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RESEARCH ARTICLE

Ontological Foundation for Representing Metaphors as Part of LOD

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ABSTRACT The main goal of this study was to lay the foundation for the representation of written metaphors as Linked Open Data (LOD) on the Semantic Web (SW). To achieve this goal, this study proposed concepts and properties that allow metaphors from different domains to be linked. The use of the proposed formalism was illustrated through a case study of biblical data extracted from text, represented, populated, and queried to demonstrate the usage of the proposed ontological concepts. The proposed model reuses the FaBio bibliographic ontology to represent the bibliographic information of metaphoric data, and the OWL-Time ontology to represent the temporal aspects of events associated with metaphors. Examples from different domains are used to illustrate the implementation and population of concepts related to time instants and intervals. The notions of approximation and uncertainty in the description of the time of occurrence of events associated with the creation, publication, and translation of metaphors were also discussed. An important aspect of the proposed formalism is the representation of the qualities attributed to the vehicle and the target concepts of conceptual metaphors. This enables the identification of symbolism and interpretation of concepts in different contexts and domains. The proposed formalism was tested against a number of queries and proved to satisfy the information requirements.

INDEX TERMS Semantic web, linked data, natural language processing, ontologies, knowledge representation.

I. INTRODUCTION

The essence of metaphor is *"understanding and experiencing one kind of thing in terms of another"* [1]. Their association with shaping thoughts has been reported by several researchers [2], [3], [4], [5]. Metaphors influence the way information is assimilated and the inferences drawn from it [6], [7], [8]. They are used in every domain during communication, whether a scientific domain, a social domain or literature, in order to realize knowledge structures and '*provoke structurally consistent inferences*' [6]. For example, in [6], metaphors were investigated for their role in reasoning about social policies regarding crime. It was demonstrated that the metaphor used to address the social problems of crime influenced the proposed solutions.

Linguistic expressions can be spoken, signed or written. The current study focuses on written metaphorical phrases. The purpose of the present manuscript is to create an ontological foundation for the representation of written metaphorical phrases as part of Linguistic Linked Open Data (LLOD) on the Web that carries temporal and bibliographic information. It advocates the idea of representing metaphors as named resources on the Web that provide provenance, temporal, and bibliographic information and sets the foundation for the representation of similar linguistic phrases in the future. The representation of metaphors as distinct entities on the web that can be linked to online resources would enable users to query metaphors used in different domains such as scientific or literary resources.

The remainder of this paper is organized as follows. Section II introduces the notion and principles of Linked Open Data (LOD) and provides an overview of the important work in this area. It refers to important technologies underpinning the deployment of Linguistic Linked Open Data (LLOD), such as shareable Vocabularies, and annotation models. Section III describes the ontologies reused by the

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proposed model. Section IV presents the background of this study. It discusses the notion of metaphors, conceptual metaphors, and vehicle and target concepts of metaphors. Section V discusses the modeling requirements using metaphor examples. In Section VI, the proposed ontology is presented. Section VII presents a case study that demonstrates the derivation, population, and querying of concepts and roles introduced in Section VI. Section VIII provides an alignment between the proposed model and the OWL-Time ontology by introducing uncertainty and approximation in the representation of time instants. Section IX describes the use of temporal entities in which certain metaphor-related events occur.

Section X describes the implementation and evaluation of the proposed formalism. Section XI describes the innovation of the proposed formalism. Section XII compares the proposed model with important frame -based models. Finally, Section XIII is the Conclusion Section, which discusses the challenges and future work.

II. RELATED WORK

The present manuscript advocates the representation of metaphors as enriched linguistic resources that can be linked to other online resources following the *principles* of LOD. To formalize the representation of metaphors as linked open data, the proposed model was aligned with the OWL-Time [9] and FaBio [10] ontologies to represent time and bibliographic information, respectively. The next paragraphs introduce Linked Data (LD) and provide an overview of the principles for publishing Linked Data and the importance of interoperability, and shareable vocabularies.

A. LINKED DATA

Linked Data (LD) [11], [12] has gained widespread popularity in recent years as a representation formalism for publishing data on the web. The term Linked Data refers to the representation of data as a first class citizen on the Web [12] and as a paradigm supported by a set of best practices for publishing and interlinking structured data on the Web'' [12], [13]. This is an advancement over the idea of the World Wide Web (WWW) as a network of documents connected via hypertext links. Despite its global acceptability, the traditional WWW suffered from an important drawback: the fact that actual data and relations between data were not represented in documents as named objects was a major impediment to the interoperability, share-ability, and re-usability of resources. Furthermore, the structural and semantic properties of the data and data relations within documents and across different datasets are not retrieved through user search queries or dedicated application interfaces.

Linked Data (LD) advocates the representation of data according to web standards so that its structure and links with other data are explicitly stated. Representing data in this manner makes them directly accessible to web applications (through standard web protocols). The representation, publication, and querying of data on the web has become possible because of the implementation of Semantic Web (SW) technologies for the representation, deployment, and retrieval of data. Data resources and relations are expressed via Resource Description Framework (RDF) [14] statements (or triples) of the form (subject, predicate, object). The internal structure of the data can be represented by the construction of RDF graphs that can be queried via SPARQL and retrieved or searched via appropriate search engines, such as Falcons [15] and SWSE [16], and Linked Data Browsers such as Tabulator [17] and DBpediaMobile [18].

RDF is based on the concept of named resources and relationships between resources. Class-subclass and property-subproperty relations can be defined via RDF Schema (RDFS) and (OWL) [19], enabling taxonomic inferences. Links between the objects of different datasets can be established via ontology language primitives such as owl : sameAs, which enable the integration of different datasets. OWL XML/RDF serialization enables the representation of OWL ontologies on the Web.

1) LD APPLICATIONS AND WEB APIs

Since the inception of the linked data paradigm, several LD applications, Web APIs, and LD application platforms have been deployed. LD application platforms are multi-layered applications that enable the consumption, management, and deployment of linked data. For example, the Information Workbench platform [20] supports multi-layered LD application development. Web applications such as Silk[1] [21] provide tools that support the interlinking of data with datasets on the web, and transform and manage different sets of data sources. The linked Media Framework (LMF) offers a means to set up a server application for linked data and provides SW technologies to support the creation of a link data management system that allows access to linked data and the integration of metadata and resources.

B. LD PRINCIPLES

In 2006, Berners-Lee [11] set the following principles for publishing and interlinking data on the SW: (1) Use URIs as names of things, (2) use HTTP URIs to allow people to look up the names of things, (3) when someone looks up a URI, provide useful information using the standards (RDF, SPARQL), and (4) include links to other URIs so that they can discover more things. These principles are treated as the rules that guide the development of LD applications. According to these principles, every object and abstract concept should be uniquely identifiable by a URI [13], which should be de-referenced to the URL of a document containing useful information [13]. A generic document can be encoded in different formats, such as HTML, XML, and RDF, because the content of the response can be negotiated

[1] http://silkframework.org/

via the HTTP *content negotiation principle*.[2] This provides greater flexibility for resource representation.

C. INTEROPERABILITY

The representation and retrieval of linked data using common format (RDF) and query protocols (SPARQL) encourages interoperability. Applications are interoperable if they can meaningfully exchange information and work together by integrating and exchanging resources towards accomplish common tasks. Ide and Pustejovsky [22] cite a distinction between syntactic and semantic interoperability. The former refers to the format of data exchanged between applications and communication protocols used during data exchange. Semantic interoperability refers to the mutual interpretation of data. Consequently, semantic interoperability can be assumed when the two systems share a common vocabulary [23], and provide the same interpretation of terms in the shared vocabulary.

1) SHAREABLE VOCABULARIES AND ONTOLOGIES

Several shareable vocabularies, annotation models, and ontologies have been proposed to aid interoperability. Examples of widely used vocabularies encoded in RDF are the Friend of a Friend Vocabulary (FOAF)[3] [24], which describe people and social relationships on the Web; the Dublin Core (DC) Specifications[4] [25], [26] consisting of general-purpose annotation elements; the SIOC[5] [27], [28] vocabulary aimed at providing terminology for annotating online communities and their activities [27]; Geo[6] developed by the W3C Semantic Web Interest Group describing the position of spatially located objects; and the Data Catalog (DCAT) [29] vocabulary initially developed by the Digital Enterprise Research Institute (DERI) to facilitate the annotation of government catalogs on the Web. Vocabularies encoded via RDFS and OWL can be linked to the LOD Cloud [30]. Terminological relationships between the terms of different vocabularies can be established via OWL, RDFS, and the Simple Knowledge Organization System (SKOS) [31], [32]. The SKOS vocabulary aims to represent semi-formal organization systems such as thesauri, taxonomies, classification schemes, and subject-heading lists [31]. This enables the representation of concepts and the relationship between concepts, including terms representing concepts of different vocabularies, such as the skos:broader relation between two concepts of different vocabularies or ontologies. It is encoded in the RDF [31], making it possible to refer to it as part of the LD.

Not all vocabularies are underpinned by a consistent ontology formalism, which enables reasoning and inference. Trying to link data from many resources and importing different ontologies makes it difficult to maintain a consistent knowledge base. The intended semantics of the importing ontology should map the intended semantics of the imported ontologies or at least their part(s) used [33]. This also increases the verbosity of the user queries at the cost of additional effort.

a: LINGUISTIC LINKED OPEN DATA (LLOD).

The publication and interlinking of datasets that are globally available according to LD principles have provided a cloud of data on the web. LLOD [23], [34], [35], [36], [37] is the implementation of LD standards for the publication of globally accessible linguistic resources. A major problem in the use and integration of different linguistic resources is the lack of common standards for representing data structures and semantics [23], [34]. The inception of the LLOD Cloud was founded by the Open Linguistics Working Group (OWLG) to establish standards for the publication of linguistic resources under an open license. The group that is an open non-profit organization aims to: *(i) promote the idea of open linguistic resources, (ii) develop a means for representing open data, and (iii) encourage the exchange of ideas across disciplines* [23], [34]. There is a rapidly growing volume of published linguistic resources with data sets published in the LLOD cloud falling under the following categories [35], [38]: (i) corpora, (ii) terminology, thesauri, and knowledge bases, (iii) Lexicons and Dictionaries, (iv) Linguistic Resource Metadata, (v) Linguistic Data Categories, and (vi) Typological Databases.

III. REUSED ONTOLOGIES

To represent bibliographic and temporal information regarding metaphors, the proposed model reuses the following ontologies:

- FaBio [10] bibliographic Ontology
- OWL-Time [9] ontology

A. FABIO ONTOLOGY

The selection of an appropriate bibliographic ontology for reuse depends on the expressiveness required of the proposed model. An example of a bibliographic ontology investigated in the context of this research is the Bibliographic Ontology (BIBO)[7] ontology, which aims to represent bibliographic data on the Semantic Web. It is intended to be used ''as a citation ontology, as a document classification ontology, or simply as a way to describe any kind of document in RDF'' [39]. It includes definitions for the classes Document, DocumentPart, and Book, which can be used to provide a useful albeit broad classification of the resources from which metaphors are either extracted or cited. BIBO ontology provides a simple model for referencing bibliographic resources.

FaBio provides a detailed bibliographic ontology aimed at describing entities that are *''published or potentially publishable''* on the Semantic Web which can *''contain*

[2]https://www.w3.org/blog/2006/02/content-negotiation
[3]http://www.foaf-project.org
[4]www.dublincore.org/specifications/
[5]https://www.w3.org/Submission/sioc-spec/
[6]https://www.w3.org/2003/01/geo/
[7]http://purl.org/ontology/bibo

TABLE 1. FRBR and FaBio ontology core classes.

frbr : Work [40] A distinct intellectual or artistic creation; an abstract concept recognized through its various expressions; exists only in the commonality of content between the various expressions of the work [8]	**fabio : Work** [10] "A subclass of FRBR work, restricted to works that are published or potentially publishable, and that contain or are referred to by bibliographic references, or entities used to define bibliographic references" [10].
frbr : Expression [40] "The intellectual or artistic realization of work in the form of alpha-numeric, musical, or choreographic notation, sound, image, object."	**fabio : Expression** [10] "A subclass of *FRBR Expression*, restricted to expressions of *fabio : Works*" [10].
frbr : Manifestation [40] The physical embodiment of an expression of a work.	**fabio : Manifestation** [10] A subclass of FRBR manifestation, restricted to manifestations of fabio : Expressions . Applies to electronic (digital) as well as to physical manifestations of expressions.
frbr : Item [40] A single exemplar of a manifestation.	**fabio : Item** [10] A subclass of FRBR item, restricted to exemplars of fabio : Manifestations.
frbr : Endeavour [40] All of the above classes are subclasses of frbr : Endeavour	**fabio : Endeavour** [10] FaBio reuses frbr : Endeavour

or be referred to by bibliographic references or entities that are used to define bibliographic references" [10]. This is used to describe both textual and electronic bibliographic resources. FaBio is aligned with the generic non-application-dependent Functional Requirements for Bibliographic Records (FRBR) [40] data model. Similar to FRBR, it follows a multi-layered approach to modeling information representing separately: (i) the conceptualization of each resource (fabio : Work), (ii) its realization as content irrespective of formatting (fabio : Expression); (iii) its manifestation (fabio : Manifestation) as a physical or electronic embodiment of a work [41], taking into consideration formatting and physical or electronic properties; and (iv) its particular instantiations to items (Item) constituting physical or electronic examples of expression embodiment. The difference between a fabio : Expression and an frbr : Expression as stated in [10] is that: "a fabio:Expression can only have part or be part of another fabio:Expression. Moreover, it can only be a representation of a fabio:Work, and it can be embodied only in fabio:Manifestation(s)" [10]. That is, it is a "subclass of frbr:Expression, restricted to realizations of fabio :Work" [10]. This requirement is not enforced by the FRBR Ontology.

A FaBio Expression denotes the sequence of words and phrases in published or publishable textual objects, including their structural parts, examples of which are books, abstracts, chapters, articles, and excerpts, corresponding to the classes Book, Abstract, Chapter, Article, Excerpt, and Quotation, respectively.

[8]http://purl.org/spar/fabio

One disadvantage of using FaBio is that the distinction among FaBio Works, Manifestations, and Expressions is not always clear. For example, a particular publication of Plato's 'Republic' is an instance of a fabio:Manifestation class whereas the sequence of words and sentences constituting the content of 'Republic' is considered as an instance of the fabio : Expression class. For example, the fabio : Book class is a subclass of the fabio : Expression class, whereas the fabio : Poem class is a subclass of the fabio : Work class.

However, the alignment of FaBio with the widely used FRBR model, the inclusion of FaBio ontology to the SPAR [42] (Semantic Publishing and Referencing) complementary set of ontologies covering a wide range of bibliographic requirements and the fact that SPAR is written in OWL 2 DL makes it a suitable candidate for the representation bibliographic information.

A written metaphor (WrittenMetaphor in the proposed model) is considered as a subclass of met : Metaphor and met : WrittenLingExpr[9] (see later).

In DL:

$$\text{met : WrittenMetaphor} \equiv \text{met : Metaphor} \sqcap \text{met : WrittenLingExpr}$$

Because the class met : Metaphor is a subclass of the class fabio:Expression, an instance of WrittenMetaphor can only be a representation of a fabio:Work and can be embodied in a fabio:Manifestation. A met : LinguisticExpression is not constrained to realizing a particular instance of fabio:Work class and can be any constituent of a phrase.

B. OWL-TIME ONTOLOGY

To query time periods and instants associated with events relevant to metaphoric expressions, such as publication, translation, and the creation of metaphoric expressions, the notion of time must be integrated into the proposed model.

Dates concerning the provenance of written expressions follow particular patterns and may include uncertainty and approximation.[10] Simple references to time periods or instants of time on the web have been expressed via annotation schemes and vocabularies, such as dbpedia classes and properties (for example, dbo:birthYear) and the Dublin Core metadata element set (for example, dc : date). FaBio reuses Dublin Core's elements of time and location as well as the prism[11] annotation scheme to record time and location. For example, property fabio : hasPublicationYear is a sub-property of dcterms : issued[12] and its range property (rdfs : range) is xsd : gYear, as shown in Encoding 1.

The XML Schema [43], [44] language specifications of date and time datatypes are widely used in many ontologies, including FaBio Ontology, because they enable the representation of date and time values at various precision levels,

[9]met is he proposed IRI prefix for the proposed model
[10]http://www.museumprovenance.org/pages/standard_v1/
[11]http://prismstandard.org/namespaces/basic/2.0/
[12]http://purl.org/dc/terms/issued

