Creating ontoterminologies for antiquity: workflow, challenges and solutions

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Abstract

In this paper, we explore the workflows and challenges involved in creating ontoterminologies for the study of antiquity, focusing on three distinct humanities use cases developed using the TEDI software. We present a systematic approach to building FAIR (Findable, Accessible, Interoperable, and Reusable) datasets for legal processes in Classical Athens, Archaic Lyric poetry, and the archaeological site of Göbekli Tepe. The paper discusses the workflows we employed to create and define concepts and terms, detailing the conceptual and linguistic challenges encountered, such as aligning ancient and modern terminology and representing uncertainty in historical data. We propose that the iterative nature of TEDI allows for flexible and accurate ontoterminologies that can evolve with scholarly research. Furthermore, we highlight how ontoterminologies can enhance the interoperability of data across different humanistic research projects, contributing to the broader vision of the Semantic Web. Our findings emphasize the potential of ontoterminologies to bridge conceptual gaps, clarify domain-specific terms, and enable more effective knowledge exchange within the humanities.

Keywords

ontology, terminology, ontoterminology, multilingual ontoterminology, digital humanities, ancient Greek literature, archaeology, historical data modeling

1. Introduction

In this short paper, we introduce our methodologies for the creation of ontoterminologies for the study of antiquity. By presenting our experience building findable, accessible, interoperable, and reusable (FAIR) [1] datasets through ontoterminologies, we also propose solutions for the challenges researchers of antiquity may face in this process. This paper presents three humanities use cases for ontoterminologies created with the software TEDI (ontoTerminology EDItor)[2]: one describing legal processes in Classical Athens [3] (Author 1); one describing the genres and literary production of Archaic Lyric poetry [4] (Author 2); and one describing the archaeological finds at Göbekli Tepe [5] (Author 3). All three databases are openly available for download on the Zenodo repository. By means of a thorough analysis of the steps taken and challenges overcome in each use case, we demonstrate the value of multilingual ontoterminologies for the structuring of humanities data.

While "ontology" and "terminology" predate the digital era, both have taken on new meaning within the proposed Semantic Web [6]. The ontology, originally the philosophical study of existence, describes the hierarchical concepts and relationships within a domain. Terminology is the study of the set of specialized language ('terms') and concepts within a domain [7], and has been implemented and managed digitally [8]. Terminology and ontology are combined in the paradigm of ontoterminology, or "a terminology whose conceptual system is a formal ontology" [9]. Ontoterminology handles the conceptual and linguistic facets of terminology by providing two distinct definitions: one that outlines the concept in a formal manner and another that elaborates on the term's meaning and application from a linguistic standpoint [10]. In addition, ontoterminology allows for the conversion

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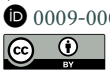

of multilingual terminology into linked data that is standardized, queryable, and machine-readable. Humanists, therefore, can use ontoterminologies to align and define specialized terms across languages within their domain.

In order to create humanist ontoterminologies, we use the software TEDI [2]. TEDI is a free software environment that allows the user-friendly creation of ontoterminologies according to Aristotelian principles, namely essential and descriptive characteristics [11]. TEDI follows the main principles of the ISO-1087 standard for terminology, which defines a concept as a "unit of knowledge created by a unique combination of characteristics" [7]. Additionally, TEDI operates off of the hypothesis that a term is a verbal designation of a concept. Therefore, the interface is divided into conceptual and linguistic dimensions. As has been observed, ontology tools and OWL Description Logics can be formidable to humanities domain experts, leading to mistakes, frustration, or loss of interest [12]. However, TEDI is designed with these experts in mind, prioritizing accessible workflows that mirror humanities research [13]. Through our use of TEDI to create ontoterminologies across the domains of Classics and Archaeology, we have gained insights into the methodology and challenges of ontoterminology authoring for scholars in the humanities.

2. Ontoterminologies for Classics

In this section, we introduce two ontoterminologies within the domain of Classical studies. The first of these describes the Classical Athenian legal system by defining the processes and legal bodies [3] (Author 1). The second models the sub-genres of Archaic Lyric poetry along with its poets and their literary production [4] (Author 2). These databases contain concepts designated by either ancient Greek and English or English and Modern Greek terms respectively. Although the domains are distinct, we discovered many illustrative similarities in our workflows.

