FROM ONTOLOGY CONCEPTS TO PROJECT MEMORY

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Abstract: In this paper the objective is to study the state of the art of ontologies and to synthesize it. We make a synthesis of definitions, languages, ontology classifications, ontological engineering, ontological platforms and application fields of ontologies. We present an example of application of ontology which is the project. The architecture of such a memory is presented together with the relation teeing the ontology and the project memory. The objective of this study is to present a new vision of the ontological concepts through the proposition of a number of cartographies related to these concepts.

1 INTRODUCTION

Historically, the ontological engineering yielded the engineering of knowledge. This latter has for a long time been considered as the domain of appraisal development in the conception of systems of knowledge management.

Although the engineering of knowledge contributed to increase this appraisal while organizing the engineering in an automated perspective, some members of the community of the artificial intelligence felt the need to spend more on the theoretical and methodological foundations to improve the conception of the intelligent systems: the ontological engineering (OE) permits to specify the conceptualization of a system, providing with the formal representation of knowledge that he must acquire, under the shape of exploitable declarative knowledge by an agent. Thus, the exploitation of a declarative type of representation as the ontology, by a mechanism of inference while following rules of definite inference in this ontology, is the source of the intelligence of the system.

The engineering of knowledge gave birth thus to the ontological engineering where the ontology is the key basis. The necessity of ontology and ontological engineering of systems as a basis of knowledge have begun to be understood and accepted by the community.

To found the ontological engineering requires that one defines its object and defends the specificity of its methodology. However, if no one contests that the object of the ontological engineering is the ontology, the explicit definition and the precise identification of this concept raises some aspect all at the same time: philosophical, epistemological, cognitive and technique order.

There are several domains of application of ontologies: (1) medical domain (MENELAS) [19], (2) agriculture domain (AOS) [19], (3) modeling enterprise domain (TOVE) [19], (4) management of a shared enterprise knowledge memory domain (CoMMA) [18], (5) evaluation of information systems models (BWW) [77]etc. The most retained definition of ontology throughout these domains was proposed by Gruber [24]: "Ontology is an explicit and formal specification of a shared conceptualization". The construction of ontology poses real problems relative to knowledge engineering, conception, maintenance and reuse. In spite of the existence of interesting results, problems raised by the ontology theme remain numerous and complex.

This paper presents a contribution to the development of the state of the art of ontologies. Its originality consists in the cartography of ontology concepts. It will be able to help a simple reader to position these concepts, to distinguish them and to understand them. It is especially dedicated to beginners, simple users of ontologies.

The second section of this paper presents cartography of definitions met in the literature. The third section introduces cartography of ontology languages. The fourth section presents the ontological engineering. The fifth section introduces the classification of ontologies and cartography of relative classification approaches. In the sixth section, we present the most relevant application domains of ontologies.

In the seventh section we present some platforms used for the construction of ontologies.

Finally we present a domain of application of ontologies that is the memory of project and the relationship between ontology level and project memory level.

2 CARTOGRAPHY OF DEFINITIONS

A large number of definitions exist in the literature. These definitions diverge in two aspects :

1) Whether ontology must be formal [42] or no [48].

2) Whether ontology is a conceptualization [46] or a specification of a conceptualization [24].

The cartography of these definitions permits, firstly, to extract the main considered concepts and, secondly, to position our definition in relation to those in the literature. We extract and describe the following main terms present in ontology definitions overhauled in this paper:

