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Abstract
This work applies knowledge engineering's techniques to medieval illuminations. In this article, an illumination is considered as a graph of knowledge which was used by elites in the Middle Ages to represent themselves as a social group and to exhibit their cultural models and the events in their lives. In order to achieve this, combination of symbolic elements were used to encode influential messages more or less implicitly. Our work aims to identify the meaning of these elements through a logical model using ontologies. The idea is to identify logical reasoning rules and simulate them using artificial intelligence mechanisms. The goal is to facilitate the interpretation of illuminations and provide a logical formalisation of new encoding and information transmission services in the future evolutions of current social media.

Keywords
Symbolic relation; Medieval illumination; Semantic relation; Ontology; Social network

I INTRODUCTION

Knowledge engineering aims to formalise human knowledge so that it can be manipulated by computerised systems. In this paper, its techniques are used to characterise and formalise symbolic relations (social norms) between concepts in medieval illuminations. These illuminations are images that were designed and used by elites in the Middle Ages to represent themselves as a social group and to exhibit their cultural models and the events in their lives. They constitute an information system based on symbolic relations with meanings and messages that are determined in a particular and changing context. The components (concepts, symbolic relations and messages) of an illumination constitute a part of its knowledge. The other part is the interpretation associated to the first part. Therefore, the medieval illuminations can be represented by knowledge graphs. The strong correlation between the medieval illuminations and current social media is explained by the processes through which the illuminations served as a visual support for the social communication. Although the power of images is to illustrate scenes, they also aim to act on the cognitive perceptions of users and therefore on their behavior. The medieval illuminations used in our work refer to those related to the court of Burgundy Duke (cf 2.1), Philippe The Good[1]. They were made for the Duke, with the goal to influence his social network: families, knights, allies, enemies, other European princes, competitors, etc. This influence was shown during the expositions and was also reinforced by the copies of these illuminations that other persons made. These medieval illuminations could be considered as a first

[1]Philippe The Good (1419-1467) is the most famous of Burgundy Dukes and one of the most powerful European princes at the Hundred Years War's time (1337-1453).

social media and can enrich the structure of current and future social media.

The main issue we faced is the abundance of symbolic relations and implicit messages strewed in the medieval illuminations. To highlight the meaning of these relations, the illuminations components must be specified and formalised properly. Another problem we also faced is the strong correlation between these components. These correlations lead to new knowledge which can be inferred from the explicitly formalised ones.

1.1 Research objectives

We seek to formaly describe the knowledge contained in medieval illuminations, to identify the meaning of its symbolic elements and semantic relations through a logical modeling using ontologies. To achieve this, we develop computerised tools and we build an ontology which captures the meaning of illuminations single components and their relations. Beyond a simple taxonomic modeling, we could constrain the illumination's ontology to make it more expressive through the combination of single components. The level of expressiveness reached is equivalent to the SHOIN(D) language (cf 4.1) in description logics. This allows us to build reasoning rules and to use a triplestore[2] inference engine. Then our computarised system could be able to reason on graph's elements which describe the illuminations and to discover new implicit knowledge using the formalised reasoning rules.

The digitalisation of cultural heritage data is an active research field. It has especially increased with the proliferation of digital museums on Internet. In our work, the combination of the data extracted from medieval illuminations, knowledge engineering's techniques and social networks is a main contribution for this digitalisation. The data we analyse are structured as knowledge graph as the structure of current social media. So the comparison of the two structures could allow to enhance the current social media's one (*e.g the structural representation of users in order to improve privacy and make a user's social influence estimation more qualitative*). The use of knowledge engineering's techniques on these data through their representation, storage, easy interpretation, combination with other data and their reuse by computarised system is very helpful for the performances of professionals in the cultural heritage.

1.2 Organisation of the document

In the following sections, we will firstly present our vision on social media and show the correlation between medieval illuminations and social media. Subsequently, an historical context and principle of design of illuminations will be detailed before the presentation of some backgrounds of our study. In further step, an ontology modeling of illumination with some examples of formalised symbolic relations will be showed. And we will present an interface of our computarised system's prototype for the annotation of illuminations. Lastly, we will conclude and give some future work perspectives.

II SOCIAL NETWORK AND MEDIEVAL ILLUMINATIONS

Social networks are the subject of many academic and industrial research projects. These projects deal with different aspects of social networks: social relations analysis [Raad, 2011], sentiment analysis on social network [Martínez-Cámara et al., 2014], implicit communities discovery in social networks [Leprovost et al., 2012], profiles extraction in a social network

[2]A triplestore is a database especially designed for storing and retrieving RDF data (Resource Description Framework, a knowledge representation format in the form of a triplet (subject, predicate, object)). Like a relational database, it stores data and retrieves them through a query language

[Ramiandrisoa and Mothe, 2017], information's dissemination on social networks [Bakshy et al., 2012], etc.