The first ontoterminology, which describes Classical Athenian legal processes and bodies, is part of a PhD thesis entitled "Semantic Annotation and Attic Oratory". This PhD aims to create a semantic resource for the study of Attic oratory, utilizing a data model built by merging three ontoterminologies created in TEDI in the standard ontology editor Protégé [14]. In order to describe these legal processes, Author 1 began with a survey of the domain. For this, she utilized the corpus of forensic Attic oratory. Each speech is written for a legal dispute, such as a suit over financial damages or a suit against a public official for accepting bribes. Author 1 consulted commentaries in order to manually determine which case types aligned with which speech, and then created a list of terms to include in the source language of ancient Greek. While NLP methods were considered, quite often orators do not outwardly state the name of the legal process, sometimes even intentionally obfuscating the charges. Furthermore, as explained by Todd, Athenian law was more procedural than substantive, meaning there were multiple procedures that could be used to prosecute a crime such as theft [15]. Therefore, the process of domain survey, which identified around twenty-five case types from approximately 120 speeches, was best done manually.

In the next step, Author 1 consulted secondary bibliography for scholarly discussions of the ancient Greek terms for case types. Through this, she determined the axes of analysis for the concepts designated by the terms. For example, in the Classical Athenian legal system, different magistrates oversee different types of proceedings. The Eponymous Archon ( ) oversees family law, while the Basileus () supervises suits related to religious infringements [16]. Therefore, an axis essential to each legal proceeding is the supervising body. After determining the essential characteristics of each legal proceeding and sorting these into axes of analysis, Author 1 inputted these axes and characteristics into TEDI in order to generate formal definitions of concepts via unique combinations of characteristics. For example, a suit for financial damages can be defined as (Figure 1):

<Private legal proceeding> + /initiated by submitting a charge in writing/ + /supervised by the Forty/ + /tried by the dikasterion/ + /prosecutor issues oral summons at the Assembly/ + /for causing financial loss/ + /assessable penalty/ + /fine/ + /penalty of one sixth of the sum at issue for failed prosecution/

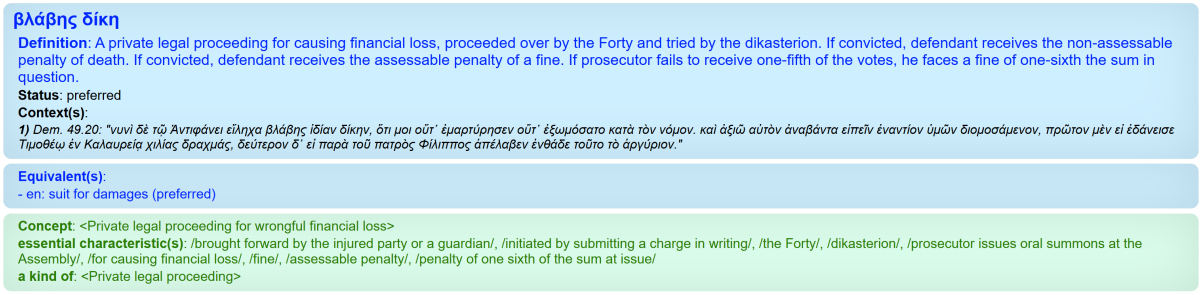

Figure 1: HTML Onto-Dictionary export for a suit for financial damages (Author 1)

The final step was to determine the equivalent terms in other languages (English in this case). This step introduces challenges, especially when terms refer to practices which no longer exist in modern legal systems. For instance, the ancient ‘ ’ (literally ‘suit for intentional homicide’) is not a direct equivalent to the US or UK ‘murder in the first degree’. Therefore, Author 1 decided to use more literal English translations of the ancient Greek from scholarship and commentaries, rather than draw false equivalencies between ancient and modern legal systems.

Author 2 followed a similar workflow to model the genre of Archaic Lyric poetry, but experienced particular challenges due to the fragmentary nature of the genre and debates in current domain research [17]. This ontoterminology aimed at developing a well-structured and comprehensive model that integrates the terminology and literary production of Archaic lyric poetry, with the goal of serving as an effective tool particularly for educational purposes. To further enrich its usability, the database has been linked to several academic resources, such as the Thesaurus Linguae Graecae Canon [18], the Perseus Catalog [19], and the Pleiades Gazetteer [20], as well as publicly curated resources like Wikidata, allowing users to explore a broader range of materials. In this regard, TEDI's user-friendly HTML Onto-Dictionary plays a particularly significant role in enhancing accessibility and facilitating seamless navigation (Figure 2).