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<http://purl.org/spar/fabio/hasPublicationYear>
rdf : type owl : DatatypeProperty ;
rdfs : subPropertyOf < http : //purl.org/dc/terms/issued > ;
rdf : type owl : FunctionalProperty ;
rdfs : range xsd : gYear ;
rdfs : comment "The year in which a resource is published."@en ;
rdfs : label "has publication year"@en .
```

ENCODING 1. FaBio has publication year property definition.

such as years via xsd : gYear, dates via xsd : date, date-time via xsd : dateTime, year and month via xsd : gYearMonth, and month via xsd : gMonth. The XSD date values follow a 7 element composition structure consisting of a century, year, month, hour, time, minute, and second. The time duration is expressed in a similar way with particular fields representing different units of time, so that the duration can be expressed at various precision levels using years, months, days, hours, and seconds. The values of these data types are represented in the proleptic Gregorian calendar. Total ordering is possible for xsd : dateTime and derived times when the zone indicator is absent. The derived datatypes of duration have a total order when they include elements from either (i) year, month, or (2) day, hour, minute, or second [43]. XML Datatypes are supported by many technologies; for example, they can be retrieved and processed by XPath [45], XQuery [46], [47], and XSLT [48] technologies. OWL 2 DL [49] supports only xsd : dateTime and xsd : dateTimeStamp datatypes.

Although XSD Encoding and vocabularies are sufficient for a wide range of applications, they do not provide an ontological foundation for the representation of (topological) ordinal relationships between time intervals or inference on (topological) ordinal relationships between time intervals. As datatypes, they do not enable the inclusion of properties, such as uncertainty and approximation.

The OWL-Time[13] [9] ontology was developed by Spatial Data on the Web Working Group[14] (SDWWG) in OWL 2 DL for the SW, aiming to provide a representation of topological ordering relations for time intervals and instants. Topological ordering refers to the time associated with the geographical location and calendar of the places where the events were recorded. Based on Allen Temporal Calculus [50], [51], it creates the prospects of inference over temporal entities. It also creates the prospect of associating events or activities with temporal entities, such as entities that belong to the time : Instant or time : Interval classes (refer to Figure 1).

OWL-Time [9] uses XSD data types to describe the time values for objects of class time : Instant, and the starting and ending times for objects of class time : Interval. The TemporalEntity class is the union of the time : Instant and time : Interval classes, as shown in Figure 1. Other classes include temporal duration (time :TemporalDuration)

[13]http://www.w3.org/TR/owl-time
[14]https://www.w3.org/2021/10/sdw=charter.html

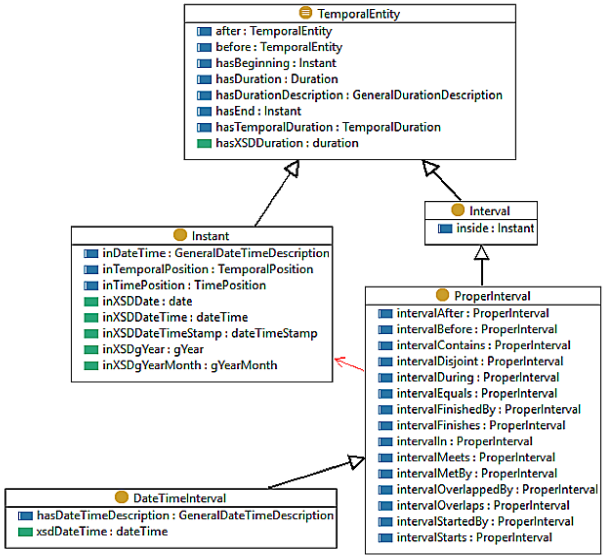


FIGURE 1. Basic classes of OWL-Time ontology.

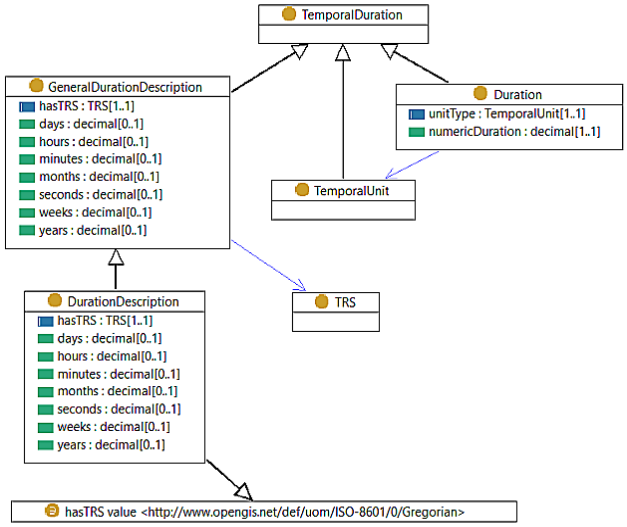


FIGURE 2. OWL-time classes for temporal duration.

and time position (time : TemporalPosition), as shown in Figures 2,3 allowing the representation of duration in the case of a non-Gregorian calendar, and temporal coordinates denoting a scaled position on a continuous temporal axis. For example, the GeneralDurationDescription class enables the representation of a date using a calendar other than the Gregorian calendar, in which case the calendar being used needs to be disclosed via time : hasTRS property.

Another factor that influences the treatment of temporal entities as first-class citizens is the representation of approximate and uncertain temporal instants. The present manuscript treats uncertain and approximate instants as instants whose uncertainty and approximate properties are set to true, respectively.

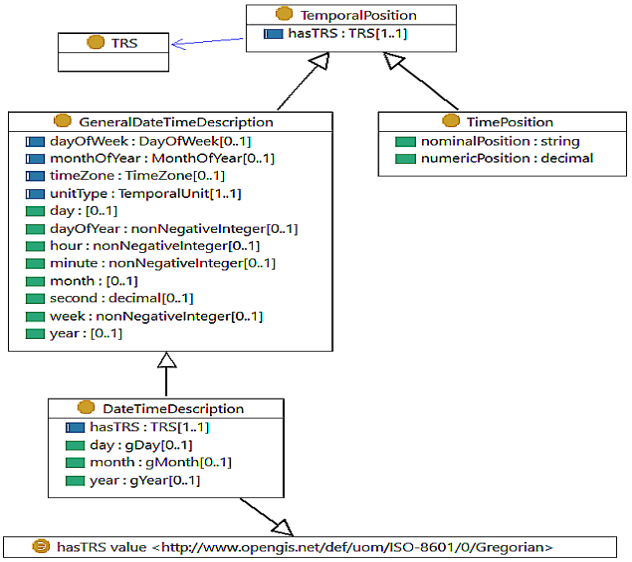


FIGURE 3. OWL-time classes for temporal position.

IV. BACKGROUND

In 1980, Lakoff and Johnson cited the first systematic study of Conceptual Metaphors [52], which led to the Conceptual Metaphor Theory (CMT) [52]. Thus far, the conceptual and linguistic nature of metaphors has been extensively discussed in the literature; for example, in [53], [54], [55], [56]. Knowles and Rosamund [57] defined metaphor as *the use of language to refer to something other than what it was originally applied to or literary means to suggest some resemblance or make a connection between the two things*.

Zoltan [3] discussed the different nature of conceptual metaphors and metaphorical linguistic expressions, stating that the former refers to mapping one conceptual domain to another. Lakoff and Johnson [52] pointed out the importance of metaphor *not only in language, but also in thought and action* and stressed the essential role of metaphor in structuring reasoning.

Conceptual metaphors are closely related to conceptual (cognitive) systems. Knowles and Rosamund [57] referred to metaphors as 'a kind of thinking or conceptualization.' Allbritton et al. [58] commented on the schema-based structure of metaphors, as discussed by Gibbs [59]. Linguistic metaphors are considered realizations of conceptual (or cognitive) metaphors [56].

Words or phrases participating in a metaphor can be identified as the *source* (or *vehicle*) and *target* (or *topic* or *tenor*) concepts of the metaphor, respectively. The term *target* (or *topic* or *tenor*) refers to the intended meaning of metaphor; the unit of linguistic expression attributed to metaphor is described as the *vehicle* of the metaphor and the similarity or connection between a unit of linguistic expression attributed to metaphor (*vehicle*) and its meaning is referred to as the *ground* of metaphor [57]. The following example extracted from [57] addresses the different parts of a metaphor:

- context: Be prepared for a mountain of paperwork
- metaphor (vehicle): mountain
- meaning (topic): a large amount
- Connection (grounds): ideas of size, immovable, and difficult to deal with.

In the above example, the *Conceptual Metaphor* (CM) can be expressed as "LARGE IS (AS, COMPARED TO) A MOUNTAIN'. The vehicle is considered to be the concept of 'mountain,' which is compared to a large amount (of paperwork), representing the target concept.

The present work models the comparable qualities of the target and vehicle concepts by defining the classes met : ConceptQuality, met : VehicleTargetParallel, and properties: met : parallel_properties, met : target_quality, met : vehicle_quality, and met : parallel_to, as described in Section VI.

One of the main criticisms of linguistic literature is that it does not set any decision criteria regarding the unit of metaphor [60]. The annotation of CMs in natural language data has proven to be more problematic than the identification of linguistic metaphors [55]. In [55], the annotators labeled the vehicle and target domains of metaphors at different levels of granularity, even when provided with a common CM list such as the Master Metaphor List [61]. Several researchers have expressed skepticism about the use of CMs to classify metaphors and have commented on the lack of criteria for determining whether a phrase or word is classified as a metaphor [62]. Owing to the above observations, the current work does not attempt to provide a list of conceptual metaphors per ce but to identify the basic concepts underpinning an ontology of written metaphors. The representation of qualities attributed to the vehicle and target concepts in CMs, helps compare the interpretation of concepts in different domains.

The importance of context in the representation of metaphor is discussed in [3] and is reflected in the Metaphor Identification Procedure (MIP) published by the Pragglejaz group of researchers [63]. The MIP procedure requires reading a text-discourse first to gain a general understanding of its meaning, determine the lexical units in the text-discourse, and for each one of them determine its contextual meaning. If a linguistic unit has a more basic contemporary meaning in other contexts and if its contextual meaning contrasts with a more basic conventional meaning, then it should be recognized as metaphorical. In this study, the context of qualities attributed to the vehicle and target concepts of metaphorical phrases was defined as an object property linking (indirectly) the qualities of these concepts to their metaphorical phrases.

V. MOTIVATING EXAMPLES

A case study was developed to model the domain of the freely available file B25425.xml [64] which encodes in XML-TEI format the content of the book titled: *"Troposchēmalogia:Tropes and figures; or, A treatise of the*

metaphors, allegories, and express similitudes, &c. [65]. The file records an extensive list of metaphoric epigraphs together with bibliographic information and information about the verses, chapters, and books from which the epigraph metaphors are extracted, as well as parallelism sections that list the grounds for comparing the qualities of the vehicle and target concepts. Additionally, it includes separate sections in which the qualities of vehicle concepts are discussed. Representing this information helps identify and compare the interpretations of metaphors of different domains and creators. For example the interpretation of 'light' in Heraclitus example is different from the interpretation of 'light' in the Bible. However, on many occasions, authors are influenced by symbolism in religious and other domains.

In this case study, a small ontology of the file content was created by linking the concepts of the proposed metaphor model to the domain of the file. The methods deployed for the extraction, representation, population, and querying of data are outlined in Section VII.

Apart from the Scriptures Examples in [64], additional examples included in the current section aim to show the wide applicability of the concepts involved in the proposed model to a variety of domains. These are also encoded in the RDF to show (i) the use of temporal entities, and (ii) queries concerning particular target or vehicle concepts that can be deployed for metaphors of different domains. Creating a detailed representation of the domain of each example used is beyond the scope of this study.

A. EXAMPLES FROM THE RELIGIOUS DOMAIN

Metaphors are extensively used in religious literature, and the Bible is a rich source of figurative expressions including metaphors and similes. Symbolism interwoven into the Bible has significantly influenced Western and American literature. For example, Eliot ''Four Quartets'' [66], Shakespeare's ''Sonnet 146'' [67], Milton ''Paradise Lost'' [68], Blake ''The Lamb'' poem [69], and many eminent writers were influenced in their writings by the symbols and vocabulary of the Bible. The religious data and examples used in this section were extracted from the B25425.xml [64] file representing the content of the book titled *Troposchēmalogia: Tropes and figures; or, A treatise of the metaphors, allegories, and express similitudes, &c.*.[15] The grounds upon which the association between vehicle and target concepts are based are included in [64] under the heading parallel qualities; for each conceptual metaphor being considered in [64], there is an association between the qualities of the target and source concepts being compared. The qualities of either of these concepts are also discussed separately on many occasions without mentioning their parallelism to either their target or the vehicle concept.

Example 1: The metaphoric expression: *"He cometh up like a Flower and is cut down"* is included under the heading: *"Man compared to Flower"* materializing the conceptual metaphor: ''MAN IS A FLOWER.'' The conceptual metaphor is grounded in parallel quality comparisons, as follows:

- [Vehicle (metaphoric) concept (flower) quality]. ''A flower hath a root, from whence it grows and springs up''
- [Target concept (man) quality] . ''So all men have one common root, from whence they spring up, viz. the first Adam''.

Example 2: The expression: *"Have Salt in your selves, &c."* (Mark 9.50.) in [64] is used metaphorically. The comparison: *"Grace compared to Salt"* instantiates the conceptual metaphor: ''GRACE IS SALT''. The stated conceptual metaphor is grounded in parallel quality comparisons as follows:

- [Vehicle concept (salt) quality]. ''Salt is of a searching quality; if it be laid or rubbed upon meat, it will pierce and search it to the very bone;''
- [Target concept (grace) quality]. ''True grace, or the spiritual operation of the spirit, is of a searching nature; it will (when received in Truth) infuse itself into every faculty of the soul: The Spirit searcheth all things, yea, (Cor. 2.) the deep things of God. If there be any sin hid, it will search and find it out.''

Example 3: The comparison: *"The Holy Angels compared to the Morning-Stars"* implies the conceptual metaphor: ''ANGELS ARE MORNING-STARS.'' Some of the stated grounds supporting this parallelism are as follows:

- [Vehicle concept (morning star) quality]. ''Morning-stars are full of beauty, bright, and glorious; Morning-stars give light; they are not only beautiful but shining. The chief morning-star, Lucifer, signifies a light-bringer.''
- [Target concept (angel) quality]. ''Angels are very beautiful creatures, their glory is wonderful. Hence, Stephen's face was said to be as it had been the face of an Angel; Acts 6. ult. and very beautiful persons are said to resemble or seem like angels. Tho they have not a visible bodily beauty, yet they have better beauty than any body. Stars are guides to mariners, by which they know how to steer a right course.''

Example 4: Consider the metaphoric expression: *"The Roaring of the Lion, and the Voice of the fierce Lion, and the Teeth of the young Lions are broken"*. The conceptual metaphor of this expression in [64] is the ''WICKED MEN ARE LIONS''. Conceptual metaphors can be paraphrased in the same file to express comparisons or similarities. For example, the conceptual metaphor of this example is expressed as a ''WICKED MEN COMPARED TO LIONS''. The qualities compared include the following.

- [Vehicle concept (lion) quality]. ''[...] Lions are of fierce, sower and stern countenance (Gesner. Topsel. p. 370.)'' and in the sight of men, ''...tis said, he is seldom found without rage.''

[15] https://llds.ling-phil.ox.ac.uk/llds/xmlui/handle/20.500.14106/B25425

- [Target concept (wicked man) quality]. ''[. . .]And we may see what the intent of a person is, by his looks; many are in this respect lion-like: They have (as Aristotle saith of the Natural Lion) clouds and storms hanging about their eye-brows; [. . .].''

Example 5: Metaphoric Expression (as epigraph): *''Ye are the Light of the World; a City that is set on a Hill cannot be hid''*. The conceptual metaphor supported for this phrase in [64] is: ''SAINTS ARE LIGHT.'' The file explains that the qualities that make these concepts comparable, as stated by the authors, are:

- [Vehicle concept (light) quality]. ''[. . .] Light shines forth and is visible to all; every one that hath eyes may see the light. A candle should not be lighted, and put under a bushel, but on a candlestick, that it may give light to all that are in the House''.
- [Target concept (Saint) quality]. ''So the Saints should let their good works appear to all (Mat. 5.16.)''. ''Let your Light so shine before men, that they may see your good works, and glorify your Father which is in Heaven. Tho the Saints should do nothing through vain-glory, i. e. to be seen of men; yet their good works, and holy walkings should be so done, that others should see it''.

B. EXAMPLES FROM DIFFERENT DISCIPLINES

Non-religious examples were downloaded via an available tool in CSV format from the University of Virginia Metaphor Database [70].

Note 1: The grounds for vehicle and target concepts quality comparisons in the following examples' conceptual metaphors were not stated and omitted.

Example 6: Following is an example of expressions that have the same conceptual metaphor.

- The expression *''Time flies,''* is a translated form of the Latin expression *''tempus fugit.''* It is derived from the expression *''Sed fugit interea fugit irreparabile tempus''* extracted from line 284, book III of the work of Virgil titled Georgics.
- The phrase *''Swift fly the years''* by Alexander Pope (1688-1744) from line 21 of his poem ''The Messiah'' published in 1712 is influenced by the phrase *''Time flies.''*

The conceptual metaphor of all phrases in Example 6 may be expressed as ''TIME IS A MOVING OBJECT'', with the target concept being the concept of time and the vehicle being the concept of a moving object. Bibliographic information is also disclosed for all phrases and temporal information regarding the creator's lifespan and the year in which *swift fly the years* is published.

Additional information can be added to represent the derivation and influence of one metaphor from another, as shown in Figure 11, where derivation associates a phrase to its original form. In this case, the property *wasDerivedFrom* must be a sub-property of the property *wasInfluencedBy*.

Example 7: Consider the metaphoric expression: *''All religions, arts, and sciences are branches of the same tree''* (by Albert Einstein). The following properties apply to this metaphor:

- This sentence materializes the conceptual metaphor ''DISCIPLINE IS A (TREE) BRANCH''.
- This metaphor was authored by Einstein in an article titled ''Moral decay'' in 1937 [71].

Example 8: Consider the metaphoric expression cited in [70]: *''When we are babies we must suppose this receptacle empty, and take the birds to stand for pieces of knowledge''*. This phrase was extracted from the dialogue between Socrates and Theaetetus [72]. The following observations can be made regarding this metaphor:

- It materializes the Conceptual Metaphors:
  1) ''MIND IS A CONTAINER'',
  2) ''KNOWLEDGE AS BIRD''
- The metaphor dates back to the temporal interval: 360 BC–355 BC.
- The author is: Plato (427 BC – 347 BC).

Example 9: Consider the metaphoric expression: *''A dry gleam of light is the wisest and best soul''*.

Date of creation: c. 501 B.C..

Author: Heraclitus (fl. 504 − 1 B.C)'' The metaphor materializes the conceptual metaphor: Wise Soul is a Dry gleam of light. The metaphor is part of the ''Fragments by Heraclitus'' translated from the original expression by G.T.W. Patrick. According to Heraclitus, the soul is made up of fire and water where fire denotes the noble part and water the 'ignoble' part; a soul is dry and light when it is made mostly of fire.

C. MODELING REQUIREMENTS

The above examples focus on the requirement to answer the following queries about metaphors:

1) What is the Conceptual Metaphor associated with each metaphor?
2) What metaphors share the same Conceptual Metaphors?
3) What are the Source and Target Concepts associated with each metaphor?
4) What are the respective qualities of source and target concepts being compared?
5) What bibliographic information is associated with each metaphor (e.g., title of the work or creator)?
6) What is the temporal information regarding the occurrence of events such as translation, publication, and creation of metaphors, as well as the life-span of an author or his/her froluit period?
7) What is the context of interpretation of each concept quality?
8) What metaphors are derived or influenced by another metaphor?

Note 2: Information on the last requirement is not provided for the case study data, and is omitted from this study. It is modeled for the non-religious examples.

VI. PROPOSED ONTOLOGY

The core concepts of the proposed model are illustrated in Figure 4. Each vehicle or target concept of a conceptual metaphor is linked to its quality(ies) (expressed as an instance of the ConeptQuality class) using the property has_quality.

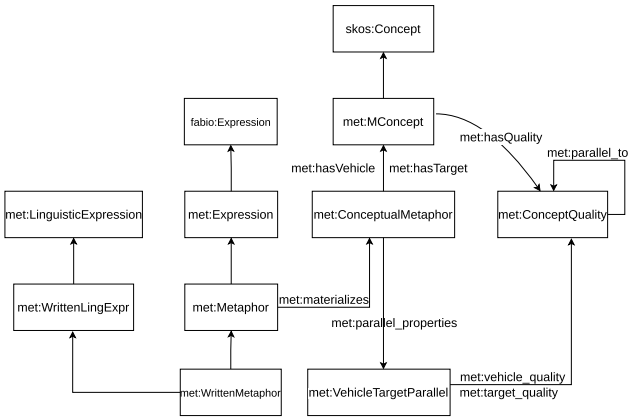


FIGURE 4. Main ontology concepts and roles.

Conceptual metaphors were also linked to instances of the Vehicle_Target_Parallel class by comparing the qualities of the vehicle and target concepts. On some occasions, the qualities of one of the vehicle or target concepts of a conceptual metaphor appeared in the domain file without a parallel comparison with the qualities of the other. Property hasQuality in Figure 4 aim to represent the quality of each concept separately. The domain does not include a 1 : 1 correspondence between the qualities of the vehicle and the target concepts of conceptual metaphors, but sets of qualities of one concept compared to sets of qualities of the other. Qualities in the same set express different views of the same concept.

The qualities ascribed to each concept depend on the context in which they are considered. To determine the context in which a particular quality holds, the property met : inContextOf is defined as an object property using the following SWRL rules:

$$\begin{aligned}&\text{met}:\text{WrittenMetaphor}(?\text{m})\,\hat{}\,\text{frbr}:\text{partOf}(?\text{m},?\text{e})\,\hat{}\\&\quad\text{met}:\text{inContextOf}(?\text{q},?\text{m})\rightarrow\text{met}:\text{inContextOf}(?\text{q},?\text{e})\\&\text{met}:\text{inContextOf}(?\text{q},?\text{e})\,\hat{}\,\text{met}:\text{traslatedFrom}(?\text{e1},?\text{e})\\&\quad\rightarrow\text{met}:\text{inContextOf}(?\text{q},?\text{e1})\end{aligned}$$

The concepts of the proposed ontology were combined with bibliographic concepts from FaBio ontology, as shown in Tables 2 and 3. The Description Logic (DL) [73] definitions provide the logic-based theoretical underpinning of the definitions of concepts and roles and aim to provide a concise and compact definition of the TBox and ABox of the main concepts and roles of the proposed formalism. The ABox is formed by the population of the proposed ontology using a case study, as presented in Section VII.

However, it was omitted from the subsequent definitions of concepts and roles in the remaining sections of the paper, and the Turtle[16] syntax, in which the ontology is encoded, was used. The steps followed in the development of the proposed ontology were as follows: (i) extraction of domain knowledge, (ii) representation of the ontology in the RDF, (iii) population of the ontology, and (iv) evaluation of the ontology.

A. TBOX

The Core Concepts and Roles of the proposed ontology are presented in Tables 2 and 4, respectively. Other concepts that are useful in the representation of the bibliographic knowledge of the case study aligned with FaBio Ontology concepts are listed in Table 3.

Note 3: For brevity, the suggested namespace (met) of the proposed ontology is omitted from the tables.

VII. CASE STUDY

The aim of this case study was to demonstrate the implementation and population of the concepts introduced in Section VI. The case study is based on the contents of file B25425.xml encoding in TEI [77], [78] format the contents of the book titled "*Troposchēmalogia: Tropes and figures; or, A treatise of the metaphors, allegories, and express similitudes, &c.*" [65]. As such, it does not provide a complete model for the underlying domain, but demonstrates the implementation of core metaphoric concepts and suggests the benefits of aligning the proposed model with a domain to improve query expressiveness. The file served as an input to a sequence of programming steps for the extraction of its contents in a structured form, as there was no tool available to the author's awareness for the extraction of relevant parts in text format, and the file included paraphrased titles linking text, which made the extraction process more specific.

A. COLLECTION METHOD

Several scripts were developed (eight in total) in Python to extract the relevant parts from the B25425.xml file. The scripts were run sequentially, and each script created a CSV file that served as input to the following script(s). The B25425.xml file was initially scraped using the Beautiful Soup [79] library written in Python. The following steps were performed.

- First, the Table Of Contents (TOC) was scraped after removing unnecessary elements, such as removing <gap> elements and replacing <hi> elements with their content. The TOC includes comparison phrases (associating source and target concepts) paraphrasing conceptual metaphors. These were scraped and stored in a CSV file for subsequent use in the following scripts, together with more general themes. Concept metaphors were identified as the most specific titles of the items listed in the TOC and had to be retrieved recursively. Broader titles (embedding items) served as themes and classification titles. For example, in HTML Encoding 2,

[16]https://www.w3.org/rdf12-turtle

TABLE 2. Core concepts of metaphor ontology.

Class	Description
ConceptualMetaphor	Expresses a comparison between dissimilar concepts, referred to as tenor and vehicle, respectively. ConceptualMetaphor $\sqsubseteq$ owl:Thing
ConceptQuality	Used to describe the qualities of each of the vehicle and tenor concepts of each conceptual metaphor. ConceptQuality $\sqsubseteq$ owl:Thing.
Vehicle_Target_Parallel	Each instance of Vehicle_Target_Parallel includes a link to one vehicle quality description and one parallel tenor quality description. The parallelism between the two quality descriptions aims at grounding the comparison made by the conceptual metaphor. The direct link between the ConceptualMetaphor and Vehicle_Target_Parallel enables the explicit representation of the pair of qualities being compared discriminating between vehicle quality and target quality.
MConcept	Any concept being a target or a vehicle in a metaphor. MConcept $\sqsubseteq$ skos:Concept
Expression	Comprises all instances of fabio:Expressions which include or represent metaphors. Expression $\sqsubseteq$ fabio:Expression
ExpressionCollection	A recorded collection of objects of type Expression. It is a subclass of fabio:ExpressionCollection (itself a subclass of fabio:Expression) and Expression. ExpressionCollection $\sqsubseteq$ fabio:ExpressionCollection $\sqcap$ Expression
LinguisticExpression	Comprises identifiable expressions in Natural Language consisting of intelligible sequences of words. A linguistic expression is not constrained to be a realization of an identifiable fabio:Work. It may be a phrase which does not realize an identifiable work, but is an intelligible sequence of words, such as the simple phrase "I am writing". As stated in the definition of fabio:Expression in Table 1, an instance of Expression may not be in Natural Language. A ballet, a painting, and a musical are all instances of Expressions. However, a ballet and a painting are not instances of LinguisticExpressions since they not spoken, printed or written sequences of words. The definition of LinguisticExpression class is influenced by the definition of the E33 LinguisticObject class in the FRBR_oo model [74], [75] which is not a subclass of F2 Expression [74]. LinguisticExpression $\sqsubseteq$ owl:Thing.
WrittenLingExpr	The written or printed form of linguistic expressions. Can be part or have parts only instances of WrittenLingExpr. WrittenLingExpr $\sqsubseteq$ LinguisticExpression, $\forall$part.WrittenLingExpr $\sqsubseteq$ WrittenLingExpr, $\forall$partOf.WrittenLingExpr $\sqsubseteq$ WrittenLingExpr.
Metaphor	A non-literal "figure of speech that implies comparison between two unlike entities"[17]. Metaphors considered in this manuscript are both Expressions (i.e. realizations of identifiable works for which bibliographical information may be kept and Linguistic Expressions in Natural Language consisting of intelligible sequences of words). Metaphor $\sqsubseteq$ Expression
WrittenMetaphor	A written or printed form of a Metaphor. WrittenMetaphor $\sqsubseteq$ WrittenLingExpr $\sqcap$ Metaphor

TABLE 3. Other useful concepts.

WorkCollection	A collection of works where each work is an instance of the fabio:Work class and is realized by an Expression. WorkCollection $\sqsubseteq$ fabio:WorkCollection $\sqcap$ $\forall$fabio:realization.Expression WorkCollection $\sqsubseteq$ $\forall$partOf.fabio:Work, WorkCollection $\sqsubseteq$ $\forall$part.fabio:Work
Book	A subclass of fabio:Book represents the class of written or printed objects of type fabio:Book that are referred to in metaphor representation. The fabio:Book is described as "a document that is complete in one volume or a designated finite number of volumes. A book published by a publisher is usually identified by an International Standard Book Number (ISBN), and may be manifested as a physical printed publication on paper bound in a hard or soft cover, or in electronic format [...]" Book $\sqsubseteq$ Expression
BookVolume	A written or printed book volume (type fabio:BookVolume) only part of some book. Following FaBio, a book volume is a document that is complete in one volume which may be manifested as a physical printed publication on paper bound in a hard or soft cover individually, or in electronic format. FaBio used metadata to represent volume numbers. BookVolume $\sqsubseteq$ Book $\sqcap$ $\exists$partOf.met:Book.
Epigraph	An epigraph is described as a "short quotation often from a classical or biblical source, which appears at the beginning of a work such as a novel, poem or non-fiction book" [76]. In this context, an epigraph is an Expression. Epigraph $\sqsubseteq$ Expression.

a specific comparison *"Saints Eagles"* is under the heading *"Concerning the Saints."*

[17]https://www.britanica.com/art/metaphor

- Next, the HTML DIV elements containing conceptual metaphors (mostly paraphrased in the form of comparisons between concepts) were scraped (<DIV type = "part"> or <DIVtype = "subpart">)). The extracted

TABLE 4. Main roles of the proposed ontology.

Role	Domain	Range
materializes	Metaphor $\exists$materializes.$\top \sqsubseteq$ Metaphor	ConceptualMetaphor (CM) $\top \sqsubseteq \forall$materializes.CM*
has_target	ConceptualMetaphor (CM) $\exists$has_target.$\top \sqsubseteq$ CM	MConcept $\top \sqsubseteq \forall$has_target.MConcept
has_vehicle	ConceptualMetaphor $\exists$has_vehicle.$\top \sqsubseteq$ CM	MConcept $\top \sqsubseteq \forall$has_vehicle.MConcept
has_quality	MConcept $\exists$has_quality.$\top \sqsubseteq$ MConcept	ConceptQuality $\top \sqsubseteq \forall$has_quality.ConceptQuality
parallelTo	CQ* $\exists$parallelTo.$\top \sqsubseteq$ CQ	CQ $\top \sqsubseteq \forall$parallelTo.CQ
parallel_properties	ConceptualMetaphor $\exists$parallel_properties.$\top \sqsubseteq$ CM*	Vehicle_Target_Parallel $\top \sqsubseteq \forall$parallel_properties.VTP
vehicle_quality	Vehicle_Target_Parallel (VTP) $\exists$vehicle_quality.$\top \sqsubseteq$ VTP*	CQ $\top \sqsubseteq \forall$vehicle_quality.CQ
target_quality	Vehicle_Target_Parallel $\exists$target_quality.$\top \sqsubseteq$ VTP*	CQ $\top \sqsubseteq \forall$target_quality.CQ
genre	frbr : Endeavour $\exists$genre.$\top \sqsubseteq$ frbr : Endeavour	skos : Concept $\top \sqsubseteq \forall$genre.skos : Concept
lineOf	frbr : Endeavour $\exists$lineOf.$\top \sqsubseteq$ frbr : Endeavour lineOf $\sqsubseteq$ partOf	Expression $\top \sqsubseteq \forall$lineOf.Expression
volumeOf	frbr : Endeavour $\exists$volumeOf.$\top \sqsubseteq$ frbr : Endeavour	met : Expression $\top \sqsubseteq \forall$volumeOf.met : Expression
wasDerivedFrom	met : Metaphor $\exists$wasDerivedFrom.$\top \sqsubseteq$ met : Metaphor	met : Metaphor $\top \sqsubseteq \forall$wasDerivedFrom.met : Metaphor
wasInfluencedBy	met : Metaphor $\exists$wasInfluencedBy.$\top \sqsubseteq$ met : Metaphor	met : Metaphor $\top \sqsubseteq \forall$wasInfluencedBy.met : Metaphor
Property	**subPropertyOf**	**DL Axiom**
lineOf	partOf	met : lineOf $\sqsubseteq$ partOf
volumeOf excerptOf wasDerivedFrom	partOf partOf wasInfluencedBy	met : volumeOf $\sqsubseteq$ partOf met : lineOf $\sqsubseteq$ partOf met : wasDerivedFrom $\sqsubseteq$ met : wasInfluencedBy

(*): For brevity, the following names were used instead of the original names whenever there was a space limitation:
1) CM $\equiv$ ConceptualMetaphor
2) VTP $\equiv$ Vehicle_Target_Parallel
3) ConceptQuality $\equiv$ CQ

