

Designing an Ontology for the Study of Ritual in Ancient Greek Tragedy

Gloria Mugelli
Università di Pisa

gloria.mugelli@gmail.com

Andrea Bellandi
ILC, CNR Pisa

andrea.bellandi@ilc.cnr.it

Federico Boschetti
ILC, CNR Pisa

federico.boschetti@ilc.cnr.it

Anas Fahad Khan
ILC, CNR Pisa

fahad.khan@ilc.cnr.it

Abstract

We examine the use of an ontology within the context of a system for the annotation and querying of ancient Greek tragic texts. This ontology in question results from the reorganisation of a tagset that was originally used in the annotation of a corpus of tragic texts for salient information regarding ritual and religion and its representation in Greek tragedy. In the article we discuss the original tagset as well as providing examples of the annotation. We also describe the structure of the ontology itself as well as its use within a system for querying the annotated corpus.

1 Introduction

In this article we look at the use of an ontology as part of a system for annotating and querying ancient Greek tragic texts¹. This system was designed to support the research carried out by the first author on the dramatic function of religious ritual in ancient Greek tragedy including an analysis of the utilisation of ritual actions by tragic authors in developing tragic plots. In order to carry out this research it was necessary to create a corpus of annotated texts with the annotation taking into account the most salient phenomena from ancient Greek religion as well as the characteristics of ancient Greek rituals. As background here it is important to consider the fact that religion was embedded into every facet of everyday life in Ancient Greece² and that Greek tragedy was primarily a ritual and religious phenomenon³. Tragedies were performed during the Great Dionysia, a major Athenian festival dedicated to Dionysus which involved the mass participation of all Athenian citizens together with metics (resident strangers) and strangers⁴. Tragic authors could, then, count on the ritual competences of their audiences when it came to constructing their plots: since, having been involved throughout the year in various public and private religious events, the audience of Greek tragedy had both a ritual memory⁵ as well as various ritual skills, including the ability to perform rituals themselves⁶. Studying the dramatic form and function of ritual in Greek tragedy is therefore a matter of analysing the similarities and the differences between the rites as they were performed or described in ancient Greek tragedy, and the actual rituals, as they must have been known by 5th century audiences.

¹The project Euporia, Rituals in ancient Greek tragedy, is carried on by the Laboratorio di Antropologia del Mondo Antico (University of Pisa) and the CoPhiLab of the Institute of Computational Linguistics at the CNR in Pisa, see <http://www.himeros.eu/euporiaRAGT/> for details.

²See Parker (2005, 2011).

³On the relationships between ritual and ancient Greek drama see the long debate between Winkler and Zeitlin (1990); Friedrich (1998); Seaford (1998); Scullion (2002) and the discussion in Graf (2006). See also Calame (2017).

⁴On the dionysiac festivals see Pickard-Cambridge (1968) and the sources collected in Csapo and Slater (1994). On the participation at great public festivals in Athens see Parker (2005).

⁵On the role of memory in ancient Greek ritual see Chaniotis (2006); Taddei (2010).

⁶On the composition and the behavior of the tragic audience see Loscalzo (2008); Roselli (2011). On the competences of the audience in general see Revermann (2006); on the ritual competences of the public of Greek tragedy see Taddei (2014).

The corpus chosen for the annotation comprised all 33 surviving plays by Aeschylus, Sophocles and Euripides, although it does not yet include any of the fragments. The annotations were carried out by the first author (a specialist in the field) using specialist annotation software and with a tagset which she specifically devised for the purpose. The annotation software, known as Euporia, was developed through the adoption of a user centred design based on the annotation practices of classicists. Euporia allows the user to annotate continuous and discontinuous passages of various lengths, and deals with textual and interpretive variants⁷. It is then possible to perform queries on the annotated corpus, searching for all the occurrences of one hashtag or the co-occurrences of two or more hashtags⁹. Once the tragic corpus had been annotated, it became clear that restructuring the tags in the tagset into an ontology would make the annotated corpus even more useful and allow more complex and expressive queries to be made against the text. We will discuss the design of this ontology in section 3, while in the next section we will look in more detail at the original tagset itself.

2 The Design of the Original Tagset

The most representative category in the tagset is that of actions and ritual actions, these include ritual acts (such as sacrifices, supplications, libations, lamentations) but also parts of rituals (such as gestures, movements, speech acts). In order to facilitate research on rituals in their dramatic form, the annotation had to take into account two different types of problems: the dramatic and scenic conventions, and variations from actual ritual norm. Not all kinds of rites were meant to be directly performed on the ancient Greek theater stage: although some ritual actions were extremely well suited for the tragic performance (lamentations, supplications, funerary rites) others, above all animal sacrifice, were never represented. However, even if they were excluded from direct representation on the tragic stage, sacrifices were still very common in tragic plots, and established interesting dynamics between scenic and extra-scenic space: so that for instance characters are imagined performing sacrifices in some distant ritual space (for example a character exits to perform a sacrifice or enters and says he has just finished sacrificing). At the same time, sacrificial rituals performed outside the visible scenic space are discussed, ordered, described, and prepared onstage; sometimes sacrificial objects are even directly carried onstage: for example, a character coming back from a sacrifice may enter the scene wearing his sacrificial robe.

