano*
Department of Computer Science
Via Celoria, 18 - 20133 Milano, Italy

Abstract

In the shift from Digital to Computational Humanities, the role of artificial intelligence, data science and digital technologies is fundamental to achieve advances and results. As a concrete example of *Computational Humanities Research*, we present the vision of the EU H2020 VAST project (*Values Across Space and Time*) recently started, where cutting edge digital technologies and knowledge modeling tools are in place to study how the meaning of European moral values has been expressed, transformed, and appropriated throughout time, going back to the stories that helped to shape part of the European culture.

Keywords

Computational Humanities, Knowledge Modeling, Ontology-based data management

1. Introduction

In the field of the Humanities, Social Sciences, and Cultural Heritage, the demand is increasing for semantic text-analysis techniques as well as for intelligent discovery, linking, querying, and visualization of massive volumes of data [1]. On the one side, this leads to large-scale digitization projects and tools for producing, curating, and exploiting humanities and social-science data, by relying on text analysis techniques and new hybrid methodologies derived from the intersection/intertwining of the involved research communities [2]. On the other side, the need to keep humans "in-the-loop" leads to crowdsourcing solutions, to help in large-scale, human-intensive processes such as text tagging, commenting, rating, and reviewing, as well as in the creation and upload of content in a methodical, task-based fashion. Furthermore, the rapid development and diffusion of artificial intelligence techniques and data science approaches, enable research in the field of humanities and social sciences to become more and more computational. For example, various studies are devoted to exploit AI techniques to analyze literary texts, historic productions, or public opinions about political events for knowledge extraction and/or classification/analytics purposes. As a consequence, we are assisting to a shift from *Digital Humanities* (DH) to the so-called *Computational Humanities* (CH) research, where the

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silvana.castano@unimi.it (S. Castano); alfio.ferrara@unimi.it (A. Ferrara); stefano.montanelli@unimi.it (S. Montanelli); francesco.periti@unimi.it (F. Periti)

role of artificial intelligence, data science and cutting edge digital technologies is fundamental to achieve research advances and results [3].

In this paper, we present the EU H2020 VAST project (*Values Across Space and Time*), a concrete example of Computational Humanities Research (CHR). Going beyond analysing the transformation of moral values in the past, the VAST project will study how moral values are communicated and perceived today, by collecting, digitising, and analysing narratives and experiences of both communicators of moral values, like for example artists, directors, culture and creative industry institutions, museum curators, storytellers, educators, and the respective audiences, like spectators, museum visitors, students, and pupils. Within VAST, an interdisciplinary consortium of scholars from both humanities and computer science has been created. VAST aims to study the transformation of moral values across space and time, with particular emphasis on the core European Values, such as freedom, democracy, equality, rule of law, tolerance, dialogue, and dignity, that are widely recognized as the essential pillars to constitute a society in which inclusion, tolerance, justice, solidarity, and non-discrimination prevail [4].

The project envisions to bring European Values to the forefront by using cutting edge technologies to create a digital platform and a knowledge base by including narratives from three main areas: i) *theater*, focusing on ancient Greek Drama, ii) *science*, focusing on Scientific Revolution and natural-philosophy documents of the 17th century, and iii) *folklore*, focusing on folktales and fairy-tales. Through advanced techniques and digital tools, the research teams in the project are going to study how the meaning of specific values has been expressed, transformed, and appropriated throughout time, going back to the stories that helped to shape part of the European culture. VAST will examine narratives and user experiences that represent significant moments of European culture and history such as the classical period, and the Scientific Revolution of the 17th century, when the conceptual, methodological and institutional foundations of modern science were first established, to the modern era. In this respect, the main VAST issues about knowledge modeling and architectural design are discussed in the paper both from methodological and technical point of view.

The paper is organized as follows. Section 2 provides an overview of the VAST goals and features. In Section 3, the architectural design of the VAST platform is presented. Details about the VAST ontology meta-model are discussed in Section 4. In Section 5 and 6, related work and concluding remarks are finally provided.

