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Authors

Sartini, Bruno

Lucarelli, Rita

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Towards a Semantic Representation of Egyptian Demonology: Requirements and Benchmark Study

Bruno Sartini[1,*], Rita Lucarelli[2]

[1]Ludwig-Maximilians-Universität München
[2]University of California, Berkeley

Abstract

This work proposes a first step in the semantic representation of Egyptian demonology, a complex domain within Egyptology. We first use insights from (i) literature review and (ii) empirical data analysis from structured descriptions of Egyptian demons extracted from the DemonThings database, to formulate functional and non-functional requirements, and with competency questions. We then assess the coverage of existing ontologies on the topic by testing the competency questions on linked open data about Egyptian demons generated following the structure of the ontologies. Although certain aspects, such as symbolism, were adequately addressed, deficiencies were identified in areas such as iconographic interpretations, linguistic relationships (with names and their transliterations), and specific conceptualizations of demon roles, their appearance, and the events to which they are connected. The study highlights the need for a specialized ontology tailored to the specific characteristics of Egyptian demons. Future work will focus on the development of such an ontology, with the potential integration of Semantic Web technologies into current digitization projects related to Egyptology.

Keywords

Semantic Web, Knowledge Representation, Modelling Requirements, Egyptian Demonology

1. Introduction

The intersection between Semantic Web technologies and the study of ancient Egyptian culture, known as Egyptology, presents a fascinating and multifaceted landscape. On the one hand, the Semantic Web has evolved as a powerful paradigm for representing and interlinking diverse knowledge domains within and beyond cultural heritage (CH), promoting interoperability, and enabling advanced data analysis [1, 2, 3]. On the other hand, when it comes to describing ancient Egyptian culture, we encounter a significant gap: the almost complete lack of linked open data (LOD) about this domain. In this context, our research focuses on a particular subset of Egyptology: **Egyptian demons**.[1] These enigmatic beings, with their diverse forms, roles,

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*Corresponding author.
b.sartini@lmu.de (B. Sartini); rita.lucarelli@berkeley.edu (R. Lucarelli)
https://vcresearch.berkeley.edu/faculty/rita-lucarelli (R. Lucarelli)
0000-0002-9152-4402 (B. Sartini); 0000-0003-3117-7688 (R. Lucarelli)
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[1]In this paper, we use the word "demon" from an Egyptian perspective. Unlike the predominantly malevolent perception of "demons" in modern contexts, Egyptian demonic entities could display both benevolent and malevolent traits. Furthermore, the Egyptian language does not have a word that corresponds to "demon" and marks a clear distinction between deity and demon [4]. Therefore, scholars have to rely on other criteria, such as function, appearance, and status, to identify and classify demonic beings. We refer to [5] for a thorough comparative analysis

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and iconography, serve as a compelling case study for both the Semantic Web and traditional Egyptology. Egyptian demons defy easy categorization. Their characteristics vary widely, from malevolent wanderers to protective guardians [4].

To the best of our knowledge, no previous studies have attempted to express the characteristics of Egyptian demons in LOD. Furthermore, scholars in Egyptology have not reached a general consensus on a structured, standardized way of describing Egyptian demons (beyond LOD and the Semantic Web) [4]. The lack of extensive prior work necessitates a benchmark study of how current ontologies can be employed to describe this domain. In this work, we first produce a list of requirements for the knowledge representation of Egyptian demons with a combination of a literature-driven and a data-driven approach. Then, we test a set of existing ontologies on these requirements to assess the extent to which Egyptian Demonology is currently covered by the semantic models, highlighting potential reuse cases and areas that will require, in a future work, the development of a new ontology.

We employ a literature-driven approach that involves consulting domain experts and reviewing their previous scholarly contributions, ensuring that the proposed model aligns with the literature. Simultaneously, we adopt a data-driven approach by investigating how information on Egyptian demons is currently collected and stored in datasets, focusing on the DemonThings database,[2] an online catalog of ancient Egyptian supernatural beings from the second millennium BC.

We selected several ontologies from the CH domain that will be tested in light of the requirements. The evaluation of the proposed semantic model will be quantitatively based on the testing of competency questions (CQ) [6] and qualitatively by the supervision of a domain expert on the results, to assess their robustness and relevance. To test the CQs, we will reuse the selected ontologies to describe the data contained in DemonThings, creating test LOD datasets of it using the classes and properties of the ontologies.