Author 2 began with an examination of the original works of the Archaic Lyric poets. Next, he expanded on his knowledge of the primary texts by reviewing secondary sources, which provided key discussions for the defining characteristics of this poetry. Although this method of textual analysis proved to be challenging due to the multiplicity of perspectives presented by domain experts, it allowed for the identification of axes of analysis by constructing concepts based on discrete combinations of features. These axes of analysis included elements such as content, dialect, performer, and occasion. For example, the “content” axis contained: /with erotic content/, /with gnomic content/, /with imitation content/, /with political content/, and /with war content/. Thus, by prioritizing the primary texts themselves, Author 2 developed a clearer understanding of the sub-genres, ultimately enabling the formulation of an accurate conceptual framework. For example, through this approach, the “erotic elegy” was defined as:

<Archaic Lyric Poem> + /only in ionic dialect/ + /in elegiac couplet/ + /with specific content/ + /with erotic content/

Finally, Author 2 opted to confine the process of designating concepts by terms that have been used by the bibliography for the literary production of the specific period and the specific poetic genre. To demonstrate, although these terms appear elsewhere in the ancient Greek literature, e.g. “thrēnos" and “hymenaios" [21], the current approach focused on the bibliography of the specific domain (Archaic Lyric poetry). Thus, in this base, the terminology refers to the literary genres of Archaic Lyric production per se and not, for example, to passages of such content encapsulated in other literary genres, such as tragedy and epic poetry. This ensured that the analysis remained grounded in the particularities of the genre and era, avoiding the extension of terms or concepts to other periods of antiquity or modern

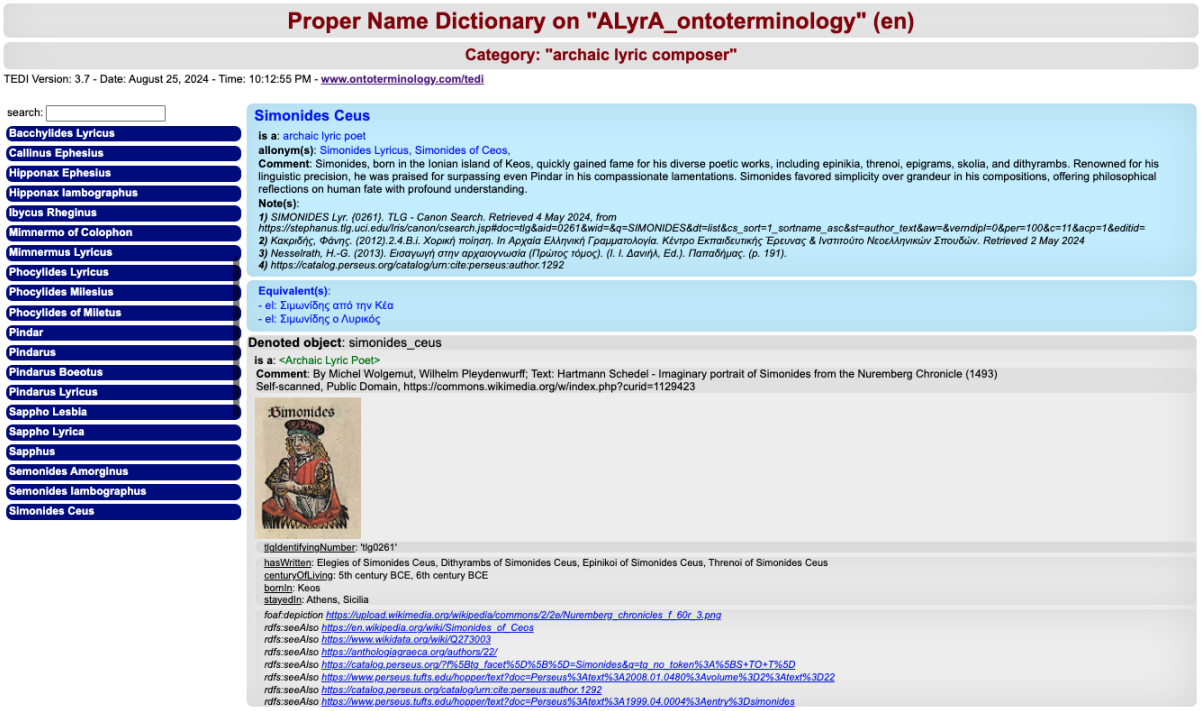

Figure 2: The 'Simonides Ceus' proper name entry in TEDI Onto-Dictionary export (Author 2)

times. By restricting the scope in this way, the risk of drawing false equivalencies between distinct ancient literary traditions or between ancient terms and their modern counterparts was effectively minimized. This boundary was essential for maintaining historical and contextual accuracy throughout the study.

