Using an Ontology for Representing the Knowledge on Literary Texts: the Dante Alighieri Case Study

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Abstract. This paper describes a digital library developed within the "Towards a Digital Dante Encyclopaedia" project, a three years Italian National Research Project that aims at building services supporting scholars in creating, evolving and consulting a digital encyclopaedia of Dante Alighieri's works. The digital library is based on a knowledge base storing knowledge on the primary sources that Dante refers to in his works. At present, this information is scattered on many paper books, making it difficult to systematically overview the culture background of Dante and to obtain a well-founded perception of how this background was gradually set up in time. The same applies also to other authors, therefore the applicability of our work extends well beyond the specific author we are considering in our project. The digital library that we are building is based on an ontology for representing the knowledge on one author's works and on the primary sources embedded in the commentaries to these works. Following this approach, a semantic network of Dante's works and of references to primary sources of these works was created. Furthermore, a web application allowing users to explore the semantic network in various ways and to visualize statistical information about the references as charts and tables was developed.

Keywords: Ontology, Semantic Web, Digital Libraries, Digital Humanities

1. Introduction

Representing knowledge included in literary texts is a complex issue. In the digital humanities literature, there are many ontologies focusing on different aspects of textual information. Unfortunately, there is no one single ontology representing all aspects that are relevant to study a literary author's work. The work we present in this paper is part of the "Towards a Digital Dante Encyclopaedia", an Italian National Research project supporting scholars in formally expressing the knowledge present in Dante Alighieri's works

and more in general in literary texts. Moreover, the project aims at developing a system to automatically discover complex semantic relationships among different parts of the text or between the text and its related resources. This work presents an ontology developed on the basis of a previous preliminary study [1], to represent knowledge on the references to primary sources included in literary texts and in their commentaries, with a specific focus on Dante's works. In this article we report the process that we followed to extract the relevant knowledge from natural language commentaries to Dante's works and to express this knowledge with a formal semantic representation. We started from an Excel file provided by an authoritative Ital-

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ian scholar, reporting commentaries and references to primary sources embedded in a Dante's work. On the basis of the analysis of the contents of the Excel file, we developed a conceptualization, i.e. a set of concepts and relations underlying the knowledge reported in the spreadsheet. Next, we reviewed existing ontologies in the digital library domain in order to create a vocabulary to express the identified concepts and relations. We adopted several terms from these ontologies to maximize the interoperability of our representation. Finally, we added our own classes and properties to represent the terms that we did not find in the analyzed ontologies. The resulting ontology is expressed in RDF/S[1]. Once the ontology had been defined, we populated it with the knowledge included in the Excel file but also with the knowledge included in other commentaries to Dante's works. We persisted the resulting RDF graph into a Virtuoso triple store [5]. On top of this graph, we developed a web application allowing a number of data visualizations of Dante's works and primary sources. Such visualizations are expected to provide useful knowledge to the scholars that work on the creation of a complete encyclopaedia of Dante's works. The paper is structured as follows: Section 2 reports the analysis and the evaluation of the initial representation requirements. In Section 3, the review of the existing ontologies is reported, while Section 4 presents the classes and properties of these ontologies that we re-used. It also introduces the classes and properties that we added to capture missing aspects. Section 5 presents the ontology population process. Section 6 describes the web application that we developed on the basis of our ontology. Finally, in Section 7 we report our conclusive remarks.

2. Requirements

The references to primary sources are contained in commentaries to Dante's works written by authoritative scholars. Each commentary applies to a fragment of a work by Dante and asserts, among other things, that the Dante's fragment makes a reference to a work of another author. The reference may be to a specific fragment or to the totality of a work. Our first task was to understand how formally representing the described knowledge to implement automatic services on top of it. In order to achieve this goal, we started with

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[1] http://www.w3.org/RDF/ and http://www.w3.org/TR/rdf-schema/

the study of a spreadsheet, provided by an authoritative Italian scholar, reporting the relevant knowledge relative to Convivio [6]. Each row of the spreadsheet reports (see Figure 1):

- the number of the book, of the chapter (e.g. 1.01 indicates the first book and the first chapter of Convivio) and of the paragraph to which the commentary is applied;
- the Dante's text fragment which the commentary is applied to (e.g., *"Sì come dice lo filosofo nel principio della Prima Filosofia"*/ As the Philosopher says at the beginning of the First Philosophy);
- a fragment of the commentary to the Dante's text;
- primary source, structured as:

  * author (e.g. Aristotle);
  * title (e.g. Metaphysics);
  * thematic area (e.g. Aristotelianism).