2. The VAST project overview

The aim of the VAST project is to investigate how the values at the basis of the European Union have been transformed over the ages. Across time, from antiquity to modernity, a value represents a message that is communicated through different mediums (e.g., text, visual art, drama, oral narration) and this message can change when the context and the society where citizens live change. As a first goal, VAST aims at representing values and associated messages as they are extracted from sources of the past, such as for example literature texts and theatrical performances. As a further goal, VAST aims at collecting and digitizing the today messages associated with values as they are perceived by the general audience in the present days. To this end, the activities of the project are organized in three pilots that are characterized by i) different

significant moments of the European history and ii) different types of sources that are exploited for extraction of the value messages. In particular, we focus on studying the transformations of values from ancient Greek tragedies to modern theatrical plays (i.e., *Pilot 1: Ancient Greek Drama*), from seventeenth century works of natural philosophy to science museum exhibits (i.e., *Pilot 2: Scientific Revolution Texts*), and from traditional European fairy tales to different types of storytelling (i.e., *Pilot 3: European Folktales*). The pilot features are summarized in Table 1 and they are described in the following.

Table 1
The VAST pilot properties

Pilot	Pilot 1	Pilot 2	Pilot 3
General Context	Arts	Science	Folklore
Type of Narrative	Greek Tragedies	17^{th} Century Texts	European Folktales
Time	Antiquity Present	Early Modern Present	Modern Present
Space	Western Europe	Western Europe	Western Europe
Communication Medium	Theatre	Museum Exhibitions, Educational Activities	Museum Exhibitions, Educational Activities
Theoretical background-Methodology	Philosophical, Philological, Theatrological	Philosophical, Pedagogical, History & Communication of Science	Philosophical, Pedagogical Psychological
Communicators	Artists, Culture/Creative Industry Institutions	Curators	Curators, artists, storytellers
User Engagement	Theatrical Plays	Exhibitions, Educational Programs, Special Events	Exhibitions, Educational Programs, Special Events
Target Audiences	Spectators	Visitors, Students, Pupils	Visitors, Students, Pupils
Studied Values	Freedom, democracy, equality, tolerance, dialogue, human dignity, the rule of law		

Pilot 1: Ancient Greek Drama. The Pilot 1 of VAST is related to values in ancient Greek tragedies and how they are perceived by contemporary theatrical plays and general audiences. It is mainly focused on Greek tragedies and their adaptations across Europe and the World along time. The goal is to analyze how the values of the antiquity, that are recognized to be discussed in specific tragedies (e.g., *Lysistrata*, Comedy, 411 BC), are revisited in the present through modern artistic reproductions, such as acting, music, and voice. The pilot aims at inspiring ideas and debates on what people find important in their own life and in their life with the others, like for example human rights, the right of political asylum, expansionism, genocide, the conflict between East and West, and the concept of the "other".

Pilot 2: Scientific Revolution Texts. The Pilot 2 of VAST is related to values in texts of 17^{th} century about natural philosophy and how they are perceived by experts in science museums and museum visitors like students and pupils. It is mainly focused on the early-modern era, the period known as the *Scientific Revolution* featured by great discoveries and inventions. The texts considered in the project are mostly about imaginary travel stories or fictional communities of ideal perfection in which the new intellectual achievements were embedded in an imaginary narrative context (e.g., *The Man in the Moone*, Francis Godwin, 1638). The goal is to analyze the shift in the message communicated by values concerned with the science of the past and the those concerned with the modern science. The pilot aims at promoting the organization of educational programs for museum visitors, focused events, such as talks and debates, where visitors are encouraged to share their experiences and visions about science-related values (e.g.,

freedom of research, science for public good).