All of these studies required a large and diversified set of information in differents contexts where the notion of social network refers to any relationship involving regular social interactions between individuals, organisations, companies, regions, countries, etc. These relationships are based on acquittances, collaboration, collegiality, friendship and other. They can be direct relationships (an entity A has a direct relationship with the entity B, $A \rightarrow B$) or indirect ($A \rightarrow B \rightarrow ... \rightarrow X$, so $A \rightarrow X$); symmetric relationships ($A \rightarrow B$ implies $B \rightarrow A$) or asymmetric relationships ($A \rightarrow B$ does not involve $B \rightarrow A$). Regardless of the type, every social network is maintained by the sharing of resources which can be material (money, livestock, food, equipment, weapons) or not (information, strategies, decisions, mood, activities). The more the reactions of members on the shared resources are high in the network, the more important it becomes. This sharing of resources is one of the fundamental characteristic of every social network whether it is represented by a virtual community: website on the internet such as Facebook[3], LinkedIn[4], Viadeo[5], Twitter[6]; or by a real life community. In the case of virtual community it is called **social media**.

To sum up, a social media is a set of representations (avatars) of individuals or moral people that share texts, images, documents, videos or other media in a computerised platform and who are encouraged to interact each with other publicly or in private using the disseminated information. The majority of the current social media are structured around the self-valuation of users through their avatars.

2.1 Illumination: definition and principles of design

This representation of the "me" and "my" environment is known in the human history. Rock paintings illustrated a vision which was published through a horizontal support, writing and drawing (as opposite to oral dissemination, called vertical). In the Middle Ages, to communicate with the educated class in the society, the illuminations were developed in books. An illumination is a fixed painting made on a manuscript parchment's sheets (usually tanned animal leather). It is a codified representation to value the sponsor's personality. This codification can easily be represented as a graph that describes semantic and symbolic relations between its components. This graph also expresses concepts and conveys explicit and implicit messages. It is structured using topology (positioning relations), hierarchy, semantic (for example meronymy) and metaphorical relations (for example, an animal representation to express a human moral value).

A metaphor is an important rhetorical process since antiquity. A medieval definition of metaphor is *the replacement of the true significance of something by an imaginary term, responding to an implicit comparison* [Pernot, 1993]. It is created using four methods: from the animate to the inanimate, from the inanimate to the inanimate, from the animate to the animate and from the inanimate to the animate. Metaphorical relations are very common in the illuminations we study: the illuminations of the Burgundy Duke's court.

The court of the Duke was an aristocratic micro-society composed of a set of entities including the Duke himself, the Count (his eldest son), the Duchess, their wide family, the ecclesiastics

[3] www.facebook.com
[4] www.linkedin.com
[5] www.viadeo.com
[6] https://twitter.com

(bishop, clerics), the advisors, the knights. Its territory was vast from the south of actual Burgundy to Amsterdam partially made of rural areas but also urban areas (Brussels, Bruges, Ghent, Dijon, Lille, etc.). Different social groups in the network of the court (bankers, shopkeepers, academics, townspeople, etc.) operated in more or less wide networks. The illumination on figure 1 is an example of networks. It is composed of the Duke, his son the Count, his advisors and the knights. Together they formed the closest social network symbolised by the Golden Fleece collar.

In illuminations, some objects, characters or images as a whole are also considered as a sign (sometimes stronger than metaphor or working through metaphor). They are always made in artistic, religious or profane context. An illumination is part of a communication channel from the sponsor (the Duke for example), the author (illuminator) or the copyist of the book to the target (the Duke, a noble of his court, a politician, a king/queen or an important figure in a European court). It represents themes corresponding to the sponsor/recipient, his social level, his cultural settings, his family or his society in the past, the present, the future (after death). Then it aims to give an ideological representation of the sponsor. Implicitly, it serves to convey ideas or to idealise relationships, chivalrous and religious values. Explicitly, it illustrated scenes of life in the court such as banquets, weddings, balls, etc. The scenes it describes and their meanings are not unique and change with the context. In the design process, these scenes were selected by a writer (the illuminator, the person who paints the images) according to the recipient's choices and drawn as images. These images served as information to be disseminated about the Duke and the activities in the court and to be published during political events such as the luxurious manuscripts donation to the Duke (scene described in the illumination depicted in figure 1), a banquet or a large knight's assembly.