	A	B	C	D	E	F	G
1	Book - Chapter	Paragraph	Text	Note	Author	Work	Thematic area
2	1.01	1	Si come dice lo Filosofo nel principio della Prima Filosofia	le parole con cui si apre la Metafisica di Aristotele (I 1, 980a 21). Il sintagma "prima Filosofia" è già presente in Aristotele per distinguere questa scienza dalla Fisica (cfr. Metaph. VI 1, 1026 a 27-30).	Aristotele	Metafisica	Aristotelismo

Fig. 1. A row of the spreadsheet provided by the scholar.

After discussing with the scholars, two other pieces of knowledge are added to each row of the spreadsheet:

1. the entire text of the commentary, thus making available to the scholars the context of the reference;
2. the kind of the reference, which may be:

   - *explicit,* if the reference is explicitly made by Dante, as in *"Sì come dice lo Filosofo nel principio della Prima Filosofia"*/As the Philosopher says at the beginning of the First Philosophy;
   - *strict,* if the reference is indicated by a scholar, and refers to a specific work as in *"SI MANUCA: il pane degli angeli, nella tradizione veterotestamentaria ÃÍ la manna (cfr. Ps. 77, 25 "Panem angelorum manducavit homo"*/SI MANUCA: it is the bread of the angels, the "manna" as called in the Old Testament (Ps. 77, 25 "Panem angelorum manducavit homo");

– *generic*, if the reference is indicated by a scholar, and refers to a concept (e.g. Medieval Comments to Aristotle's works).

Regarding the thematic areas, the list the scholar gave us is based on his own knowledge. In order to reuse available and standard resources, we decided to extract the thematic areas from *Nuovo Soggettario*[2]. The Nuovo Soggettario, edited by the National Central Library of Florence, is a subject indexing tool for various types of information resources. It has been developed in compliance with the International Federation of Library Associations and Institutions (IFLA) recommendations[3]. A RDF version is freely available on-line, expressed through the SKOS [10] vocabulary.

Besides Convivio, we received knowledge about references to other Dante's works from the scholars, along with their commentaries in textual format. These works are: Monarchia [12], De vulgari eloquentia [16], Vita Nova [8], Rime [7]. After a deep analysis of the commentaries, developed with the support of Italian Dante's experts, we verified that Convivio knowledge structure reported in the Excel was compliant with the knowledge structure of the commentaries on the other Dante's works provided by the scholars. Moreover, we decided to include the whole text of the above mentioned works from Dante in our digital library, modeled in a semantic way (see next Section) according to their structure. We adopted this strategy to provide the users with as many context references as possible.

3. Reused Ontologies

The analysis described in the previous Section allowed us obtaining a conceptualization of our subject matter, which is a list of the relevant concepts and relations comprising the slice of reality under study. As next step, we devised an ontology providing names for such concepts and relations as well as axioms for expressing their meaning in a formal way. In order to carry out this step, we investigated the scientific literature and the existing standards in the Digital Library field, whether official or *de facto*. In particular, we took into account the ontologies addressing issues related to the textual domain. We did not find any ontology able to represent all the concepts and relations we identified analyzing the commentaries on Dante's works. On the other hand, we could find ontologies offering classes, properties and axioms for some concepts and relations. A brief account of these ontologies and of the re-used classes and properties is given below.

CIDOC-CRM. The CIDOC Conceptual Reference Model (CRM) is an ontology that provides definitions and a formal structure for representing the implicit and explicit knowledge included in the cultural heritage documentation [3]. Since CIDOC-CRM is an ISO standard, it has been considered as a common vocabulary to represent information published on cultural heritage by archives, museums or libraries, and to map it to an equivalent digital representation [2] [4] [14]. In particular, analysing this ontology we found an interesting property to describe our knowledge: the property named hasNote. We took into account such relation to represent the link between the commentary and the text.