In the annotation of the text, these dynamics are represented with combinations of hashtags that marks not only the mention of a ritual in the texts, but also the characteristics of that ritual, and its relationship with the dramatic performance and with the ritual norm. Two macro categories of tags are used for this purpose: the tag *#s* is used to mark actions, objects, people that are directly represented onstage. On the other hand the tag *#h* is used to mark all the ritual actions that are performed in the context of the tragic plot and perceived as real by the tragic characters. For example, the sequence of the three tags *#h #s #supplicatio* marks the representation of an actual supplication carried out onstage, while the sequence *#h #sacrificium* marks an actual animal sacrifice that is not represented onstage¹⁰. The simple occurrence of the tag *#sacrificium* marks the mention of a sacrifice, one that is not necessarily performed in the tragedy. The tag *#h* is used to isolate the actual ritual events from all ritual discourses. Descriptions and prescriptions on rituals, preparations of rites or discussions on ritual efficacy are extremely relevant to research on the dramatic forms and functions of rituals: they can underline the aspects of a ritual that

⁷The passages are annotated with Latin keywords expressed as hashtags⁸. The Latin language makes the tags more concise and precise; the choice was also made for reasons of compatibility with *Memorata Poetis* (www.memoratapoetis.it) a project for the annotation of themes and motifs in Greek, Latin and Arabic epigrams. *Memorata Poetis* combines a top-down approach (with a Latin taxonomy of an index of *rerum notabilium*), and a bottom-up approach, with unstructured tags that are organized in an ontology in a second phase of the work, see Khan et al. (2016).

⁹The prototype version of the search engine (EuporiaSearch) is available at the address <http://www.himeros.eu/euporiaRAGT/>. The user can enter up to three different keywords: for example a query on the three tags *#sacrificium*, *#victima* and *#bos* retrieves all the passages in which an ox is the victim of a sacrifice: Aesch. *Ag.* 1169; Aesch. *Prom.* 531; Aesch. *Sept.* 276; Eur. *Andr.* 1134; Eur. *El.* 811; 813; 816; 1143; Eur. *Hipp.* 537; Eur. *IA* 1081, 1082, 1113.

¹⁰The absence of the tag *#s* simply marks that something is not represented onstage. When a ritual is performed offstage, the tag *#extra_scaenam/offstage* is added in the interests of clarity.

are important in the development of the plot, and that would likely have been noticed by the audiences of Greek tragedies.

In the next section we look at an example of an annotation from a particular tragedy in order to clarify certain aspects of the annotation as well as illustrating the dynamics between scenic and extra-scenic spaces, and the importance of rituals (real rituals, fake rituals and ritual discourse) in the tragic plot.

3 Iphigenia among the Taurians: a case study

Euripides' *Iphigenia among the Taurians* is one of a number of tragedies related to Agamemnon, the commander-in-chief of the Greeks during the Trojan war, and his descendants, his daughter Iphigenia and his son Orestes. Iphigenia is the eldest and the unluckiest of Agamemnon's children. She is sacrificed by her father, before the expedition at Troy, to appease the gods (Artemis in particular). Iphigenia's sacrifice has two different versions in Greek tragedy, differing in the representation of Iphigenia's attitude¹¹. In *Iphigenia among the Taurians*, Euripides represents a different ending for Iphigenia's story: the young girl is secretly saved by Artemis and carried to the land of Taurians. In Tauris, Iphigenia becomes a priestess of Artemis, in charge of human sacrifices. The play represents Orestes arriving in Tauris where he risks being sacrificed by his sister. Just before the sacrifice, Iphigenia and Orestes recognize each other, after which they finally escape from Tauris and return to Greece. In this tragedy, Euripides represents various different rituals¹². Setting the play in a remote and barbarian land allows him to initiate a discourse between standard and irregular ritual practices, regarding in particular animal and human sacrifice¹³.

Even if human sacrifices have never been attested in 5th century Athens¹⁴, Greek tragedies describing mythical human sacrifices are very likely to preserve important pieces of information about the actual animal sacrifice: descriptions of irregular ritual practice may have been modeled, by the tragic authors, on the actual ritual experiences of their audience¹⁵. Various human sacrifices are mentioned in Euripides' *Iphigenia among the Taurians*. The following examples will help to clarify both our bottom-up approach, and the possibilities that the ontology offers to perform queries on the database of the annotations.