```
<list>
The Eighth HEAD, concerning Men in general,
Good Men, Wicked Men.
<item> MAn compared to Earth </item>
<item> Man compared to a Worm </item>
<item> Man compared to a Flower </item>
<item>
 <list>
  <head> Concerning the Saints, or Good Men</head>
  <item> Saints called Babes </item>
  <item> Saints Children </item>
  <item> Saints Heirs </item>
  <item> Saints Eagles </item>
  <item> Saints Souldiers </item>
  <item> Saints Runners </item>
 </list>
</item>
</list>
```

ENCODING 2. Embedded list item Example.

metaphors were encoded in the file as XML-TEI $<$epigraph$>$ elements. The textual content of the embedded paragraph elements ($<$ p $>$) and their associated bibliographic references was scraped and stored in another CSV file. In Encoding 3, the phrase "Saints *compared to* Children." in the <head> of the element corresponds to the title "Saints children" in the TOC. The metaphors extracted under this heading are the phrases: "if children, then Heirs" (part of paragraph 17 of chapter 8, of the Romans book of the King James Version (KJV)) of the Bible and the phrase "For ye all are the Children of God, by Faith, in Christ Jesus" (chapter 3, paragraph 16, Galatians, KJV of the Bible).

Matching <DIV> <head> elements to the table of content titles with corresponding conceptual metaphors deterministically succeeded by up to 56% due to paraphrasing, although it is envisaged that there is scope for manual elaboration and improvement in the future.

Because of the incoherence of conceptual metaphor patterns, expressed as comparisons between a vehicle and a target concept at different locations in the file, several regular expressions were created to extract each

```
<div type="part">
 <pb n="142" facs="tcp:39531:86"/>
 <head> Saints compared to Children. </head>
 <epigraph>
 <q>
  <p>
  <bibl> <hi> Rom. 8.17.</hi> </bibl>
  If Children, then Heirs, <hi>&amp;c.</hi>
  </p>
  <p>
   <bibl> <hi>Gal. 3.16.</hi> </bibl>
   For ye all are the Children of God,
   by Faith, in Christ Jesus.
  </p>
  <p>
   <bibl> <hi> Eph. 5.1.</hi> </bibl>
   Be ye Followers of God, as dear Children.
  </p>
 </q>
 </epigraph>
```

ENCODING 3. Conceptual metaphor and epigraph example.

conceptual metaphor, as shown in Encoding 4. Further work is needed to represent conceptual metaphors that follow a common form, as in the existing literature. For example, following the representation of metaphors in [52], the conceptual metaphor in Encoding 3 would be "SAINTS ARE CHILDREN."

```
def recognized_pattern(txt):
 r1 = re.compile(r"(The|the)?\s?(?P<subj>.+)\ (compared\ to|why\
      called)\ (?P<obj>.+)")
 r2 = re.compile(r"(The|the)?\s?(?P<subj>.+)\ (compared\ to|why\
      called)\ (an|a|the)?\ ?(?P<obj>.+)")
 r3 = re.compile(r"(The|the)?\s?(?P<subj>.+)\ called\ (an|a|the)?\ ?(?
     P<obj>.+)")
 r4 = re.compile(r"(The|the)?\s?(?P<subj>.+)\ a\ (?P<obj>.+)")
 r5 = re.compile(r"(The|the)?\s?(?P<obj>.+)\ of\ (?P<subj>.+)")
 s_obj = r1.search(txt) or r2.search(txt) or r3.search(txt) or r4.search
     (txt) or r5.search(txt)
 return s_obj
```

ENCODING 4. Regular expressions matching conceptual metaphors.

Other relevant elements extracted include:

- Metaphor-parallel <table> elements including comparisons between the qualities of vehicle and target concepts of conceptual metaphors;
- elements (<DIVtype = "parallel">) including paragraphs referring to the qualities of the vehicle concept,
- paragraph elements providing further relevant explanations;
- paragraphs referring to the qualities of vehicle concepts.

The above list is by no means exhaustive because the primary concern of this application was to exemplify the usage of the core concepts of the proposed ontology rather than to develop a fully fledged domain ontology for the scriptures.

B. CONCEPTS AND PROPERTIES

The concepts and properties created to model the domain knowledge of the case study according to the information requirements (refer to the query section) are illustrated in Figures 5, 6 and Tables 5 and 6. Some metaphors appeared in the context of a sequence of bible verses. To address this issue, class BibleVerseSeq was defined to hold information about these sequences of verses. The object properties first_verse, last_verse, and next_verse are used to provide ordering in the appearance of verses. Each verse in a sequence of verses is defined as a component of that sequence by using the component_of object property. An example of usage in Turtle format is included in Appendix A.

C. QUERYING

Queries were created to satisfy the following goals:

1) Determine the conceptual metaphors of the domain knowledge.
2) Determine the conceptual metaphors of each structural part (such as Book, Chapter, and Verse) of the Bible.
3) Determine the vehicle and target concepts of each conceptual metaphor.
4) Determine the qualities of source and target concepts grounding the conceptual metaphors.
5) Determine the 'parallel' qualities grounding the comparison between the source and target concepts of conceptual metaphors.
6) Find the metaphors that correspond to each conceptual metaphor.

Examples of queries and their results can be traced in Appendix B.

VIII. TEMPORAL INFORMATION ABOUT METAPHORS

The current section describes the alignment of the proposed metaphor formalism and FaBio with the OWL-Time ontology to represent time instants and intervals of time associated with events that influence the creation, translation, and publication of metaphors as well as the birth, death, and floruit life of the author of a metaphor. However, it is important to note that because the constructs of OWL-Time are not built into OWL 2, a purpose-built processor is required to process them.

The main classes of OWL-Time are illustrated in Figures 1, 2, and 3 in Section III. The proposed model associates instances of the FaBio Endeavour class with activities such as translation, creation, and publications as well as with the time instants and intervals over which these activities occur. The definitions of the time constructs in OWL-Time use XSD datatype properties to define their value spaces.

The definition of date-fragment elements is a particularly difficult task in XML Schema [81], which requires the definition of string patterns, value spaces for each pattern involved, and the development of an appropriate reasoner. Additionally, considering the calendar used in each historic reference increases complexity, because a calendar date referring to a non-Gregorian system may not correspond directly to the same date in the Gregorian calendar. For example, in the

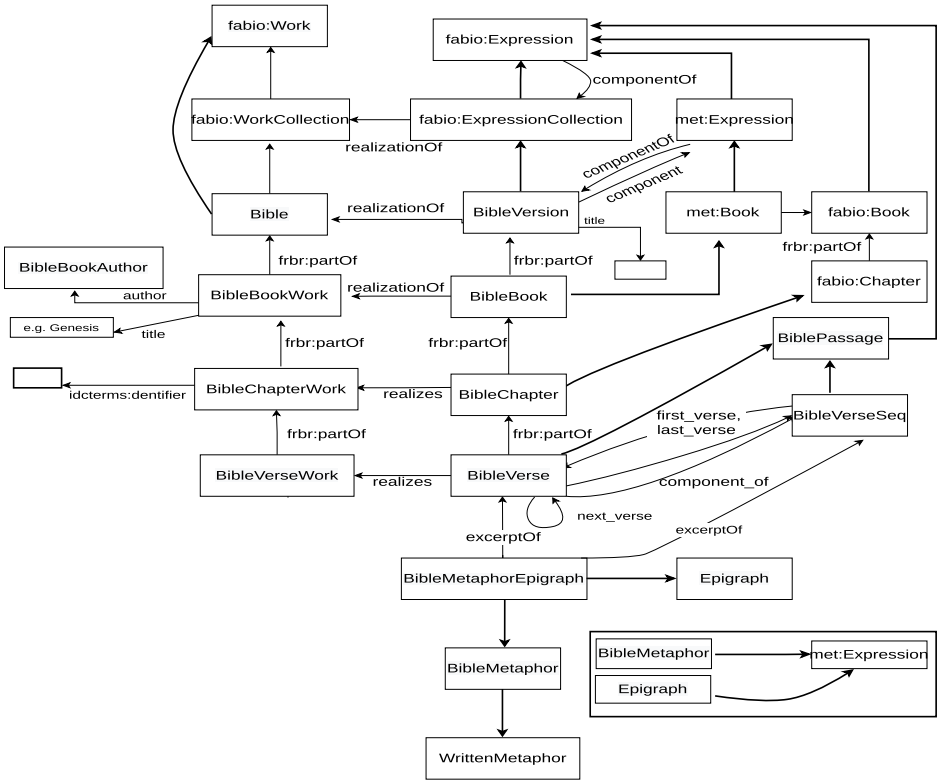


FIGURE 5. Core bible ontology.

TABLE 5. Case study concepts - for brevity the description logic (DL) definitions are omitted.

Concept	SuperConcept	Description
Bible	WorkCollection	In this context Bible refers to the work realized by a bible version. It is a conceptual representation that allows the grouping of all bible versions; no single bible version can be identified as the Bible Work.
WorkCollection	fabio:WorkCollection	Following the definition of fabio:WorkCollection a work collection is a collection of works, only that in the case of the proposed work a work collection refers to the works realized by instances of the class Expression.
BibleVersion	ExpressionCollection	A translation or paraphrase of the scriptures; may be from original, Hebrew, Greek and Aramaic languages or from another language.
BibleBook	Book	A scripture writing by a single author in the Bible. The Bible itself is considered as a book of books. For example, the book of Genesis traditionally attested to Moses although it contains much older stories.
BibleBookWork*	fabio:Work	In this context BibleBookWork refers to the work realized by a BibleBook.
BibleEpigraph	Epigraph	In the context of this work a Bible Epigraph is an excerpt taken from one or more bible verses suggesting a theme.
BibleChapter	fabio:BookChapter	A chapter in the Bible is a chapter in a Bible Book subdivided into bible verses. Both chapters and verses in the Bible are numbered.
BibleChapterWork*	fabio:Work	Refers to the work realized by a BibleChapter
BibleVerse	Verse	From the 16th century onwards each bible chapter is divided into verses where each verse consists either of a few short lines or one or more sentences[18].
BibleParagraph	Expression	A bible paragraph is a number of sentences grouped together according to thematic or sense units. The system of division of earliest biblical texts was paragraphs according to thematic or sense units [80]
Evangelist	Saint	Writers of the four Gospels are named after Evangelists.
Saint	Person	A follower of Jesus Christ preaching the word of God in Christian faith and devoting his or her life in serving God.
Gospel	BibleBook	Any of the four books of Bible that contain details of the life of Jesus Christ (Cambridge Dictionary)
BibleExcerpt	Excerpt	An extract taken out of a bible. An Excerpt is defined in Fabio as "more general than a quotation, and is generally used to indicate a re-published extract from a book, instruction manual, film, radio programme, etc, that need not be what someone said". A Excerpt is an excerpt (i.e. an extract) of an instance of the class Excerpt that is an instance of Expression. A Excerpt $\sqsubseteq$ fabio:Excerpt $\sqcap$ Expression.

* Note that, by definition, the partOf property is a transitive property, and also by definition, any part of fabio:Work is a fabio:Work.

Ancient Chinese and the French Revolutionary calendars, a week lasted for 10 days.[19]

[18] en.wikipedia.org/wiki/Chapters_and_verses_of_the_Bible
[19] https://www.w3.org/TR/owl-time/

Although it is beyond the scope of the present manuscript to address the representation of time using different time reference systems (TRS), the reuse of an ontology that sets the foundation for the representation of time data using

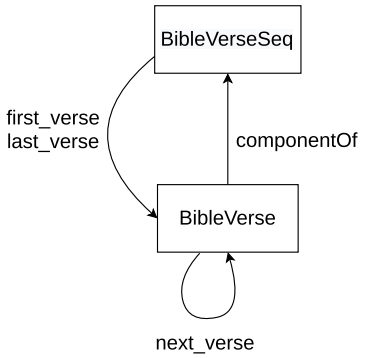


FIGURE 6. Core bible ontology (Verse sequence construct).

TABLE 6. Main concepts and properties of the bible case study.

Named Individual	RDF.type
KJV	BibleVersion

different calendars is useful. This will provide an opportunity to address this issue in the future.

For the purposes of the present manuscript, representing time objects as first-class citizens enables the representation of uncertainty and approximation inherent in date descriptions as properties of time objects.

A. TEXT FRAGMENTS DESCRIBING PROVENANCE OF METAPHORS

The Art Tracks Project of the Carnegie Museum of Art developed a model for recording provenance. Part of this model involves the development of linked data using an event-based CIDOM−CRM conceptual model for the history of museum objects. The guidelines for Date Parsing for Provenance [82] recommend a list of preferred phrasings and formats for describing dates for provenance, suggesting that alternative forms should be converted to these formats. Provenance information for metaphor representation does not require the same level of precision as these objects because information about museum objects includes time events, such as changes in ownership, transfers between museums, and auctions, and requires a high level of precision in the representation of time. Examples of date phrases referring to cultural objects from [82] are as follows.

- ‘‘after 1995’’, ‘‘by 1995’’ (i.e. it could have happened in 1995 or sometime before) [82], ‘‘before 1995’’, ‘‘sometime between 1995 and 1996’’, ‘‘500BCE-450BCE’’, ‘‘1980’s’’, ‘‘19th century’’, ‘‘8th century BCE’’,
  ‘‘bap. 1567, d.c. 1601’’, ‘‘1523?-1604’’,
  ‘‘701 BCE - 800BCE’’, ‘‘450 BC’’, ‘‘5th Century BC’’ (i.e. from year -0499 to year -0400)

Additionally, the following representative examples were selected from [83] to describe the chronology of the metaphors. Where multiple dates are provided for a single metaphor, date fragments are surrounded by brackets.

- [w.1592-3 or 1595?, 1623], (where w. 1592 means: Wednesday the first day of leap year 1592), [1586, 1589], ‘‘1588’’, ‘‘c.1508?’’, ‘‘1500?’’, [1590?, 1623]

Observing the metaphor entries of the historical reference Metaphor database by Pasanek [83], the precision levels used in the present study are: (i) dates known to the century (e.g., 20th century, 5th century BC), (ii) dates known to the decade (e.g., 1980s), and (iii) dates known to the year (e.g., 800 BCE). Question mark (‘?’) signifies uncertainty and the ‘c.’ (or ‘circa’) preceding a date designates approximation. Thus, c. 1700 or (equivalently circa 1700) means ‘approximately 1700’.

The available software (yearspans [84] to the author’s awareness) supports the automatic conversion of known dates to a common format expressed in years. This software complies with the CIDOC−CRM model and can be used to automate the recognition and normalization of phrases according to the CIDOC−CRM model.

The notion of uncertainty and approximation was incorporated into time : Instant, as shown in Encoding 5.

