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Illumination3.0: A Semantic Annotation Platform Based on Ontology for Medieval Illuminations

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Résumé

Les enluminures médiévales sont très riches en contenu sémantique illustré par des ornements, objets symboliques et animaux fantastiques, qui sont reliés par des relations sémantiques contextuelles et cela complique souvent leur compréhension. Dans ce papier, nous proposons un système d'annotation de ces images médiévales afin d'aider à leur compréhension par le plus grand nombre de personnes. Il est basé sur des modèles de représentation de connaissance (ontologie) et des techniques de l'intelligence artificielle.

Mots Clef

Ontologie, Enluminure médiévale, Système d'annotation, Raisonnement.

Abstract

Medieval illuminations are very rich in semantic content illustrated by ornaments, symbolic objects, fantastic animals and decorative initials, linked each to others with contextual semantic relations that make them difficult to understand. In this contribution, we propose an annotation's platform for those medieval images in order to help in highlighting their public understanding by the means of a knowledge representation model (ontology) and artificial intelligence techniques.

Keywords

Ontology, Medieval illumination, Annotation system, Knowledge inference.

1 Introduction

The development and generalization of the Internet increase the presence of cultural heritage collections on the Web through the digital online version of institutions such as the museum, archives, and libraries which manage them in real life. Those institutions should adapt by progressively integrating functions and technologies of the Web in order to move from a simple exhibition of digital representation of the collections to a semantic description of them through their semantic annotation.

An annotation consists to categorize the components within a corpus and identify relations between specific components [1, 9]. It can be applied on a textual corpus [1] in the identification of named entities [4], for example, or on images in order to link them and make easier their retrieval from repositories (the Web or bounded databases) as in [6, 11]. In this contribution, we present a semantic annotation's platform of an item of those cultural heritage collections: *medieval illuminations*.

Medieval illuminations (see an example in fig. 1) are images which were painted on parchment in the medieval manuscripts in the Middle Age [3, 2]. Those images contain semantic elements richly decorated with ornaments, illustrations, fantastic animals, and decorative initials making their layout complex and their semantic meaning difficult to understand. To overcome those understanding problems, a semantic annotation could be very helpful, but it raises another problem which is the full requirement of an expert for that annotation since these picture's contents are difficult to understand. In this paper, we propose an ontology based semantic annotation's system in order to help the experts and enable the not experts to annotate illuminations following the ontology's terms in opposition of most of the systems developed for cultural images' annotation such as the one described in [5] or the one in [10].

One can see in our platform a restriction of the annotators who should follow our proposed semantic ontology's lexicons in the annotation's process, but this limitation has the advantage of avoiding the use of other lexicons unrelated to our images. However, the ontology can be dynamically extended by adding new concepts and relations with the respect of the expert's advice. Moreover, our ontology contains inference's rules (logical axioms which enable to infer new statements from a set of declared statements within an ontology) which could help toward a semi-automatic objects recognition within an illumination through the use of

deep learning's algorithms.
In the rest of this paper, section 2 describes our built domain ontology (see section 2.2), the web application (see section 2.4) in implementation and an API[1](Application Programming Interface) which intermediates them (see section 2.3). And section 3 concludes and outlines our future works.

Figure 1: Medieval Illuminations illustrating donations scenes of luxurious illuminated manuscripts to the Burgundy Duke, Philippe the Good. *Brussels, Royal Library of Belgium, ms. 9243, folio 185 verso, Chronicles of Hainaut by Jean Wauquelin, 1446*

2 The System Illumination3.0

This section presents our semantic ontology based annotation's platform which contains three main components: the ontology, API, and Web application. We describe them in an architectural organization in the subsections below.

2.1 Architecture of the System

The three components of *Illumination3.0* are structured in an architectural view as shown in fig. 2. It illustrates four steps for our platform's realization. The first (black dashed rectangle, *step 1*) indicates the ontology's creation. The second (yellow dashed rectangle, *step 2*) and third (red dashed rectangle, *step 3*) indicate the communications of the API with the ontology by a side and with the Web application by the other. And the fourth (green dashed rectangle, *step 4*) indicates the effective annotation's process of illuminations within the Web application.