In the prologue, Iphigenia describes her sacrifice, explaining why she is still alive and what is she doing in Tauris. The tag *#h* marks the ritual as a real one, since the sacrifice of Iphigenia is supposed to have been performed before the events of the tragic plot took place.

[24 καί μ' Ὀδυσσέως τέχναις...29 Ἀχαιοῖς] #h #virginem_sacrificare

Afterwards, Iphigenia makes several mentions of her duties as a priestess in Tauris, and the human sacrifices of strangers she is used to perform. None of these passages are marked by the tag *#h*, since they do not refer to a specific event: they describe the Taurian ritual practice – abnormal and barbaric for the audiences of Greek tragedy – of sacrificing any strangers who arrive in the land.

When Orestes arrives *incognito* as a stranger, he is the perfect candidate for being sacrificed by his sister, who actually gives the order to prepare the ritual. Here, the annotation marks the fact of giving instructions (*#praecepta*) to prepare a human sacrifice (*#ritum parare #hominem sacrificare*).

¹¹In Aeschylus' Ag., Iphigenia is trying to escape the sacrifice, while in Euripides' IA she ultimately consents to being sacrificed. The willingness of the (animal) sacrificial victim is a very debated question among the specialists of ancient Greek sacrifice.

¹²On ritual practices in Eur. IT see Taddei (2009).

¹³See Bremmer (2013).

¹⁴In 5th century Athens animal sacrifices were performed on a great number of ritual occasions, see Detienne and Vernant (1979); Van Straten (1995); Ekroth (2002); Parker (2005, 2011); Naiden (2013); human sacrifices instead have never been attested in ancient Athens, although at the same time they are very common in mythical narratives, and are often represented in literary sources, and in Greek tragedy above all, see Bonnechere (1994); Bonnechere and Gagné (2013); Nagy and Prescendi (2013)

¹⁵A common tragic ritual pattern is the so-called perverted sacrifice: in the tragic texts various homicides described using sacrificial metaphors, see Zeitlin (1965); Henrichs (2004, 2012).

When Orestes and Iphigenia find out the truth about their respective identities, they hatch a plan to escape from Tauris and return to Greece: first of all, Iphigenia has to pretend that the sacrifice is impeded by Orestes' pollution, so that they can reach the seaside for a fake cathartic ritual and escape by sea.

Neither Orestes' sacrifice nor the cathartic ritual are actual rituals within the context of the tragic plot: they are explicitly fake by the characters, and have the function to carry out the tragic plot. At the same time, the two fake ritual have interesting features that can be compared with both the rites actually performed in the tragedy and the actual ritual practice.

When it comes to set out for the cathartic ritual, for example, Iphigenia arranges onstage a procession with Artemis' statue, torches, ritual objects. The procession also escorts the tied Orestes and the lambs whose blood is going to be used in the cathartic ritual. The annotation marks all the details of the sacrificial procession and the fact that we are dealing with a simulation (*#ritum_simulare*) of a procession (*#pompe*) going to a purificatory rite (*#lustratio*).

Eur. IT 1222-1225

1222 τούσδ' ἄρ' ἐχβαίνοντας ἤδη δωμάτων ὄρω ξένους
1223 καὶ θεᾶς κόσμους νεογνούς τ' ἄρνας, ὡς φόνῳ φόνον
1224 μυσαρὸν ἐκνίψω, σέλας τε λαμπάδων τὰ τ' ἄλλ' ὅσα
1225 προυθέμην ἐγὼ ξένοισι καὶ θεᾷ καθάρσια.

I see the strangers coming out of the temple now, and the ornaments of the goddess and the new-born lambs, because I will wash blood-pollution away with blood, and the flash of torches and all the rest that I have set out as purification for the strangers and the goddess.

[1222 τούσδ ...1233 θεά] #s #ritum_simulare #pompe #lustratio

[1222 τούσδ~ξένους] #s #xenos #victima

[1222 τούσδ ...1233 θεά] #s #statua

[1223 νεογνούς τ' ἄρνας] #s #agnus #victima #aetas

[1223 θεᾶς κόσμους] #s #instrumenta_ritus #kosmos

[1224 σέλας τε λαμπάδων] #s #taedae

4 From the textual annotation to the ontology

Organising the hashtags in the annotation tagset in an ontology enhances the usability of the tagset and allows more complex and expressive queries to be carried out on the annotated text. Furthermore the creation of ontological entities for mythical and dramatic events and characters allows users to integrate their textual annotations with further pieces of background knowledge: this strategy makes it possible to carry out queries that are based both on that which is explicitly stated in the text as well as on other background information about the events themselves which has been added to the ontology¹⁶.