Pilot 3: European Folktales. The Pilot 3 of VAST is related to values in folktales throughout the History of Europe and how they are perceived by storytelling experts in fairytale museums and museum visitors. Though fictitious, folktales are important simulations of the reality. Moreover, the variability of tales makes them the ideal case study for cross-cultural comparisons on social dynamics, including cooperation, competition, or decision making. The pilot is mainly focused on archetypical stories (e.g., the *Grimms' Fairy Tales*, 1812) and it includes texts from several European countries (i.e., Portugal, Italy, Slovenia, Greece, Cyprus). Folktale narratives are central to the construction of the self, embodied with memories, emotions, appetites, and culture-based values. The goal is to analyze the value dichotomies that are typically addressed in folktales, such as for example good/evil, right/wrong, punishment/reward, moral/immoral, trust/distrust, and male/female. The pilot aims at promoting events where a given folktale with a number of associated national adaptations are presented and the museum visitors can provide their feedback and emotions in the form of comments and/or storytelling with respect to the received value(s).

3. The VAST architecture

The VAST architecture describes the modules and the tools that are employed to enforce the project activities and the pilot development (Figure 1). In particular, the VAST architecture is

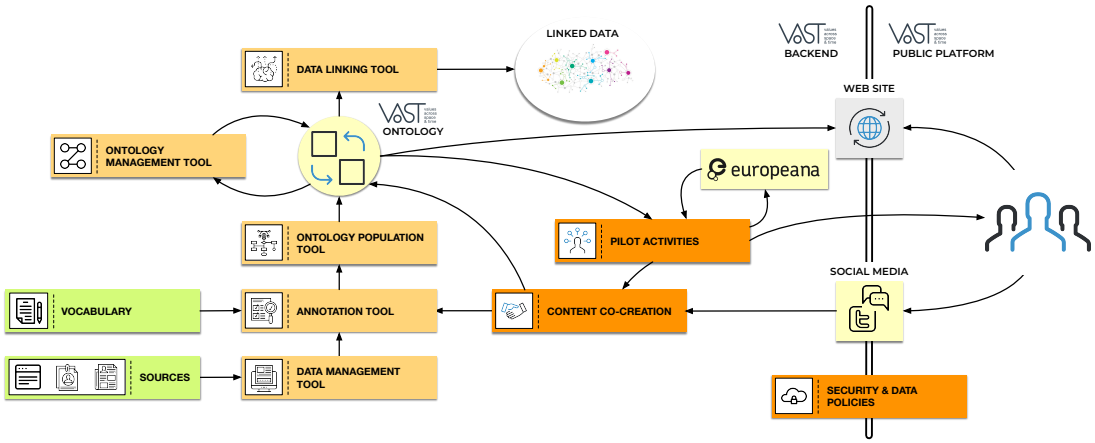

Figure 1: The VAST architecture

designed to support a computational-oriented approach focused on three main targets described in the following.

Historical content digitization. The VAST pilots require the acquisition of a number of heterogeneous historical sources that are selected to provide either explicit and implicit references

to messages/interpretations associated with values. Document annotation modules and tools are designed in the VAST architecture to support historians and humanity scholars in the extraction of value-related knowledge from sources. A crucial aspect for annotation task is the specification of a reference vocabulary to support the work of human annotators and to avoid undisciplined proliferation of keywords. The idea is to go beyond conventional annotation approaches and to investigate the adoption of semi-automated solutions to the progressive enrichment of the reference vocabulary based on machine learning techniques (see for example [5]).

Multi-dimensional knowledge modelling and visualization. A key aspect in the VAST project is about the use of space and time as dimensions of analysis for observing the transformation of values throughout the considered historical sources. As a further issue, it is possible that a certain value is associated with multiple, different interpretations provided by distinct individuals in the same historical period. As a result, the VAST ontology meta-model needs to be defined not only around the specification of concepts featuring the values, but also around the association of each value with the keywords (i.e., the tags) used by individuals to denote the meaning of that value. In addition to the knowledge extracted from the historical sources through annotation, it is important to note that the VAST ontology has to contain the value interpretations provided by the final users (e.g., museum visitors, educators, students) as a feedback to the activities/events proposed within the pilots (see Section 4 for further details). The ontology-related modules and tools of the VAST architecture are designed to enforce modeling, population, and linking functionalities over the knowledge acquired through annotation. The VAST ontology aims at supporting i) dissemination tasks to the general audience through the VAST website, and ii) content creation activities to the final users involved in the pilots. In both scenarios the idea is to go beyond conventional visualization tools of the ontology contents and to provide interactive dashboards characterized by topic-driven organization of values aimed at highlighting the available value interpretations collected across space and time from sources and users (see [6] for a possible solution in this direction).