By working towards a semantic representation of Egyptian demons, this research aims to offer a framework for utilizing ontologies to describe them while identifying existing gaps. Future work will focus on developing an ontology to address these gaps. The significance of this work lies at the intersection of Digital Humanities, Semantic Web Technologies, and Egyptology. Anticipating that data about this domain will eventually be expressed in the LOD format, it is crucial to mitigate issues like coercion, which involves placing metadata in an incorrect category, and flattening, which involves placing metadata in a broad category without considering the domain's specificity [7]. Both challenges have been observed in other disciplines, such as iconography and iconology [8]. With the current trend towards digitizing Egyptian cultural artifacts [9], this study represents an initial step to avoid the recurrence of these issues in LOD related to Egyptian demons.

The structure of the paper is described below.

In Section 2, a foundational understanding of Egyptian Demonology is offered. Section 3 explains both the literature-driven and data-driven approaches and their respective contributions to defining the requirements. In Section 4 we explain the derived requirements for semantic modeling. Moving forward, Section 5 examines and justifies the selection of specific

of the meaning of "demon" between Egypt and other cultures.

[2]Accessible at http://iss-demonology.swan.ac.uk/demonology/

ontologies for the subsequent evaluation task, considering their compatibility and relevance to the requirements. Section 6 explains the process of generating data using these selected ontologies as the structural back-end, providing insight into their practical implementation in the domain of Egyptian Demonology. Section 7 contains the evaluation of the results, both using CQs and qualitative analysis from a domain expert. Following this, in Section 8 we discuss the results in the context of the purpose of the paper. Finally, Section 9 closes the article, summarizing key findings and highlighting potential directions for future research.

2. Background and motivation

Egyptian demonology is the study of supernatural beings in ancient Egyptian religion. These beings were believed to have the power to cause harm, afflictions, and anxieties to humans, but also to provide protection and guidance in the afterlife. There are two main types of Egyptian Demons:

1. **Wanderers**: these demons traverse realms, acting as emissaries of the gods or as independent agents. They bring diseases, nightmares, and misfortune [10, 4, 11, 12, 13]. Their malevolence is evident, yet their roles change according to context [4]. As Egyptians believed that giving them an image would increase their power and hold over humans, wanderers are often aniconic. Therefore, most of their characteristics are contained in epithets, and, for most of them, we have only written descriptions.
2. **Guardians**: tied to specific locations, guardians protect against intrusion and pollution. Their belevolence or malevolence depends on human interaction. They guard the gates of the afterlife and guide humans in trespassing. For this reason, they usually have a pictorial representation as a way for humans to recognize them. Iconographically, they tend to blend human and animal characteristics, highlighting their otherworldly nature [4, 11].

The description of Egyptian demons poses several challenges. First, demons often blur the boundaries with other deities or humans (as sometimes they are represented in disguise as humans [14]). Another key characteristic is their ability to shape form [11]. Distinguishing them solely by appearance can be elusive.

The iconographic characteristics of Egyptian demons are diverse and varied. They are often depicted with animal heads, wings, and/or tails and sometimes with human bodies. The (part of) animals used to represent demons represent both their benevolent and malevolent nature. For example, demons that possess body parts of poisonous creatures such as snakes and scorpions can be both protectors or illness-bringers, depending on the context in which they act and the reason why they are summoned up or confronted [4]. Some demons are depicted with multiple heads, while others have elongated arms or legs. Demons are also often depicted holding weapons, such as knives or spears, or carrying objects, such as bags or baskets. The iconography of the demons is believed to have been influenced by the psychological needs of the people who created them, as well as by the cultural and religious beliefs of the time. In addition, the objects they hold in their depictions often symbolize their benevolence or malevolence. Most demons are male. Female demons are rare and are often associated with illnesses. Gender

does not play a significant role in the function and behavior of demons, but rather reflects the idea that the active power of demons is a male characteristic [12, 4, 10]. However, goddesses can have demonic qualities or control demonic beings, especially when they are angry or destructive. Finally, the names and epithets of Egyptian demons refer to their physical or moral attributes and agencies [11]. Descriptions and visual representations of demons can be found in various media, including coffins, manuscripts, temple walls, and chapters of the Book of the Dead [4, 10].