FRBR and FRBRoo. The Functional Requirements for Bibliographic Records model (FRBR) is a conceptual entity-relationship model developed by the International Federation of Library Associations and Institutions (IFLA). It allows users to perform tasks of retrieval and access to online library catalogues and bibliographic databases [9]. FRBR contains many classes useful to describe a textual domain, e.g. the class Work, to represent an intellectual creation, or the class Expression whose members are a realization of a single work, usually in a physical form. FRBRoo is essentially the FRBR ontology expressed in an object-oriented form, which is more compatible with that of the CIDOC-CRM. As explained in the next Section, we used many classes and properties from FRBR and FRBRoo to represent our knowledge.

Dublin Core. The Dublin Core Metadata Element Set is a vocabulary of fifteen properties for usage in resource description. These fifteen elements of the Dublin Core are part of a larger set of metadata vocabularies and technical specifications developed by the Dublin Core Metadata Initiative. We analysed the Dublin Core because its metadata can be used to describe a full range of web resources (video, images, web pages, etc.) but also of physical resources, such as books and objects like artworks. As explained in the next Section, we reused several classes from the Dublin Core vocabulary.

SKOS. Simple Knowledge Organization System (SKOS) is a model for sharing and linking knowledge organization systems such as thesauri, classification schemes, subject heading systems and taxonomies within the framework of the Semantic Web [10]. In

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[2] http://thes.bncf.firenze.sbn.it/index_eng.html
[3] http://www.ifla.org/

particular, such vocabulary contains the term Concept that we reused to describe the thematic area of a work or a general concept like Comments to Aristotle's works.

FOAF. Friend of a friend (FOAF)[4] is a machine-readable ontology linking people and information using the Web. In particular, FOAF describes persons, their activities and their relations to other people and objects. The FOAF ontology was useful to represent the knowledge on the author of a work.

The SPAR (Semantic Publishing and Referencing) Ontologies[5] are a suite of complementary ontologies to describe all the aspects of bibliographic publications as comprehensive machine-readable RDF metadata. Since we wanted to describe the text structure, the textual publication type and the bibliographic citations, we specifically analyzed and reused some classes and properties from the following three ontologies, developed within this project:

- DoCO, Document Components Ontology[6], allows describing document components in RDF. Such components are both structural (e.g. block, chapter, heading, paragraph, section) and rhetorical (e.g. Abstract, Introduction, Results, Discussion, Conclusions, Acknowledgements, Bibliography).
- FaBiO, the FRBR-aligned Bibliographic Ontology [11], is an ontology to record and publish bibliographic records created by scholars on the Semantic Web. FaBiO entities are primarily textual publications such as books, magazines, newspapers and journals, and items of their content such as poems, conference papers and editorials.
- CiTO, the Citation Typing Ontology [11], is an ontology for the characterization of bibliographic citations, both factually and rhetorically and for their publication on the Web.

Finally, we also reused classes and properties from the *Open Annotation Core Data Model* that provides concepts and properties to represent textual commentaries and to create explicit relationships between such commentaries and their related resources. The Open Annotation Core Data Model [13] specifies an approach to associate annotations with resources, using a methodology that conforms to the Architecture of the World Wide Web and the Linked Data initiative. Within the

Open Annotation Model, *"an annotation is considered to be a set of connected resources, typically including a body and a target, and it reveals that the body is related to the target"*[7]. Such ontology is especially interesting for our aims because it defines and represents the structure of the commentaries in detail. Indeed, as reported in the next Section, we reused many classes and properties from the OA vocabulary.

4. The Ontology

As previously mentioned, one of the aims of our project is to develop an ontology for expressing the knowledge on the structure, the content and the context of Dante's works and, more in general, of literary texts. Thus, we reused and extended some existing vocabularies of relevance to textual descriptions. We selected several ontologies [1] in order to identify concepts and properties we could reuse. After a deep analysis of these ontologies, we selected, from the ontologies described in the previous Section, some classes and properties useful for representing the specific kind of knowledge that we consider in our study.