Collaborative content creation. Each VAST pilot aims at promoting focused events and activities to engage different target audiences on the project ambitions. The idea is to design interactive experiences where the final users are exposed to the value messages and interpretations coming from the Past, so that they can realize how these values have been transformed and differently perceived in the Present. The users involved in the pilot activities are encouraged to share their feelings according to modalities and mediums that are being defined within the project. A first modality is called *immediate* and it is based on the "syncronous" collection of user feedback during and/or at the end of the event/activity. In this modality, we expect to rely on interviews and questionnaires to enforce the user contributions. A further modality is called *remote* and it is based on the "asyncronous" collection of the user feedback some days/weeks after the participation to the event/activity. In this modality, social media channels represent a spontaneous medium that a user can exploit to share her personal feedback. As a further option, we plan to develop content-creation mechanisms where users are involved in collaborative writing experiences. The idea is to define a human-in-the-loop approach to *participatory storytelling* where users can contribute to the definition of a value interpretation

by providing personal considerations as well as like/dislike reactions to the proposals of the other users (see for example [7]).

4. The VAST ontology meta-model

The VAST ontology is based on three main notions, namely i) *VAST annotation*, ii) *VAST interpretation* and iii) *VAST concept*, as highlighted in Figure 2. A **VAST annotation** represents an

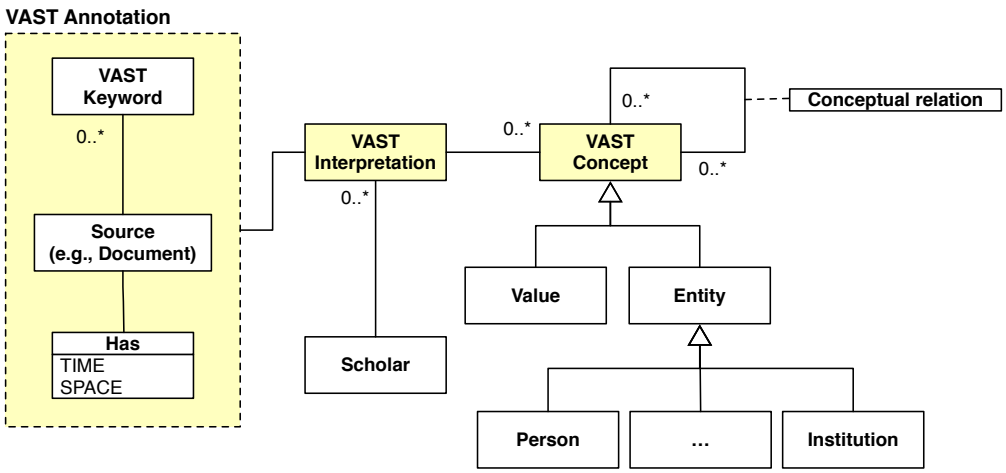

Figure 2: The VAST ontology meta-model

association between a source document, either a whole document or a small part of it, and one or more VAST keywords taken from a controlled vocabulary. Annotations are performed by scholars and expert of the source documents under examination. One of the main goals of annotation is to tag and select the specific portions of document that may be relevant for the understanding of values in time and space. In fact, each document in VAST is a historical source of information that is associated with a temporal dimension, typically the date of the document, and a spatial dimension, typically the country or the geo-political entity where the document has been historically written and published. VAST keywords are mainly tags that have been defined by domain experts with the goal of providing a first level of abstraction over the document contents but that still do not represent a conceptualization of the document contents. So, the goal of the VAST keywords is mainly related to the fact of overcoming the linguistic differences among documents (to this purpose all the VAST keywords are English words or short English sentences) and of providing a reference terminology that can be associated with document portions that are similar in terms of content but different in style and lexicon. The step of conceptualizing the document content with respect to the VAST values of interest is represented by interpretation.