In comparing these two ontoterminologies, we see how structured, domain-specific approaches can clarify the ancient Greek literary production and its complexity. Despite differences in subject matter—legal processes and poetic genres—both studies relied on rigorous primary text analysis, secondary scholarship, and systematic classification of essential characteristics. By prioritizing historical accuracy, both authors ensured that their models remain faithful to the original sources while enhancing accessibility for contemporary research and education.

3. Ontoterminologies for Archaeology

In this section, we introduce our third case study, an ontoterminology within the domain of Prehistoric Archaeology [5]. This ontoterminology serves as a database for archiving findings of an archaeological site and presents the objective attribution of the archaeological finds for professional and educational reasons. The specific domain is the archaeological site of Göbekli Tepe, the first known religious site found in SE Turkey, focused on the reliefs of the T-shaped pillars found on the site. Due to the nature of archaeology, Author 3 took a different approach from Authors 1 and 2 to address questions related to sites, objects, dating, and provenance, as well as linking archaeological data with visual and written sources.

Author 3's first step was the collection of the archaeological data of the site. She consulted the archaeological archives of the excavator [22] [23] [24] and recognized research work [25] [26] [27]. Her data involved the stratigraphy of the site, the architecture, and the type and material of the archaeological finds. Following the workflows within traditional archaeology, Author 3 created two root concepts: <Location> denoted by the term "location" and <Type of Archaeological Finds> denoted by the term "type of archaeological finds". <Location> defined and categorised the concepts of stratigraphy, with the

sub-concept <Layer>, followed by more specific types of locations such as <Enclosure> and <Buildings with Rectangular Rooms>. Under <Type of Archaeological Finds>, she categorized the archaeological finds collected from the site: the T-Shaped Pillars distinguished based on their location and their reliefs, which are the main concern of the ontoterminology.

Next, Author 3 defined the concepts in formal language and the terms in natural language. She searched for the archaeological terms and their definitions in recognised archaeological lexicons [28] [29] and the reports of the excavators of Göbekli Tepe [22] [23] [24]. Then, she determined the best possible definition of the concepts in machine-readable language depending on the essential characteristics of the archaeological data (either geographical, architectural or technical data).

For example, the term "central T-Shaped pillar" designates a concept with three essential characteristics: that it is a /type of archaeological find/ and not a stratigraphic or relief data; that it is a part of the main architecture of the site (the enclosures); and that it is located in the centre of the enclosure (differentiation from the lateral pillars of the enclosures). The two first characteristics are inherited from the main concept (<T-Shaped Pillar>) and the last one is a delimiting characteristic. These three together create the formal definition:

<type of archaeological find> + /the main supporting component of the sites architecture/ + /in the centre of the enclosure/.

The choice to develop a unique ontoterminology instead of strictly following standards like CIDOC-CRM, while still drawing on their foundational principles, was guided by the structure of the taxonomy and the nature of data from existing research. It was crucial to remain aligned with the intent of previous researchers and present the data accurately and faithfully. In archaeology, precise definition and categorization of artifacts are essential for constructing coherent interpretations. Ontoterminologies created through TEDI offer the opportunity to insert different date values and characteristics on the objects, something that leads to a more concrete manner of modeling the site and categorizing the data. Through the relationships between the objects of the ontoterminology, we gain a holistic view of the findings.

Figure 3: The 'Enclosure D' proper name entry in TEDI Onto-Dictionary export (Author 3)

The ultimate goal of the current ontoterminology is to accurately represent archaeological findings without bias or excessive detail, aiming for an objective, logical, and comprehensive view of the research subject. Data was meticulously gathered from publications by site excavators and cross-referenced with various sources to ensure a holistic and detailed representation of the site. This ontoterminology aligns with the efforts of site excavators and researchers, catering to the needs of the archaeological community. In this context, TEDI facilitates the incorporation of visualizations, allowing users to easily export a HTML Onto-Dictionary of terms or proper names which includes images, which is very useful

for describing archaeological findings (Figure 3).

4. Evaluation

In order to demonstrate the efficacy of the three ontoterminologies for antiquity, we provide SPARQL queries. TEDI allows ontoterminologies to be exported in RDF, which means they can be queried using the SPARQL Protocol and RDF Query Language (SPARQL) [30]. Through these queries, we explain the advantages for humanists of creating ontoterminologies with TEDI.