The motivation behind this work lies in multiple factors. First, the representation of Egyptian demons in structured formats has long been a challenge due to the absence of consensus among scholars. This lack of standardization presents an opportunity to establish a structured format following the principles of LOD, incorporating logical inferences from the outset of the design process. Second, given the diverse manifestations of these demons in various media, including sarcophagi, temple walls, and the Book of the Dead, and their significance in funerary contexts, they are associated with heterogeneous types of information. The use of semantic web technologies and LOD becomes particularly pertinent in this scenario, as it facilitates the integration of data from these different types of information. Furthermore, with the emergence of Large Language Models (LLMs), significant research is being conducted on the use of KG to improve the effectiveness of LLM-generated output [15, 16]. In this study, we embark on the initial step towards conceptualizing this information, with the future aim of developing an ontology and subsequently a knowledge graph of Egyptian demons. Such a graph has the potential for integration into information retrieval systems (including LLM-based) in Egyptology, thus advancing the accessibility and comprehensiveness of demon-related knowledge within the scholarly discourse, especially in the field of Digital Humanities.

3. Methodology

The primary objective of this study is to establish a comprehensive list of requirements that serves as a foundation for the evaluation of how current ontologies can cover the domain of Egyptology, in particular, in the descriptions of ancient Egyptian demons. To achieve this goal, a dual approach has been adopted that combines literature- and data-driven methodologies.

The literature-driven approach involves an examination of the scholarly literature to identify the prevalent methodologies and conventions for describing demons. Specifically, we are interested in identifying commonalities and variations in the description of demons. We selected the initial literature with the help of a domain expert and then expanded it with related articles with the help of the search indexes of Google Scholar,[3] Academia.edu,[4] and Semantic Scholar.[5] Although Egyptology as a domain has been studied by many scholars, only in recent years has the particular subfield of Egyptian Demonology become the center of specific studies [12]. Therefore, starting from the work of the domain expert Rita Lucarelli [4, 11, 13, 17], we expanded our bibliography with 3 more articles of relevant work [12, 18, 10]. We will not describe the content of selected articles (Section 2 already contains a summary of the whole bibliography in Egyptology consulted for this work), but we compare them in Section 4 in terms

[3] https://scholar.google.com/
[4] https://www.academia.edu/
[5] https://www.semanticscholar.org/

of mention (or lack of mention) of a specific requirement.

The data-driven approach involves empirical analysis of data extracted from DemonThings, an Egyptian demon database that is one of the richest openly available databases dedicated to describe demons. We extracted the data from DemonThings using scraping techniques that exploit the query function of the database. Because no dump download of the data was available, we launched a series of queries containing all demon IDs in the database by systematically sending requests through the URL http://iss-demonology.swan.ac.uk/demonology/get-entities.php?http://iss-demonology.swan.ac.uk/demonology/get-entities.php?id=, as the IDs were numerical and ordered. We performed the scraping in a Python environment using the BeautifulSoup library.[6] All the demons are described according to 14 fields: *Name, Appearance Pose, Head, Upper Torso, Lower Torso, Image, Book of the Dead Chapter Number, Coffin Text Spell Number, Description, Costume, Headgear, Holding,Pose, Gesture*. Out of these, we exclude *Image* because the images are covered by copyright and *Pose* because it is just a duplicate of *Appeareance Pose*. Not every demon is described using all fields. We extracted the description of 4043 demons from DemonThings, and the script to extract the data in a JSON file is available on GitHub[7] for reproducibility purposes.

Combining insights from both approaches, a comprehensive set of functional and non-functional requirements [19] is compiled. These requirements, explained in Section 4, serve as the basis for formulating CQs aimed at testing the adequacy of existing ontologies in fulfilling the identified needs.

Afterwards, we selected several existing ontologies within the semantic web ecosystem that covered the topics which emerged from the requirements. The data from DemonThings is then transformed according to the structures provided by the surveyed ontologies using the RDFlib library[8] in a Python environment.

Finally, the competency questions, initially formulated based on the identified requirements, are translated into formal SPARQL queries. These queries are executed against the transformed data, enabling an evaluation of the extent to which existing ontologies address the identified requirements and revealing any gaps in the current state of semantic representation of Egyptian demons.

