

Crisis in troubled ancient times : ontological modelling of textual evidence from Greek historians

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Abstract. This article presents work-in-progress towards the construction of a model of crises for ancient Greek historiography and a terminology of crises with equivalents in Greek (ancient and modern) and English. In order to solve the problem of linking and aligning these three vocabularies as well as defining their meaning, we rely on a common conceptualization of crises. This conceptualization is represented as an ontology built in a computer readable form compliant with the W3C standards for opening and linking data on the Semantic Web. By means of the temporal and causal relational information not found in any of historiographical resources, the ontology facilitates reasoning on and across documents, revealing relationships between events to answer complex questions.

Pourquoi tirons-nous tant de jouissance d'être si différents non seulement des autres mais de notre propre passé? Quel psychologue assez fin expliquera cette délectation morose à être en crise perpétuelle et à finir l'histoire?

Why do we get so much pleasure out of being so different not only from others but from our own past? What psychologist will be subtle enough to explain our morose delight in being in perpetual crisis and in putting an end to history?

Bruno Latour, 1993, *We have never been modern*, Ch. 1
“Crisis” [Transl. C. Porter]

1. Introduction

Crises can leave an indelible mark on history. Crises are commonly defined as turning points in a sequence of events that can determine future events. Crisis definitions and the terminology around crises are, at heart, political issues [McConnell 2022]. One cannot deal with the long and complicated history of a nation or of an entire period without referring to the great crises and it is the salient crises that are most likely to form the political memory of a people [Verba 1965, 55].

This article presents research done towards building a model for the computational representation of crisis events using an ontology encoded in the Web Ontology Language -OWL [OWL 2004]. The ontology aims principally at the semantic annotation that enables the semantic querying of ancient Greek historiographical texts and the definition of the terminology of crisis in ancient Greek times. This work is done within the framework of the *Leaders and Crisis Management in Ancient Literature. A Comparative Approach* (LACRIMALit) project¹. Scholarship so far has studied the phenomenon of crisis mainly as times of intense difficulty or danger linked with a specific historical period and sometimes even with one single aspect (financial, social, political, cultural, etc.) of human activity. Most of these studies do not provide a thorough examination of the term “crisis”, they do not analyse the elements which form a crisis narrative and they do not attempt a comparison between the various crisis narratives. The LACRIMALit project aims to fill this gap by investigating contemporary theories on the notion of crisis [Engels 2012; Hermann 2011], applying them to the study of ancient texts and proposing analogies with contemporary debates, when needed, with caution and while acknowledging the different historical and political contexts.

As part of the LACRIMALit project, the LACRIMALit ontoterminology of crisis is built taking into account different sources reporting crisis incidents in Greco-Roman antiquity. As structured descriptions of events are either missing or not marked up explicitly, the LACRIMALit ontoterminology of

1 The *Leaders and Crisis Management in Ancient Historiography. A Comparative Approach* (LACRIMALit) is a project hosted at the Institute for Mediterranean Studies/ Foundation for Research and Technology (IMS-FORTH), 2022-2025. The project has received funding by the Hellenic Foundation for Research and Innovation (H.F.R.I). Principal Investigator: Eleni-Melina Tamiolaki, University of Crete, Greece. The acronym is a pun whose first component (*lacrima* = tear, in Latin) suggests a link between the notion of crisis as a turning point that can reduce one to tears. Project website : <https://ims.forth.gr/en/project/view?id=219>.

crisis aims to narrow this existing gap. Also, the LACRIMALit structured vocabulary of crisis-related terms in Greek (in both its ancient and modern varieties) and English is usable by both humans (via an electronic dictionary interface) and machines (via the W3C standard languages). It thus supports consistency in the terms used, open and linked data discovery across multiple sources [Heath and Bizer 2011], automated reasoning upon the modelled data, and, finally, semantic annotation of the relevant textual sources with the terms linked to the ontology. The overall aim of ontology-based semantic annotation of these ancient texts is the promotion of new affordances in their reading online, now possible only via the hyperlinked e-texts openly accessible by the Perseus Digital Library [Crane 2012]. The ontoterminological resources to be created by the completion of the project will be of use to classical scholars as well as comparative politics experts making at their disposal a computerised model of crisis-related shared terms in Linked Open Data formats, i.e., tagged in a consistent and interoperable manner increasing their findability and accessibility.