One such advantage, showcased through a SPARQL query for the ontoterminology created by Author 1 for Classical Athenian Legal Processes, is the ability to query for essential characteristics. For instance, the following query returns a list of the ancient Greek terms for all legal proceedings supervised by the Thesmothetai, as well as the natural language definitions of these terms (see Figure 4 for results):

```
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX otv: <http://www.ontologia.fr/OTB/otv#>
PREFIX skos: <http://www.w3.org/2004/02/skos/core#>

SELECT distinct ?termName ?diff1Name ?definition
FROM <http://www.ontologia.fr/OTB/oratory_v.1.0.rdf>

WHERE {?cpt1 rdfs:label ?termName.
?cpt1 otv:difference ?diff1.
?cpt1 skos:definition ?definition.
?diff1 rdfs:label “thesmothetae".
?diff1 rdfs:label ?diff1Name.
FILTER (lang(?termName) = ‘grc’)
FILTER (lang(?definition) = ‘en’)}
```

termName	diff1Name	definition
"κλοπῆς δίκη"@grc	"thesmothetae"	"A private legal proceeding for theft of private property, proceeded over by the Thesmothetae and tried by the
"εὐθυναι"@grc	"thesmothetae"	"A public legal proceeding initiated after a magistrates term for theft of sacred or public property, proceeded
"δοκιμασία"@grc	"thesmothetae"	"A public legal proceeding initiated before a magistrate's term and proceeded over by the Thesmothetae."@en
"ὕβρεως γραφή"@grc	"thesmothetae"	"A public indictment for crimes of hubris, proceeded over by the Thesmothetae and tried by the dikasterion. If
"μοιχείας γραφή"@grc	"thesmothetae"	"A public indictment for illicit consensual sex with a woman, proceeded over by the Thesmothetae and tried by t
"δωροδοκίας γραφή"@grc	"thesmothetae"	"A public indictment for accepting bribes, proceeded over by the Thesmothetae and tried before the dikasterion.
"ξενίας γραφή"@grc	"thesmothetae"	"A public indictment for exercising citizenship rights as a noncitizen, proceeded over by the Thesmothetae and
"ἑταιρήσεως γραφή"@grc	"thesmothetae"	"A public indictment for exercising citizenship rights having engaged in prostitution, proceeded over by the Th

Figure 4: Result of SPARQL Query for Legal Processes Ontoterminology (Author 1)

As previously mentioned, TEDI’s RDF export enables users to query essential characteristics, making it, in the context of ALyrA Ontoterminology, particularly valuable for retrieving the defining features of each type of Archaic Lyric poem. For instance, the following query extracts the essential characteristics that define the concept denoted by the term ‘hymn,’ along with the poetess who composed this type of Archaic Lyric poem (see Figure 5 for results):

```
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
```

```
PREFIX alyra: <http://www.ontologia.fr/OTB/ALyrA_v.1.0#>
PREFIX otv: <http://www.ontologia.fr/OTB/otv#>

SELECT ?authorName ?diffLabel
FROM <http://ontologia.fr/OTB/ALyrA_v.1.0.rdf>

WHERE {?conceptPoem rdfs:label “hymn"@en;
otv:difference ?diff.
?diff rdfs:label ?diffLabel.
?instancePoem otv:instanceOf ?conceptPoem;
alyra:isWrittenBy ?composer.
?composer otv:instanceOf alyra:Archaic_Lyric_Poetess.
?composer rdfs:label ?authorName.}
```

authorName	diffLabel
"sappho_lesbia" @en	"archaic lyric poem"
"sappho_lesbia" @en	"in ionic or in doric or in aeolic dialect"
"sappho_lesbia" @en	"performed by a chorus or by a single performer"
"sappho_lesbia" @en	"dedicated to a god"

Figure 5: SPARQL query results for ALyrA Ontoterminology (Author 2)

The third and final ontoterminology, showcasing the archaeological finds at Göbekli Tepe, can be evaluated through the following query, which returns a list of the English terms and their definitions in natural language (see Figure 6 for results):

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX otv: <http://www.ontologia.fr/OTB/otv#>

SELECT ?termName ?definition
FROM <http://www.ontologia.fr/OTB/Gobekli_Tepe_v.1.0.rdf>

WHERE { ?concept rdf:type otv:Concept.
?concept otv:denotedByTerm ?term.
?term otv:language ?lg.
?term otv:termName ?termName.
?term otv:termDefinition ?definition
FILTER (?lg = “en")}