4. Formulation of requirements and competency questions

In this section, we will describe the requirements that we have formulated from the literature-driven approach according to the literature on Egyptian demons (a summary of the domain of Egyptian Demonology is already presented in Section 2) and the data-driven approach according to the information of DemonThings. These requirements will guide us in the selection of existing ontologies that could be used to cover this domain, and they will also be used to develop competency questions to test those same ontologies. Although it is generally part of the ontology requirements [19], we will not perform a full evaluation of the usability of the selected ontologies, as they were not developed for domain experts in Egyptology. The domain

[6]BeautifulSoup website and documentation: https://beautiful-soup-4.readthedocs.io/en/latest/
[7]https://github.com/br0ast/egyptianDemonsBenchmarkStudy
[8]RDFlib website and documentation: https://rdflib.readthedocs.io/en/stable/

expert is involved in evaluating the accuracy and granularity of the ontologies when expressing data on Egyptian demons.

4.1. Functional Requirements

We will divide the functional requirements into several areas.

1. **Different types of demons and their role**: The ontology used to describe demons will have to take into consideration the concept of demon from an Egyptian perspective, which includes the different types of demons, namely (i) Guardian Demons and their roles as doorkeepers, heralds, and watchers and (ii) Wanderer Demons. Demons must be connected to their gender, if known. The ontology must connect demons to the funerary events in which they play a role.
2. **Name representation**: Demons must be linked to their names in the ontology. Given the importance of demon names in Egyptology, the ontology will also need to be able to link names with moral attributes and physical characteristics. In addition, names will need to be expressed in different forms, transliterated, and also linked to the hieroglyphs that make up their part. Hieroglyphs will also need to be connected to their original meaning.
3. **Representations of demons**:
    - **Multimodal forms**: The ontology (or ontologies) will need to cover the different forms of demon representation. These forms include textual format, pictorial representations, and multimodal representations that combine images and text.
    - **Textual representation in epithets** The ontology will need to conceptualize the concept of Egyptian epithets, which needs to be linked to both the demons to which they refer and the agencies (of that demon) that they express.
    - **Pictorial representation** The ontology will need to conceptualize the acts of interpretation of the visual representation of the demon, focusing on the recognition of the pose, headgear, costume, gesture, body characteristics (head, upper body, lower body) and the objects held.
        - **Symbolic elements** The ontology will need to cover the symbolic aspects of the represented element, focusing on symbols of the benevolence or malevolence of the demon.
        - **Part classification** The ontology will need to classify the body parts of demons according to their origin between parts derived from animals, humans or hybrid. Depending on the combination of the parts of the body, the ontology must contain axioms that classify the demons themselves as animal, anthropomorphic, human, or hybrid.
4. **Medium context**: The ontology must consider the media in which demon representations appear, including spells, morturary objects, and temple walls. Demons must be linked to the media that contain their representation, either directly or through the representation themselves.

Table 1 summarizes the functional requirements, listing whether they are mentioned in bibliographic sources, contained in the demon database, or both.

4.2. Non-functional Requirements

The ontology must be expressed in a standardized machine-readable format to comply with interoperability measures. Moreover, the ontology must be multilingual, allowing for the definition of terms in ancient Egyptian transliteration. Finally, the ontology must contain axioms to infer the membership of individuals to specific classes.

4.3. Competency question formulation

In this paragraph, we formulate a series of CQs from the requirements. We will use these CQs to test existing ontologies, which deal with (parts of) the topic of Egyptian demons and their characteristics, in Section 7.

CQ1 Which demons are classified as Guardian Demons?

CQ2 Which demons are classified as Wanderer Demons?

CQ3 What are the roles of the Guardian Demons?

CQ4-6 Which demons are male/female/do not have a specified gender?

CQ7 What are the funerary events connected to the demons?

CQ8 What are the names of the demons?

CQ9 What are the transliterations of the names of the demons?

CQ10 What are the hieroglyphs related to the names of the demons?

CQ11 What are the moral attributes of the demons highlighted by their names?

CQ12 What are the physical characteristics of the demons highlighted by their names?

CQ13 Which demons have been represented in a multimodal form?

CQ14 Which demons have been represented only in a textual form?

CQ15 Which agencies of the demons are described in their textual representations?

CQ16.1 What are the body characteristics of the demons recognized in their pictorial representation?

CQ16.2-9 What is/are the poses/gestures/headgear/costume/head characteristics/upper body characteristics/lower body characteristics/held objects of the demons recognized in their pictorial representation?