2. The LACRIMALit project

The LACRIMALit ontology project is part of a broader research which aims to offer a comprehensive study of the phenomenon of leadership and crisis management in Greco-Roman Antiquity focusing on four genres of ancient Greek literature (historiography, rhetoric, comedy and biography). It also relies on theoretical texts dealing with the issue of leadership in Antiquity, such as Xenophon's *Hieron*, Isocrates' *Nicocles* and *To Nicocles*, the first two books of Aristotle's *Politics*, the sixth book of Polybius' *Histories* and Cicero's *De re publica*. Our work on the ontology of crisis will start with studying crisis in ancient historiography.

3. Modelling Events in Digital Humanities

Although still in an unsystematic and uncoordinated fashion, ontologies are more and more used in the Digital Humanities [Jansen, 2019]². As Cybulska & Vossen 2010 aptly remark, the ability to automatically determine relations between historical events and their sub-events over textual data, based on the relations between event participants, time markers and locations,

2 For a curated list of ontologies in Digital Humanities see <https://github.com/CLARIAH/awesome-humanities-ontologies>.

have important repercussions for the design of historical information retrieval systems. Ontologies, however, are mostly manually constructed.

The LACRIMALit model for crisis in ancient historiography is an event centric model. Several event models have been published over the past years in different humanities domains, notably in the domains of history and cultural heritage. In what follows we include the definitions of events in event-centric models most relevant to the LACRIMALit model, starting from the ontological definition of a recent paper [Guarino *et al.* 2022]. The paper asks two central questions to the development of event-centric ontologies, the first focusing on metaphysics, the other on semantics: ‘What are events?’ and ‘What is the referential mechanism that is in play when we describe an event?’ The short answer to the first question is that the simplest events are qualitative changes cognitively constructed. The short answer to the second question is that the notion of event is intimately connected to that of context, i.e., describing an event means not just saying what happened, but also specifying how it happened, by specifying details that often involve the *context* in which the event occurred.

From an ontological, formalizable, viewpoint, an event is anything that has occurred in a certain time and environment where some actors could take part and show some action features. In contrast to “objects” or “continuants”, which take up space, *are in* time and persist through time by being wholly present at every time at which they exist, “events” or “occurrents” (i.e., entities that occur or happen), also referred to as “perdurants”, or “processes”, are four-dimensional: they *take up* time and persist through time by having different “stages” [Maienborn 2011; Galton 2012; Arp *et al.* 2015, 87; Rodrigues and Abel 2019; Casati and Varzi 2020] or -in event calculus terms- “fluents” (i.e., statements representing properties that vary over time, e.g., the number of a person’s children at different times).

Event-centred modelling captures the dynamic aspects of a domain. In addition, events provide a natural way to explicate complicated relations between people, places, actions and objects [van Hage *et al.* 2011]. Events are central elements in the representation of data from various fields such as history and cultural heritage. Doerr and Kritsotaki 2006 propose to see events as meetings, that are, in turn, interactions of participants which bring about changes of state. Corda *et al.* 2011 identify events in the domain of the history of science as situated occurrences incorporating complex and rich information about the subject of the event (who), the object (what), the time (when), the place (where), the cause(s) and effect(s) (why).

3.1. CIDOC-CRM

The literature on modelling events is vast³. Different event models provide different definitions of events. Here we present models of interest for the domain of LACRIMALit ontology. Of the models included below, at its present state, LACRIMALit is only aligned to CIDOC-CRM.

The most important model for the domain of digital humanities and cultural heritage is CIDOC-CRM, therefore LACRIMALit is aligned to CIDOC. The CIDOC Conceptual Reference Model (CRM), [ISO 21127:2014, first edition ISO 21127:2006] is a high-level, event-centric, formal ontology of things and events happening in spacetime. In CIDOC the E5_Event class comprises “distinct, delimited and coherent processes and interactions of a material nature, in cultural, social or physical systems, involving and affecting instances of E77_Persistent Item in a way characteristic of the kind of process. Typical examples are meetings, births, deaths, actions of decision taking, making or inventing things, but also more complex and extended ones such as conferences, elections, building of a castle, or battles” (CIDOC Version 7.7.1, April 2021)⁴. Among the different subclasses of E5_Event, the E7_Activity comprises “actions intentionally carried out by instances of E39_Actor that result in changes of state in the cultural, social, or physical systems documented. This notion includes complex, composite and long-lasting actions such as the building of a settlement or a war, as well as simple, short-lived actions such as the opening of a door” (CIDOC Version 7.7.1, April 2021).