```
:UncertainIntant rdf:type owl:Class ;
    rdfs:subClassOf time:Instant ;
    rdfs:subClassOf [
      df:type owl:Restriction ;
      owl:hasValue "true"^^@xsd:boolean ;
      owl:onProperty :uncertain ;
    ] .
:ApproximateInstant rdf:type owl:Class ;
    rdfs:subClassOf time:Instant ;
    rdfs:subClassOf [
      rdf:type owl:Restriction ;
      owl:hasValue "true"\text{^^}@xsd:boolean ;
      owl:onProperty :approximate ;
    ] .
:uncertain rdf:type owl:DatatypeProperty ;
    rdfs:domain :TemporalEntity ;
    rdfs:range xsd:boolean .
:approximate rdf:type owl:DatatypeProperty ;
    rdfs:domain :TemporalEntity ;
    rdfs:range xsd:boolean .
```

ENCODING 5. Uncertain and approximate dates.

Here, uncertainty refers to knowledge of the actual position of an instant (e.g., year) on a time axis. The current work treats uncertainty and approximation as attributes restricting instances of the time : Instant class. A list of examples of dates in natural language and their corresponding representations in the Turtle format is included in Appendix D. However, it is important to note that the definitions of classes met : ApproximateInstant and met : UncertainInstant are not semantically associated with Allen Calculus [50], [51] underpinning the OWL-Time ontology.

B. ALIGNMENT WITH FABIO AND TIME ONTOLOGY

In Fabio ontology, the domain of datatype properties aimed at recording dates and duration information is typically the class frbr : Endeavour, allowing date properties to be used for objects that belong to any one of the subclasses of frbr : Endeavour. The range of

these date properties is usually the XSD-type literals. Examples are: fabio : hasPublicationDate, fabio : created, fabio : issued, and fabio : dateCopyrighted. However, properties in OWL-Time have the class time : TemporalEntity for their domain, and XSD-type literals or other temporal entities (such as time position and time duration) for their range, as shown in Figures 1, 2, and 3 of Section III. For example, the property inXSDgYear with domain class time : Instant and range class xsd : gYear.

C. TREATMENT OF EVENTS

Two existing ontologies were considered regarding the approach to modeling events, such as publication, translation, and creation of metaphors in association with OWL-Time.

1) The FRBRoo Conceptual Model for Bibliographic Information [85] (based on FRBR) defines a publication as an indirect subclass of the E5 Event event class. Events in the FRBRoo are considered temporal entities (class E2 Temporal Entity). However, the interpretation of the class E2 Temporal Entity in FRBRoo does not coincide with the interpretation of the class TemporalEntity in OWL-Time. The former refers to ''all phenomena, such as the instances of E4 Periods, E5 Events, and states, which happen over a limited extent in time''. E5 Event*s* are ''changes of state brought about by physical or cultural phenomena''. Although events span time intervals, they are not time intervals or instants themselves, as is the case with OWL-Time. Further, the E4 Period class is described as ''the social or physical coherence of these phenomena that identify an E4 Period and not the associated spatio-temporal bounds''. Date values such as the following [85]: (i) 1961, (ii) from 12 − 17 − 1993 to 12 − 8 − 1996, (iii) 4h30 − 16h22 4th July 1945, and (iv) 30 am 1.1.1999 to 2.00 pm 1.1.1999 fall under the class E61 Time Primitive, which together with E50 Date creates the value space of time and date values. Both the E61 Time Primitive and E50 Date are disjoin with the E2 Temporal Entity.
2) In the alignment of the provenance PROV-O ontology [86] with the OWL-Time ontology [87], activities and instantaneous events are treated as temporal entities and time : Instants, respectively. A temporal entity (TemporalEntity) in OWL-Time is either a temporal interval or instant. An instantaneous event (InstantaneousEvent) in PROV − O is a subclass of time : Instant class.

prov : Activity rdfs : subClassOf time : TemporalEntity
prov : InstantaneousEvent rdfs : subClassOf time : Instant

Representing events separately from their time of occurrence allows for the representation of information that is not necessarily confined to a time-span or the instant of occurrence of events. For example, a publication event may include information regarding its publisher and its location.

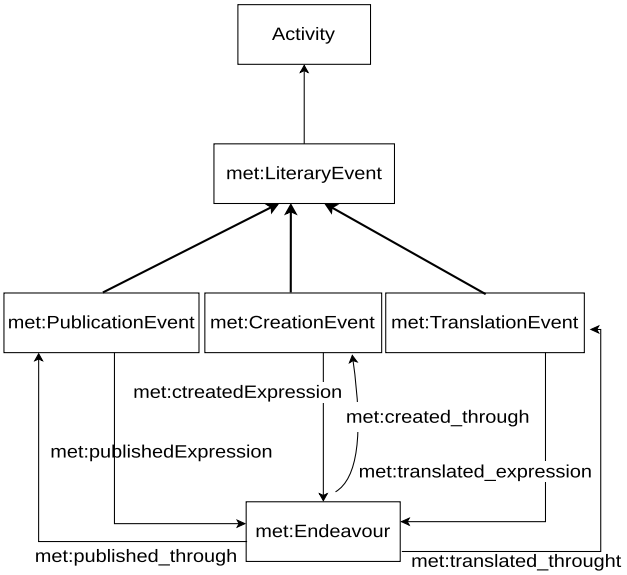


FIGURE 7. Literary activity and subclasses.

The FRBRoo model appears to be in line with this view, and is based on FRBR, which is reused by FaBio. The definitions of TranslationEvent, CreationEvent, and PublicationEvent classes are in line with this approach. However, FRBRoo is unnecessarily verbose for use in modeling metaphors, unnecessarily increasing the complexity of inference and querying. Similarly, PROV − O's approach to creating a separate class for InstantaneousEvent was not considered necessary to meet the information requirements of the present manuscript. Such information would be relevant if, for example, the location of the birth or death of metaphor creators were necessary. The present manuscript focuses on the time intervals over which the life of creator of a metaphor spans, or the periods over which they are considered to have been created or published.

The time span (class TimeSpan) of each activity is modeled as a (subclass of) time : Interval. The activities of publication, creation, and translation of an expression were grouped under the LiteraryEvent class, as illustrated in Figure 7. The alignment of the proposed model with the OWL-Time ontology is shown in Figure 8. Additionally, birth, baptism, and death events occur at instants of time, modeled as subclasses of time : Instant. A translation instant occurs at the end of the translation activity, as shown in Figure 9

Note 4: If this requirement arises, an Instantaneous Event class can be easily implemented as another type of event that occurs at a particular instant. For example, when information about the beginning and end of a span, such as birth, start of floruit period, and death, is necessary (for example, information about the location of birth), the model can be extended to include Start and End as sub-classes of the Instantaneous Event class. However, disseminating this information regarding metaphors was beyond the scope of this study.

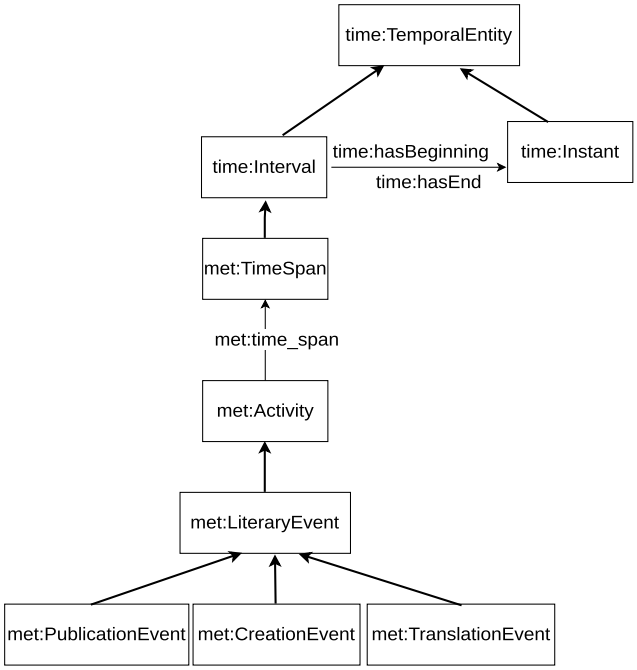


FIGURE 8. Alignment with OWL-Time Temporal Entity.

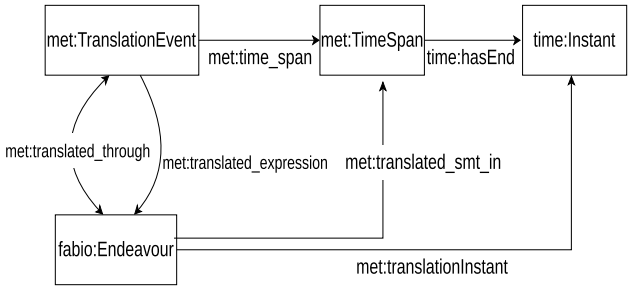


FIGURE 9. Different paths to translationInstant - may be inferred via SWRL rules. Similarly, for creationInstant and publicationInstant.

1) TIME AND EVENT CONCEPTS AND ROLES

The proposed concepts and roles relevant to events and times are presented in Tables 7 and 8, respectively. DL definitions were omitted to save space.

2) SWRL RULES.

To align with the FaBio representation of dates, the following examples of SWRL (DL-Safe) rules were added together with the Axioms in Encoding 7.

SWRL provides its own built-in properties for comparison. However, these primitives are not supported by Hermit[20] reasoner. For example, the property swrlb : greaterThan(?y1, ?y2) in Encoding 8 raises error exception. For this reason, only declaratively asserted relations of comparisons of properties time : before and time : after are supported for the time being.

Note 5: In FaBio ontology, time properties such as fabio : publication Date[21] and fabio : hasPublicationYear are

[20] cs.ox.ac.uk/people/boris.motik/pubs/ghmsw14HermiT.pdf

[21] http://prismstandard.org/namespaces/basic/2.0/publicationDate

```
frbr : Endeavour(?e) ^ met : published_smt_in(?e, ?i1) ^ hasEnd(?i1, ?end)
        → met : publicationInstant(?e, ?end)

frbr : Endeavour(?e) ^ met : created_smt_in(?e, ?i1) ^ hasEnd(?i1, ?end)
        → met : creationInstant(?e, ?end)
met : creationInstant(?e, ?i) ^ time : inXSDDate(?i, ?d)
        → met : hasCreationDate(?e, ?d)
frbr : Endeavour(?e) ^ met : translated_smt_in(?e, ?i1) ^ hasEnd(?i1, ?end)
        → met : translationInstant(?e, ?end)
frbr : Endeavour(?e) ^ met : translated_through(?e, ?te) ^
        met : time_span(?te, ?ts) ^ time : hasEnd(?ts, ?tend) →
        met : translationInstant(?e, ?tend)
met : translationInstant(?e, ?i) ^ time : inXSDDate(?i, ?d)
        → met : hasTranslationDate(?e, ?d)
met : publicationInstant(?e, ?i) ^ time : inXSDDate(?i, ?d)
        → met : hasPublicationDate(?e, ?d)
met : translationInstant(?e, ?i) ^ time : inXSDDate(?i, ?d)
        → met : hasTranslationDate(?e, ?d)
met : creationInstant(?e, ?i) ^ time : inXSDDate(?i, ?d)
        → met : hasCreationDate(?e, ?d)
met : publicationInstant(?e, ?i1) ^ time : before(?i1, ?i2) ^ time : Instant(?i2)
        → met : publishedBeforeInstant(?e, ?i2)
met : publishedBeforeInstant(?e, ?i2) ^ time : inXSDDate(?i2, ?d) →
        met : publishedBeforeDate(?e, ?d)
met : creationInstant(?e, ?i1) ^ time : before(?i1, ?i2) ^ time : Instant(?i2)
→ met : createdBeforeInstant(?e, ?i2)
met : createdBeforeInstant(?e, ?i2) ^ time : inXSDDate(?i2, ?d) →
        met : createdBeforeDate(?e, ?d)
met : translationInstant(?e, ?i1) ^ time : before(?i1, ?i2) ^
        time : Instant(?i2)
→ met : translatedBeforeInstant(?e, ?i2)
met : translatedBeforeInstant(?e, ?i2) ^ time : inXSDDate(?i2, ?d) →
        met : translatedBeforeDate(?e, ?d)
```

ENCODING 6. Examples of SWRL rules relating temporal entities and FaBio endeavour.