CQ17 What are the symbolic meanings of the objects held by the demons?

CQ18-20 Which demons have animal/human/hybrid features?

CQ21.1 In what media are demons represented?

CQ21.2-4 Which demons are represented in temple walls/coffins/book of the dead spells?

Table 1: Requirements for the knowledge representation of Egyptian Demons, associated with the sources that mention them

Requirement	**Source**						
	Hammad (2018) [10]	Kousoulis (2011) [5]	Lucarelli (2010a) [4]	Lucarelli (2010b) [11]	Lucarelli (2017) [13]	Szpakowska (2009) [12]	DemonThings
Name	V	V	V	V	V	V	V
Name Function	V	V	V	V	V	V	X
Name Transliteration	V	X	V	V	V	V	X
Name Hieroglyph	V	X	V	V	X	X	X
Demon Type (Guardian and Wanderer)	V	X	V	V	V	V	X
Guardian Demon Roles (doorkeeper, herald, etc.	V	X	X	V	X	X	X
Demon Gender	V	X	V	X	V	V	X
Demon funerary role	V	V	V	V	V	V	X
Epithets representation	V	V	V	V	V	V	X
Pictorial Representation	V	V	V	V	V	V	V
Pose	X	X	X	X	X	X	V
Gesture	X	X	X	X	X	X	V
Headgear	X	X	X	X	X	X	V
Costume	X	X	X	X	X	X	V
Body Characteristics	V	V	V	V	V	V	V
Head Characteristics	X	X	V	V	X	X	V
Upper Body Characteristics	X	X	V	V	X	X	V
Lower Body Characteristics	X	X	V	V	X	X	V
Held Items	V	X	V	V	X	V	V
Symbolism of held items	V	X	V	V	X	V	X
Classification of demons based on body characteristics	V	V	V	V	V	V	X
Medium Context of the representation	V	X	V	V	V	V	V
Medium Context: temple walls	V	X	V	V	V	V	V
Medium Context: spells (i.e., Book of the Dead)	V	X	V	V	V	V	V
Medium Context: Mortuary objects	V	X	V	V	V	V	V

5. Ontology Selection

To the best of our knowledge, there are no ontologies dedicated to the description of Egyptian Demons. Even in general knowledge bases such as Wikidata, there is an extremely limited amount of information about them, and they are not described with custom properties.[9] Because of this, we decided to combine multiple ontologies to cover the requirements to the greatest extent. We searched for the most common ontology repositories such as Linked Open Vocabularies[10] and OntoHub,[11] as well as searching in the most common search engines. We also looked at potential ontology design patterns (ODPs) present in the ODP repository.[12] When possible, we tried to use standard domain ontologies. Finally, we filled up the remaining gaps with our (the authors) personal knowledge.

CIDOC-crm [20] is an ISO standard for the knowledge representation of the cultural heritage domain. Its event-based structure, combined with the possibility to customize entities via type relationships (`crm:P2 has type`), offered a good starting point to describe demons and types of demons, along with their names (via the `crm:E41 Appellation` class) and the relationships linked to names, the events to which demons participate, and also the information medium (`crm:E73 Information Object` in CIDOC) connected to the representations of demons. The class `crm:E77 Persistent Item` was chosen to represent demons, as this class includes entities that possess enduring structural attributes closely tied to their identity and wholeness. Persistent items can be tangible entities such as humans, animals, or objects, as well as abstract entities like ideas, concepts, imaginative creations, or names [20]. Moreover, information objects are linked to persistent items via the `crm:P67 refers to` property, which can be used to link the information media to the demons. We also added the possibility to describe the information medium or its written content via the Dublin Core property *description* (`dc:description`). For the Demons' names, we adopt the ConceptTerm [21] design pattern, which can be used to express different linguistic variations of a name. We also adopt the SKOS vocabulary [22] to link names with moral and physical characteristics (expressed as concepts). We define the gender of demons via the Appearances Ontology [23].[13] For what concerns the interpretation of pictorial representations, we adopt the ICON ontology [24, 25] that conceptualizes artistic interpretations. Because ICON is based on a European perspective on art (following Panofski's approach [26]), we will have a critical look into how this perspective can be applied to the iconography of Egyptian demons. In particular, we aim to use the recognition of *compositions* (`icon:Composition`) to express how the single physical characteristics of the demons are grouped together and are used as a reference for the iconographical recognition (`icon:IconographicalRecognition`) of the demon itself. To express the symbolism of the items of the demons, we reuse the Simulation Ontology (compatible with ICON) [27]. With the `sim:Simulation` class from this ontology, it is possible to express symbolism via reification, which allows adding contextual information about the context (`sim:Context`) in which a symbol (`sim:Simulacrum`) symbolizes a specific