ORDER BY ?term
LIMIT 10
```

5. Conclusion

Through our individual experiences creating ontoterminologies for antiquity with TEDI, some mutual challenges emerged. A key challenge was manually determining the relevant terms for each domain. In all three ontoterminologies, NLP methods were determined to not be adequate for term extraction. Although Author 1 and Author 2 worked with a corpus of texts, these texts seldom contain the terms that are used in modern scholarship to describe and categorize the texts. Author 3, working with

termName	definition
"animal relief"	"A type of relief sculpture where the sculpted elements depict animals. In this form of art, the animal shapes and details are carved or modeled to project from the background, creating a three-dimensional effect while still being attached to the underlying plane. "
"anthropomorphic being relief"	"Human relief is a type of relief sculpture in which the figures represent humans or human-like beings. In this artistic form, the human shapes and details are carved or modeled to stand out from a flat background, creating a three-dimensional effect while remaining connected to the surface plane."
"building with rectangular rooms"	"Building with rectangular rooms found in Layer dated in the Pre-Pottery Neolithic B period."
"central t-shaped pillars"	"T-shaped pillars are a distinctive architectural feature characteristic of several Neolithic sites, most notably Göbekli Tepe in southeastern Turkey. These pillars are so named because they have a T-shaped cross-section, with the horizontal part of the T typically resting on smaller supports or directly on the ground."
"enclosure"	"A defined area or boundary within a site, often marked by physical features such as walls, ditches, or fences. In the case of the archaeological site of Göbekli Tepe, Turkey, they are dated in the 10th millennium BCE, Pre-pottery Neolithic A period (PPNA). "
"engraving"	"Engraving is a technique used in art and printing where an image or design is carved or etched into a hard surface, such as metal, wood, or stone. The process involves cutting or scratching the surface to create lines, textures, or patterns. "
"high relief"	"Type of relief sculpture where the sculpted elements are significantly raised from the background, creating a pronounced three-dimensional effect."
"lateral t-shaped pillars"	"T-shaped pillars pillar, lateral t-pillar."
"layer"	"In archaeology, a layer (also known as a stratum) refers to a distinct level or deposit of soil, sediment, or cultural material found within an excavation site. Each layer typically represents a different period of time or phase of activity, and the sequence of layers can provide valuable chronological and contextual information about past human activities and environmental changes. Archaeologists analyze these layers to understand the stratigraphy of the site and to reconstruct the historical and cultural development over time."