```
@prefix prism : http : //prismstandard.org/namespaces/basic/2.0/
met : hasPublicationDate rdfs : subPropertyOf
        prism : publicationDate
met : hasPublicationYear rdfs : subPropertyOf
        fabio : hasPublicationYear
met : hasCreationDate rdfs : subPropertyOf dcterms : date
        or xsd : date
met : hasTranslationDate rdfs : subPropertyOf dcterms : date or
        xsd : date
```

ENCODING 7. Alignment of dates with FaBio dates.

either defined directly using the prism and dublin core (dc) annotation vocabularies, or indirectly as sub-properties of datatype properties defined in these vocabularies. These properties either have an unspecified domain property or (as in fabio : PublicationDate) their domain is set to the class frbr : Endeavour. For example, the property fabio : hasPublicationYear is a sub-property of the dublin core property issued.[22] Also, fabio: hasPlaceOfPublication is a subproperty of dc : location, and its domain property is set to the class frbr : Endeavour. The approach followed in this study also links the time properties associated with the publication, creation, and translation instances to the Endeavour class. In this way, they can be applied to objects of both classes Work and Expression, respectively. Additionally, the publication instant is considered to be at the end of the translation event, similar

[22] http://purl.org/dc/terms/issued

TABLE 7. Metaphor time-event related concepts.

Concept	Super Concept	Description
Activity	owl:Thing	An activity is carried out by an agent in order to cause a change in the state of things such as create an expression by realizing a work, produce a publication, or produce a translation. It has a temporal extend having beginning, end and duration; assumed therefore to occur over an interval of time.
LiteraryEvent	Activity	in this context, a literary activity is either an activity used to create an expression by realizing a work, or an activity used to create a translation of a resource or an activity used to publish a resource.
PublicationEvent	LiteraryEvent	represents the activities used to publish a resource. Influenced by F30 Publication Event in FRBRoo defined as the class that "comprises the activities of publishing. Such an event includes the creation of an F24 Publication Expression and setting up the means of production. The end of this event is regarded as the date of publication, regardless of whether the carrier production is started".
CreationEvent	LiteraryEvent	represents the activities used for the creation of an Expression. (see F28 Expression Creation) Influenced by the definition of E7 Activity in FRBRoo [85] stating that Activity "class comprises events that result in the creation of conceptual items or immaterial products, such as legends, poems, texts, music, images, movies, laws, types etc."
TranslationEvent	LiteraryEvent	Comprises the activities used in the translation of a resource.
TimeSpan	time:Interval	Denotes the span of time over which an activity consisting of a sequence of events takes place.
LifeSpan	time:Interval	The span of time over which a person is considered as alive.
UncertainInstant	time:Instant	An instant of time known with uncertainty.
ApproximateInstant	time:Instant	An instant of time determined with approximation.

TABLE 8. Roles.

Role	Domain	Range
time_span	LiteraryEvent	TimeSpan
translated_smt_in	frbr:Endeavour	TimeSpan
created_smt_in	frbr:Endeavour	TimeSpan
published_smt_in	frbr:Endeavour	TimeSpan
translated_through	Expression	TranslationEvent
published_through	Expression	PublicationEvent
translationInstant	frbr:Endeavour	time:Instant
publicationInstant	frbr:Endeavour	time:Instant
creationInstant	frbr:Endeavour	time:Instant
createdExpression	CreationEvent	Expression
translated_expression	TranslationEvent	Expression
publishedExpression	PublicationEvent	Expression
lifeSpan	Person	LifeSpan
birthInstant	LifeSpan	time:Instant
baptismInstant	LifeSpan	time:Instant
floruitLifeBeginning	LifeSpan	time:Instant
deathInstant	LifeSpan	time:Instant
floruitLifeEnd	LifeSpan	time:Instant
approximate	ApproximateInstant	xsd:^^@boolean
uncertain	UncertainInstant	xsd:^^@boolean

to the approach followed in the FRBRoo model where the The same approach was followed for the translation and creation instants. The dates of publication, translation, and creation are obtained using the time:inXSDDate property at the instants of publication, translation, and creation, respectively, as shown in Encoding 6.

A LifeSpan class designating the lifespan of a person is depicted in Figure 10 to show the life limits of persons such as publishers and translators. Definitions of the concepts and properties are presented in Tables 7 and 8, respectively. For the purposes of the present work, date information about metaphors focuses primarily on their date of creation and publication. FaBio includes properties for detailed bibliographic information that satisfy library recording needs, which are not necessary for recording the provenance of metaphors.

The examples of SWRL rules in Encoding 6 may be used to infer whether metaphors or literary events happened before or after the lifetime of an author or at other time intervals. The following (fictitious) example illustrates the application of some of these rules.

From the above statements it follows that: met:createdBeforeInstant(ex:met_1, ex:AugEmperBirth), met:createdBeforeDate(ex:met_1, "-0063-09-23"^^xsd:

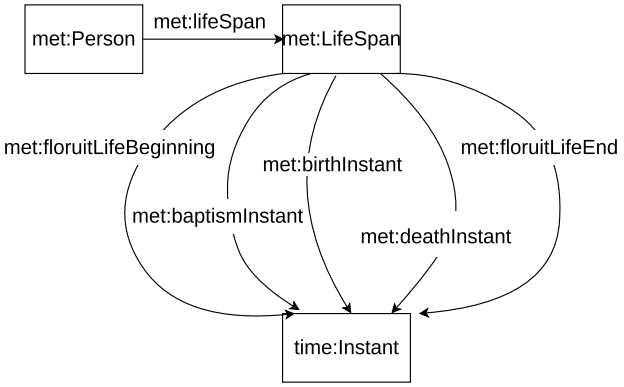


FIGURE 10. Agent LifeSpan Class.

```
time:Instant(?inst1)^time:inXSDgYear(?inst1, ?y1)^
    time:Instant(?inst2)^time:inXSDgYear(?inst2, ?y2)^
    swrlb:greaterThan(?y1, ?y2) → time:after(?inst1, ?inst2)
```

ENCODING 8. SWRL greaterThan binary relation Example.

```
ex:met1 a met:Metaphor ;
        met:creationInstant ex:inst1 .
ex:inst1 a time:Instant ;
        time:before ex:AugustusEmperorBirth .
ex:PlatoBirthInstant a time:Instant ;
        time:inXSDDate "-427"^^xsd:gYear .
ex:Plato a met:Person ;
        met:birthInstant ex:PlatoBirthInstant .
ex:AugustusEmperor a met:Person ;
        met:birthInstant ex:AugEmperBirth .
ex:AugEmperBirth a time:Instant ;
        time:inXSDDate"-0063-09-23"^^xsd:date ;
        time:after ex:PlatoBirthInstant .
```

ENCODING 9. Example of using SWRL inference rules.

date) Queries that may be answered can take the form: Which metaphors were created after or before a literary event? Similar queries may be posed for intervals. In the above example, an interval may start from the birth of Plato to the birth of the Augustus Emperor. Queries may then be used to retrieve metaphors created, published, or translated within this interval. The model may be extended further to include the notion of Period to record particular historical periods (in alignment with the definition of the E4 Period in FRBRoo [85], discussed in Section VIII), so that metaphors may be queried according to the period in which they were created.

IX. POPULATING NON-RELIGIOUS EXAMPLES

The examples of metaphors from different disciplines in Section V were used to populate the concepts relating to the life-span of the authors and periods over which the metaphors were created using OWL-Time constructs, which were not modeled in the case study of Section VII. The core concepts of Example 6 are illustrated in Figure 11. The bibliographic information for each phrase is omitted from this diagram to improve clarity, but may be modeled by using FaBio concepts as shown in Figure 12 for the phrase *"swift fly the years"*.

It is beyond the scope of this study to provide a detailed model of the domain of each metaphor used in these examples. However, the alignment of the proposed ontology concepts with the implementation of domain-specific concepts enriches the query results, because domain entities may then be queried for metaphors. An initial alignment with the poetic concepts is shown in Figure 13 in Appendix C. It is important to emphasize that modeling poetic data should be reconsidered in the context of reusing an existing ontology, such as PostData.[23]

X. IMPLEMENTATION AND EVALUATION

A. IMPLEMENTATION

The ontology was implemented semi-automatically in the OWL 2 DL using the Turtle Syntax. Ontology classes and properties were created in Python using the RDFLib[24] library. The population of the classes and properties of the proposed formalism were also created in Python by using RDFLib.

Protegè was used to import the OWL-Time and the FaBio ontologies, to define the SWRL rules, and for consistency and satisfibility checking via the Hermit 1.4.3.456 reasoner.

Description Logics (DL) [73] is a family of logic-based knowledge representation formalisms. OWL 2[25] is an Ontology Web Language used to represent the knowledge of the SW founded on DL. The OWL2 DL is based on *SROIQ*, which is a decidable fragment of DL. The HermiT[26] reasoner is one of the few reasoners that support the OWL 2 DL and (DL safe) SWRL rules. The (DL Safe) rules defined using the SWRL language constitute a decidable fragment of Horn Clauses applied to named individuals defined in an ontology ABox.

Protegè is an easy-to-use graphical environment. The reused ontologies can be visualized together with the classes of the active environment making the design pitfalls easily observable. SWRL rules were created using the SWRL tab provided as an option in the Protegè development environment. Consistency and Satisfiability were checked using the Hermit 1.4.3.456 reasoner in the Protegè development environment (Java plugin).

Protegè supports the generation of ontologies in various syntactic variants, such as RDF/XML, OWL/XML, OWL Functional Syntax, Turtle (Terse RDF Triple Language), Manchster OWL Syntax, and JSON – LD. RDF/XML is the OWL 2 normative syntax, which means that every tool that supports OWL 2 must support this syntax. Turtle Syntax (the Turtle version of the RDF/XML Syntax) was used in the implementation of the ontology because it is easy to read and reflects the graphical nature of the linked data.

To show correspondence with the logic-based DL definition of concepts and properties, the core ontology definitions

[23] postdata.linhd.uned.es/ontology/postdata-core#
[24] rdflib.readthedocs.io/en/stable
[25] http://www.w3.org/TR/owl2-overview
[26] cs.ox.ac.uk/people/boris.motik/pubs/ghmsw14HermiT.pdf

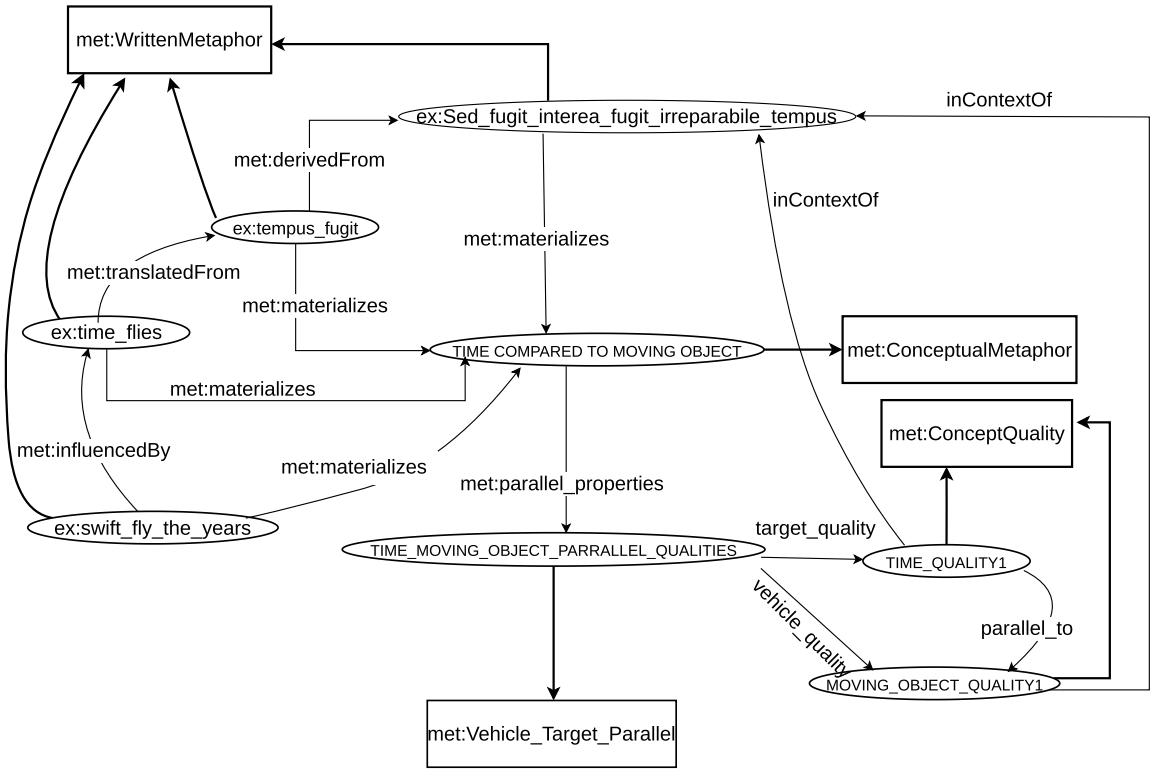


FIGURE 11. Conceptual Metaphors for Example 6.

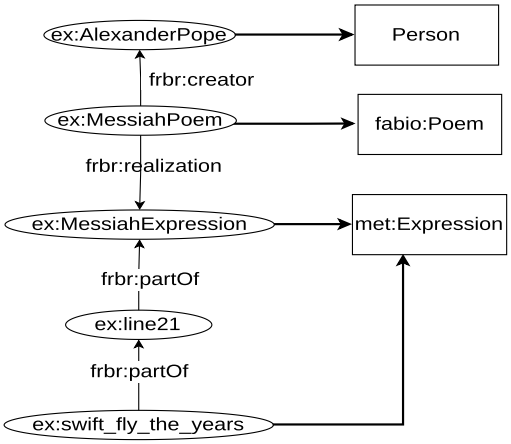


FIGURE 12. Bibliographic modeling for "swift fly the years" Example 6.

of concepts and properties in this manuscript are defined in DL, and the actual implementation is in Turtle syntax.

B. EVALUATION

The ontology is consistent and coherent, as proven by the Hermit 1.4.3.456 reasoner. The OWL-Time and FaBio ontologies were imported directly into Protegè. This was done to avoid the use of XSD datatypes not supported by OWL 2.

The proposed formalism was tested by creating a case study in which the domain of a file [64] was modeled and implemented along with the main metaphor concepts. The file was created and structured by an expert in metaphorical and biblical data. The ontology concepts in this manuscript are restricted to the representation of domain knowledge relevant to metaphors. This study included TBox declarations and ABox populations. The ontology meets all query objectives by using 100% of the core ontology concepts and role definitions.

All targeted queries were answered and the meaning of the concepts was as intended. More (Non-religious) examples were used to implement the creation, translation, and publication (events) of metaphors. Notions of approximate and uncertain instants were used to express the instants in which these events occurred. Time instants were queried declaratively because they referred to XSD datatypes that had not yet been implemented by OWL 2 and Hermit. To overcome processing problems, these were declared using the xsd : string datatype.

XI. INNOVATION

The proposed formalism creates a foundation for the representation of metaphors as LOD, with which ontologies from different domains can be linked. Unlike previous works on modeling metaphors via Semantic Frames [88], such as MetaNet [89] and Amnestic Forgery [90], the proposed

model links the concept of Metaphor (as a sub-class of Expression) to bibliographic information and the main concepts of CMT [52] (such as conceptual metaphors and vehicle and target concepts) to their qualities, adding temporal information concerning their creation, publication, translation of resources, and the life-span of authors. The concepts and roles defined to represent the domain knowledge of the case study were aimed at demonstrating the use of the core concepts of the model. The representation of metaphors as part of LD enables a comparison of conceptual metaphors within the context of different domains, such as biblical data and conceptual metaphors in poetry.

The qualities that form the basis of the comparison between the target and vehicle concepts in different domains can also be compared. The context (isContexOf) of each quality is defined as an object property that links the quality of a vehicle or target concept to the metaphor to which it is associated. This enables the comparison of symbolism underpinning the usage of each concept across different domains and religions. For example, the poetic concepts in Appendix C enable querying the qualities of concepts in metaphors of poem verses and the same concepts in bible verses or other domains; in Example 9 the notion of 'light' according to Heraclitus theory differs from the notion of 'light' as a vehicle concept in each metaphor in the scriptures.

An important aspect of the proposed formalism is the alignment with FaBio ontology, which enables the representation of associations between metaphors and the resources from which they are extracted. With this alignment, it is possible to query the metaphors of particular resources and metaphor creators such as the metaphors of particular authors or textual resources. The alignment of the model to the OWL−Time ontology and the definition of UncertainInstant and ApproximateInstant classes for the representation of uncertain and approximate instants of time where events such as creation of a resource or birth and death of a creator have taken place have not been done before.

XII. COMPARISON WITH METANET, FRAMESTER AND AMNESTIC FORGERY

MetaNet [89] plays a central role in the formalization of metaphors, the implementation of which gave rise to a semantic wiki of conceptual metaphors [90]. MetaNet's formalization was based on Frame Semantics [91], combining a top-down theoretical modeling of metaphors that reflects Cognitive Linguists' understanding of the structure and complexity of metaphors, with a bottom-up design emanating from the implementation of metaphors in a corpus [91]. Theoretical modeling in this case is based on the schematic, and taxonomic nature of Semantic Frames [88], which are similar to the ones used in FrameNet [92] emphasizing the cognitive and schematic nature of conceptual metaphors. Fillmore [93] described a Frame as "any system of concepts related in such a way that to understand anyone of them you have to understand the whole structure to which it fits".

In MetaNet, frames are described as "coherent semantics and cognitive structures, formed from bodily interaction with the world" [91]. Metaphors are described in MetaNet as schema relations, where the schemas are manually created. Its formalism uses two-slot constructions, with slots occupying the position of the source (vehicle) and the target of conceptual metaphors. For example, the metaphoric phrase 'poverty continues to cripple' [94], 'poverty' is considered as the target and 'attacks' as the verb subject (vehicle) of the metaphor). The target and vehicle verb Lexical Units (LU) are recognized via a syntactic analysis (including dependency analysis). Effectively, the target and vehicle concepts of metaphors are the conceptual types of LUs filling the slots of relevant syntactic constructions such as Subject(T)-Verb(S), which lead to the identification of a hierarchy of relevant schemas. For example, the 'poverty continues to cripple' metaphor, is associated with the following hierarchy of schemas:

POVERTY IS PHYSICAL HARM →
ECONOMIC HARDSHIP IS PHYSICAL HARM→
EXPERIENCING A NEGATIVE STATE IS EXPERIENCING HARM

Conceptual Metaphors in MetaNet [89] are therefore represented as mappings between frames. Associations between conceptual metaphors can be hierarchical based on the subsumption hierarchy of the frames of the target and source concepts. This is convenient for studying conceptual associations between metaphors and for classifying metaphors. A similar approach for associating prepositional phrases via subsumption hierarchies using WordNet was shown in [95].

Framester [96] is a "a frame-based ontological resource" linked to several linguistic repositories, such as FrameNet, WordNet [97], and VerbNet. Its predicate formalization is also based on the frame-semantics [88] and semiotics [98], incorporating the hierarchical concept structure of WordNet and frame definitions from FrameNet. The Amnestic Forgery [90] ontology for metaphors was built on top of Framester and populated with metaphor data from MetaNet. The model of metaphors in Amnestic Forgery was created by formalizing the MetaNet schema according to Description and Situations (*D&S*) [97], [99]. Then, the MetaNet data was extracted and represented formally according to this schema, and aligned with FrameSter knowledge graph.

Frame-based models offer a conceptual underpinning for linking metaphors via associations between frames, which is of particular importance to Cognitive Linguists, and for making use of lexicographic databases such as WordNet to establish hierarchical associations between concepts, which leads to automatic classification and association of conceptual metaphors. They assume a repository of (handcrafted) frames upon which the associations between source and target concepts in conceptual metaphors are based.

The proposed model advocates the association of metaphor entities with bibliographic information by aligning the core metaphor concepts to the FaBio model. Metaphors, which are a part of bibliographic Expressions, are represented as indirect instances of Expressions adhering to the constraints

of FaBio. By linking the proposed metaphor model to the FaBio model, it associates metaphoric expressions with the relevant bibliographic resources. In its current form, it does not include frame-mappings, although an alignment with frame-based methods seems possible, owing to the conceptual nature of source and target concepts (MConcept) that can lead to conceptual hierarchies.

The qualities of concepts (instances of ConceptQuality) in the examples of the proposed metaphor model of this study record the philosophical, poetic, and theological points of view or underlying theory of experts or creators of a metaphor, and they do not constitute frame roles. In Example 9, the quality of light was based on Heraclitus's philosophical view of light. In this case, the meaning of the target concept is derived from an underlying theory and needs to be represented separately from the frame-based approaches.

Additionally, the proposed metaphor model links the qualities of source and target concepts with their related metaphors, and expressions from which the metaphors are extracted via the met : isContextOf property. In this way, the context (expressions) that makes these qualities comparable can be retrieved via SPARQL queries (please refer to Figures 11 and 15).

Frame-based models can play a complementary role to the proposed metaphor formalism in this study, where the semantics of the source and target concepts may be associated with frames, and conceptual metaphors to frame-mappings. It is also worth investigating whether it is possible to align the proposed model with the Lexicon Model of Ontologies [100], where the senses of word or multi-word expressions denoting vehicle and target concepts in conceptual metaphors may be linked to ontology concepts. However, it is beyond the scope of the present study to elaborate on this aspect further.

XIII. CONCLUSION

This manuscript lays the ontological foundation for the presentation of metaphors as open data on the Semantic Web. The main ontology classes aimed to represent metaphoric phrases, their conceptual metaphors, vehicle and target concepts, and the qualities of the vehicle and target concepts being compared.

The proposed model reused FaBio Ontology to represent bibliographic sources of metaphors restricted to the conceptual (fabio : Work) and content (fabio : Expression) levels. The manifestation level has not been addressed in the current manuscript, although its use for the representation of information about media used to record metaphors is envisaged as important when metaphors in non-printable or publishable media are represented. The distinction between different levels of representation in FaBio is frequently blurred; however, manifestation information may be important in the representation of metaphors or resources that first appear in non-printable or publishable media. For example, the manuscript 'lament for ur' was created in 1800 BC. At that time, there was no printed form in the electronic way we knew today. The manuscript was written in Cuneiform using wedge-shaped marks on clay.

An important part of this work is a case study based on freely available biblical data showing the implementation of the main concepts of the proposed formalism. The steps used in the extraction, representation, and query of the data used in the case study are discussed in Section VII. The case study does not purport to provide a complete ontology of the scriptures and focuses on written metaphoric epigraphs extracted from a single verse or a sequence of verses and written expressions.

The OWL-Time ontology was reused to create a foundation for representing information regarding temporal instants and intervals over which metaphor-relevant events (such as translations and publications) occurred. The advantage of using primitives for temporal entities is that they allow the potential representation of different time-reference systems. The representation of an interval, such as the birth of Plato to the birth of the Augustus Emperor, allows for the association of literary events with time intervals. As stated in Section VIII, the model may be extended to include the notion of Period to record particular historical periods, so that metaphors may be represented and queried in relation to the period in which they were created. This study also enables representation of the uncertainty and approximation inherent in provenance date descriptions, as discussed in Section VIII. However, the reuse of OWL-Time is hindered by the fact that a purpose-built reasoner is required to draw inferences and associate time intervals at different time periods. Examples from non-religious domains in this manuscript focus on the representation of uncertainty and approximation in the descriptions of phrases that refer to time.

An important problem in the implementation of the time concepts of the proposed formalism is that the XSD datatypes are not supported by OWL 2 DL. The use of user-defined types via pattern facets to specify their lexical space via regular expressions (identical to regular expressions of the corresponding XSD datatypes) did not solve this problem, because the definition of the lexical space needs to be mapped to a value space.

An important aspect of the representation of core concepts is the definition of classes for the representation of qualities attributed to the vehicle and target concepts of conceptual metaphors that make them comparable. The qualities of relevant concepts may be represented separately or in parallel. Additionally, linking metaphoric data from different domains enables a comparison of qualities attributed to vehicle and target concepts across different domains. For example, the concept of light in Heraclitus phrase *"A dry gleam of light is the wisest and best soul"* means a soul whose noble part prevails (a soul near to fire where fire denotes the noble part) whereas in the bible Saints are considered as light due to, among other reasons, the quality: ''Light discovers and makes manifest the Nature of Things to Men. . . ''.

Future work will aim to extend this ontology to the representation of other figures of speech and provide

provenance information about metaphors. Additionally, the main concepts relevant to metaphors and event constructs created for this study will be implemented in different modules and associated with more realistic resource identifiers. The URI name serves only for illustrative purposes. Additionally, the text property will be implemented on several occasions where only the rdfs : label is used. For Example, the classes: met : ConceptQuality and met : WrittenMetaphor will include a text property to provide a description of properties attributed to target or vehicle concepts and metaphor text, respectively.

The proposed formalism focuses on metaphors and their relationships with bibliographical and temporal events. However, it is important to explore the possibility to improve reusability by leveraging concepts like Framester's Metaphor/Frame and the hasSourceFrame/hasTargetFrame properties within the proposed model. Similarly, MetaNet's and AmnesticForgery's concept of Metaphor, MetaphoricRoleMapping, targetRole, and sourceRole properties should be reused to enhance compatibility and define alignment with the proposed model's WrittenMetaphor and ConceptualMetaphor to allow seamless compatibility between the data used to populate the proposed model and the existing resources.

APPENDIX A BIBLE VERSE SEQUENCE

An example of the usage of class BibleVerseSeq in the Turtle syntax is included below. Bibliographic information about each metaphor in the B25425.xml file may appear in various forms such as: Zech. 1.8, 11 (i.e., a range of consecutive verses), and 2 Rev. 2.4. (a verse preceded by a book number) and Rom. 8.1. (single verse).

For each metaphor in a paragraph <p> or <q> element which is embedded within an <epigraph> element, bibliographic information is parsed using a regular expression with groupings to identify information about the book number, book name, chapter, first verse, and last verse in which the metaphor occurs. When a range of verses is provided, such as in Zech. 1.8, 11, both first and last verses have a value; In this case, (''Zech'', None, 1, 8, 11) represents the values of (book_name, book_number, chapter, first_verse, last_verse), respectively. The regular expression pattern (with a minor modification to deal with the extraneous characters in the file) is:

r'(([1−2]\ )?[A−Z][a−z]+)\.?\ (\d{1,3})\.(\d{1,3})?(\,\ \d{1,3})?'

When an epigraph appears in a sequence, the sequence is represented by an object in the class BibleVerseSeq. The first and last verse numbers were used to create the intervening verse names, which were added as components to BibleVerseSeq. For example, Zech.1.8 is a component of Zech. 1.8, 11. In addition, because a component is a sub-property of the partOf property, it follows that it is also a part of Zech. 1.8, 11. Encoding 10 represents the sequence of verses created for the bibliographic reference Zech. 1.8, 11.