Figure 1: An illumination, it presents a scene of a luxurious manuscript's donation to the Burgundy Duke Philippe The Good. *Brussels, Royal Library of Belgium, ms. 9243, folio 185 verso, Chronicles of Hainaut by Jean Wauquelin, 1446*

2.2 Correspondence between illuminations and social media

From these virtues and uses, an illuminated book is as a social media as Twitter or LinkedIn in terms of communication and resource sharing tool. However, an illumination in itself can be assimilated to an animation or upkeep resource of a social network (the Duke's social network) insofar as it tells and shares a history with the network members. The goal is then to show the Duke's influence and to convey it. Some signs of this influence could be seen through some relations in the illumination such as:

- the allegiance of the court to the Duke: the advisors, the illuminator, the Count, the knights (except for the green one), the greyhound are faithful to the Duke. In the same way, the advisors stand behind the Duke and the writer knelt down facing the Duke;
- the wealth of the Duke through the purses he wears and his outfit;
- the power of the Duke: he holds a command stick.

III RELATED WORKS

In general, the use of ontologies for the representation of knowledge graphs is not new and several studies treated it. Especially for social networks which are knowledge graph composed of entities linked by social ties, a famous ontology has been modeled: the FOAF[7] ontology. The authors designed this famous ontology after a deep analysis of social network platforms. They gathered and reviewed information from activities, events, documents (images, videos, etc.) that users post on these platforms. By understanding how the users were organised and how they interact each with other through the posts, the authors built the FOAF ontology which is used like dataset that represent social networks platforms. The FOAF's specification is detailed in [Brickley and Miller, 2007]. FOAF has been used by many authors who seeked to treat some issues in these platforms such us trust in recommendation systems [Golbeck et al., 2006], [Sherchan et al., 2013], security [Kruk, 2004], etc. These authors modified the FOAF ontology to include an initial trust scale in the relationship between entities. In our work, we used FOAF ontology to show the similarity between illuminations and the social media and to extend our modelling ontology of illuminations in order to be more exact in our specification.

In regards to the description of medieval images and cultural heritage in general, [Dörr, 2002] proposes an ontology (Cultural Images and Documents object-oriented Conceptual Reference Model, CIDOC-CRM) that models information on cultural heritage. It describes the concepts and relationships underlying the structures of the documents and images used in the domain of cultural heritage. According to the website[8] dedicated to CIDOC-CRM, it contains 90 concepts and more than 140 properties both organised in subsumption relation. The model provides the level of details and precision necessary for museum professionals to perform their work well. It is very common, because it covers every single document used in the field of cultural heritage and it has a high contribution in the digitalisation of this field's data. The ontology we propose here also contributes to the digitalisation of the cultural heritage's data but it is specific to the illuminations of Burgundy Dukes. Many other works on historical images (museums, archives, etc.) use the CIDOC-CRM in order to extend their ontology through mapping.

The [Doerr et al., 2006] extended the CRM by combining it with another ontology that describes the digital library. This promoted knowledge integration. Our ontology also can be extended to other models (e.g FOAF). The [Damova and Dannélls, 2011] proposed an infrastruture to allow the easy extension of the domain specific data and convenient querying of multiple datasets. The approach is based on a model of schema level and an instance level alignment. This infrastructure combines several ontologies such as PROTON[9] and CIDOC-CRM. The resulting ontology is applied on real data from the Gothenburg City Museum in order to handle querries on multiple datasets in the way of open linked data (LOD). Our ontology could be used in the

[7] FOAF, Friend of A Friend is a popular ontology that describes the social relations between entities as well as the interests of these entities in a social network

[8] http://www.cidoc-crm.org/get-last-official-release

[9] PROTON is an upper-level ontology, 542 entity classes and 183 properties. http://proton.semanticweb.org/

same way. We linked it to other ontologies, for example FOAF, the Event ontology[10] and it could be a dataset on illuminations of the Burgundy's Duke.