2.2 The Ontology

The first component of *Illumination3.0* is a formal ontology (see fig. 3) which semantically describes the illuminations' contents. An ontology is a formal and explicit knowledge representation model [7]. We named the one

[1]API is the acronym for Application Programming Interface, which is an intermediate software that allows two applications (or modules of an application) to talk each to other.

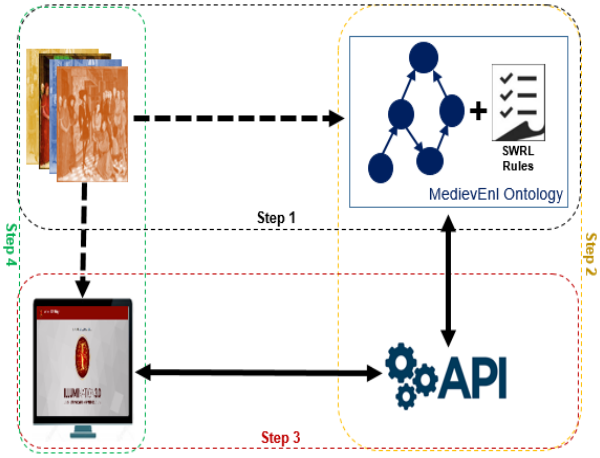

Figure 2: The architecture of illumination3.0

we create for our medieval illuminations (those of the Burgundy duke) by *MedievEnl*. We create it by analyzing some of those illuminations, extracting their contents by the help of an expert, and organizing them with ontological terms (classes, relations, individuals and axioms). Beyond a simple terminological organization, our ontology contains inference's rules which enable to reason about its contents. These rules are expressed in SWRL[2] language. They improve the expressivity power of the built ontology. The space of this paper is bounded for our ontology's full detail (for more specification about its components, see `http://medievenl.ontology.checksem.fr`). An ongoing article is submitted about it.

2.3 The Application Programming Interface (API)

The second component is an API (see an interface in fig. 4) which enables to manage the ontology. It is a combination an OWL API[3] and a Pellet reasoner[4]. The former enables to explore the ontology's components and extend the ontology by adding new concepts or individuals. And the latter enables to reason about the ontology, through its contained inference's rules, in order to infer new knowledge from the explicitly described ones. The choice of Pellet reasoner is because of its simplicity and free availability, but all other reasoner would be suitable.

2.4 The web application for annotation

The third component is a Web application whose an interface is shown in fig. 5. It is linked to the API in order to get knowledge from and put them into the ontology. Con-

[2]SWRL, for Semantic Web Rules Language, is an inference's rules construction's language based on the logic of predicates (see [8])

[3]The OWL API is a Java API and reference implementation for creating, manipulating and serializing OWL ontologies. OWL (Ontology Web Language) is an ontology development language. It is a recommendation of 3WC (World Wide Web Consortium)

[4]Pellet reasoner is an open source Java based OWL 2 reasoner. It can be used in conjunction with both other reasoners and OWL API libraries.