```
ex:ISBNABAMRUARHAH a ex:MetaphorEpigraph ;
rdfs:label "I saw by Night, and behold a Man riding upon
a red Horse, and he stood among the Myrtle−Trees that
were in the Bottom." ;
ex:has_context ex:Zech_1_8_11 ;
ex:materializes ex:saints_compared_to_myrtletrees .

ex:Zech_1_8_11 a ex:BibleVerseSeq ;
frbr:partOf ex:Zech_1 ;
ex:component ex:Zech_1_10,ex:Zech_1_11,ex:Zech_1_8,ex:Zech_1_9 ;
ex:first_verse ex:Zech_1_8 ;
ex:last_verse ex:Zech_1_11 .

ex:Zech_1_11 a ex:BibleVerse ;
rdfs:label "Zech. 1.11" ;
frbr:partOf ex:Zech_1 ;
ex:component_of ex:Zech_1_8_11 ;
ex:partOf ex:Zech_1 .

ex:Zech_1_10 a ex:BibleVerse ;
rdfs:label "Zech. 1.10" ;
frbr:partOf ex:Zech_1 ;
ex:component_of ex:Zech_1_8_11 ;
ex:next_verse ex:Zech_1_11 ;
ex:partOf ex:Zech_1 .

ex:Zech_1_8 a ex:BibleVerse ;
rdfs:label "Zech. 1.8" ;
frbr:partOf ex:Zech_1 ;
ex:component_of ex:Zech_1_8_11 ;
ex:next_verse ex:Zech_1_9 ;
ex:partOf ex:Zech_1 .

ex:Zech_1_9 a ex:BibleVerse ;
rdfs:label "Zech. 1.9" ;
frbr:partOf ex:Zech_1 ;
ex:component_of ex:Zech_1_8_11 ;
ex:next_verse ex:Zech_1_10 ;
ex:partOf ex:Zech_1 .
```

ENCODING 10. Population of the BibleVerseSeq class.

TABLE 9. Further example concepts.

Concept	SuperConcept	Description
PoeticWork	fabio : Work	The intellectual, artistic and abstract concepts recognized through poems or other poetic expressions that are published or potentially publishable and are contained or are referred to by bibliographic entities or entities used to define bibliographic references.
PoeticExpression	met : Expression	Comprises all types of poetic expressions. These include poems, verses, lyrics, lines of poems.
PoemExpression	met : Expression	designates the realization of a Poem (FaBio defines Poem as a subclass of fabio : Work)
PoeticLineExpression		the line of a poem is considered as a poetic expression itself.
PoemVerseExpression	met : Expression	the line of a poem is considered as a poetic expression itself.

APPENDIX B POPULATING AND QUERYING RELIGIOUS DATA

An example of instances of the Bible Case Study is illustrated in Encoding 11. In the current version of the implementation, the rdfs : label is used frequently in the same way as the text property of the relevant entities. This issue should be addressed in the future. The names of entities representing verses, or other phrases, like qualities, are derived by using

TABLE 10. Examples of textual Date fragments with their turtle Encodings.

Examples of textual date fragments with their Encodings	
Phrase	**Encoding**
"before 1995"	: before_1995 a time : Interval ; time:hasEnd [rdf:type time:Instant ; time:before :Instant_1995 ;] :Instant_1995 a time:Instant .
"Sometime between 1995 and 1996"	:In_1995_1996 a time:Instant ; time:inside :Interval_1995_1996 ; :Interval_1995_1996 a time:Interval ; time:hasBeginning :Year_1995 ; time:hasEnd :Year_1996 ; : Year_1995 a time:Instant ; time:inXSDgYear "1995"^^@:gYear . : Year_1996 a time:Instant ; time:inXSDgYear "1996"^^@:gYear .
"after 1990"	:after_1990 a time:Interval; time:hasBeginning [rdf:type time:Instant ; time:after :Instant_1990 ;] : Instant_1990 rdf:type time:Instant ; time:inXSDgYear "1990"^^@xsd:gYear .
"by 1990"	by_1995 a time:Interval ; :hasEnd :Instant_1995 . : Instant_1995 a time:Instant .
"500 BCE - 450 BCE"	:Interval_500_450_BC a time:Interval time:hasBeginning :Year_499_BC ; time:hasEnd :Year_449_BC ; :Year_499_BC a time:Instant ; time:inXSDgYear " − 0499"^^@xsd:gYear . :Year_449_BC a time:Instant ; time:inXSDgYear " − 0449"^^@xsd:gYear .
"1980's" (i.e. 1980-1989)	:Interval_1980_to_1989 a time:Interval ; time:hasBeginning :Year_1980 ; :hasEnd :Year_1989 . :Year_1980 a time:Instant ; time:inXSDgYear "1980"^^@xsd:gYear . :Year_1989 a time:Instant ; time:inXSDgYear "1989"^^@xsd:gYear .
"19th Century" (or "19th Century AD")	:_19th_century a time:Interval ; time:hasBeginning :Year_1801 ; time:hasEnd :Year_1900 . :Year_1801 a time:Instant ; time:inXSDgYear "1801"^^@xsd:gYear . :Year_1900 a time:Instant ; time:inXSDgYear "1900"^^@xsd:gYear .
"8th Century BC" (or "8th Century BCE")	:_19th_century a time:Interval ; time:hasBeginning :Year_0799_BC ; time:hasEnd :Year_0700_BC. :Year_0799_BC a time:Instant ; time:inXSDgYear " − 0799"^^@xsd:gYear . :Year_0700_BC a time:Instant ; time:inXSDgYear " − 0700"^^@xsd:gYear .
"c. 1500" (or "circa 1500" or "approximately 1500")	:circaYear1500 a met:ApproximateInstant ; time:inXSDgYear :Year1500 ; :Year1500 a time:Instant ; time:inXSDgYear "1500"^^@xsd:gYear .
"c. 1500?"	:circaYear1500 a met:ApproximateInstant, met:UncertainInstant ; time:inXSDgYear "1500"^^@xsd:gYear .
"1500? - 1600"	:_1500UNC_to_1600 a time:interval ; time:hasBeginning a :_1500UNC :_1500UNC a met:UncertainInstant ; time:inXSDgYear "1500"^^@xsd:gYear .

the first letter of each word in the phrase, after removing punctuation.

A. POPULATING RELIGIOUS DATA

See Encoding 11.

B. EXAMPLE QUERIES

This section presents example queries that were implemented using the RDFLib module in Python. The output was was

```
ex:man_compared_to_a_flower rdf:type owl:NamedIndividual ,
        met:ConceptualMetaphor ;
        met:has_target ex:man ;
        met:has_vehicle ex:a_flower ;
        met:parallel_properties ex:a_flower_man_parallel_qualities ;
        rdfs:label "man compared to a flower" .
ex:man rdf:type met:MConcept ,
        skos:Concept ;
        met:has_quality ex:ISCCFHPSAMLAAWT ,
        ex:ISMIHFSIONWHHMH ,
        ex:ISMIHNSLUTEATTT ,
        ex:ISMIOTMDFSSATWM ,
        [...]
ex:a_flower rdf:type owl:NamedIndividual ,
        met:MConcept ,
        skos:Concept ;
        met:has_quality ex:AFHARFWIGASU ,

    ex:IAFHBALTOCTSALT ,
    ex:IAFIMBWIIFR ,
    ex:IAFSUOOTESAAFIB ,
    ex:ITADSOFSFTLUVLT ,
    [...]
ex:a_flower_man_parallel_qualities rdf:type met:Vehicle_Target_Parallel ;
        met:target_quality ex:ISCCFHPSAMLAAWT ,
        ex:ISMSULAFAAFILAT ,
        [...]
        met:vehicle_quality ex:AFHARFWIGASU ,
        ex:IAFHBALTOCTSALT ,
        ex:IAFIMBWIIFR ,
        [...]
ex:ISCCFHPSAMLAAWT a ex:ConceptQuality ;
        rdfs:label "IX. So Christ's choice Flowers, his precious Saints, are most
            lovely and amiable, when they are fully ripe for Heaven" ;
        ex:parallel_to ex:IAFIMBWIIFR .
ex:IAFIMBWIIFR rdf:type met:ConceptQuality ;
        met:parallel_to ex:ISCCFHPSAMLAAWT ;
        rdfs:label "IX. A Flower is most beautiful, when it is fully ripe" .
```

ENCODING 11. Example of instances of the core concepts of the ontology.

formatted appropriately using Python code. The qnames were transformed into short IRI names for readability (http://www.example.org/Metaphors/ has been restated to ex).

```
query_Q1 = """
PREFIX ex: <http://www.example.org/Metaphors/>
PREFIX rdf: <http://www.w3.org/1999/02/22−rdf−syntax−ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf−schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX fabio: <http://purl.org/spar/fabio/>
select distinct ?cm ?m ?veh ?targ
where {
        ?m ex:materializes ?cm .
        ?cm rdf:type ex:ConceptualMetaphor ;
        ex:has_vehicle ?veh ;
        ex:has_target ?targ . }
"""
```

ENCODING 12. Query 1.

1) EXAMPLE QUERY 1

Query Q1 selects tuples consisting of: (i) conceptual metaphors, (ii) metaphor epigraphs materializing these conceptual metaphors, (iii) relevant vehicle concepts, and (iv) relevant target concepts for each epigraph metaphor in the dataset.

OUTPUT OF QUERY 1:
conceptual_metaphor:ex:THOASCTAHOF
materialized_by: ex:And_I_will_give_them_a_Heart_of_Flesh
has_target:ex:heart_of_a_saint
has_vehicle:ex:an_heart_of_flesh

conceptual_metaphor:ex:death_a_departure
materialized_by: ex:Having_a_desire_to_depart
has_target:ex:death
has_vehicle:ex:departure

conceptual_metaphor:ex:death_a_rest
materialized_by: ex:AIHAVFHSUMWBATD
has_target:ex:death
has_vehicle:ex:rest
[..]

2) EXAMPLE QUERY 2

Query Q2 aims to select: (i) the conceptual metaphors of the domain, and for each conceptual metaphor: its source and target concepts, and for each concept involved (iii) its qualities, and for each quality involved (iv) its parallel quality; the latter is the quality of the vehicle concept compared with the corresponding quality of the target domain.

OUTPUT OF QUERY 2:
# ONLY A SMALL PART IS INCLUDED FOR BREVITY
row = conceptual metaphor:ex:grace_compared_to_salt
has_vehicle:ex:salt
has_target:ex:grace
vehicle has_quality: ex:IIMBQCPSAILSCRI
target has_quality: ex:IBITSBWOIEFTCSA

ex:IIMBQCPSAILSCRI **rdf**:type ex:**ConceptQuality** ;
rdfs:label "II. If Meat be quite corrupted, putrified,
stink, and is loathsom, Salt cannot recover it,
nor make it savoury" .

ex:IBITSBWOIEFTCSA **rdf**:type ex:**ConceptQuality** ;
rdfs:label "II. But if the Soul be wholly or in every
Faculty thereof corrupted, stinks, and is loathsom in
the Nostrils of God, yet Grace can quickly recover it,
and make it very Savoury and Sweet to God and good Men" ;
ex:**parallel_to** ex:IIMBQCPSAILSCRI .

row = conceptual metaphor:ex:grace_compared_to_salt
has_vehicle:ex:salt
has_target:ex:grace
vehicle has_quality: ex:ISHAPQIWNOPCOOM
target has_quality: ex:IGPTSFAMOSADIWN
ex:ISHAPQIWNOPCOOM **rdf**:type ex:**ConceptQuality** ;
rdfs:label "III. Salt hath a preserving quality;
it will not only purge Corruption out of Meat, but
also preserve Meat, and other things, from Corruption and
Putrefaction" .

ex:IGPTSFAMOSADIWN **rdf**:type ex:**ConceptQuality** ;
rdfs:label """III. Grace preserves the Soul from all manner
of Sin and Defilements; it will not suffer a Saint to run
with others to the aame excess of Riot; 1 Pet. 4.4.
but teacheth us to deny all ngodliness, and worldly Lusts,
and to live righteously, soberly, Tit. 2.12.
and godly in this present World. How shall I do this thing,
and sin against God?""" ;
ex:**parallel_to** ex:ISHAPQIWNOPCOOM .
[...]

conceptual_metaphor:ex:THOASCTAHOF
materialized_by: ex:And_I_will_give_them_a_Heart_of_Flesh
has_target:ex:heart_of_a_saint
has_vehicle:ex:an_heart_of_flesh

conceptual_metaphor:ex:death_a_departure
materialized_by: ex:Having_a_desire_to_depart
has_target:ex:death
has_vehicle:ex:departure

conceptual_metaphor:ex:death_a_rest
materialized_by: ex:AIHAVFHSUMWBATD
has_target:ex:death
has_vehicle:ex:rest
[..]