A **VAST concept** is the ontology representation of an entity, like a person or an institution, or a value considered in VAST, like freedom, democracy, and equality. The VAST concepts are interconnected by conceptual relations. In particular, a binary relationship among a pair of concepts can be specified to denote a semantic relation holding between them.

A **VAST interpretation** is a relation between an annotation, that means a textual portion with time and space metadata and with VAST keywords associated, and a VAST concept. The association of concepts about entities with annotations is usually straightforward because such entities are mentioned directly in the source document or because there is a historical or philological evidence supporting that annotation. In case of values, the association of the concept representing the value and the document annotation is less straightforward because it derives from a specific interpretation that a scholar gives of the text at hand. For this reason, the design choice of the VAST ontology is to reify the notion of interpretation as a class of spatial ontology entities that represent the relation between a VAST concept, an annotation, and the scholars who propose or support that interpretation. Thanks to this design, the VAST ontology can model the existence of multiple interpretations of the same annotation. Moreover, we implicitly introduce a notion of consensus concerning interpretations because different, and potentially controversial, interpretations might be supported by more or less scholars. This flexibility of design is motivated by the need of supporting different views of the VAST values across time and space. In fact, by selecting a specific time and space frame we can easily select the interpretations involved and - through those - the keywords that are associated with a value in that interpretations in order to study how the definition of values in terms of keywords and documents vary in the temporal and spatial dimensions.

Example. As an example of how the VAST ontology is used in the project, in Figure 3 we present a portion of the concrete instance that describes the Galileo *Sidereus Nuncius*, published in the Republic of Venice on March 13, 1610. The source document is associated with several metadata, including the date of publication and the spatial reference to the Republic of Venice. This last reference is also linked to the corresponding entity in Wikidata. From the text, we take the example of a text snippet (TS1) that has been annotated with the keywords K1 ("for the people") and K2 ("democratic"). This association between keywords and text is represented in the VAST ontology by the annotation A1. Note that keywords may be used for multiple annotations as for the keyword K1 and the annotation A2. Then a scholar, omitted in the example just for the sake of readability, provides an interpretation of the fact that keywords K1 and K2 have been used to annotate TS1. Her interpretation is that the portion of the document annotated by A1 is related to both the value of democracy, represented by the concept C1, and the topic of science revolution, represented by the VAST concept C2. By providing her interpretation, the scholar generates an instance of VAST interpretation I1 that is linked to both A1 and C1 and C2, which are in turn related by a conceptual relation the one to the other. Although not shown in this example, I1 will also be associated with the scholar who proposed the interpretation and could be associated further with all the other scholar who will support this interpretation. Assuming that a second scholar wants to argue against this interpretation by claiming that TS1 is actually related to science revolution but not to the value of democracy, the second scholar may create a different interpretation linking A1 to C2 only. This way, multiple interpretations of the same text