As a notational convention, in what follows we use prefixed q-names (e.g., efrbroo:hasFragment) to denote terms re-used from other vocabularies, whereas we use local names (e.g., hasCitingFragment) to denote terms of our own ontology. We started from the analysis of the The CIDOC-CRM and FRBR vocabularies which are particularly relevant in terms of the transmission of cultural information and ideas expressed in written works. In particular, we considered FRBRoo as the appropriate ontology to represent some aspects of our textual knowledge. Therefore, to describe the text which was annotated by the scholar, we reused the following FRBRoo classes:

1. efrbroo:Work corresponding to a specific work, cited by the commentaries, (e.g. Metaphisics) without reference to a specific edition;
2. efrbroo:Expression corresponding to a precise edition of the Dante's work;
3. efrbroo:ExpressionFragment corresponding to a fragment of a work to which the commentary refers to. In our ontology it represents a fragment of Convivio which the scholar has annotated, but it represents also a fragment of a commentary that refers to a specific primary source.

Each instance of efrbroo:ExpressionFragment is in textual form. In order to model the textual content of an ExpressionFragment instance, we followed the recommendations of the W3C's Content in RDF[8], and we used two specific sub properties we defined:

1. a sub property of dc:format, called efFormat, taking as values MIME types. It gives the media type of the instance. For example, it allows distinguishing between embedded content in plain text versus that encoded in HTML;
2. a sub property of cnt:chars, called efChars, taking literals as values. It represents the sequence of the characters of the content.

Furthermore, we represented the textual nature of an ExpressionFragment instance using two classes:

1. dctypes:Text class, to denote the fact that the instance represents a resource primarily intended to be read;
2. cnt:ContentAsText class represents the textual content of the instance.

Figure 2 shows the textual content representation in RDF graph. In this and the following graphs, we have used the standard RDF graphical notation: URIs are written as qnames and are enclosed in ovals or used as arrow labels, whereas literals are enclosed in rectangles. Qnames without prefixes (e.g., âĂIJ:ef1âĂİ) use the base namespace, which is left undefined.
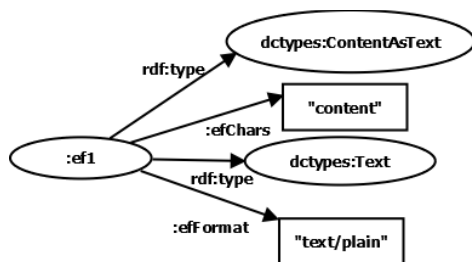
Fig. 2. Textual content of the expression fragment ef1.

In addition to the classes and properties reported so far, we used the concept of Selector from the Open Annotation Core Data Model, in order to identify in the most precise way a specific fragment of a text. A selector is a specifier that describes how to determine the segment of interest within a specified text. The text from which the segment was extracted is named Source in the Open Annotation Model. The nature of

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[8]http://www.w3.org/TR/Content-in-RDF10/

the Selector depends on the type of representation for which the segment is conveyed. In our case, we used the oa:TextPositionSelector that describes a range of text based on its start and end positions within a paragraph or a poem. The paragraph, or the poem, plays therefore the role of Source of the Selector. The connection between a fragment of a work and its Source is established using the property oa:hasSource. In Figure 3 we report the representation of the Selector and Source terms in our RDF graph.
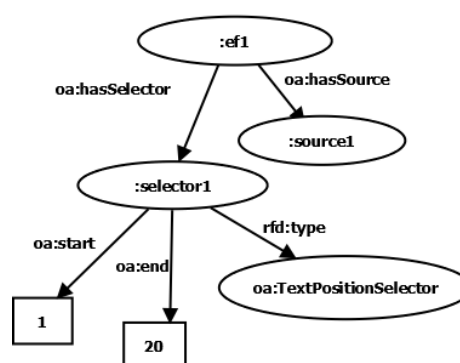
Fig. 3. Selector and Source.

To describe the structure of the resource from which the fragment is extracted we reused three classes of Fabio and Doco ontologies:

1. doco:Paragraph, which represents a self-contained unit of discourse that deals with a particular point or idea;
2. fabio:Poem, that is an artistic work written with an intensity or beauty of language more characteristic of poetry than of prose;
3. doco:Chapter, which represents a principle division of the body matter of a large document;
4. fabio:Book, which defines a non-serial document that is complete in one volume or a designated finite number of volumes.