```
query_Q2 = """
PREFIX ex: <http://www.example.org/Metaphors/>
PREFIX rdf: <http://www.w3.org/1999/02/22−rdf−syntax−ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf−schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX fabio: <http://purl.org/spar/fabio/>
select distinct ?cm ?veh ?targ ?cq1 ?cq2
where {
        ?cm rdf:type ex:ConceptualMetaphor ;
        ex:has_vehicle ?veh ;
        ex:has_target ?targ .
        ?veh ex:has_quality ?cq1 .
        ?targ ex:has_quality ?cq2 .
        ?cq1 ex:parallel_to ?cq2 .
}"""
```

ENCODING 13. Query 2.

3) EXAMPLE QUERY 3

Query3 retrieves all instances of the MConcept class and their associated qualities (each quality is an instance of the met : ConceptQuality class); and for each quality its parallel qualities are used in grounding a conceptual metaphor.

OUTPUT OF QUERY 3 (PART OF):
Concept: ex:a_flower
ConceptQuality: ex:XTOOFKTBTTCTAWS
ConceptQuality.text: X. The Owner of Flowers knows the best Time to crop them; and who shall be offended at him, when he takes to himself this or that Flower out of his Garden? He may do what he pleaseth with his own
parallel_to:
Concept: ex:man
ConceptQuality: ex:XSGKTBTTCOOTABD
Concept Quality.text:X. So God knows the best Time to crop off, or take away by Death this and that precious Flower. Sometimes he cuts them down, before others think they are half ripe; but God knows better than we. He never pulls, nor takes any of his Saints unto himself, till he seeth they are fit to die. And who shall be offended at him in what he doth? tho he take such out of the Garden, that we would fain have grow still there, because they are such a sweet Ornament to it; but may not God do what he pleaseth with his own?
Concept: ex:swine
ConceptQuality: ex:XTSUTTIAGMEUTAB
ConceptQuality.text: XI. The Swine under the Tree in a greedy manner eat up the Acorns, but never look up to the Tree or Oak from whence they fall
parallel_to:
Concept: ex:wicked_men
ConceptQuality: ex:XSWAGMTTEATWGNL
Concept Quality.text:XI. So wicked and graceless Men, tho they enjoy all this World 's Good, never look up in a due manner to God, who is the Tree of Life, and is the Author and Giver of it
[...]

4) EXAMPLE QUERY 4

Query 4 finds the qualities of concept ex : light.

OUTPUT OF QUERY 4:
Quality of light: ex:IIIAGMABTSTLLIS
Label: III. It is a great Mercy and Blessing to see the Light;
Light is sweet, Light drives back, or expells Darkness
Quality of light: ex:ILSFAIVTAEOTHEM
Label: II. Light shines forth, and is visible to all;
every one that hath Eyes may see the Light.
A Candle should not be lighted, and put under a Bushel,
but on a Candlestick, that it may give Light to all that
are in the House

Quality of light: ex:IWTLOTCIPOWITGL
Label: IV. When the Light of the Candle is put out, which is
to give Light to the whole House, how do Men stumble, and grope
in Darkness?

Quality of light: ex:LDAMMTNOTTMIHAD
Label: LIght discovers and makes manifest the Nature of Things to
Men; it hath a directive **Quality** in it, Men thereby know which way
to go; it directs Travellers in their Way
[...]

5) EXAMPLE QUERY 5

Query 5 selects the conceptual metaphors materialized by the metaphor epigraphs of the King James Version of the Bible.

OUTPUT OF QUERY 5:
conceptual metaphor: ex:falseteachers_compared_to_deceivers
conceptual metaphor: ex:ministers_compared_to_trumpeters
conceptual metaphor: ex:afflictions_compared_to_clouds
conceptual metaphor: ex:the_church_compared_to_an_olivetree
conceptual metaphor: ex:saints_compared_to_lions
conceptual metaphor: ex:conscience_a_witness
conceptual metaphor: ex:sin_a_plague
conceptual metaphor: ex:grace_compared_to_salt
conceptual metaphor: ex:wicked_men_compared_to_captives
conceptual metaphor: ex:saints_compared_to_stewards
conceptual metaphor: http://www.example
[...]

APPENDIX C EXAMPLE ALIGNMENT WITH CONCEPTS FROM THE POETIC DOMAIN

An initial alignment of met : Expression with poetic concepts is depicted in Figure 13 of Appendix C. Implementing the graph of Figure 14, it is possible to query all lines of poem Georgics that include metaphors, all metaphors included in Book Volume III. Equally, with all poems modeled in this way, it would be possible to query, for example, all metaphors of each book of each author (frbr : partOf is the inverse property of frbr : part).

The met : PoemVerseExpression denotes a poem verse; all met : PoemLineExpression, PoemVerseExpression, and fabio : Poem are subclasses of met : PoeticExpression that realizes met : PoeticWork, as shown in Figure 13. In this way, every part of a met : PoeticExpression realizes fabio : Work.

The graph of phrase: "*sed fugit*" in Figure 14 uses the following classes: met : PoeticWork, met : PoeticExpression,

```
row = conceptual metaphor:ex:grace_compared_to_salt
has_vehicle:ex:salt
has_target:ex:grace
vehicle has_quality: ex:IIMBQCPSAILSCRI
target has_quality: ex:IBITSBWOIEFTCSA

ex:IIMBQCPSAILSCRI rdf:type ex:ConceptQuality ;
rdfs:label "II. If Meat be quite corrupted, putrified,
stink, and is loathsom, Salt cannot recover it,
nor make it savoury" .

ex:IBITSBWOIEFTCSA rdf:type ex:ConceptQuality ;
rdfs:label "II. But if the Soul be wholly or in every
Faculty thereof corrupted, stinks, and is loathsom in
the Nostrils of God, yet Grace can quickly recover it,
and make it very Savoury and Sweet to God and good Men" ;
ex:parallel_to ex:IIMBQCPSAILSCRI .

row = conceptual metaphor:ex:grace_compared_to_salt
has_vehicle:ex:salt
has_target:ex:grace
vehicle has_quality: ex:ISHAPQIWNOPCOOM
target has_quality: ex:IGPTSFAMOSADIWN
ex:ISHAPQIWNOPCOOM rdf:type ex:ConceptQuality ;
rdfs:label "III. Salt hath a preserving quality;
it will not only purge Corruption out of Meat, but
also preserve Meat, and other things, from Corruption and
Putrefaction" .

ex:IGPTSFAMOSADIWN rdf:type ex:ConceptQuality ;
rdfs:label """III. Grace preserves the Soul from all manner
of Sin and Defilements; it will not suffer a Saint to run
with others to the aame excess of Riot; 1 Pet. 4.4.
but teacheth us to deny all ngodliness, and worldly Lusts,
and to live righteously, soberly, Tit. 2.12.
and godly in this present World. How shall I do this thing,
and sin against God?""" ;
ex:parallel_to ex:ISHAPQIWNOPCOOM .
[...]
query_Q3 = """
PREFIX ex: <http://www.example.org/Metaphors/>
PREFIX rdf: <http://www.w3.org/1999/02/22−rdf−syntax−ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf−schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX fabio: <http://purl.org/spar/fabio/>
select distinct ?c1 ?l1 ?c2 ?l2
where {
        ?concept1 ex:has_quality ?c1 .
        ?c1 rdfs:label ?l1 .
        ?concept2 ex:has_quality ?c2 .
        ?c2 rdfs:label ?l2 .
        ?c1 ex:parallel_to ?c2 .
}"""
```

ENCODING 14. Query 3.

met : PoemLineExpression, and met : BookVolume defined in Table 9.

The graph for Example 9 is included in Appendix E. The graph shows the usage of LifeSpan and TranslationEvent classes.

Concept: ex:a_flower
ConceptQuality: ex:XTOOFKTBTTCTAWS
ConceptQuality.text: X. The Owner of Flowers knows the best Time to crop them; and who shall be offended at him, when he takes to himself this or that Flower out of his Garden? He may do what he pleaseth with his own
parallel_to:
Concept: ex:man
ConceptQuality: ex:XSGKTBTTCOOTABD
Concept Quality.text:X. So God knows the best Time to crop off, or take away by Death this and that precious Flower. Sometimes he cuts them down, before others think they are half ripe; but God knows better than we. He never pulls, nor takes any of his Saints unto himself, till he seeth they are fit to die. And who shall be offended at him in what he doth? tho he take such out of the Garden, that we would fain have grow still there, because they are such a sweet Ornament to it; but may not God do what he pleaseth with his own?
Concept: ex:swine
ConceptQuality: ex:XTSUTTIAGMEUTAB
ConceptQuality.text: XI. The Swine under the Tree in a greedy manner eat up the Acorns, but never look up to the Tree or Oak from whence they fall
parallel_to:
Concept: ex:wicked_men
ConceptQuality: ex:XSWAGMTTEATWGNL
Concept Quality.text:XI. So wicked and graceless Men, tho they enjoy all this World 's Good, never look up in a due manner to God, who is the Tree of Life, and is the Author and Giver of it
[...]

Example Query 4.
Query 4 finds the qualities of concept ex : light.

```
query_Q4 = """
PREFIX ex: <http://www.example.org/Metaphors/>
PREFIX rdf: <http://www.w3.org/1999/02/22−rdf−syntax−ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf−schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX fabio: <http://purl.org/spar/fabio/>
select distinct ?q ?l
where {
        ex:light ex:has_quality ?q ;
        rdf:type ex:MConcept .
        ?q rdfs:label ?l .
}"""
```

ENCODING 15. **Query 4.**