- *Conceptualization* refers to an abstract model of a phenomenon in the world, identifying the suitable concepts relative to this phenomenon.
- *Explicit* means that the used concepts and their relations are defined explicitly.
- *Formal* means that the ontology should be expressed formally in order to facilitate its translation into an interpretable language by a machine.
- *Shared* means that ontology captures the consensual knowledge which is not reserved to some individuals, but shared by a group or a community.
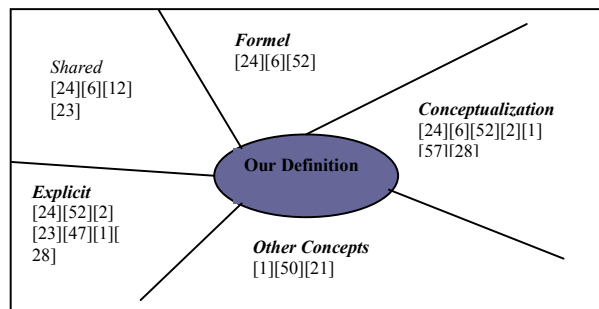

Figure1: Cartography of ontology definition concepts

In this paper we propose the following definition: "Ontology is an explicit and formal shared abstract view of a part of the real world. This view is described by a whole of tools as a vocabulary formed of concepts, relations, axioms and rules of inference".

Our definition is at the intersection of definitions whose concepts are presented in the Figure 1. This definition is inspired from terms explicitly invoked (full arrows) or implicitly invoked (dashed line arrows) in the corresponding references.

3 ONTOLOGY LANGUAGES

According to the approach of Corcho and Gómez-Pérez [8], languages of ontology development are classified into three categories (Figure 2):
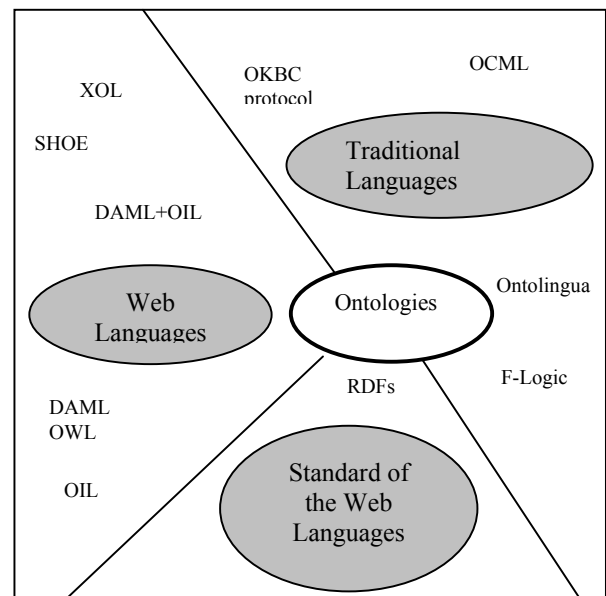

Figure 2: Cartography of ontology languages. Languages concepts

- *Traditional ontology languages* are divided into four categories: (1) languages relative to the logic of the first order predicate as CycL[63], (2) frame based languages as Ontolingua[64], F-Logic[65], CML[66] and OCML[67], (3) languages based on description logic as Loom[68] and (4) others such as Telos[78].
- *Standard languages of the Web* as XML [69], RDF [70]
- *Web ontology languages* as OIL [71], DAML+OIL [72], OWL [73], SHOE [74] and XOL [75].

4 ONTOLOGICAL ENGINEERING

4.1 Ontology Components

Ontology components have been identified in [21] as:
- *Concepts:* called also ontology terms or ontology classes. They correspond to the applicable abstractions of a part of the reality (problem domain) that have been chosen according to the ontology objectives. According to [22] these concepts can be classified according to several dimensions: (1) abstraction level (concrete or abstract), (2) atomicity (elementary or composed), (3) reality level (real or fictitious).
- *Relations:* are the relevant associations existing between the concepts present in the analyzed part of reality. These relations include for example associations such as sub-class-of (generalization-specification), part-of (aggregation or composition), associated-with, etc. These relations enable us to analyse the interrelationship of the considered concepts.
 - *Axioms:* are the true assertions relative to the ontology domain.

4.2 Ontology Construction

The construction process of ontology is complex. Managing this complexity requires precise management rules in order to control costs and risks, and to insure the quality throughout the construction process. Until now, there is no consensus about the best practices to adopt during the ontology construction process or even about the technical standards governing the process of ontology development. However, several methodological contributions were introduced to help ontology construction [2], [25], [36], [38], [49], [56].