3 For a comparative description of five existing event models, see [Astrova *et al.* 2014]. Indicatively, the ABC Ontology for digital libraries, whose purpose was to facilitate interoperability between metadata vocabularies from different domains. [Lagoze and Hunter 2001]; the Event ontology [Raimond and Abdallah 2006] is an event-centric model for the domain of Music, which defines events as arbitrary classifications of space/time regions by a cognitive agent that may have participating agents, passive factors, products, and a location in space/time. Event-Model-F [Scherp *et al.* 2009] designed to facilitate interoperability in distributed event-based systems. The model is based on the foundational ontology DOLCE+DnS Ultralite (DUL) (DnS = Descriptions and Situations). It provides comprehensive support for the representation of time and space, objects and persons, as well as the mereological, causal and associative relations between events. Event-Model-F provides a means for event composition, modelling event causality and event correlation, and representing different interpretations of the same event, and can be easily extended by domain specific ontologies.

4 [Bekiari *et al.* 2021]. Accessible online: <https://cidoc-crm.org/version/version-7.1.1>.

LACRIMALit events fall under class E7_Activity, a subclass of E5 Event, as LACRIMALit extends CIDOC⁵.

3.2. LODE (Linking Open Descriptions of Events)

LODE (*Linking Open Descriptions of Events*) [Shaw *et al.* 2009]⁶ is an ontology for publishing descriptions of historical events as Linked Data, and for mapping between other event-related vocabularies based on what happened, where something happened, when it happened, and who was involved. These “factual” relations within and among events are constructed to generate representations of “intersubjective consensus of reality” not necessarily associated with a particular perspective or interpretation of one principal class (Event) and seven properties that refer to the happening of the event. The “Event” class is defined as “something that happened”, which has temporal and spatial boundaries, thus enabling statements correlated to people, places or things. By this definition some particular event does not necessarily involve state change. Additionally, events are not differentiated from processes or states.

LODE defines one class: Event class “Something that happened,” as might be reported in a news article or explained by a historian. LODE defines two properties for location where an event happened: atPlace, for a named or relatively specified place, and inSpace, for an abstract region of space, e.g., a geospatial point or region. Also, LODE has two properties of time atTime, for abstract instants or intervals of time and circa property for precise intervals of time, such as calendar dates and clock times. Finally, LODE defines two properties for an agent or object (physical, social, or mental), respectively.

3.3. SEM (Simple Event Model)

The Simple Event Model (SEM) was created to model events in various domains, without making assumptions about the domain-specific vocabularies used. It is presented by virtue of two use cases: historic events and events in the maritime safety domain [van Hage *et al.* 2011]⁷. Events, according to SEM, describe everything that happens, including fictional events. SEM classes are

5 [Casati and Varzi 2020: 2.1] distinguish “events” into “activities”, “accomplishments”, “achievements”, and “states”.

6 Available online: LODE: An ontology for Linking Open Descriptions of Events (linkedevents.org).

7 Available online: <https://semanticweb.cs.vu.nl/2009/11/sem/>

divided into three categories: Core classes, Types, and Constraints. There are four core classes: `sem:Event` (what happens), `sem:Actor` (who or what participated), `sem:Place` (where), `sem:Time` (when). The SEM Type class contains all types of Core instances. These can be either individuals or classes themselves. This class is meant to be extended for each application domain. There are three kinds of Constraints: Role, Temporary and View. `sem:Role` describes the role that an individual of a class is playing in the context of a specific event. Roles can be specified for all Core individuals. The SEM Constraint class contains instances of properties that have a constrained (i.e., not universal) validity. This includes time-dependent validity (Temporary), validity in the guise of a specific role (Role), or validity according to a given Authority (View). Each core class has an associated `sem:Type` class, which contains resources that indicate the type of a core individual. Individuals and their types are usually borrowed from other vocabularies, e.g., Getty Thesaurus of Geographical Names (TGN)⁸.

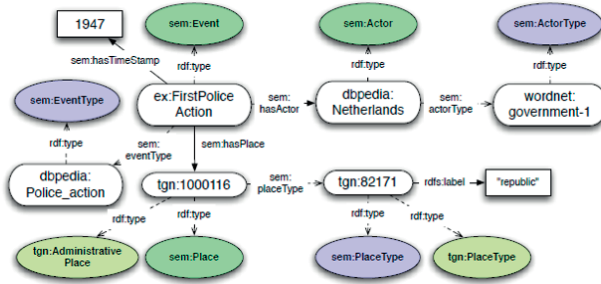
SEM's properties are divided in three kinds: `sem:eventProperty`, `sem:type` properties and a few other properties like `sem:accordingTo` and `sem:hasTimeStamp`'s subproperties. The `sem:eventProperty` relates `sem:Events` to other individuals. A `sem:type` relates individuals of the `sem:Core` class to individuals of `sem:Type`. There are subproperties of `sem:type` for each of the separate core classes to facilitate querying. To represent opinions `sem:accordingTo` relates a `sem:View` to a `sem:Authority`. In terms of Time, the `sem:hasTimeStamp` property is for single time values, while for time intervals SEM has two properties (`sem:hasBeginTimeStamp` and `sem:hasEndTimeStamp`), and for uncertain time intervals, SEM has four properties (`sem:hasEarliestBeginTimeStamp`, `sem:hasLatestBeginTimeStamp`, `sem:hasEarliestEndTimeStamp`, and `sem:hasLatestEndTimeStamp`).