Information Extraction aims to retrieve some types of information from natural language text or images by processing them automatically [Wimalasuriya and Dou, 2010] or semi-automatically. For example, an information extraction system might retrieve information about art works made by an artist, from a database while ignoring other types of information. Ontology-based information extraction has recently emerged as a subfield of information extraction. In this case, ontologies play a crucial role in the extraction process [Wimalasuriya and Dou, 2010]. The proliferation of resources sharing services on Internet increased the need of images retrieval from web pages or other repositories. A main goal in image retrieval is the finding of images based on their semantic content, for example their topic or contents (objects, persons, etc.). There are two major image retrieval paradigms that attempt to capture this goal: text-based metadata image retrieval and content-based image retrieval (CBIR) [Manzoor et al., 2012]. According to the goal mentioned above, CBIR is the most used and is based on ontologies for the easy description of image's contents and the simple calculation of their similarity. This similarity allow a user to find exact and related results in images extraction process according to the contents. CBIR approach is used in [Manzoor et al., 2012] to propose a system through which an end-users will find relevant images when facing a repository of images whose content is complicated and partially unknown to them. In order to achieve this, the authors provide semantic annotation of all images stored in the repository following an ontology built for that purpose. CBIR is also a trend in annotation of images within social media like applied by [Ghosh and Bandyopadhyay, 2017] for the semantic annotation of images within a social media in order to facilitate their retrieval, semantically combination and their reuse by computarised systems. The ontology we built could be used as support for images (illuminations) semantic annotation, in order to have precise illuminations according to their content from a repository. In this way, our approche fits together in ontology-based information extraction.

Cultural heritage data are considered syntactically and semantically very heterogeneous, multi-languages, semantically very rich and highly connected because they are produced by different entities (museums, archives, archaeological digs, etc.). The [Hyvönen, 2012] gives an insight about when, why and how to use Semantic Web technologies in practice to publish cultural heritage knowledge on the Web. He mentioned most of the formalisms we used in our work. The main reasons that motivate us in this study are: the sharing of the knowledge extracted from illuminations, their interoperability and possible integration in other similar knowledge and the provision of a valid model which could be use in computerised systems used to manage such cultural heritage data.

Moreover, the particularity of the ontology we built is its frequent evolution. We can integrate concepts from other illuminations in order to have a great dataset about illuminations. The system that accompains the ontology helps a lot in this integration process. The system actually allows the user to load an illumination and to extract its components, by manual delimitation through some features. That is the first step of building the ontology. The system must also allow the automatic integration of new concepts from the new loaded illumination in the already built ontology, if it does not contain them yet.

[10] http://motools.sourceforge.net/event/event.html. Event ontology is centered around the notion of event, seen here as the way cognitive agents classify arbitrary time/space regions.

IV SEMANTIC FORMALISATION OF ILLUMINATIONS

This section is dedicated to our semantic formalisation of illuminations. A brief description of the concepts and used terms is given as well as some results we found.

4.1 Ontological modeling of an illumination and the light on the terms and formalisms used

Etymologically related to the theory of the existing, the term "ontology" has many definitions in the literature because it is applicable to many fields such as philosophy, information sciences, linguistics, knowledge engineering, artificial intelligence, etc. In our project we used the definition in [Studer et al., 1998]: *"An ontology is an explicit and formal specification of a shared conceptualisation"*.

An ontology represents a formal conceptualisation of a domain[Gruber, 1993]. In this case, a domain refers to the environment we describe. An ontology includes a hierarchical organisation of the relevant concepts in the domain, the relations between these concepts as well as rules and axioms that constrain their operations. The knowledge of a domain is formalised in an ontology using five main components which are:

- concepts: also called classes, they correspond to the relevant abstractions of the domain retained following the finals objectives and applications of the ontology. A concept's name begins with capital character;
- relations: are relevant associations between concepts. They can be hierarchical (generalisation (Up-Down)/specialisation (Down-Up), aggregation/composition, instance of), associative, equivalent (synonym, homonym, antonym, etc.);
- axioms: are assertions accepted as true about the domain abstractions. They constrain the operations of the concepts and allow to infer new knowledge from the described one in the domain;
- instances: constitute the ontology extensional's definition. These objects convey the static or factual knowledge of the domain.

For the illumination in figure 1, examples of ontological components are: for the concepts (*Duke, Book, Greyhound, Knight, Activity, Person, Animal*); for the relations of generalisation (*Duke is a Person, Greyhound is an Animal*); for the relations of aggregation (*a Project is composed of Activities*); for the relaton of synonymy (*Prince is synonymous with TheCount*); for the associatives relations (*Writer offers the Book, the Book is offered to the Duke*); for the instances of concept (*banquet, game, hunting, falconry* are instances of activity). The ontological representation of a domain must banish any semantic ambiguity. It provides then an uniform and reusable knowledge support to the community of users for an effecient sharing and communication.