The model of a work structured in paragraphs, chapters and books is reported in Figure 4. To relate the paragraph with the related chapter and book, we defined three sub properties of the frbr:isPartOf: (i) isParagraphOf, (ii) isChapterOf, and (iii) isBookOf. In the case that the source corresponds to a poem, like in Rime, in our model the class :source1 in Figure 3 corresponds directly to the poem in which the instance of the Expression Fragment class is included. On the other side, for the Divina Commedia, we defined two

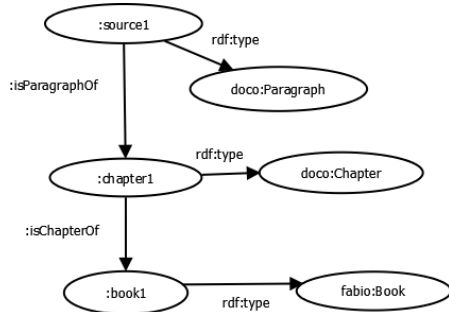specific classes: the Source is a *canto* that is a part of a *cantica*.

Fig. 4. The structure of Convivio.

In the context of representing the relationship between the commentary and the text, we noticed that the CIDOC-CRM has an underlying conceptualization that is very close to our model. We used the property crm:hasNote to describe the relationship between the text and the commentary. On the other hand, since the Open Annotation Model is the standard *de facto* adopted by the WC3, we decided to be compliant with this ontology and to guarantee the interoperability with it. For these reasons, we used the definition of the commentary reported by the OA: *"an Annotation has a single Body, which is the comment or other descriptive resource, and a single Target that the Body is somehow about"*[9]. In order to link the annotation with its components, we used the properties oa:hasBody and oa:hasTarget but we also introduced the class crm:hasNote to directly link the target text with the commentary. The properties are reported in Figure 5.
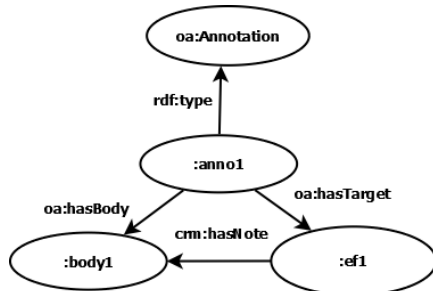

Fig. 5. Relation between the text and the commentary.

We modeled the content of a commentary as an instance of the class oa:Body. Figure 6 shows the repre-

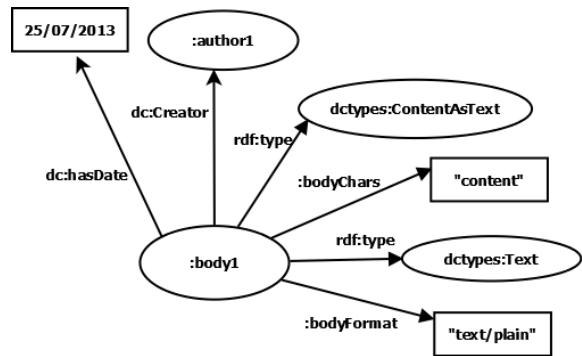sentation of a commentary having, like the Expression Fragment, a textual content.

Fig. 6. Representation of a commentary.

A commentary can have more than one fragment, where a fragment in a commentary is the portion of text within the commentary that cites a single primary source. The frbroo:ExpressionFragment is also used to represent a fragment of commentary. A Selector is used to identify the exact portion of the commentary that is part of the fragment.

In order to model the textual content of a fragment of a commentary and to distinguish it from a fragment of Dante's text, we defined two sub properties:

1. a sub property of dc:format, named bodyFormat, taking as values MIME types. It gives the media type of the body.
2. a sub property of cnt:chars, named bodyChars, which represents the character sequence of the body.

We added the new property hasCitingFragment to relate the commentary with its own fragments. We defined the hasCitingFragment as a sub property of the frbroo:hasFragment.

The fragment of commentary refers to a primary source through three sub properties of the cito:cites property we defined: (i) citesAsExplicitCitation, (ii) citesAsStrictCitation, (iii) citesAsGeneralCitation.