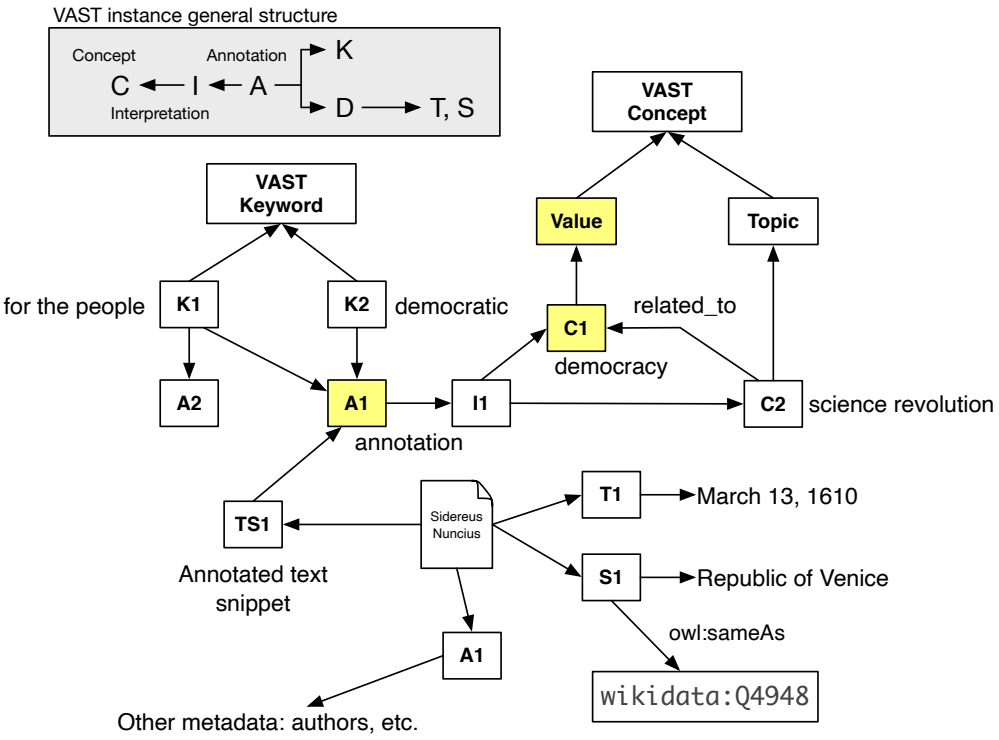

Figure 3: Example of a VAST ontology instance

may co-exists in the VAST ontology. At the same time, a given value (e.g., C1) can be associated with different interpretations and also with different texts and keywords. As an example of retrieval, consider the query Find democracy in the XVII century and the corresponding answer extracted from the VAST ontology:

```
{
   Value: democracy,
   Time: March 13, 1610,
   Space: Republic of Venice,
   Snippet: "Neque porro quisquam ...",
   Source: Sidereus Nuncius,
   Keyword: democratic
}
{
   Value: democracy,
   Time: March 13, 1610,
```

```
    Space: Republic of Venice,
    Snippet: "Neque porro quisquam ...",
    Source: Sidereus Nuncius,
    Keyword: for the people
}
```

The example shows how a value can be associated with a set of space locations (i.e., the Republic of Venice) and keywords (i.e., "democratic", "for the people") given a temporal constraint. By shifting the temporal reference along history trough other queries we can support a study on how the spatial reference and the keywords associated with values change.

VAST ontology implementation. For implementation of the VAST ontology meta-model, we rely on the CIDOC Conceptual Reference Model, (also referred to as CRM) [8]. CRM is a formal ontology specifically designed to support the integration, mediation, and interchange of heterogeneous cultural heritage information. It is developed by the ICOM/CIDOC group and it has been accepted as ISO standard (ISO21127:2006) since 2006[1]. In CRM, basic classes and properties are specified aimed at representing documentation of cultural heritage and scientific activities. The ontology is complemented by a number of modular extensions of the basic model. These extensions are designed to support different types of specialized research questions (e.g., representation of bibliographic data, geographical and archaeological data, data about social phenomena) and they are harmonized with the base ontology.

The choice of CRM for implementing the VAST meta-model is based on multiple motivations. First, CRM is a standard that aims to offer a complete and relatively off-the-shelf solution that is readily applicable. In VAST, we need to represent both temporal and spatial data, and CRM provides specific constructs to this end. For instance, a document to annotate has a creation/publication date and this feature can be represented by exploiting the class E52-Time-Span and the property P160-has temporal projection. As a further example, the class E53-Place and the property P161-has spatial projection are defined in CRM to represent geo-referenced data about documents. Furthermore, CRM supports an *event-oriented modeling* of knowledge, meaning that fact representation is articulated in a set of event-based relationships. As an example, a value interpretation that we aim to model in the VAST ontology can be implemented as an instance of the class E5-Event to represent a specific association between a document text snippet, a keyword, and a scholar, thus providing an explicit description of a document annotation. Moreover, CRM can be integrated with the CRMdig extension about representation of provenance metadata [9]. This extension provides formal constructs for annotation representation like the class D30 Annotation Event and the property L43 annotates (is annotated by).