For the design of the ontology a 'bottom-up', a posteriori approach was adopted¹⁷: we organised the hashtags from the original tagset in classes and subclasses¹⁸, and worked upwards creating new superclasses. We also created object properties to express the relationships between different classes. It is important to point out here that the first author's (our domain expert) knowledge of ancient Greek drama and religion was crucial for reorganising the tagset, and that various other specific issues explored in her research were also taken into consideration during the reorganisation. A large number of the elements in the tagset refer to ritual practices or actions performed during rituals.

¹⁶For a similar approach see Khan et al. (2016)

¹⁷The bottom-up approach was described at the Göttingen Dialog in Digital Humanities 2016 (<http://www.etrapp.eu/activities/gddh-2016/>), the proceedings of which are forthcoming.

¹⁸Although classes are usually expressed with character strings that begin with a capital letter, and properties with strings that begin with a lowercase letter, we chose to preserve the conventions of the tagsets used in the annotation: individuals and classes are expressed, in our ontology, in lowercase and are marked with a sharp (#). The properties we created to establish relationships between classes are expressed in lowercase.

With the purpose of organising the different ritual actions included in the original tagset, we created in the ontology the superclass *#actus* (action) and its subclass *#ritus* (ritual action), along with several other subclasses referring to different types of action: gestures, speech-acts, movements.

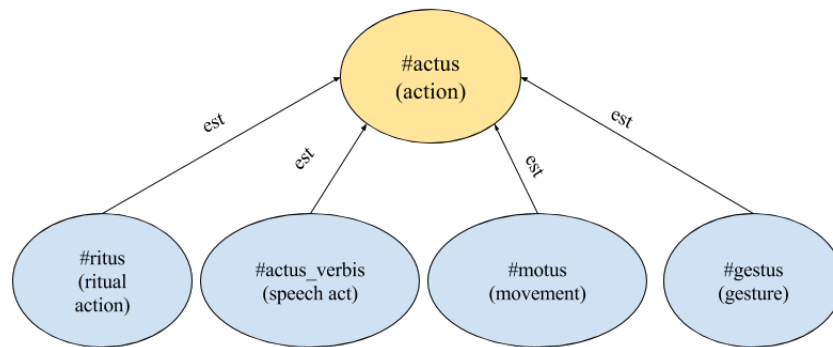


Figure 1: Actions and ritual actions.

Rituals can be characterised by one or more of the categories of actions: a prayer, for example, is a rite (and falls therefore under the *#ritus* class) that also falls under the speech-act class. At the same time, a ritual can involve one or more different sub-actions, annotated in the original tagset. We chose to express the relationship between the different sub-actions performed during a rite and the ritual action itself by creating the property *habet_actum* (has sub-action). The property *habet_actum* (has sub-action) marks an action for the involvement of one or more sub-actions: e.g., a prayer involves the gesture of outstretched-hands.

Creating the superclass *#actus* (action) and the property *habet_actum* (has sub-action) allowed us to model complex ritual practices (ex. sacrifices), that can be divided in phases and can involve a large number of sub-actions. The most important sub-action of a sacrificial ritual, for example, is the ritual killing of the victim; all of the other sub-actions performed within the context of a sacrifice can be divided into two phases, pre-killing and post-killing, during which different types of actions are performed. During the pre-killing phase, for example, the participants are arranged around the altar and the *sacri-ficant* sprinkles the altar with water and utters a prayer. This phase of the sacrifice therefore involves different sub-actions: a specific position, a gesture and a speech-act.

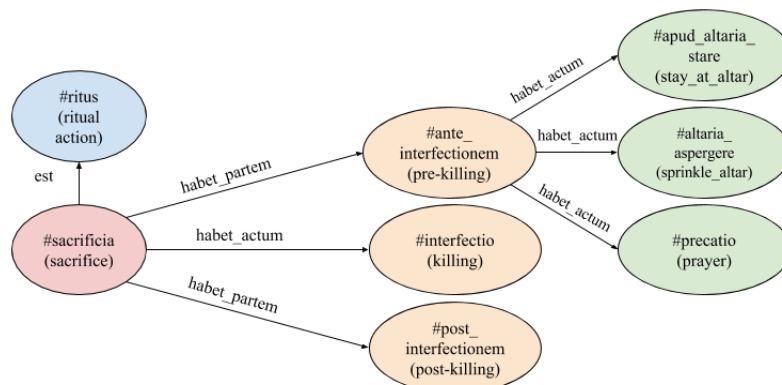


Figure 2: Sacrifice description.