A historical event that occurred in 1947 Indonesia (Dutch East Indies, at the time) - the first police action in the Dutch East Indies in 1947 by the Dutch, who presented themselves as liberators, but were seen as occupiers by the Indonesian people - as represented in SEM is shown in Figure 1:

8 Available online: <https://www.getty.edu/research/tools/vocabularies/tgn/>

Representation of an historical event in SEM

The Dutch launched the first police action in the Dutch East Indies in 1947; the Dutch presented themselves as liberators but were seen as occupiers by the Indonesian people.



- it contains conflicting views on the role of the actor: were the Dutch liberators or occupiers?
- it makes explicit according to which authority the roles hold (the Dutch / Indonesian people)
- it presents a challenge for modelling the type of the place involved: the Dutch East Indies were at that time an independent Republic
- according to the Indonesians, but were a “controlled region” according to the Dutch

FIG. 1 – Representation of an historical event in SEM.
Adapted from [van Hage et al. 2011, fig. 3]

3.4. REO (Rich Event Ontology)

The goal of the Rich Event Ontology (REO) is to provide a unified representation of events with a rich structure of event concepts that connects varying levels of event specificity, relates events to their key objects and participants, and encodes the temporal and causal relationships between events. REO aims to bridge the gap between spatiotemporal ontological approaches to representing events and the representations stemming from semantic role labelling (SRL) resources. Unifying NLP resources, such as the FrameNet, VerbNet, the Rich Event Ontology (REO) [Brown et al. 2021] marries ontology with lexical resources (corpora) and serves as a shared hub for the disparate annotation schemas.

REO supports mapping between specific event types of different resources and enables the merging of associated annotated corpora and expanding sets of related event triggers. By adding temporal and causal relational information that does not exist in these resources, REO facilitates reasoning on and across documents, revealing relationships between events that come together in temporal and causal chains [Chiarcos *et al.* 2020:15].

To capture some of the rich and complex relations between events or between events and objects, REO includes temporal and causal relations extended from the Richer Event Description (RED) project [Ikuta *et al.*, 2014; O’Gorman *et al.*, 2016], such as the *hasPrecondition*, *hasCause*, *hasResult*, and *hasSubevent* relations. The RED project aims to annotate text with mentions of events and entities, with the goal of representing the temporal and causal relationships between those events in such a way that an accurate timeline of events could be automatically constructed.

4. Competency Questions

Competency Questions [Ren *et al.*, 2014] play an important role in the life-cycle of engineering an ontology. Competency questions represent the requirements that an ontology has to fulfil.

At its present state, the LACRIMALit ontology is “competent” to answer the following set of competency questions (CQ):

- CQ1 : What are the different types of political crises ?
- CQ2 : When did a crisis occur ?
- CQ3 : Where did a crisis take place ?
- CQ4 : Who are the protagonists of a crisis (e.g., Peloponnesian war)?
- CQ5 : What are the relevant passages in the primary sources of an event ?
- CQ6 : What are the relevant terms denoting crises (military, political etc.)?

5. Modelling Crises

Defining a crisis is quite complex because of the interdisciplinary nature of the concept. According to the Oxford Dictionary⁹ it is defined as a point in time: 1. A time of intense difficulty or danger. 1.1 A time when a difficult or

9 Oxford English Dictionary (online) s.v. crisis <https://www.lexico.com/definition/crisis>.

important decision must be made. 1.2 The turning point of a disease when an important change takes place, indicating either recovery or death¹⁰.

Historically, increasing numbers of crises/disasters, natural and human-made, have demonstrated the importance of crisis management. The success of crisis management largely depends on finding, assembling, and successfully integrating related information in order to inform both the decision-making/response stage, as well as and planning the preparedness/planning stage. Also, the degree of predictability of a crisis event is crucial: a crisis is predictable, if place, time or in particular the manner of its occurrence are knowable to at least one concerned party and if the probability of occurrence is not negligible.