In our work this constraint is ensured by the use of a formal language: the description logics (DL) through its variant SHOIN(D). This DL's variant is widely used in ontological representation because of its expressiveness, decidability and controlled complexity. The constructors (the set of lexical symbols and operators used in the DL) of DL give it a sufficient expressiveness for the ontological description. These constructors are S(ALC and R+), H, O, I, N [Baader et al., 2005], [Baader, 2011]. Their meaning are:

- **S(ALC and R+)**: is the name given to a DL's sub-variant which groups the ALC constructors (basic DL's sub-variant composed of following operations - the definition of the global concept (Top, represented by $\top$), the concept of nothing (bottom, $\perp$), every concept (Duc for example), the conjunction of concepts (Duc AND $Knight$, $Duc \sqcap Knight$), the universal quantification (All the Duke's children, $\forall child.Duc$), the existential quantification (the Count's father, $\exists father.TheCount$) and the negation of a concept (not Animal, $\neg Animal$)) and constructor R+ (which allows the composition of roles(relations). *Example:* $father(father(X, Y), Z)$ *to say that X is the grandfather of Z where* X, Y, Z *are concepts and* $father$*, a relation*);
- **H**: designates the constructor of the hierarchy between concepts. *Example:* Duc *is-a* $Person$*,* $Duc \subseteq Person$;
- **O**: designates the constructor of instances. *Example: games, banquet are instances of the concept Activity,* $Activite\{games, banquet\}$;
- **I**: is for the inverse of a role (a relation). *Example: the relation* $child$ *is the inverse of the relation* $father$*,* $child.\top \equiv \exists father^{-1}.\top$;
- **N**: is for the restriction of number.
Example: Knights are up to 8, $KnightNumber._{<=}8Knight$.

Moreover, these constructors can be combined by operators of hierarchy (subsumption, expressed by $\subseteq$) or of equivalence ($\equiv$) to definite other concepts or to organise them through rules (or axioms).

Table 1 presents some ontological concepts, relations and individuals (instances) of the illumination in figure 1. Figure 2 represents a view of the concepts of an ontology on this illumination. It is modeled in Protege[11].

Once this modeling is finished, it could be saved in a formal syntax's form in a language[12], such as RDF/XML, Turtule or OWL, generated by the tool (Protege). Our ontology is extensible and it can be combined with other ontologies to complete the initial modeling, such as FOAF with which it has many common terms like *foaf:Person, foaf:member, foaf:interest, foaf:Group , foaf:depict, foaf:Image*.

In addition, we have developed a web platform[13] that allows us to select an illumination and to index semantically its components. On this platform accessible via a web browser, it is possible to load a digital version of an illuminated image (in jpeg or png format). Then graphic selection's tools are used to frame important elements in the image as concepts. Once these concepts are annotated, it is possible to define semantic relations between them. The verification of the added relations and the definition of inference's rules are not yet treated and will be the subject of future works.

Even if the annotation of the concepts and their relations are made manually, they are done following a list of concepts and relations provided by the medievalists (experts in medieval illuminations). This guarantees a certain consistency of concepts and relations annotated. Figure 3

[11] Protege is a software dedicated to ontology modeling. http://protege.stanford.edu/

[12] RDF/XML, Turtle are computer languages used in ontologies development. To respect the number of pages allowed, we have not developed the specification of these languages

[13] Illumination3.0, our platform (the implementation is in progress) for the annotation of medieval illuminations of the Burgundy Duke, Phillip The Good. http://illumination.checksem.fr/#/login

illustrates an interface of the platform. It shows some annotations that are made and related in the illumination in figure 1. Annotations and relations created can be retrieved and saved in JSON[14] format. This file is created to allow the extension of the ontology on both its Tbox (the set of concepts of an ontology and their relations) and Abox (the set of instances, facts or individuals in the model).

The modelling of this ontology is realised from the expertise of medievalists. The model can be queried by SPARQL[15] in order to extract targeted components and to answer precise questions such as *activities represented in the illumination ; who are the faithful persons to the Duke ?* The interest of ontology is its ability to discover new knowledge from the ones described initially. This discovery is achieved by the construction of inference's rules and their execution within an inference engine. Beyond our terminological description of illuminations, the interpretation of some symbolic elements remains to be defined through the formulated inference rules. We are currently working on these rules in SWRL[16](Semantic Web Rules Language) in order to reason about symbolic relations within an illumination. In the one depicted in figure 1, some examples of symbolic relations and their formalisation with Horn clauses are in table 2.

4.2 Example of formalisation of symbolic relations: metaphors

The formulation of logical rules in the form of Horn's clause will enable us to interpret metaphors which are common in illuminations. Metaphor is a rhetorical figure that makes a not explicit, but intuitively perceptible comparison between two dissimilar concepts. Although the two concepts related by the comparison belong to different semantic fields, they share common characteristics which create an analogy between them. For example, one can praise the bravery of a man by designating him by a lion but man and lion remain concepts that are totally different (man is a human while lion is an animal). Although there is no real consensus from linguists on a universal typology of metaphors [Perrenoud, 2002], two main types can be enumerated: metaphor in praesentia and metaphor in absentia.