As reported above, in order to describe a work referred by the commentary, we used the class frbroo:Work. In our schema a work has an author and a thematic area (e.g. Rhetoric, Astronomy, Aristotelianism, etc.). We represented this additional knowledge using the classes foaf:Person and skos:Concept, respectively. To link the frbroo:Work class with the other two classes we used two Dublin Core properties: dc:creator, and dc:subject, respectively. In Figure 7 we
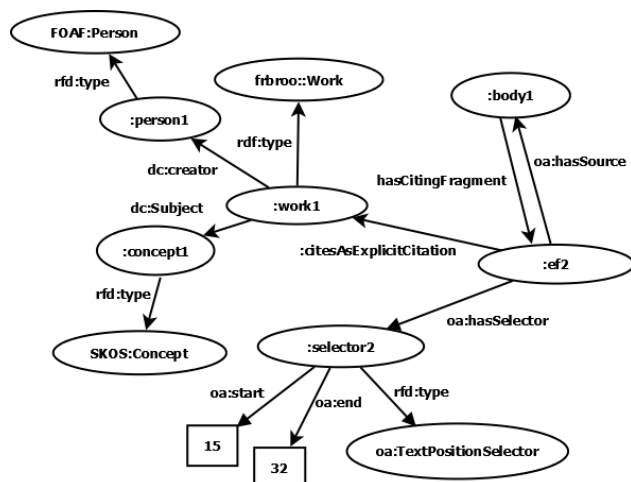
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[9]http://www.w3.org/ns/oa

Fig. 7. The representation of the knowledge on a commentary.

present the representation of the knowledge on a commentary. Currently, we are working on translating the ontology from RDF language to OWL.

5. Ontology Population

A Java tool to transform our original data set of Dante's works in DOC format into an annotated corpus in RDF format, using a text processing approach, was developed. The tool allows automatically extracting the following pieces of information from the DOC and putting them into a CSV file:

– number of the book, the chapter and the paragraph of the text fragment to which the commentary refers to;
– the text fragment to which the commentary applies (e.g., *"Sì come dice lo filosofo nel principio della Prima Filosofia"*/As the Philosopher says at the beginning of the First Philosophy);
– the entire text of the commentary;

After this first step, the following knowledge has been manually added to CSV by three scholars:

– author of primary source (e.g. Aristotle);
– title of primary source (e.g. Metaphysics, the title is reported preferably in Latin);
– thematic area of the primary source (e.g. Aristotelianism, extract from the Nuovo Soggettario, as reported in Section 2);
– fragment of the text of the commentary citing a primary source (e.g.*"Queste sono le parole con*

cui si apre la Metafisica di Aristotele"/These are the words that open the Aristotle's Metaphisics);
– kind of reference (explicit, strict or generic reference)

At the same time, we developed an XML schema (XSD), compliant with the ontology, in order to represent our knowledge in a pre-axiomatic form. The schema defines the permitted elements, the related data and the hierarchy of elements. Then, the our tool automatically translates the CSV into an XML file, following the XML schema. Finally, we extended the tool in order to translate the XML into a RDF/XML file, which we stored into Virtuoso along with Soggettario Nazionale in RDF format.

6. Using the Ontology: the Web Application

In order to extract and display the knowledge stored in our digital library, we developed a web application to support scholars in writing a complete encyclopaedia of Dante's works. The application extracts knowledge by making SPARQL queries to the ontology. It is able to produce column bar charts in order to show the data about primary sources cited by Dante. We used the Highcharts[10] JavaScript library to implement these charts. This library allows exporting the charts in various well-known formats: PDF, PNG, JPEG, SVG. Furthermore, we implemented an additional JavaScript function allowing users to automatically export and download all the data extracted by the application in CSV format[11]. This feature is particularly important since it allows scholars to obtaining and managing raw data, in order to apply further data analyses.

Up to now, six different predefined SPARQL queries are available to extract data for a representation using column bar charts. They can be distinguished into two different groups. The first group includes three queries. For these queries the user can choose one Dante's works (or even all his works) and, in addition, a specific sub part of the work (e.g. a book). The queries return data regarding the distribution of the works, the authors and the thematic areas cited by Dante. Additional information about primary sources, authors and thematic areas are available by clicking on their names.

The three queries of the second group return several charts reporting the distribution of a particular pri-

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[10]http://www.highcharts.com/
[11]http://www.w3.org/2013/05/lcsv-charter.html

mary source, cited author or thematic area chosen by the user. The data regarding the distribution are available not only for an entire Dante's work, like Convivio, but also for its sub parts as books, chapters and poems.

The application is freely available on the web[12].