When modelling the classes of ritual actions and actions in general, we had to take into account the problem of ritual agency, that is extremely important for the study of rites and religion. The textual annotation already included hashtags marking the different roles that can be performed during a ritual action, such as *#ritum_agens* (ritual agent) or *#recipients* (recipient). In our ontology, we chose to model the ritual roles as classes, and we created the correspondent properties (using the latin verb corresponding to the roles) to describe the relationships between the ritual actions and their agents or recipients. A

#ritum_agens (ritual agent) is defined as the class of every individual who **agit** (performs) some **#ritus** (ritual action) and a **#recipiens** (ritual recipient) is defined as the class of every individual who **recipit** (receives) some **#ritus** (ritual action).

We also used the properties **agit** and **recipit** and their inverse properties (**agitur** and **recipitur**) to create axioms that describe the relationships between specific ritual actions and their specific agents or recipients: sacrifices, for example, are always dedicated to gods. We used the property **recipitur** (is received by, inverse property of **recipit**) to state as an axiom that sacrifices have only recipients in the subclass **#deus_recipiens** (recipients-gods): **#sacrificia** \sqsubseteq **recipitur** ONLY **#deus_recipiens**. The subclass is therefore defined as a subclass of both the class **#dei** and **#recipiens**.

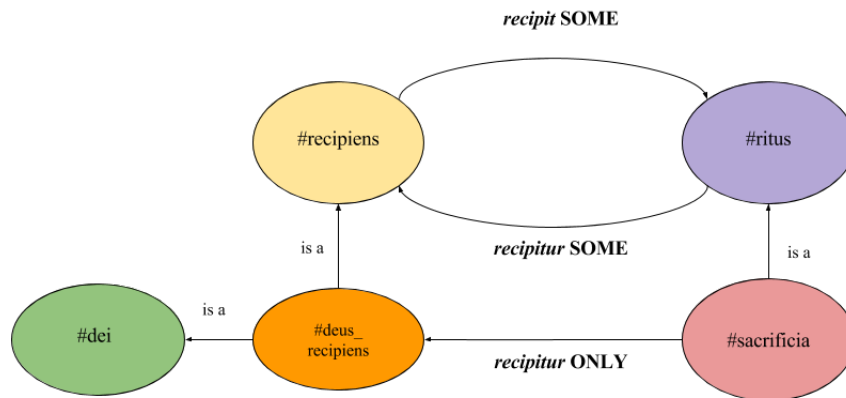


Figure 3: Sacrifices and recipients.

In a sacrifice the role of the victim is of course very important, and it is expressed in our ontology by the class **#victima** (already included in the textual annotation). In actual ancient Greek sacrificial practice this victim was usually an animal. However, our interest in the portrayal of rites in Greek tragedy means that we have to include human sacrifices in our ontology, with sacrifices of virgins as a special case. We defined three types of sacrifice (**#sacrificia**¹⁹) based on the type of victims they required, specified via the **habet_victimam** (has victim) property. An animal sacrifice has victims only in the subclass **#victima_animalis** (animal victim), a class that is defined as the intersection of the **#victima** (victim) and **#animal** classes; the victims of a human sacrifice only belong to the class of human victims (**#victima_humana**) which latter is represented as an intersection between the class **#victima** and the class **#homo** (human being); finally, a virgin sacrifice is a human sacrifice that has a victim in the subclass of virgins (a subclass of the **#homo** class).

Our ontology can be used to add another layer of salient information pertaining to the tragic texts. Each character in a specific text is represented as an individual in the ontology, however characters can also have different variants across different myths or across different variations of the same myth, and it is useful to model this as well. Indeed myths are naturally subject to variation, and tragic plots represent mythical narratives as well as, at the same time, creating different variants of a myth. In order to give a stable identity to variant versions of the same character we decided to create new individuals, belonging to the class **#heros**, that represent a mythical ‘pattern’ or ‘prototype’ for a given character. We link instantiations of characters in an individual text with this so called mythical identity via the property **#est_persona** (is character of)²⁰. We have adopted the same approach in creating single ontological events for the mythical or dramatic ritual events.

In Eur IT, we modelled four events as ontological individuals:

¹⁹In the ontology, we used the plural **#sacrificia** to mark the superclass of sacrifices (both animal and human). The singular and unmarked term **#sacrificium** was used in the textual annotation to mark the most common sacrificial practice (animal sacrifices) and it is therefore used in the ontology for the subclass of animal sacrifices.

²⁰The annotation included the names of tragic characters only when they were relevant in the understanding of ritual actions (for example when a tragic character is a ritual agent). In our ontology we chose to include an individual for each of characters represented in a play, linked to the corresponding individual in the class **#heros**.

1. The sacrifice of Iphigenia, that is an individual of the *sacrifice of a virgin* class of events, performed by Agamemnon and that has Iphigenia as a victim;
2. The Taurian practice of *human sacrifices* that is a class of events, in particular a subclass of the human sacrifice type. This type of ritual has (human) strangers as victims, and is performed in Tauris by the priestess of Artemis, a role played by Iphigenia in the Euripidean tragedy;
3. The fake sacrifice of Orestes, that is an individual event belonging to the *#ritum_simulare* class, that enacts a human sacrifice of the *taurian_sacrifice* type. The fake sacrifice has Orestes as a victim, and Iphigenia (in her role of Artemis' priestess) as the ritual agent.
4. The fake purification of the human victims, enacted in the context of the fake human sacrifice.