[9] The query to extract potential Egyptian demons in Wikidata is available here: https://qlever.cs.uni-freiburg.de/wikidata/8cXENp. As of April 2024, it retrieves only 2 demons.
[10] https://lov.linkeddata.es/dataset/lov/
[11] https://ontohub.org/repositories
[12] http://ontologydesignpatterns.org/
[13] We are aware that this ontology was mainly created for people, and we discuss about this in Section 7

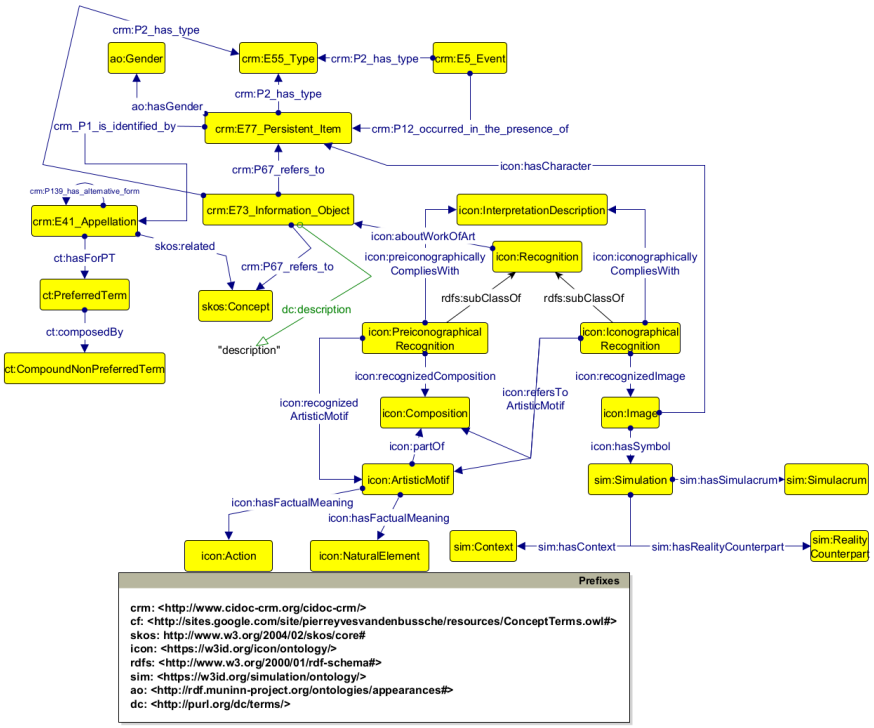


Figure 1: Selection of classes and properties from existing ontologies to describe Egyptian demons

concept (`sim:RealityCounterpart`). Figure 1 shows all the classes and properties that we reused to represent knowledge about Egyptian demons. Although it may be relevant to our domain, we do not reuse the Imaginary Beings Ontology (IBO) [28] as we could not retrieve the OWL source file.

6. Generation of the Data

As mentioned in Section 4, not all the requirements information is present in DemonThings. For the information that is there, we manually created a mapping between the fields of the database and the structure of the selected ontologies. We reused information from other fields to cover some of the missing requirements. Specifically, the field *Coffin Text Spell Number* was used to identify guardian demons, as they are usually referenced in the Coffin Spell 1135 [4, 11]. All the other demons were labeled as wanderers. As for the gender of the demons, all the demons who had the strings “She of”, “She who” in the *Name* and *Description* fields were labeled as females, the ones who had “He of”, “He who” as male and the ones with “They of”, “They who” as undefined gender. To isolate potential characteristics from the names, the remaining parts of the strings “he/she/they of” were caught and turned into concepts, linked to the demons using SKOS. Despite these additions, some information was still missing from DemonThings, namely the roles of guardian demons (CQ3), the funerary events connected to the demons