"limestone"	"Limestone is a sedimentary rock made mostly of calcium carbonate ($CaCO_3$). It typically forms from the accumulation of shells and skeletons of marine organisms or through the precipitation of calcium carbonate from water. Limestone is widely used in construction and as a building material."

Figure 6: Result of SPARQL Query for Archaeological Findings Ontoterminology (Author 3)

archaeological findings, experienced a similar challenge of manually determining domain terms by consulting secondary scholarship. All three authors had to undertake the humanistic effort of ensuring our concepts, terms, and definitions aligned with scholarly consensus, which was especially challenging due to the dynamic nature of our fields. The TEDI software proved essential, allowing iterative updates to ontoterminologies and accommodating alternative or regionally specific terms, which enriched our representation of these domains.

Another common challenge was the representation of uncertain attributes, particularly dates. In the study of antiquity, precise dating is rare, and many objects and concepts exist within broad ranges or with multiple proposed dates. Representing these ambiguities in a consistent manner was crucial to ensure we accurately reflected our fields. However, TEDI does not currently have a direct solution for representing uncertainty (although this is a challenge with standard ontologies as well, leading to the development of new standards for knowledge graph representation such as RDF-star [31]). This required the authors to develop strategies to express uncertainty. Author 3 and Author 1 represented dates with two attributes as a range from earliest to latest, in order to show the boundaries which are used in the dating of antiquity (Figure 7). Author 2 decided not to use uncertain dates for the chronological placement of the composers, but preferred to situate them in the century or centuries in which they lived. Additionally, Author 2 confined concepts and terms to the domain period.

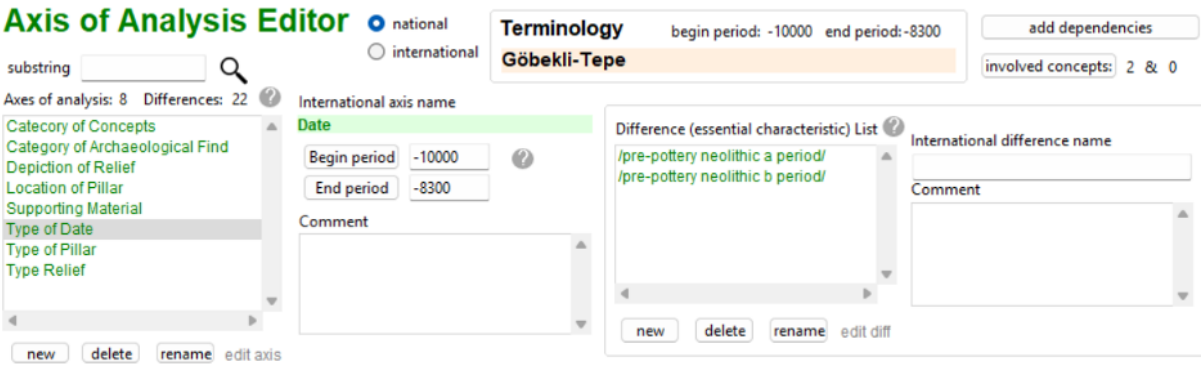

Figure 7: Representation of the dates of the site layers and artifacts with two attributes in the TEDI's Axis of Analysis Editor (Author 3)

There were, however, some unique challenges faced by each ontoterminology. Author 1 had to deal with the translation of ancient terms into modern language, even when such terms refer to legal processes which no longer exist. TEDI's incorporation of SKOS Core vocabulary made it possible to include multiple English terms that designated the same concept, and easily denote terms as 'Preferred', 'Alternative', or 'Obsolete' [32] (Figure 8).

Author 2's domain terms are absent from Archaic Lyric poetry itself but found elsewhere in ancient

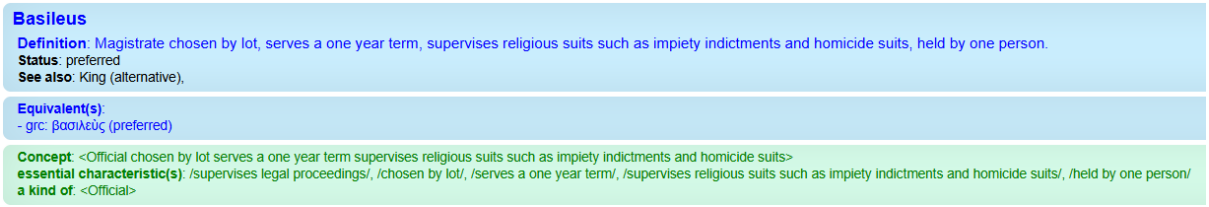