Points 3 and 4 stress the difference between the actual rituals (marked with the tag *#h*) and actions that involve rituals (for example simulations, ritual discourses, ritual prescriptions or the preparation of a ritual). The class *#ritum_simulare* includes all fake rituals, and can be used to study the function of this dramatic mechanism in the tragic plot. The relationship between a simulated rite and the actual rite is represented by duplicating the ontological events referring to the ritual: we have an individual of the *#ritum_simulare* (fake_rite) class representing the simulation, and an event of the *#ritus* type representing the object of the simulation. The relationship between the simulation and the simulated rite is expressed via the property *agitur_in_aliquid* (has object). The duplication of the ontological events stresses the differences between the fake and the real rituals (a fake ritual is not a subclass of *#ritus*). One of the most interesting differences between real and fake rituals is their purpose (*#ritus_propositum*): in the case of the fake purification, for example, we can distinguish between the purpose of the purification (the purity of the sacrificial victim) and the intention of the fake ritual (the escape of the two characters).

By creating single ontological individuals representing specific events we can gather together all the textual mentions of the same event, so that users can easily collect all the different information included in the annotation for a single ritual event. This makes it possible to study how a mythic ritual (the sacrifice of Iphigenia, for example) is represented in different tragedies. It also makes it possible to analyse all the patterns of action involving a ritual in a specific tragedy: in Eur. *IT* the sacrifice of Orestes is firstly recommended and prescribed, then refused, finally simulated by Iphigenia. Moreover, including the ritual events in the ontology allows the user to add (and retrieve) some additional pieces of information about the specific individuals of his/her ontology.

4.1 Using the Ontology to Query the Tragic Corpus

One of the main characteristics of the system which we are currently constructing, and of which the ontology and the annotated corpus are parts, is its close relationship with the tragic text: so that users are able to retrieve information, based on an expert textual annotation, that is useful for anyone interested in the details of Greek tragic texts. And thanks to the ontological component of the system, users can perform queries on both the textual annotation and the ontological events (and their textual occurrences).

Our system prototype is depicted in Figure 4. In order to interact with the corpora itself we use our ontology to create SQL queries according to an original query posed by a user. This original query can be formulated in SPARQL. However accessing structured data in the form of ontologies requires training via a language like SPARQL can incur a significant overhead for users. This is why we feel that it is important to provide a Natural Language Interface that assists in the making of queries (step 1 of Figure 4). Afterwards a specific component maps the query into SPARQL in order to retrieve the right entities (step 2 and 3 of Figure 4). At this level the system can exploit the inferred knowledge by making an expansion of the original query in order to generate a list of SQL queries accordingly (step 4 and 5 of Figure 4). Finally, the data is retrieved by means of Euphoria search engine that performs the queries, the results of which are rendered to the scholar by the system GUI (step 6 and 7 of Figure 4).

An example should clarify. Thanks to the fact that the relations between the different type of sacrifice and the different types of agents have been defined, users can perform queries on the ritual features of

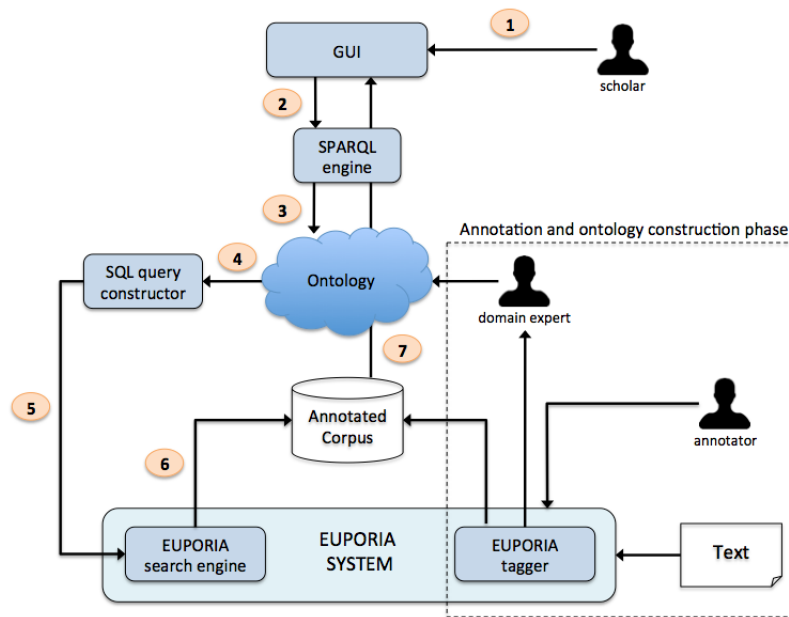


Figure 4: System prototype architecture.