(CQ7), hyeroglyphs (CQ10), the symbolic meanings of their objects (CQ17), a way to define animal, human, or hybrid features (CQ 18-20). In order to test this missing information, three (completely invented) additional demons were manually added to the test dataset. We highlight that **the purpose of creating this test dataset in LOD is purely to test the competency questions and to check whether the requested information is retrievable or not**. All the decisions that we have taken to add missing information are purely arbitrary and approximative (i.e., there might be more guardian demons than the ones added via the Coffin Spells). The construction of an accurate knowledge graph about Egyptian demons will be the objective of future work. All scripts used to generate the dataset are available on GitHub.[14]

7. Evaluation

After creating the data, we evaluated the current ontologies by turning the CQs into SPARQL queries and then querying the dataset with them.[15] First, we evaluated whether we were able to retrieve exactly what is meant by the requirements. Second, we look (with the aid of a domain expert[16]) at at the terms used by the ontologies to connect the information in the results, evaluating whether they are able to catch the complexity of the domain and express every statement with the correct granularity. Therefore, for each CQ, we have a (i) SPARQL version, (ii) an evaluation on the correctness of the retrieval, and (iii) an evaluation on the expressivity of the chosen ontologies when mapping Egyptian demon information with them. Figure 2 shows an example of CQs 1,7, and 16 formalized in SPARQL. The rest of the CQs along with their testing are available on GitHub. We provide the results of all the CQs grouped according to the results of the evaluations.

CQ4,5,6,8,17 Correct and specific. For these CQs, the retrieved results are correct, and the domain expert also evaluated them as complete. The gender of the demons, the general links to the names, and the symbolism are expressed with the correct granularity. We have to highlight that, although the domain expert did not express any concern about the use of the appearances ontology, the domain of the property `hasGender` is `Human`, which makes the reuse of this ontology in a future ontology dedicated to Demon description problematic. Another general note is that the use of *Persistent Item* form demons is still quite generic, and demons should have their own class perhaps as a subclass of the CIDOC class.

CQ1,2,7,10,13,14,18,19,20,21 Correct but not specific. This is the most common category. CQ1 and 2 are related to the type of demon (Guardian or Wanderer), which is only specified by a *type* relationship in CIDOC. For all the elements expressed merely by a *type* relationship, the domain expert expressed the need to have more specific relationships or classes. The same applies for CQ7 (funerary events expressed only with events),

[14] https://github.com/br0ast/egyptianDemonsBenchmarkStudy

[15] This process is also defined by the literature as the shift from informal to formal CQ [29]

[16] We decided to only have one domain expert because of the difficulty in finding scholars who specialize in this domain. The intervention of the domain expert was (i) to check the terminology (names and meanings of the classes and properties) of the combined ontologies, and (ii) to assess whether it was expressive enough for the domain of Egyptology

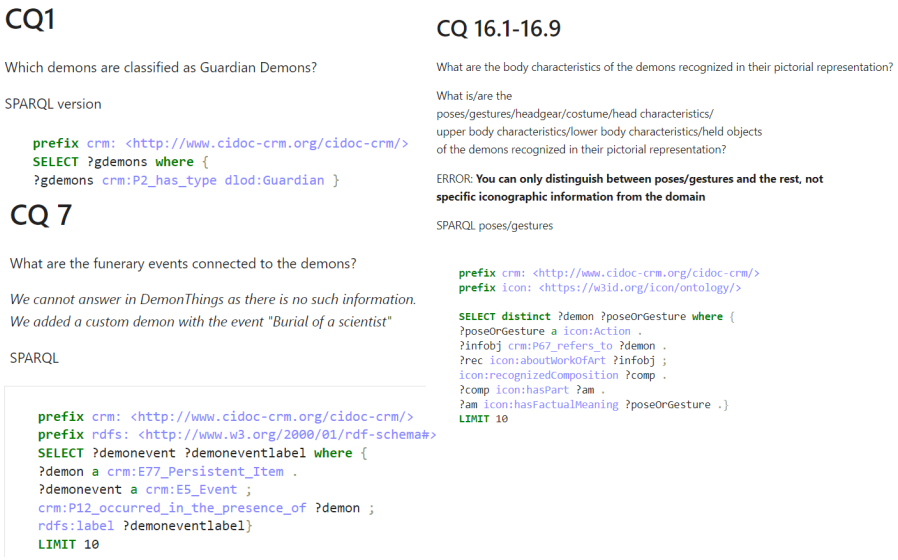


Figure 2: Example of the formalization in SPARQL of CQ1, CQ7, CQ16

hieroglyphs being names with type Hieroglyph, CQ18,19,20 being the animal, human and hybrid characteristics expressed by *type*, and CQ13, 14, and 21 for the types of media. The importance of organizing the types of media and the types of demons in hierarchies, whether from controlled vocabularies or ontologies, was highlighted many times by the domain expert.