Figure 8: A term entry in TEDI Onto-Dictionary export demonstrating the use of SKOS labels in ontoterminologies (Author 1)

Greek literature, as forms of Archaic Lyric poetry appear embedded in other ancient literary genres. His conceptual approach, grounded in primary texts and refined through secondary sources, identified key analytical axes such as content, dialect, and occasion, enabling precise classification through unique trait combinations. By restricting terminology to scholarly discussions, he ensured historical accuracy and avoided misapplications across traditions or periods (Figure 9).

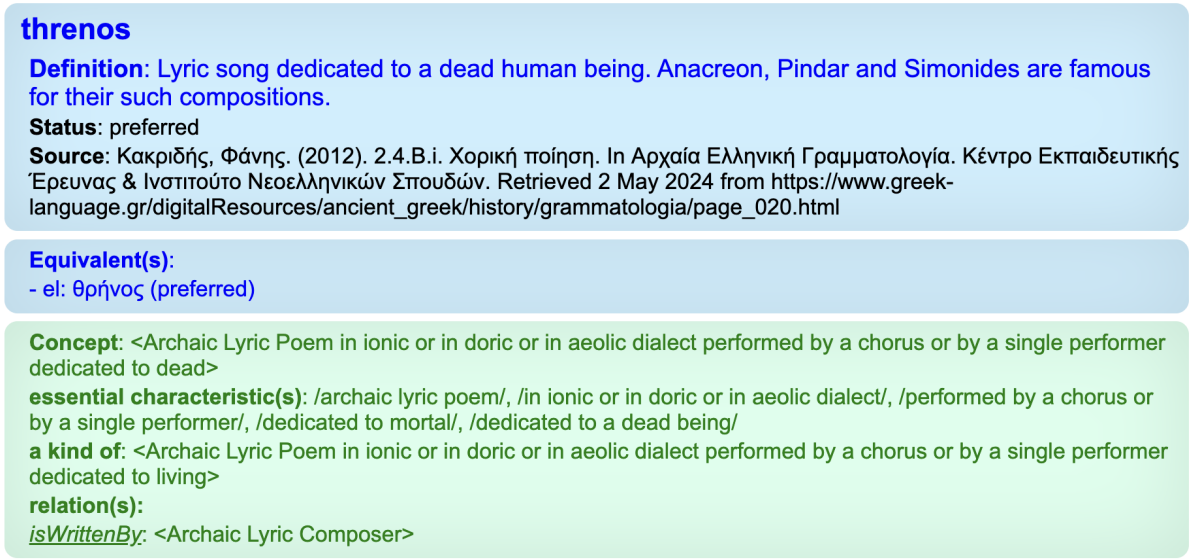

Figure 9: The 'threnos' term entry in TEDI Onto-Dictionary export (Author 2)

Despite the challenges, we believe that our resulting ontoterminologies demonstrate the value of using TEDI for our workflows. Compared to standard ontology editors such as Protégé, TEDI facilitates the creation of complex RDF while accommodating the needs and practices of humanists. Specifically for the creation of terminologies, TEDI streamlines the process of defining concepts through essential characteristics and aligning concepts with terms. The resulting ontoterminologies are queryable for concepts, terms, axes of analysis, and essential characteristics, without requiring users to learn Description Logics. Furthermore, because TEDI allows for the export of ontoterminologies into RDF, it is still possible to view and edit ontoterminologies in Protégé, which was done by Author 1 to merge three ontoterminologies into one database (Figure 10).

TEDI's flexibility and the iterative nature of our work allowed us to maintain accurate, adaptable ontoterminologies that reflected the latest research while accommodating uncertainty and evolving scholarly perspectives. We also believe that the workflow we each followed for creating ontoterminologies runs in parallel to the methods used in non-digital humanistic research. Once accustomed to TEDI's interface, humanists can easily incorporate the creation of ontoterminologies into their research,

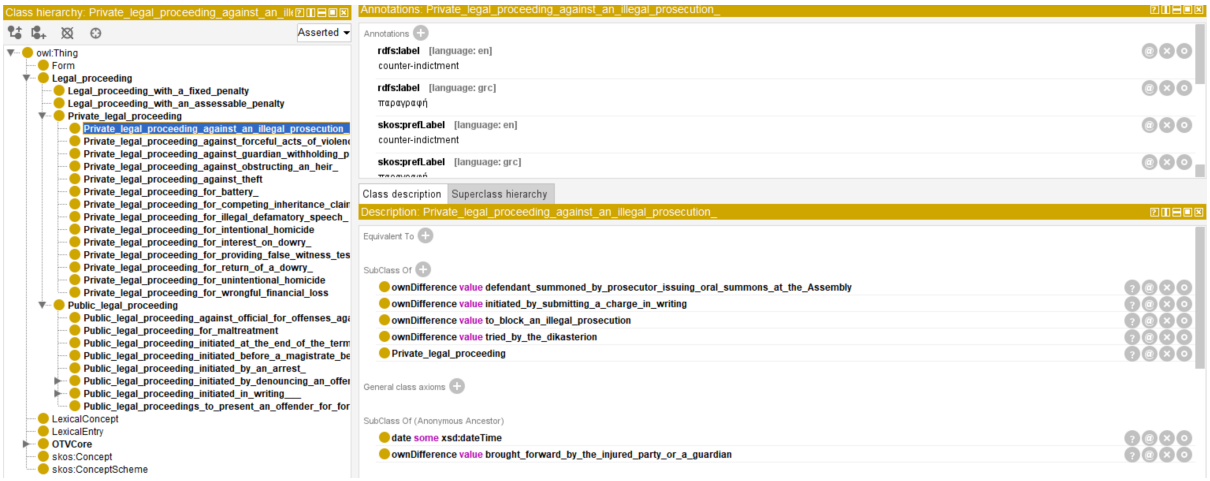

Figure 10: Legal Processes ontoterminology exported to Protégé (Author 1)

leading to the development of more machine-readable terminologies. Ontoterminologies can be reused to eliminate confusion regarding domain specific terms and to link data across different humanistic research projects, allowing us to further fulfill the promise of the Semantic Web.

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Declaration on Generative AI

During the preparation of this work, the authors used ChatGPT-4 for grammar and spelling checks. The authors have subsequently reviewed and edited the content and take full responsibility for the publication's final version.

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