both human and animal sacrifices: so that it's simple to write a query that retrieves, for example, all the female goddesses who receive sacrifices in Greek tragedy. In the textual annotation, the tag *#recipients* is used to mark the gods receiving a sacrifice, in association with their names whenever their names (or identities) are explicitly stated in the text. For the example query mentioned above the system generates a list of SQL queries in order to retrieve all the cases where the name of a goddess (an individual of the subclass *#dea, female goddesses*) is annotated in the role of *#recipients* in the context of a sacrifice, that is one of the subclasses of the *#sacrificia* superclass, including animal sacrifices, human sacrifices and sacrifices of virgins. The results listed below are examples of passages resulting from the different queries:

1. Eur. El. 756: a sacrifice to the nymphs (*#sacrificium + #recipients + #nymphae*);
2. Eur. Hel. 1585: a sacrifice to Poseidon and the nereids (*#sacrificium + #recipients + #nereides*);
3. Eur. IT 456: the taurian sacrifices of strangers dedicated to Artemis (*#hominem_sacrificare + #recipients + #artemis*);
4. Eur. IT 6-9: Iphigenia's sacrifice to Artemis (*#virginem_sacrificare + #recipients + #artemis*)²¹.

5 Conclusions

In this article we have discussed the use of an ontology as an aid in the study of ritual and religious facts in Greek tragedy. Starting out with an annotated corpus of ancient Greek tragedies we looked at the tagset could be reorganized as an ontology in order to better query the annotated text. This bottom-up approach was adapted to the methodology adopted by the original research on the tragic texts: on the one hand the textual annotation preserves the complexity of the dramatic texts, and allows the retrieval all the ritual-related passages in Greek tragedy; on the other hand the ontology structures the annotations in a way that takes into consideration both ancient Greek ritual norms and the dramatic mechanisms of ancient Greek tragedy. Finally we described an overall system for studying annotated texts in which the

²¹Gods and goddesses' names mentioned in tragedy were marked in the annotation, and were then included in our ontology. The domain specialist also asserted informations about the gender and the status of the gods (creating, for example, the class of virgin goddesses) and the family and marriage relations between different gods.

ontology is a component. In future work we plan to create a user friendly interface to our system and as well as looking into how to improve its usability more generally.

Our system offers many possibilities for the study of ritual in Greek tragedy and of ancient Greece in general. Due to the fact that it was designed to consider both religious and dramatic problems, it has a special focus on the comparison of different ritual practices to their literary and dramatic representation. However, the dataset and the ontology should be easily reusable in other projects with a literary or historical scope. Indeed the part of the ontology representing tragic and mythical characters was specifically designed in order to be reused in studies on Greek myth: we represent mythical and tragic characters in a way that allows integration with other mythical variants. In particular the part of the ontology representing ancient Greek rituals can be reused in a comparative perspective. It can be used to compare different aspects of ancient Greek religion and different ways to represent rituals in various sources, being integrated with other similar projects. Finally, the ontology can be used in a broader perspective, to establish comparison between the ancient Greek ritual norm and ritual practices from different civilisations.

References

- Bonnechere, P. (1994). *Le sacrifice humain en Grèce ancienne*. Number 3 in Kernos. Suppléments. Athènes Liège: Centre Int. d'Etude de la Religion Grecque Antique.
- Bonnechere, P. and R. Gagné (2013, June). *Sacrifices humains Perspectives croisées et représentations*. Liège: Presses universitaires de Liège.
- Bremmer, J. (2013). Human Sacrifice in Euripides' Iphigeneia in Tauris: Greek and Barbarian. In R. Gagné and P. Bonnechere (Eds.), *Sacrifices humains. Perspectives croisées et représentations*, pp. 87–100.
- Calame, C. (2017). *La tragédie chorale. Poésie grecque et rituel musical*. Paris: Les Belles Lettres.
- Chaniotis, A. (2006). Rituals between norms and emotions: ritual as shared experience and memory. In E. Stavrianopoulou (Ed.), *Ritual and Communication in the Graeco-Roman World*, Number 16 in Kernos Supplément, pp. 211–238. Liège.
- Csapo, E. and W. Slater (1994). *The Context of Ancient Drama*. Ann Arbor: The University of Michigan Press.
- Detienne, M. and J. Vernant (1979, September). *La cuisine du sacrifice en pays grec*. Paris: Gallimard.
- Ekroth, G. (2002). *The Sacrificial Rituals of Greek Hero-Cults in the Archaic to the Early Hellenistic Period*. Kernos suppléments. Liège: Presses universitaires de Liège.
- Friedrich, R. (1998). Everything to Do with Dionisos? Ritualism, the Dionysiac, and the Tragic. In M. S. Silk (Ed.), *Tragedy and the tragic : Greek theatre and beyond*, Clarendon paperbacks, pp. 257–283. Oxford: Clarendon press.
- Graf, F. (2006). Drama and Ritual. Evolution and Convergences. In E. Medda, M. S. Mirto, and M. P. Pattoni (Eds.), *Komoidotragoidia : intersezioni del tragico e del comico nel teatro del V secolo a.C.*, Number 6 in Seminari e convegni, pp. 103–118. Pisa: Edizioni della Normale.
- Henrichs, A. (2004). "Let the Good Prevail": Perversions of the Ritual Process in Greek Tragedy. In D. Yatromanolakis and R. Panagiotis (Eds.), *Greek Ritual Poetics*. Cambridge (Mass.): Harvard University Press.
- Henrichs, A. (2012, March). Animal Sacrifice in Greek Tragedy: Ritual, Metaphor, Problematizations. In C. A. Faraone and F. S. Naiden (Eds.), *Greek and Roman Animal Sacrifice: Ancient Victims, Modern Observers*. Cambridge University Press.