CQ3,9,11,12,15,16.1-9 Wrong and not speficic. The query formulated for CQ3 was supposed to retrieve the specific roles of guardian demons. Because these roles and the animal-human-hybrid characteristics of the demons are both expressed with *type* relationships, the results are a mix between these roles and the mentioned characteristics. CQ9 cannot be answered as there is no model that covers the Egyptian transliterations of names. CQ11 and CQ12, as the SKOS taxonomy does not provide classes for domain specific concepts, gives mixed results for the SPARQL queries. CQ15 gives wrong results as the agencies of the demons are not fully modelled by classes and also the use of a general *description* mixed the epithets information with comments from annotators of the dataset. CQ16.1-9 were wrong because applying the ICON ontology (created following eurocentric artistic theories) to the Egyptian iconography revealed limitations in expressing the systematic and precise division of an Egyptian iconographical interpretation (dividing the body in three parts and giving specific recognition to each body part). Therefore, all the results of the body characteristics were mixed together and could not be retrieved individually.

8. Discussion

What emerges from the evaluation is that existing ontologies can only partially cover the domain of Egyptian demons. In fact, not all competency questions returned a correct result.

Additionally, a domain expert highlighted the general nature of the ontologies, which do not properly describe i) the systematic iconographic representations of demons (by different body parts characteristics), highlighting the difference between the European and the ancient Egyptian perspective in terms of iconography; ii) the weak *type* relationships, which should be specialized whether they are referring to the type of information medium, the general role of the demon (Guardian, Wanderer), and their specific roles (Herald, Doorkeper, Watcher for some of the Guardian demons), and also their classification (as animal, hybrid, human); iii) the weak concept relationships, which do not fully distinguish between concept that refers to morality or physicality. A possible solution, while keeping the type relationships, would be to build a controlled vocabulary on the domain of Egytpian Demons. However, this has the disadvantage that it would not be possible to fully exploit ontological structures and their logical back-end. Developing a new ontology to cover these gaps would make inferences possible (using OWL classes restrictions), which could be extremely useful, especially in determining specific characteristics of demons. For instance, it could be inferred that a demon that shows animal characteristics in its head and human characteristics in its body is a demon with a *hybrid appearance*. We also highlight that inference capabilities were considered a non-functional requirement in Section 4. The lack of an accurate expression of iconographic interpretations is due to applying a eurocentric approach to the description of demons. In fact, the ICON ontology is designed following the theory of Panofski [26], who focused on European artworks from the Renaissance period. While in ICON it is possible to provide interpretations of the elements depicted in artworks and combine different elements together in *compositions*, this work demonstrates that both on a theoretical and technological level, Egyptian iconography requires a stricter approach (as mentioned in Section 7). The more general classes and properties of the ontologies used in this work could still be aligned with the new ontology in future work, ensuring interoperability.

9. Conclusion and future work

In this work, given the lack of an established standard to describe Egyptian demons, we took the first step towards a semantic representation of this sub domain of Egyptology. The results show how, using current ontologies, we were able to answer correctly 15 requirements out of 21 formulated from (i) selected literature and (ii) the content and structure of a database about this domain. However, we highlight that the general nature of the current ontologies is still not enough to properly describe this complex domain, and that a specialized ontology is needed in order to represent all the characteristics of demons and facilitate their retrieval. Therefore, future work will be dedicated to the development of an ontology based on the requirements established in this work. This ontology will also be developed considering potential users and use cases, the identification of which will also be part of future work. In addition, there is an ongoing project aimed at digitizing the Book of the Dead, using 3D scanning to create a digital twin of it [9], which highlights the interest of digital archaeology and digital humanities in Egyptology.[17] This work can be the foundation for a future integration between Semantic Web technologies and the Book of the Dead, giving a LOD shape, after developing the ontology, to

[17] https://3dcoffins.berkeley.edu

the descriptions of the demons contained in the book and beyond.

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