Despite extensive relevant work on the importance of building a typology of crises in recent decades [Coombs 1998, Bringmann 2003, Franchet d'Espèrey *et al.* 2003, Gundel 2005, Rousseaux & Lhoste 2010, Angiolillo *et al.* 2015, Björck 2016], no such satisfactory typology exists. As [Björck 2016] succinctly puts it: “A typology is valuable because it simplifies and structures complexity, helps to organise the collection of information, provides diagnostic insights [Burnett, 1998] and is a first step to contain a crisis [Gundel, 2005].” According to Gundel 2005, a classification of crises is the first step to keeping them under control and allows for analysis and planning of crisis management actions. He defines four conditions for a good typology: 1) mutually exclusive classes, 2) exhaustive, covering also future events, 3) practicable, i.e., covering measures of prevention and 4) pragmatic, thus manageable.

Following Gundel: 2005, 110, we have typed crises as conventional, unexpected, intractable, and fundamental. In the case of conventional crises, the occurrence of the event is known and probable, thus predictable, and easy to prevent with proper quality controls and planning, e.g., the Peloponnesian War, especially as explained by Thucydides, was inevitable as Athens was on the rise and on a colliding course with the most iconic military power among Greek city-states, Sparta. Unexpected crises are less manageable. Once an unexpected and dangerous process has been triggered, it is almost impossible to stop it within a reasonable timeframe. An emergency response can combat the crisis successfully, but its surprising occurrence can hinder the solution.

10 Originally from Greek krisis ‘decision’, krinō ‘to decide’ Liddel and Scott s.v. κρίνω, <https://www.perseus.tufts.edu/hopper/text?doc=Perseus%3Atext%3A1999.04.0057%3Aentry%3Dkri%2Fnw>

To illustrate this type of crisis, we cite the regime of the Thirty tyrants in classical Athens, the fragile pro-Spartan oligarchy installed in Athens after its defeat in the Peloponnesian War in 404 BCE. The third type is the intractable crisis that can have precedents in the past and be expected, but countermeasures are difficult because of the complexity of systems or conflicts of interest, e.g., the exile of Alcibiades, while being the leader of the Athenian fleet during the campaign in Sicily. Fundamental crises are unpredictable and difficult to influence because they give rise to chaotic, unprecedented circumstances. Examples of the fourth type are contagious illnesses, such as the plague in Athens in 430 BCE that led to a series of socio-political traumas.

6. Building the Ontoterminology of ‘crisis’

The LACRIMALit methodology takes terms to be verbal designations of concepts in a given natural language, i.e., specific words that designate concepts, in compliance with the ISO principles on Terminology [ISO 1087; ISO 704]. This allows for extralinguistic modelling (conceptualisation) of crises independently of the different ways of talking about them in natural languages.

In computer science and information science, a computer-readable conceptualization of a domain is an ontology. There are different definitions of ontology [Guarino *et al.* 2009]. All of them rely on a formal knowledge model for the comprehensive description of a domain of knowledge that encompasses the set of concepts in the domain, their properties, and the relations that hold between concepts. Ontologies are used in practice for the representation of knowledge in a way that can be calculated by the computer, for the standardisation, semantic interoperability, knowledge discovery, complex question answering and automation of the inference process. In particular, the description of the properties of the objects of the world and their classification into categories (concepts), together with the description of the relations between these categories (concepts), enables further classifications of the objects, and the extraction of further associations between the concepts.

In order to represent the knowledge about the crises recorded in the corpus of ancient historians of the Graeco-Roman period in an interoperable manner, LACRIMALit will build a semantic resource combining an ontological component with a terminological one. Semantic interoperability between information systems is guaranteed, if and only if each can seamlessly carry out the tasks for which it was designed using data taken from the other as.

Ontologies are software artefacts whose purpose is to inject semantics into the data available on the Web, attention has turned toward the use of ontologies [Gruber 1993 ; Gruber 2009 ; Sowa 2000, Guarino *et al.* 2009 ; Staab & Studer 2009] for the representation of knowledge and for applications of automatic knowledge discovery. Through the incorporation of formal definitions, they also allow the application of basic inference mechanisms when interpreting data exploiting taxonomic and other relations built into the ontology.

There are several methods for building ontologies [Uschold and King 1995 ; Grüninger and Fox 1995 ; Fernández-López *et al.* 1997 ; Fernández-López 1999 ; Noy and McGuinness 2001 ; Corcho *et al.* 2003]. Some criteria set by these methodologies are : clarity, coherence, extensibility, etc.