7. Conclusions

We have presented an ontology representing the knowledge included in literary texts and in their commentaries, with a specific attention to Dante Alighieri's works. We have described the complete process to create a formal semantic representation of the knowledge included in commentaries to Dante's works. We have started from an Excel file containing commentaries and references to primary sources. We have analyzed this file and we have developed a conceptualization, i.e. a set of concepts and relations underlying the knowledge reported in the spreadsheet. On the basis of the conceptualization we have created an ontology, expressed in RDF/S language. This ontology reuses classes and properties from other existing vocabularies and also embeds newly defined terms. We have populated the ontology with the knowledge included in several commentaries to Dante's works. On top of the RDF graph, we have developed a web application that visualizes the knowledge in the form of charts and tables. Such visualizations are useful to the scholars that work on the creation of a complete encyclopaedia of Dante's works. From our description, it emerges that our ontology and our web application can be applied also to other authors and commentaries.

References

[1] V. Bartalesi, C. Meghini, E. Locuratolo, and L. Versienti. A preliminary study on the semantic representation of the notes to Dante Alighieri's Convivio. *In Proceedings of the 1st International Workshop on Collaborative Annotations in Shared Environment: metadata, vocabularies and techniques in the Digital Humanities (DH-CASE '13)*. New York: ACM Press, 2013.

[2] C. Binding, K. May, D. Tudhope. Semantic interoperability in archaeological datasets: Data mapping and extraction via the cidoc crm. *In Proceedings of the 12th European Conference on Research and Advanced Technology for Digital Libraries, ECDL '08*. Springer-Verlag, Berlin, Heidelberg, 2008, pp. 280-290.

[3] M. Doerr. The cidoc conceptual reference module: An ontological approach to semantic interoperability of metadata. AI Mag. 24 (3) 2003, pp. 75-92.

[4] O. Eide, A. Felicetti, C. E. Ore, J. Holmen. Encoding cultural heritage information for the semantic web. *In Proceedings of EPOCH Conference on Open Digital Cultural Heritage Systems*, 2008, pp. 1-7.

[5] O. Erling and I. Mikhailov. RDF Support in the Virtuoso DBMS. Networked Knowledge-Networked Media. Springer Berlin Heidelberg, 2009, pp. 7-24.

[6] G. Fioravanti (Ed.). Opere. Vol. II: Convivio, Monarchia, Epistole, Egloghe. Mondadori, Milano, 2014.

[7] C. Giunta (Ed.), Opere. Vol. I: Rime, Vita Nova, De vulgari eloquentia, Mondadori, Milano, 2011.

[8] G. Gorni (Ed.). Opere. Vol. I: Rime, Vita Nova, De vulgari eloquentia, Mondadori. Milano, 2011.

[9] O. M. Madison. The IFLA functional requirements for bibliographic records. Library resources & technical services 44 (3) 2000, pp. 153-159.

[10] A. Miles, B. Matthews, M. Wilson, D. Brickley. Skos core: simple knowledge organisation for the web. *In Proceedings of International Conference on Dublin Core and Metadata Applications*, 2005.

[11] S. Peroni and D. Shotton. Fabio and cito: ontologies for describing bibliographic resources and citations. Web Semantics: Science, Services and Agents on the World Wide Web 17 2012, pp. 33-43.

[12] D. Quaglioni (Ed.). Opere. Vol. II: Convivio, Monarchia, Epistole, Egloghe. Mondadori, Milano, 2014.

[13] R. Sanderson, P. Ciccarese, H. Van de Sompel. Designing the w3c open annotation data model. *In Proceedings of the 5th Annual ACM Web Science Conference*, ACM, 2013, pp. 366-375.

[14] P. Sinclair, M. Addis, F. Choi, et al. The use of CRM core in multimedia annotation. *In Proceedings of Workshop on Semantic Web Annotations for Multimedia*, 2006.

[15] D. Shotton et al. Cito, the citation typing ontology. Journal of Biomedical Semantics 1 (S-1) 2010 S6.

[16] M. Tavoni (Ed.). Opere. Vol. I: Rime, Vita Nova, De vulgari eloquentia, Mondadori. Milano, 2011.

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[12] http://perunaenciclopediadantescadigitale.eu/dantesources/index.jsp