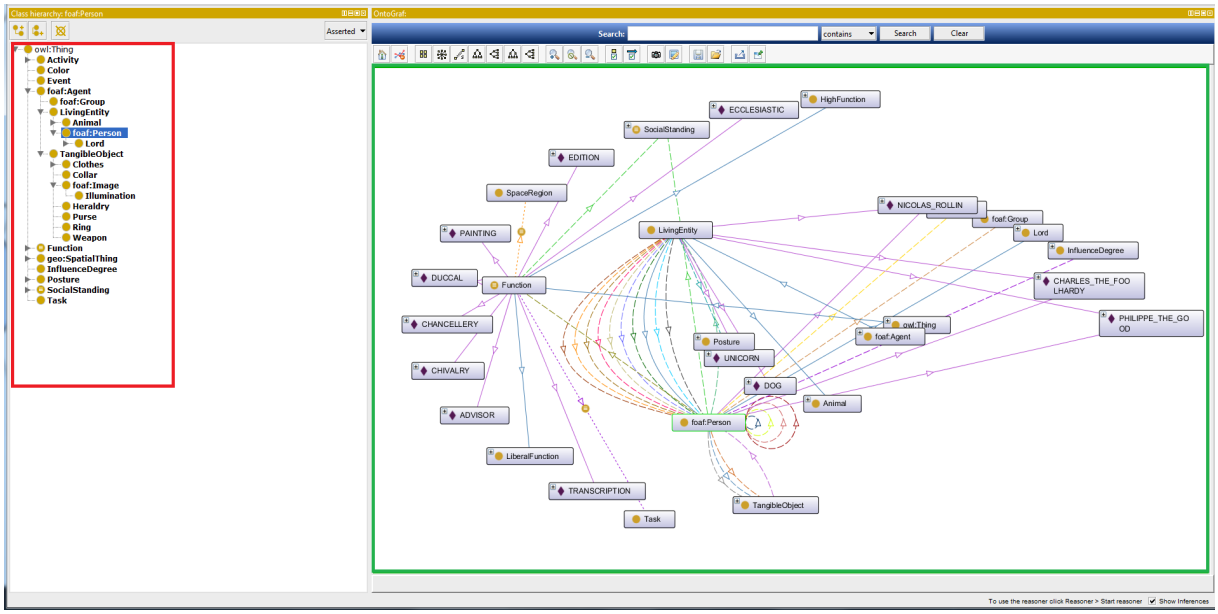

Figure 3: A view of our ontology. The red frame, in the left, shows a view of its concepts and the green one, in the right, shows a graphical visualization of some of them.

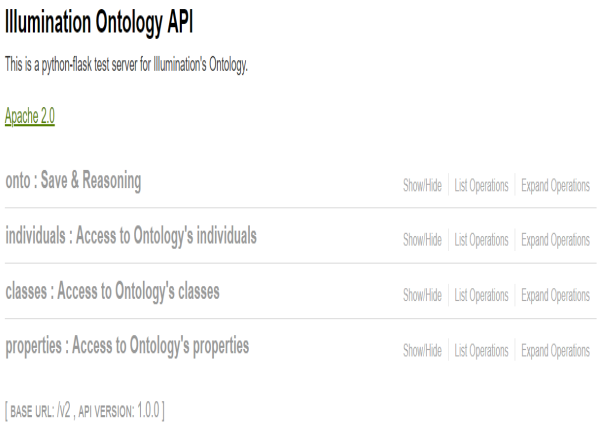

Figure 4: The API (Application Programming Interface) of *Illumination3.0*

cretely, it allows to upload an illumination, frame its important elements, annotate each of them as an individual of a concept in the ontology and connect those individuals with relations following the ones which exist in the ontology. For example, if a concept A is linked to B with a relation r in the ontology and a user annotates in an uploaded illumination an element a_1 as an individual of A and b_1 as an individual of B then s/he can link a_1 and b_1 par r.

If a concept or relation does not exist in the ontology then the user can add it to the terminological box (TBox) of the ontology, but these features are restricted to experts in order to add only consistent concepts and relations. Therefore, the annotation's process enables to populate the ontology by filling its assertional box (ABox) and extend it by adding new classes and relations to its Tbox.

Fig. 5 shows an interface in which one can see an illumination uploaded in the left half. Some entities in the image are framed with contoured rectangle. In the right half, some relations are indicated between those entities. We can see for example :

- **Individual annotated**: `Philippe le Bon` who is individual of concept `Person` in the ontology, `Chaise` which is individual of the concept `TangibleObject`, etc.
- **related individuals**: `Philippe le Bon|assis sur|Chaise` to state the relation `assoir` between the individuals `Philippe le Bon` and `Chaise`; `Wauquelin|offre|Manuscript` to state the relation `offrir` between `Wauquelin` and `Manuscript`; etc.

3 Conclusion and Perspectives

In this contribution, we describe an ontology based annotation's platform for medieval illuminations. It is a computerized system of an ongoing thesis project. We present the general architecture of the platform and detail its components which are a semantic ontology for the illuminations, an API for this ontology's easy management by a web application which completes the architecture. This latter component enables to annotated images following the ontology's terms and the API's reasoner allows to infer new knowledge from annotated entities.

As future works, we are implementing some features which take into account that reasoning process in the web appli-

Figure 5: An annotated illumination in our platform (`http://illumination2.checksem.fr/illumination/app/accueil`)

cation. Moreover, we are working on a deep learning algorithm in order to help in the recognition of an illumination content based on our ontology.

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