The LACRIMALit project follows the ontoterminological approach which combines the semasiological and onomasiological approaches while taking into account the way of thinking of Humanists [Roche and Papadopoulou 2019]. An ontoterminology is a terminology (list of terms in natural language) whose conceptual system of the domain of interest is a formal ontology [Roche 2012]. In our ontoterminological approach, special attention is paid to the construction of the formal definitions of the concepts of the ontology.

6.1. Identifying terms

The terms were not extracted automatically from texts but provided by experts and illustrated by excerpts from the corpus. Terms are organised according to the denoted information : people, places, and events corresponding to as many corresponding concepts of the ontology : “The Peloponnesian war is the conflict between the league of Delos, managed by Athens, and the league of Peloponnesus, under the hegemony of Sparta”.

The LACRIMALit project focuses on the following three basic categories of (political) crises are included in the typology and analysis :

- a. emergency crisis incidents in times of war or peace, such as dispute (Gr. *διαφωνία, διαφωνέω*), military threat (Gr. *ἀπειλή, -απειλέω*), etc., which usually require the undertaking of immediate measures
- b. breach of trust between leaders and their followers ; as well as the means (e.g., harangues, Gr. *Δημηγορία, λόγος*) by which leaders attempt to restore order
- c. conspiracy (Gr. *συνωμοσία*), treason (Gr. *προδοσία*), revolt (Gr. *στάσις*), political confusion, tumult (Gr. *ταραχή*)

The example in Figure 2 shows how ontological data and information is drawn from the text of the Wikipedia article on the naval battle at Aegospotami¹¹ and from the relevant passage from Xenophon’s text from *Hellenica* book 1, paragraph 4¹². The relevant terms denoting events such as are represented in the LACRIMALit model are expressed in the knowledge graph built from the information drawn from the texts.

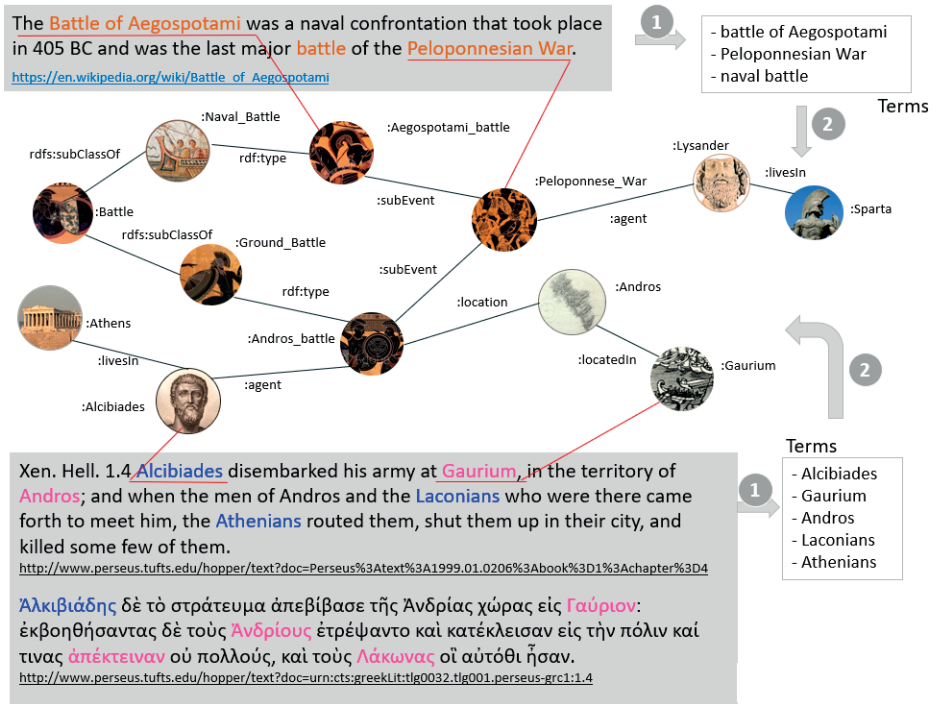


FIG. 2 – Ontology-based annotation of text

11 Available online: https://en.wikipedia.org/wiki/Battle_of_Aegospotami.

12 Xen. *Hell.* 1.4 [Translation C.L. Brownson]. Available online via Perseus Digital Library <https://www.perseus.tufts.edu/hopper/text?doc=Xen.+Hell.1.4.&fromdoc=Perseus%3Atext%3A1999.01.0206>.