- Khan, A. F., S. Arrigoni, F. Boschetti, and F. Frontini (2016). Restructuring a Taxonomy of Literary Themes and Motifs for More Efficient Querying. *MATLIT: Materialidades da Literatura* 4(2), 11–27.
- Khan, A. F., A. Bellandi, G. Benotto, F. Frontini, E. Giovannetti, and M. Reboul (2016). Leveraging a Narrative Ontology to Query a Literary Text. *OASISs-OpenAccess Series in Informatics* 53.
- Loscalzo, D. (2008, April). *Il pubblico a teatro nella Grecia antica*. Bulzoni.
- Mugelli, G., F. Boschetti, R. Del Gratta, A. M. Del Grosso, A. F. Khan, and A. Taddei (2016, December). A User-Centred Design to Annotate Ritual Facts in Ancient Greek Tragedies. *Bulletin of the Institute of Classical Studies* 59(2), 103–120.
- Nagy, A. A. and F. Prescendi (2013). *Sacrifices humains : dossiers, discours, comparaisons actes du colloque tenu a l'Université de Genève, 19-20 mai 2011*. Number 160 in Bibliothèque de l'École des hautes études. Turnhout: Brepols.
- Naiden, F. S. (2013). *Smoke signals for the gods : ancient Greek sacrifice from the Archaic through Roman periods*. Oxford [etc.]: Oxford University Press.
- Parker, R. (2005). *Polytheism and Society at Athens*. Oxford.
- Parker, R. (2011). *On greek religion*. London Ithaca: Cornell University Press.
- Pickard-Cambridge, A. W. (1968). *The Dramatic Festivals of Athens*. Oxford.
- Revermann, M. (2006). The Competence of Theatre Audiences in Fifth- and Fourth-Century Athens. *Journal of Hellenic Studies* 126, 99–124.
- Roselli, D. K. (2011, June). *Theater of the People: Spectators and Society in Ancient Athens*. Austin: University of Texas Press.
- Scullion, S. (2002, July). 'Nothing to do with Dionysus': tragedy misconceived as ritual. *The Classical Quarterly (New Series)* 52(01), 102–137.
- Seaford, R. (1998). Something to Do with Dionysos - Tragedy and the Dionysiac : Response to Friedrich. In M. S. Silk (Ed.), *Tragedy and the tragic : Greek theatre and beyond*, Clarendon paperbacks. Oxford: Clarendon press.
- Taddei, A. (2009). Inno e pratiche rituali in Euripide: il caso dell'Ifigenia tra i Tauri. *Paideia* (LXIV), 235–252.
- Taddei, A. (2010). Memory, Performance, and Pleasure in Greek Rituals. In A. Chaniotis and L. Silke (Eds.), *Ritual Dynamics and the Science of Ritual*, Volume II, pp. 87–108. Wiesbaden: Harrassowitz Verlag.
- Taddei, A. (2014). Le Panatenee nel terzo stasimo degli Eraclidi (Eur. Heracl. 748-783). *LEXIS*.
- Van Straten, F. T. (1995). *Hierà Kalà : Images of Animal Sacrifice in Archaic and Classical Greece*. Number 127. Leiden: Brill.
- Winkler, J. J. and F. I. Zeitlin (1990). *Nothing to do with Dionysos : Athenian drama in its social context*. Princeton, N.J: Princeton University Press.
- Zeitlin, F. I. (1965). The Motif of the Corrupted Sacrifice in Aeschylus' Oresteia. *Transactions and Proceedings of the American Philological Association* 96, 463.