5. Related work

In this section, we focus on available solutions about knowledge modeling and representation in the framework of Digital and Computational Humanities research. A main issue regarding knowledge modeling in the DH/CH is that metadata from different institutions (e.g., museums,

[1]The current standard is the one renewed and updated in 2014 (ISO 21127:2014)

archives, libraries) are heterogeneous and need to be integrated to offer a complete view of information about any period, geographic location, and aspect of human activity in the past. In [10], the use of metadata schemas like for example Dublin Core, MPEG7, and METS standards, is discouraged due to the fact that the available metadata are usually insufficient to represent all the real-world feature that need to be described. In this direction, the use of a common conceptualization model is recommended for ensuring interoperability of repositories, uniform access to data, and querying functionalities.

A number of conceptualization models exist that are already employed also in the field of cultural heritage, humanities, and social sciences [11]. A brief overview is available in [12] and [11]. An additional survey on this topic is provided in [13]. As an example, DOLCE [14] is a large Descriptive first-order Ontology for Linguistic and Cognitive Engineering. According to [12], the rigorous DOLCE's logical formulation makes difficult for domain experts to understand and use it. Moreover, as a difference with CRM, a modular organization of the ontology specifications is not supported in DOLCE. For instance, this means that the design of space and time data is represented as properties of concepts and not as concepts existing per sé. A further example is the PROTON (PROTo ONtology) [15]. This is an upper-level ontology characterized by a hierarchy of classes and properties without any restriction on the meaning. As a difference with CRM, PROTON does not provide specific constructs for conceptualization of space and time data.

In the context of DH/CH, CHARM [16] (Cultural Heritage Abstract Reference Model) represents an alternative to the CRM. The are three major differences between CHARM and CRM: i) the CHARM ontology is wider in scope than CRM, and this could be a matter of confusion for ontology designers with focused domain target and limited experience; ii) CHARM provides an abstract model that needs to be extended to fit a specific organisation need; iii) CHARM is expressed in ConML, a well-defined conceptual modelling language, while CRM is a conceptual model that is compatible with implementation through different formalization languages (e.g., RDF).

Finally, we note that the modular extensions of the CIDOC CRM also constitute an additional option for ontology representation of specific types of data. In particular, we mention i) CRMtex [17] for supporting knowledge representation of ancient documents, and ii) CRMsci [18] for archaeological excavations, scientific observations, and measurements.

6. Ongoing and future work

In this paper we have presented the vision of the VAST project in the context of the transition from digital to computational humanities. One of the main drivers of this transition is the need of methods and techniques capable of adding value to the historical collections of documents held by museums, archives and other cultural institutions. The vision of VAST is summarized by the principles that inspired the VAST architecture which is designed to support multidimensional modeling and visualization of knowledge extracted from the source documents and from the contents created by final users. Ongoing activities are about the following issues.

Document annotation. The VAST scholars already defined the first version of the common vocabulary to employ for document annotation. The VAST keywords are integrated within the

annotation tool and they have been associated with a set of shared annotation guidelines.

Ontology design and implementation. The VAST ontology meta-model presented in Section 4 is going to be implemented through the CIDOC Conceptual Reference Model. Details about modeling of the VAST entities through the CRM constructs are going to be investigated.

Our future work will be focused on defining the methodology and the techniques for **ontology population and exploitation**. The idea is to support a semi-automated ontology population process, where text analysis and data linking techniques are exploited to aggregate keywords and contents, and to define mapping with the VAST ontology concepts in order to suggest possible interpretations to the scholars and experts. Moreover, we will also study how to integrate the knowledge extracted from documents, concerning the Past of values, with activities and user feedback and experiences, concerning the Present of values.

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