6.2. Building the ontology

There are different theories of concept [Roche 2015] defining as many approaches. The [ISO 1087] and ISO 704] principles on Terminology rely on essential characteristics - a concept is defined as a unique combination of essential characteristics - whereas the main approach in knowledge engineering relies on the notion of class organising objects into sets according to their relationships. This article presents the first stage of the project which consists more in organising events into classes rather than defining terms. It is the reason why the second approach was chosen as well as the Protégé environment for building the LACRIMALit ontology. Protégé 3.3.1 [Musen 2015] is a free, open-source platform, a popular tool of Stanford University for developing Domain Ontology.

A LACRIMALit_Event is a type of action carried out by one or several LACRIMALit Agents that leads to changes of states in cultural, social or physical systems. It is made up of one or several LACRIMALit subevents, can have one or more causes and consequences as well as predecessors and successors, is located in a geographical space (Location), has a date of beginning and a date of ending. LACRIMALit crisis are subclasses of the LACRIMALit Event class.

The LACRIMALit Ontology is defined as a domain extension of some CIDOC classes. The LACRIMALit classes are organised into three main categories : Agent (including Group and Person), Event (Crisis) and Location, each of them defined as subclasses (rdfs:subClassOf) of respectively E39_Actor, E7_Activity, and E53_Place (see Figure 3). New relationships (object properties) between LACRIMALit_Events have been introduced for example to represent the causes and the consequences of an event.

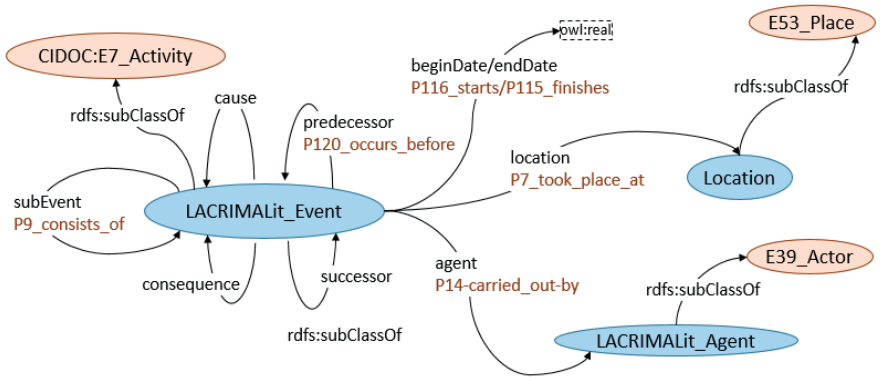


FIG. 3 – LACRIMALit model as an CIDOC-CRM extension

Figure 4 represents the formal description of the individual ‘Peloponnesse war’ as an event whose begin date was 431BCE and end date 404 BCE and that was composed of subevents (such as the battle of Aegos potami), that had locations such as Peloponnesus, and protagonists (groups such as the Athenians and the Laconians and persons such as Alcibiades and Lysander).

FIG. 4 – Fragment of the LACRIMALit ontology in Protégé ontology editor

6.3. Linking terms to concepts

The last stage consists in linking terms to the ontology. Since terms play a central role in semantic annotation to which a lot of information can be attached, they should be explicitly represented, i.e., as individuals of an OWL class ‘Term’ for example [Piccini 2015], and linked to individuals representing agents, places, events. However, terms corresponding to common nouns cannot be directly linked to classes since object properties are defined only between individuals. Classes can be treated as individuals, as it is allowed in OWL Full, using the same IRI to be both a Class (owl:Class) and an individual (owl:NamedIndividual). Unfortunately, such an approach is not completely satisfactory: mixing knowledge of different types (domain, implementation) is difficult to understand and maintain. It is the reason why it was decided to

go back to a simple representation of terms as labels in different languages attached to classes (`rdfs:label`, `skos:prefLabel`, `skos:altLabel`).

7. Evaluation

The last step is to evaluate the LACRIMALit ontology. Ontology evaluation is the task of measuring the quality of an ontology. Ontology evaluation is essential for wide adoption of ontologies in the Semantic Web and related technologies. There are different evaluation methods whose goal is “to assess the quality and correctness of the obtained ontology” [Sabou and Fernandez, 2012]. Criteria¹³ allow to calculate the “richness” of an ontology such as the attribute richness¹⁴ or relationship richness. Nevertheless, evaluation of criteria strongly depends on the aims of the ontology and the choices made for its implementation: “a good ontology does not perform equally well with regards to all criteria” [Vrandečić, 2009]. First of all, the ontology must allow providing the right answers to the competency questions. The competency questions have been translated into SPARQL¹⁵ to query the OWL version of the LACRIMALit ontology built with Protégé. All of them are satisfied. Figure 5 presents the competency question “CQ4: Who are the protagonists of a war, in this particular case the Peloponnesian war?” translated in SPARQL and the results returned, i.e., the set of individuals to which the individual ‘Peloponnesian war’ is linked by the ‘agent’ object property.