For **metaphor in praesentia** [Perrenoud, 2002], the two concepts (comparated and comparing) are presents and despite the absence of the comparison tool, it is possible to perceive quite easily their link. That makes the comparison less allusive and relatively attenuates the expressive force of the metaphor. *Example: "The butterfly, flower without stem" (Nerval).* The butterfly is compared to a flower to enhance its splendor. This metaphor can be expressed in description logics by:

$$\mathit{Flower} \equiv \mathit{Butterfly}$$
$$\mathit{Flower} \sqcap \mathit{Butterfly} \equiv \exists beingSplendid.\top$$

The **metaphor in absentia** [Perrenoud, 2002] is characterised by the unique presence of the comparing concept and the absence of the comparative one whose existence is insinuated by the context. *Example: "My bitter mind, a worried and crazy wing flies over the sea" (Verlaine).* The comparing "mind" is clearly expressed while the compared "bird" is guessable through the

[14]JSON (JavaScript Object Notation) is a lightweight data exchange format. It is easy to read, write and analyse

[15]SPARQL is the language used to query an RDF database (or triplestore defined above). It is similar to the SQL language used to query relational databases

[16]SWRL - Semantic Web Rules Language, is the language which allows us to build Horn clauses (logical rules of inferences). It helps to extend the expressiveness of some OWL's (Ontology Web Language) variants by allowing them to create complex rules. OWL is another language dedicated to creating ontologies for the Web. It has many variants: OWL-DL (corresponds to SHOIN (D)), OWL-Lite (uses fewer constructors), OWL-Full (OWL complete, which is undecidable).

words "wing" and "fly" which are part of its lexical field. It is a metaphor that is not expressed openly. The link between the comparing and the compared is made by logical inference. This example can be expressed in description logics as shown below:

$$\mathit{Bird} \subseteq \exists \mathit{hasWing}.\top \sqcap \exists \mathit{canFly}.\top$$
$$\exists \mathit{hasWing}.\top \sqcap \exists \mathit{canFly}.\top \equiv \mathit{Mind} \sqcap \mathit{Lightness}.$$

By transitivity we could deduce that $\mathit{Bird} \subseteq \mathit{Mind} \sqcap \mathit{Lightness}$.

There are other types of metaphors such as the spun metaphor which adds new terms borrowed from the lexicon of another metaphor in order to complete the meaning of the latter and intensify its effect; or the lexicalised metaphor (or catachresis) which is fully integrated into daily language (e.g *the saw's teeth; the armchair's arm; etc.*) throughout its use. Examples of these metaphors and their formalisation in description logics are:

In **spun metaphor** a constructor of equivalence connects the comparing to the intersection of the compared with the common concept. As for the union of the new metaphorical terms added, it is subsumed by the set of things which have at least one instance of the "lexicalElementOf" property to the comparing concept. *Example: "This woman is a flower, the corolla of her face obsesses me, the petals of her cheeks intoxicate me"* can be expressed in description logic like:

$$\mathit{Flower} \equiv \mathit{Woman} \sqcap \mathit{Beauty}$$
$$\mathit{Corolla} \sqcap \mathit{Petals} \subseteq \mathit{lexicalElementOf.Flower}.$$

In **lexicalized metaphor (catachresis)** the frequent use of this metaphor eventually makes it lose its poetic power. In description logic meronymic relation has been created between comparators and compared. For example:

$$\mathit{Arm} \subseteq \exists elementOf.Armchair \ ; \mathit{Sunset} \subseteq \exists phaseOf.Sun.$$

Besides the textual form, the expression of a metaphor can be visual. For example, there are images that contain underlying metaphors which are visible through shapes or symbols that embody phenomena, events, characters or other. The work we are doing allows us to formalise the expression of the visual metaphor within medieval illuminations in the OWL language and to express the influencial relations they contain. The specification and formalisation of these influencial relations will be subject of incoming work.