```
query_Q5 = """
PREFIX ex: <http://www.example.org/Metaphors/>
PREFIX rdf: <http://www.w3.org/1999/02/22−rdf−syntax−ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf−schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX fabio: <http://purl.org/spar/fabio/>
select distinct ?cm
where {
        ?metaphor_epigraph ex:materializes ?cm ;
        ex:excerptOf ?bibleVerse .
        ?bibleVerse ex:partOf ?BibleChapter .
        ?BibleChapter ex:partOf ?BibleBook .
        ?BibleBook ex:partOf ex:KJVBibleVersion .
}"""
```

ENCODING 16. **Query 5.**

Note 6: The Bible verses, chapters, and books that belong to the ex : Expression class represent a particular version of the Bible verses, chapters, and books, respectively. A more informative name for these might be BibleVerseVersion, BibleChapterVersion, and BibleBookVersion. The relationship with a bible version is implied by the fact that they all form parts of the BibleVersion. This case study used a single version of the Bible.

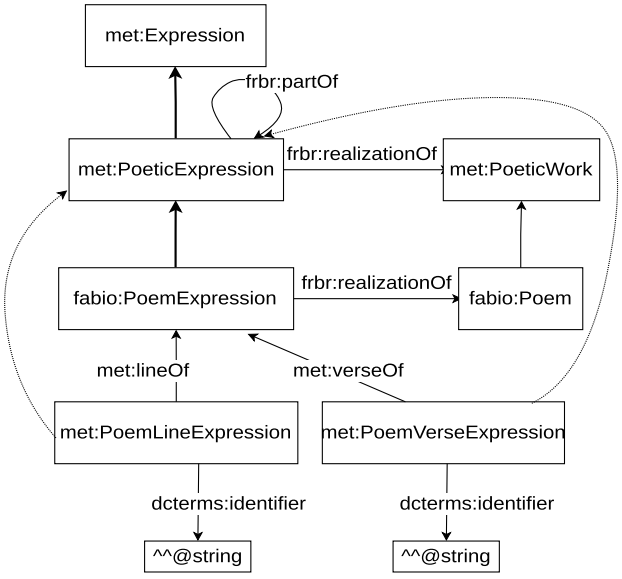


FIGURE 13. **Example 6 poetry classes.**

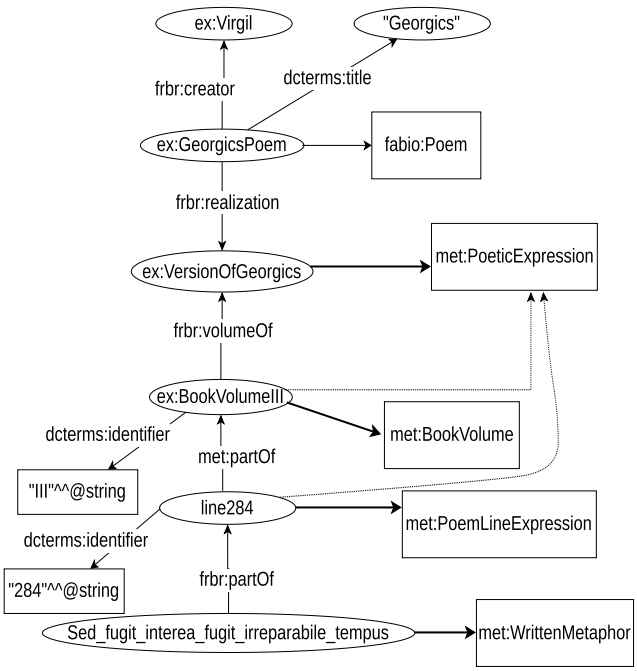


FIGURE 14. **Example 6 part of graph concerning "Sed fugit" phrase.**

APPENDIX D EXAMPLES OF DATE EXPRESSIONS

See Table 10.

APPENDIX E GRAPHS OF NON-RELIGIOUS EXAMPLES

See Fig. 15.

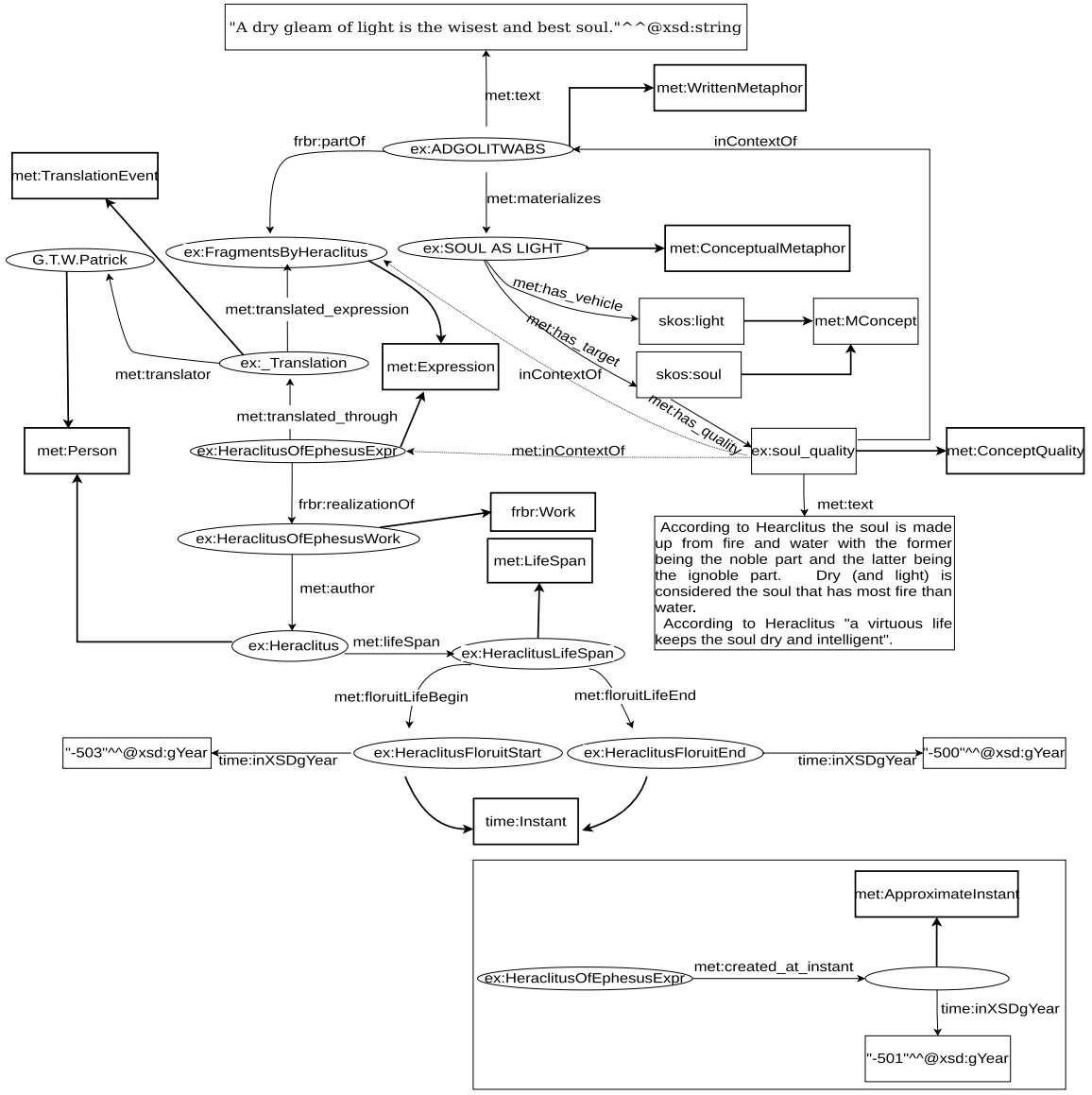


FIGURE 15. Heraclitus metaphor.

REFERENCES

[1] G. Lakoff and M. Johnson, *Metaphors We Live By*. Chicago, IL, USA: University of Chicago Press, Apr. 2003. [Online]. Available: https://press.uchicago.edu/ucp/books/book/chicago/M/bo3637992.html

[2] J. R. Gibbs, *The Cambridge Handbook of Metaphor and Thought* (Cambridge Handbooks in Psychology). Cambridge, U.K.: Cambridge Univ. Press, 2008.

[3] K. Zoltan, *Metaphor: A Practical Introduction*, 2nd ed. London, U.K.: Oxford Univ. Press, 2010.

[4] J. Grady, "Foundations of meaning: Primary metaphors and primary scenes," Ph.D. thesis, Dept. Linguistics, Graduate Division Univ. California, Berkeley, CA, USA, 1997. [Online]. Available: https://escholarship.org/uc/item/3g9427m2

[5] G. Fauconnier and M. Turner, *The Way We Think: Conceptual Blending and the Mind's Hidden Complexities*. New York, NY, USA: Basic Books, 2002.

[6] P. H. Thibodeau and L. Boroditsky, "Metaphors we think with: The role of metaphor in reasoning," *PLoS ONE*, vol. 6, no. 2, Feb. 2011, Art. no. e16782.

[7] G. Lakoff and M. Johnson, "The metaphorical structure of the human conceptual system," *Cogn. Sci.*, vol. 4, no. 2, pp. 195–208, Jun. 1980.

[8] N. Vu, "Structural, orientational, ontological conceptual metaphors and implications for language teaching," *Ho Chi Minh City Open Univ. J. Sci. Social Sci.*, vol. 3, pp. 67–71, Aug. 2015.

[9] S. Cox and C. Little, *Time Ontology in Owl*, document OGC 16-071r3, OGC, W3C, Jul. 2016. [Online]. Available: https://www.w3.org/TR/owl-time

[10] D. Shotton and S. Peroni. (Feb. 2019). *FaBio, the FRBR—Aligned Bibliographic Ontology*. [Online]. Available: http://purl.org/spar/fabio

[11] T. Berners-Lee. (2006). *Linked Data—Design Issues*. [Online]. Available: https://www.w3.org/DesignIssues/LinkedData.html

[12] C. Bizer, T. Heath, and T. Berners-Lee, "Linked data: The story so far," *Int. J. Semantic Web Inf. Syst.*, vol. 5, pp. 1–22, Jan. 2009.

[13] T. Heath and C. Bizer, *Linked Data: Evolving the Web Into a Global Data Space*. Cham, Switzerland: Springer, 2011.

[14] K. Graham, *Resource Description Framework (RDF): Concepts and Abstract Syntax*, document RDF 1.1, W3C, 2004. [Online]. Available: http://www.w3.org/TR/2004/REC-rdf-concepts-20040210/

[15] G. Cheng and Y. Qu, "Searching linked objects with falcons: Approach, implementation and evaluation," *Int. J. Semantic Web Inf. Syst.*, vol. 5, pp. 49–70, Jan. 2009.

[16] A. Hogan, A. Harth, J. Umrich, and S. Decker, "Towards a scalable search and query engine for the Web," in *Proc. 16th Int. Conf. World Wide Web*. New York, NY, USA: Association for Computing Machinery, May 2007, pp. 1301–1302.

[17] T. Berners-Lee, Y. Chen, L. Chilton, D. Connolly, R. Dhanaraj, J. Hollenbach, A. Lerer, and D. Sheets, "Tabulator: Exploring and analyzing linked data on the semantic web," in *Proc. 3rd Int. Semantic Web User Interact.*, Jan. 2006.

[18] C. Becker and C. Bizer, "DBpedia Mobile: A location-enabled linked data browser," in *Proc. CEUR Workshop*, vol. 369, Germany, C. Bizer, T. Heath, K. Idehen, and T. Berners-Lee, Eds. Aachen, RWTH Aachen, 2008, pp. 1–2.

[19] M. Smith, C. Welty, and D. McGuinness. (2004). *OWL Web Ontology Language Guide W3C Recommendation*. [Online]. Available: https://www.w3.org/TR/owl-guide/

[20] P. Haase, M. Schmidt, and A. Schwarte, "The information workbench as a self-service platform for linked data applications," in *Proc. 2nd Int. Conf. Consuming Linked Data*, vol. 782, Aachen, Germany, Oct. 2011, pp. 119–124.

[21] A. Jentzsch, R. Isele, and C. Bizer, "Silk—Generating RDF links while publishing or consuming linked data," in *Proc. Int. Semantic Web Conf. (ISWC)*, Shanghai, China. Aachen, Germany: DEU, Nov. 2010, pp. 53–56.

[22] N. Ide and J. Pustejovsky, "What does interoperability mean, anyway? Toward an operational definition of interoperability," in *Proc. 2nd Int. Conf. Global Interoperability Language Resources*, Hong Kong, 2010.

[23] C. Chiarcos, P. Cimiano, T. Declerck, and J. P. McCrae, "Linguistic linked open data (LLOD). Introduction and overview," in *Proc. 2nd Workshop Linked Data Linguistics (LDL) Representing Linking Lexicons, Terminol. Language Data*, Pisa, Italy, C. Chiarcos, P. Cimiano, T. Declerck, and J. P. McCrae, Eds. Association for Computational Linguistics, Sep. 2013, pp. 1–11.

[24] D. Brickley and L. Miller. (Sep. 2004). *FOAF Vocabulary Specification, FOAF Project*. [Online]. Available: http://xmlns.com/foaf/0.1

[25] S. Weibel. (Jul. 1995). *Metadata: The Foundations of Resource Description*. [Online]. Available: http://www.dlib.org/dlib/July95/07weibel.html

[26] J. Caverlee, P. Mitra, and M. Laarsgard, "Dublin core," in *Encyclopedia of Database Systems*, L. Liu and M. Özsu, Eds. Boston, MA, USA: Springer, 2009, p. 949.

[27] J. Breslin, U. Bojàs, A. Passant, S. Fernández, and S. Decker, "SIOC: Content exchange and semantic interoperability between social networks," in *Proc. W3C Workshop Future Social Netw.*, Jan. 2009.

[28] A. Passant, U. Bojārs, J. G. Breslin, and S. Decker, "The SIOC project: Semantically-interlinked online communities, from humans to machines," in *Coordination, Organizations, Institutions and Norms in Agent Systems V* (Lecture Notes in Computer Science). Berlin, Germany: Springer, 2010, pp. 179–194.

[29] R. Albertoni, D. Browning, S. Cox, A. Gonzalez-Beltran, A. Perego, and P. Winstanley, *Data Catalog Vocabulary (DCAT)*, document Version 2.4, 2020. [Online]. Available: https://www.w3.org/TR/vocab–2

[30] A. Abele, J. McCrae, P. Buitelaar, A. Jentzsch, and R. Cyganiak. (2017). *The Linked Open Data Cloud Diagram 2017*. [Online]. Available: http://lod-cloud.net

[31] A. Isaac and E. Summers. (Aug. 2009). *Simple Knowledge Organization System Primer*. [Online]. Available: https://www.w3.org/TR/-primer/

[32] A. Miles and S. Bechhofer. (Aug. 2009). *Simple Knowledge Organization System Reference*. [Online]. Available: https://www.w3.org/TR/skos-reference/

[33] M. Katsumi and M. Grüninger, "What is ontology reuse?" in *Formal Ontology in Information Systems*. Amsterdam, The Netherlands: IOS Press, 2016, pp. 9–22.

[34] C. Chiarcos and A. Pareja-Lora, "Open data-linked data-linked open data-linguistic linked open data (LLOD): A general introduction," in *Development of Linguistic Linked Open Data Resources for Collaborative Data-Intensive Research in the Language Sciences*. Cambridge, MA, USA: MIT Press, 2019, pp. 1–18.

[35] T. Declerck et al., "Recent developments for the linguistic linked open data infrastructure," in *Proc. 12th Language Resources Evaluation Conf.*, Marseille, France. Paris, France: European Language Resources Association (ELRA), May 2020, pp. 5660–5667.

[36] P. Cimiano, C. Chiarcos, J. P. McCrae, and J. Gracia, "Modelling lexical resources as linked data," in *Linguistic Linked Data: Representation, Generation and Applications*, P. Cimiano, C. Chiarcos, J. McCrae, and J. Gracia, Eds. Springer, 2020, pp. 45–59.

[37] J. Gracia, D. Vila-Suero, J. McCrae, T. Flati, C. Baron, and M. Dojchinovski, "Language resources and linked data: A practical perspective," in *Proc. Knowl. Eng. Knowl. Manag. Satell. Events (EKAW)*, Linköping, Sweden, P. Lambrix, E. Hyvönen, E. Blomqvist, V. Presutti, G. Qi, U. Sattler, Y. Ding, and C. Ghidini, Eds., 2014, pp. 1–17.

[38] T. Declerck, "Towards a linked lexical data cloud based on ontolex-lemon," in *Proc. 11th Int. Conf. Lang. Resour. Eval. (LREC)*, France, J. P. McCrae, C. Chiarcos, T. Declerck, J. Gracia, and B. Klimek, Eds. European Language Resources Association (ELRA), May 2018.

[39] B. D'Arcus and F. Giasson. (Nov. 2009). *Bibliographic Ontology Specification*. [Online]. Available: http://bibliontology.com/specification

[40] K. G. Saur, *Functional Requirements for Bibliographic Records—Final Report* (IFLA Section on Cataloguing), vol. 19. München, Germany: UBCIM, 1998.

[41] S. Peroni and D. Shotton, "FaBiO and CiTO: Ontologies for describing bibliographic resources and citations," *J. Web Semantics*, vol. 17, pp. 33–43, Dec. 2012.

[42] S. Peroni and D. Shotton, "The spar ontologies," in *The Semantic Web—ISWC*, D. Vrandečić, K. Bontcheva, M. Suárez-Figueroa, V. Presutti, I. Celino, M. Sabou, L. Kaffee, and E. Simperl, Eds. Cham, Switzerland: Springer, 2018, pp. 119–136.

[43] P. Biron and A. Malhotra. (May 2001). *XML Schema Part 2: Datatypes*. W3C Recommendation. [Online]. Available: https://www.w3.org/TR/2001/REC-xmlschema-2-20010502/

[44] N. Mendelsohn, D. Beech, M. Maloney, and H. Thompson. (Oct. 2004). *XML Schema Part 1: Structures Second Edition*. W3C Recommendation. [Online]. Available: https://www.w3.org/TR/2004/REC-xmlschema-1-20041028/

[45] M. Kay. (Apr. 2014). *XPath and XQuery Functions and Operators 3.0*. W3C Recommendation. [Online]. Available: https://www.w3.org/TR/2014/REC-xpath-functions-30-20140408/

[46] S. Muralidhar and J. Jim Melton. (Dec. 2010). *XML Syntax for XQuery 1.0 (XQueryX) (Second Edition)*. W3C Recommendation. [Online]. Available: https://www.w3.org/TR/2010/REC-xqueryx-20101214/

[47] M. Dyck, D. Chamberlin, J. Snelson, and J. Robie. (Apr. 2014). *XQuery 3.0: An XML Query Language*. W3C Recommendation. [Online]. Available: https://www.w3.org/TR/2014/REC-xquery-30-20140408/

[48] M. Kay. (Jun. 2017). *XSL Transformations (XSLT) Version 3.0*. W3C Recommendation. [Online]. Available: https://www.w3.org/TR/2017/REC-xslt-30-20170608/

[49] I. Horrocks, B. Parsia, and U. Sattler. (2012). *OWL 2 Web Ontology Language, Direct Semantics*. W3C Recommendation. [Online]. Available: https://www.w3.org/TR/owl-direct-semantics

[50] T. Parsons and E. A. Shils, *Toward a General Theory of Action*. Cambridge, MA, USA: Harvard Univ. Press, 1951.

[51] J. F. Allen, "Maintaining knowledge about temporal intervals," *Commun. ACM*, vol. 26, no. 11, pp. 832–843, Nov. 1983.

[52] G. Lakoff and M. Johnson, *Metaphors We Live By*. Chicago, IL, USA: University of Chicago Press, 1980.

[53] A. Deignan, *From Linguistic To Conceptual Metaphors*. Evanston, IL, USA: Routledge, Nov. 2016.

[54] L. Fan, "Literature review on the cognitive approach to metaphor," *Proc. Comput. Sci.*, vol. 131, pp. 925–928, Jan. 2018.

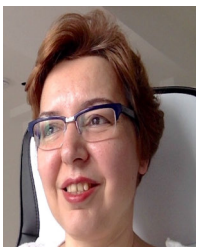
[55] E. Shutova, B. J. Devereux, and A. Korhonen, "Conceptual metaphor theory meets the data: A corpus-based human annotation study," *Lang. Resour. Eval.*, vol. 47, no. 4, pp. 1261–1284, Dec. 2013.

[56] J. Al-Hajaj, "Conceptual/cognitive metaphor theory: Some insights into metaphorical conceptual mappings in poetry," *J. Basra Researches Human Sci.*, vol. 38, no. 4, pp. 83–104, 2013.

[57] M. Knowles and M. Rosamund, *Introducing Metaphor*. Evanston, IL, USA: Routledge, 2006.

[58] D. Allbritton, G. McKoon, and R. Gerrig, "Metaphor-based schemas and text representations: Making connections through conceptual metaphors," *J. Exp. Psychol. Learn., Memory, Cognition*, vol. 21, pp. 25–612, Jun. 1995.

[59] R. W. Gibbs, "Categorization and metaphor understanding," *Psychol. Rev.*, vol. 99, no. 3, pp. 572–577, 1992.
[60] R. Gibbs, "Why do some people dislike conceptual metaphor theory?" *Cogn. Semiotics*, vol. 5, pp. 14–36, Dec. 2009.
[61] G. Lakoff, *Master Metaphor List*. Berkeley, CA, USA: Univ. of California, 1994.
[62] R. Gibbs, *Embodiment and Cognitive Science*. New York, NY, USA: Cambridge Univ. Press, 2006.
[63] P. Group, "MIP: A method for identifying metaphorically used words in discourse," *Metaphor Symbol*, vol. 22, no. 1, pp. 1–39, Jan. 2007.
[64] B. Keach and T. de Laune, "Troposchēmalogia: Tropes and figures; Or, a treatise of the metaphors, allegories, and express similitudes," Literary Linguistic Data Service, 2014.
[65] T. De Laune, *Troposchemalogia: Tropes and Figures; Or, A Treatise of the Metaphors, Allegories, and Express Similitudes*. Ann Arbor, MI, USA: ProQuest, Dec. 2010.
[66] T. S. Eliot, *Four Quartets*. New York, NY, USA: Harcourt, 1943.
[67] W. Shakespeare, "Sonnet 146," in *The Complete Works of William Shakespeare*, R. G. White, Ed. New York, NY, USA: Sully and Kleinteich, 1609.
[68] J. Milton, *Paradise Lost*. London, U.K.: Samuel Simmons, 1667.
[69] W. Blake, "The Lamb," in *Songs of Innocence and Experience*. London, U.K.: Oxford Univ. Press, 1977.
[70] B. Pasanek, *Metaphors of Mind: An Eighteenth-Century Dictionary*. Baltimore, MD, USA: The Johns Hopkins Univ. Press, 2015.
[71] A. Einstein, *Albert Einstein: Out My Later Years*. New York, NY, USA: Gramercy, 1993.
[72] E. Hamilton and H. Cairns, *The Collected Dialogues Plato*. Princeton, NJ, USA: Princeton Univ. Press, 1962.
[73] F. Baader, D. Calvanese, D. McGuinness, D. Nardi, and P. Patel-Schneider, *The Description Logic Handbook: Theory, Implementation, and Applications*. Cambridge, MA, USA: Cambridge Univ. Press, 2003.
[74] C. Bekiari, M. Doerr, P. Le Boeuf, and P. Riva. (2017). *IFLA Repository: Definition of FRBRoo: A Conceptual Model for Bibliographic Information in Object-Oriented Formalism*. [Online]. Available: https://repository.ifla.org/handle/123456789/659
[75] T. Aalberg, C. Bekiari, G. Bruseker, M. Doerr, G. Görz, P. Le Bouf, M. Nyman, C. Ore, P. Riva, M. Roche, R. Smiraglia, S. Stead, A. Velios, and M. Zumer. (2021). *LRMoo (f.k.a. FRBRoo) V.0.7 | FRBRoo*. [Online]. Available: https://www.cidoc-crm.org/frbroo/ModelVersion/lrmoo-f.k.a.-frbroo-v.0.7
[76] J. Holloway. (2023). *What is an Epigraph?* Accessed: Jun. 1, 2023. [Online]. Available: https://www.languagehumanities.org/what-is-an-epigraph.html
[77] Z. Borovsky. *Research Guides: Text Encoding (TEI): What Is TEI?* Accessed: 2022. [Online]. Available: https://guides.library.ucla.edu/c.php?g=180472&p=1190308
[78] J. Cummings, "The text encoding initiative and the study of literature," in *A Companion To Digital Literary Studies*. Hoboken, NJ, USA: Wiley, 2013, pp. 451–476. [Online]. Available: https://onlinelibrary.wiley.com/doi/pdf/10.1002/9781405177504.ch25
[79] L. Richardson. (2007). *Beautiful Soup Documentation*. [Online]. Available: http://www.crummy.com/software/BeautifulSoup/
[80] K. P. Jackson, F. F. Judd Jr., and D. R. Seely, "Chapters, verse, punctuation, spelling, and italics in the King James version," *Religious Educator*, vol. 7, no. 2, pp. 41–64, 2006.
[81] P. David, M. Sperberg-McQueen, S. Gao, P. Biron, A. Malhotra, and H. Thompson. (Apr. 2012). *W3C Xml Schema Definition Language (XSD) 1.1 Part 2: Datatypes*. W3C Recommendation. [Online]. Available: https://www.w3.org/TR/2012/REC-xmlschema11-2-20120405/
[82] Carnegie Museum of Art. *Date Parsing for Provenance*. Accessed: 2022. [Online]. Available: https://www.museumprovenance.org/reference/dates/
[83] B. Pasanek. *The Mind is a Metaphor*. Accessed: 2023. [Online]. Available: http://metaphors.liv.virginia.edu/metaphors
[84] C. Binding, "Implementing archaeological time periods using CIDOC CRM and SKOS," in *Proc. 7th Extended Semantic Web Conf. (ESWC)*. Heidelberg, Germany: Springer, May 2010, pp. 273–287.
[85] C. Bekiari, M. Doerr, P. Le Boeuf, and P. Riva. (Mar. 2017). *Definition of FRBRoo: A Conceptual Model for Bibliographic Information in Object-Oriented Formalism*. [Online]. Available: https://repository.ifla.org/handle/123456789/659
[86] Provenance Incubator Group. *Overview of Provenance on the Web*. Accessed: 2023. [Online]. Available: https://www.w3.org/2005/Incubator/prov/wiki/images/0/02/Provenance-XG-Overview.pdf
[87] S. Cox and C. Little. (Nov. 2022). *Time Ontology in OWL*. Candidate Recommendation, W3C. [Online]. Available: https://www.w3.org/TR/2022/CRD-owl-time-20221115/
[88] C. Fillmore, "Frame semantics and the nature of language," *Ann. New York Acad. Sci.*, vol. 280, pp. 20–32, Dec. 2006.
[89] E. Dodge, J. Hong, and E. Stickles, "MetaNet: Deep semantic automatic metaphor analysis," in *Proc. 3rd Workshop Metaphor NLP*, 2015, pp. 40–49.
[90] A. Gangemi, M. Alam, and V. Presutti, "Amnestic forgery: An ontology of conceptual metaphors," in *Proc. 10th Int. Conf. Formal Ontol. Inf. Syst. (FOIS)*, vol. 306, Cape Town, South Africa, S. Borgo, P. Hitzler, and O. Kutz, Eds. Amsterdam, The Netherlands: IOS Press, 2018, pp. 159–172.
[91] E. Stickles, O. David, E. K. Dodge, and J. Hong, "Formalizing contemporary conceptual metaphor theory: A structured repository for metaphor analysis," *Constructions Frames*, vol. 8, no. 2, pp. 166–213, Dec. 2016.
[92] C. F. Baker, C. J. Fillmore, and J. B. Lowe, "The Berkeley FrameNet project," in *Proc. 17th Int. Conf. Comput. Linguistics*, Montreal, QC, Canada. New York, NY, USA: Association for Computational Linguistics, Aug. 1998, pp. 86–90.
[93] C. J. Fillmore, "Frame semantics," in *Cognitive Linguistics: Basic Readings*. Berlin, Germany: De Gruyter Mouton, Aug. 2008, ch. 10, pp. 373–400.
[94] O. David, E. Dodge, J. Hong, E. Stickles, and E. Sweetser, "Building the MetaNet metaphor repository: The natural symbiosis of metaphor analysis and construction grammar," in *Proc. 8th Int. Construction Grammar Conf. (ICCG)*, 2014, pp. 3–6.
[95] C. Panayiotou, "Extraction of poetic and non-poetic relations from of-prepositions using WordNet," *IEEE Access*, vol. 10, pp. 3469–3494, 2022.
[96] A. Gangemi, M. Alam, L. Asprino, V. Presutti, and D. R. Recupero, "Framester: A wide coverage linguistic linked data hub," in *Knowledge Engineering and Knowledge Management*, E. Blomqvist, P. Ciancarini, F. Poggi, and F. Vitali, Eds. Cham, Switzerland: Springer, Nov. 2016, pp. 239–254.
[97] G. A. Miller, "WordNet: A lexical database for English," *Commun. ACM*, vol. 38, no. 11, pp. 39–41, 1995.
[98] A. Gangemi, *What is a Schema?* Cambridge, U.K.: Cambridge Univ. Press, 2010.
[99] A. Gangemi. (2019). *Whats in a Schema?*. [Online]. Available: https://www.istc.cnr.it/en/content/whats-schema
[100] J. P. McCrae, J. Bosque-Gil, J. Gracia, P. Buitelaar, and P. Cimiano, "The OntoLex-Lemon model: Development and applications," in *Proc. eLex Conf.*, 2017, pp. 19–21.



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