For the representation of facts such as “the Athenians took part in the Peloponnesian War” (i.e., facts whose Agent was a group), in Protégé, it has been required to use the same resource (IRI) both as an individual (Athenians as a protagonist) and as a class (Alcibiades is an Athenian).

13 https://ontometrics.informatik.uni-rostock.de/wiki/index.php/Schema_Metrics.

14 Attribute richness (AR) is defined as the average number of attributes (slots) per class. It is computed as the number attributes for all classes (att) divided by the number of classes.

15 [SPARQL 2013] is a language dedicated to query knowledge graphs written in RDF-family languages.

SPARQL Query	protagonistName
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>	"Alcibiades"@en
PREFIX owl: <http://www.w3.org/2002/07/owl#>	"Andrians"@en
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>	"Athenians"@en
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>	"Laconians"@en
PREFIX skos: <http://www.w3.org/2004/02/skos/core#>	"Lysander"@en
PREFIX foaf: <http://xmlns.com/foaf/0.1/>	
PREFIX lac: <http://o4dh.com/Ontologies/Crisis.owl#>	
SELECT ?protagonistName	
WHERE {	
?war rdf:type lac:War.	
?war rdfs:label 'Peloponnesian war'@en.	
?war lac:agent ?protagonist.	
?protagonist foaf:name ?protagonistName }	
ORDER BY ?protagonistName	

FIG. 5 – CQ 4 “Who are the protagonists of the Peloponnesian war” translated in SPARQL and the results it returned

8. Conclusion

In this paper, we have presented LACRIMALit ontology, a model of concepts to organise historical knowledge about crises in the Graeco-Roman world and provide access to and understanding of these historical narratives. LACRIMALit is work-in-progress towards the semantic annotation that will enable the semantic querying of a vast number of ancient Greek texts. As such, it brings to the fore central common problems faced by digital humanists, especially those working with texts. For digital humanities work to fit into the framework of the semantic web and linked and open data, taking into account the way of thinking of domain experts, the following tasks are typically required: selecting a corpus of texts to study, defining the domain of knowledge one is interested in, create or choose an ontology for that knowledge domain, and formally annotate the relevant text passages using the ontology.

We have illustrated how the LACRIMALit ontology conceptualises crises in ancient Greek historiography and allows to answer the competency questions. We put particular emphasis on those essential terms that ancient historians use to present and discuss crises on the political scene, affecting the life of many and the course of subsequent events. We envision that populating

the ontology with the crisis events from the whole corpus of ancient authors will provide a useful resource for digital historians: it can help historians to compare and contrast factual information about events.

The LACRIMALit ontology is a domain ontology defined as an extension of the CIDOC-CRM classes dedicated to the description of events involving one or more actors (E7 Activity). The LACRIMALit ontology was built using the Protégé environment, which allows the construction of ontologies in W3C format. If this environment is particularly well adapted to the organisation of individuals into classes, it is much less so with regard to the modelling of the linguistic dimension. The explicit representation of terms as individuals raises problems whose solutions are not really satisfactory.

In addition to the modelling issues necessitated by the theory underlying Protégé and the learning curve it presents for domain experts [Westerinen and Tauber 2017], the problem of knowledge and terminology modelling in digital humanities for the purposes of semantic annotation and knowledge retrieval remain open issues.

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Summary (in French)

Cet article présente les travaux en cours menés dans le cadre du projet LACRIMALit pour la construction d’un modèle de crises pour l’historiographie du grec ancien et d’une terminologie des crises en grec (ancien et moderne) et en anglais. L’alignement des trois terminologies, grec ancien, grec moderne et anglais, repose sur une conceptualisation commune des crises. Celle-ci est représentée sous la forme d’une ontologie au format du W3C construite à l’aide de l’environnement Protégé et se présente comme une extension de classes CIDOC dédiées à la modélisation d’événements. Grâce à la modélisation des événements et de leurs relations tant temporelles que causales, il devient possible de lier les différentes ressources historiographiques facilitant ainsi leur parcours et le raisonnement pour répondre à des questions complexes.

Keywords

Ontology, Terminology, Modelling Events, Ancient Greek Historiography, Crisis