V CONCLUSION AND FUTURE WORKS

This paper presents an ongoing research which combines techniques from the knowledge engineering and the historical analysis of medieval documents. This work allowed us first of all to identify the process of design and distribution of illuminations as a medieval expression of a social network. This social network obeys the same motivations and codes as the current social media. Nevertheless, this system of expression of knowledge uses more complex types of relations such as metaphors. To help the process of illuminations interpretation and to develop a computarised system for understanding metaphors, we proposed a formalisation of an ontology in description logics. This ontology described in SHOIN(D) allows medievalists and general public to describe the components of illuminations using a web interface and to encode the reasoning associated to metaphors in the form of logical rules. In future work, we plan to combine our ontology with systems of semantic representation of current social media. The goal is to eventually propose a functional extension of these social media in the objective to improve the calculation of the influence of these members through a qualitative analysis.

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Concept	Relationship	Individual
Animal	hasChild(Person, Person)	Place(PALACE, ROOM)
Duke	hasFather(Person, Person)	ExtraProfessionnalActivity (READING, FALCONRY, DANCE, MUSIC, BATH)
DucalCourt	toReunited(Person, Duke)	
Knight	bePositioned(Person, Position)	
Advisor	beKneelingInFront(illuminator, Duke)	
TheCount	offered(Book, Duke)	
Writer	talk(Duke, Person)	
Book	paint(Book, Writer)	
Illumination	holdUnder(Duke, canopy)	ProfessionnelActivity (DECISION, POLITIQUE, JUSTICE, DIPLOMATIE, FINANCES, COMMANDEMENT MILITAIRE)
Illumination	look(GreenKnight, Duke)	
Collar	beRelated(Person, Person)	
GoupToisonDor	wear(Person, Clothes)	
Activity	beOut(Writer, Framework)	
Greyhound	named(Duke, Person)	
Person	interested(Person, Activity)	
Shoes	beMember(Person, GroupToisonDor)	
ProfessionnalActivity	composer(Assembly, Personne)	
ExtraProfessionnalActivity	hasOld(Person, integer)	
Positioning	surround (Personn, Duke)	
CommandStaff		
Assembly		

Table 1: The ontological components contained in the illumination of figure 1. The lists of concepts, relations and individuals in this table are not exhaustive. They only present a slice of this illumination's components. In a relation, a variable's name beginning with a capital letter means it is a concept we suppose already defined.

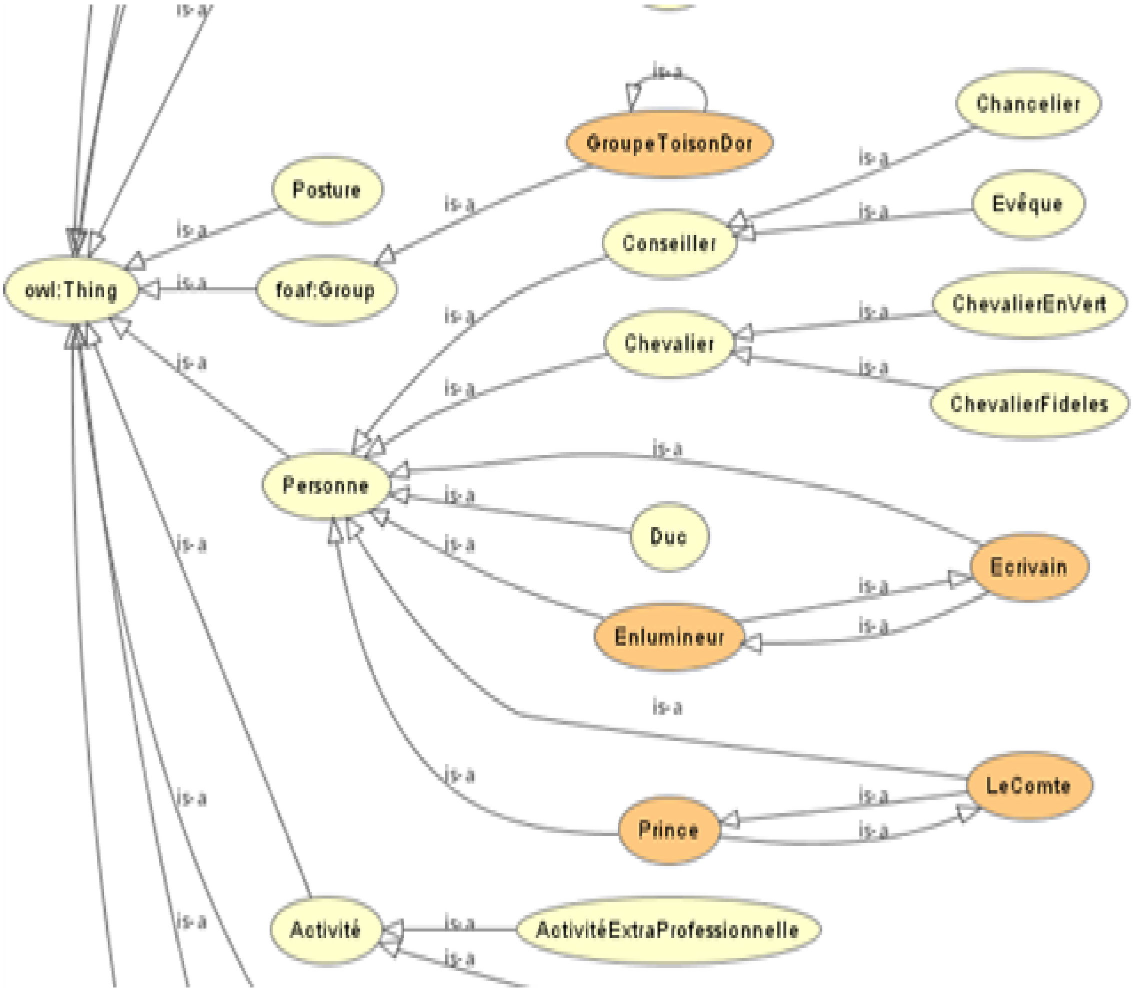

Figure 2: A view in Protege 2000 of some concepts of illumination of figure 1. These concepts are organised through the subsumption relation ($is - a$).

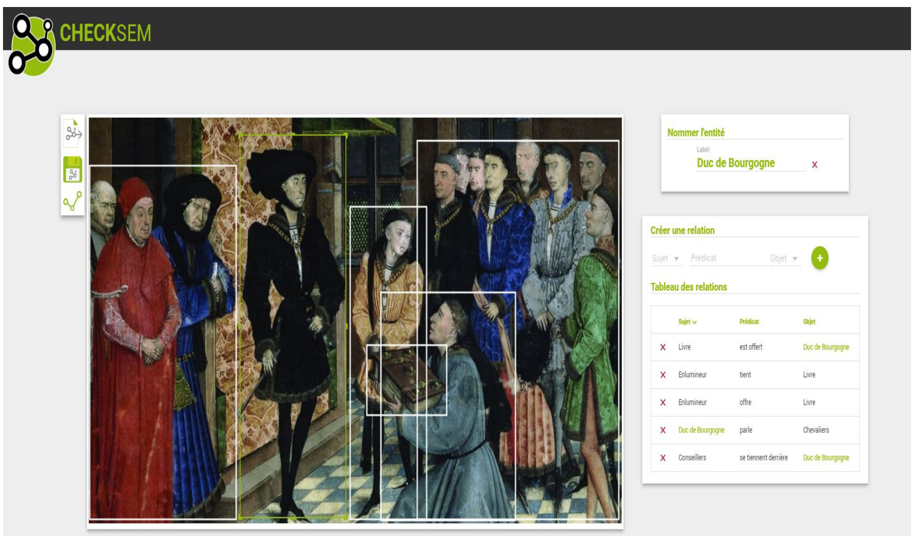

Figure 3: An interface of illumination annotation's tool we are implementing "Illumination3.0"

- **Symbolic relationships** **Formalisation in Horn Clauses**
- a knight has the right to kill $hasRightToKill(X) : -Knight(X)$
- a knight is a monk wearing the necklace of the Golden Fleece $Knight(X) : -Monk(X), GoldenFleeceNecklace(Y), wear(X, Y)$
- a person carrying a weapon has the right to kill $hasRightToKill(X) : -Person(X), Weapon(Y), carry(X, Y)$
- we are submitted to a person in front of whom we stand in a submission position $beingSubmitted(X, Y) : -Being(X), Person(Y), SubmittedPosition(Z), beIn(X, Z)$
- being submitted to someone is to be faithful to him $faithful(X, Y) : -beingSubmitted(X, Y)$
- being a felon to the Duke is to be unfaithful to him $beingFelon(X) : -\neg faithful(X, Y), Duc(Y)$
- a felon wears green clothes $beingFelon(X) : -Person(X), Clothes(Y), GreenColor(Z), hasColor(Y, Z), wear(X, Y)$
- a person in mourning dresses all in black $beingInMourning(X) : -person(X), Clothes(Y), BlackColor(Z), hasColor(Y, Z), wear(X, Y)$

Table 2: Some examples of symbolic or implicit relations in the illumination depicted in figure 1 and their formalisation with Horn Clauses. We suppose that all the explicit concepts and relations in the right side of a clause are well defined. Examples: $GreenColor(X)$ defines the green color, $hasColor(X, Y)$ means a thing X has the color Y, $Monk(X)$ is the concept which designates a monk, etc.