A recent survey in [38] shows that there are about thirty-three proposed methodologies for ontology construction. These methodological approaches can be divided into five categories: (1) constructing from the beginning, (2) integration or fusion with other ontologies, (3) re-engineering, (4) collaborative constructing (5) evaluation of built ontologies. [45] proposed a referential frame that allows a comparative analysis of these construction methodologies and their interactions. Methodological construction approaches have been in many cases associated with the evaluation process of ontology [17]. Among these approaches we can mention studies relative to the following projects: Cyc [39], Enterprise [56], TOVE [53], CommonKADS and KACTUS [34], METHONTOLOGY [13] and Ontolingua [38].

In addition to the above mentioned methodological construction approaches, there are other domain-specific studies that lead to some interesting experience-based construction methodologies. It is the case in [56] and [15]. Moreover, part of the methodological research is focussing particularly on a specific ontology construction phase such as the Knowledge representation or the conceptualization [28][35].

5 ONTOLOGY CLASSIFICATIONS

5.1 Classification Approaches

The main contributions of ontology classifications are the following (Figure 3):
 - In [53] ontologies are classified according to three criteria: 1) Formality (very casual: expressed in a natural language; semi-casual: expressed in a reduced form and structured of a natural language; semi-formal: expressed positively in a definite artificial language) expressed in natural language; 2) Objective (communication, inter-operability, advantages of the systems engineering (reutilisability, acquirement of knowledge, specification)); and 3)Topic "subject matter" (subject: domain (ontology domain), subject of problem solving (tasks, methods or ontology of problem solving), topic of languages of knowledge representation, ontology of representation or mat-ontology).
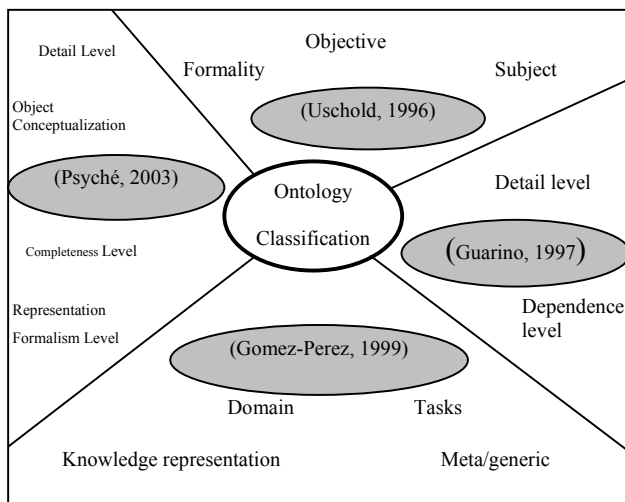
Figure 3: Cartography of ontology classification approaches.

- In [27] ontologies are classified according to two criteria: 1) detail level: for example ontology meta-level, ontologies of reference, shared ontologies, domain ontologies; and 2) dependence level: for example ontologies of high-level, ontologies of tasks and ontologies of applications.
- In [22] ontologies are essentially classified according to the following criteria: 1) ontologies of knowledge representation (formal ontologies); 2) common/general ontologies; 3) top-level ontologies,4) meta/generic ontologies; 5) domain ontologies; 6) linguistic ontologies; 7) tasks ontologies (ontology task-domain, methods ontology, application ontology).
- In [45] ontologies are classified according to the following criteria: subject of conceptualization, detail level, completeness level, representation formalism level.
1) According to the object of conceptualisation, ontologies are classified by [22], [27],[39], [41], [57], [58], [60], [61] in the following way: a) representation of the knowledge; b) superior / High level; c) generic; d) domain; e) task; f) application.
2) Detail level: In relation to the level of detail used at the time of the conceptualization of the ontology according to the operational objective considered for the ontology, two categories at least can be identified: fine granularity, large granularity.

3) Completeness level: has been landed by [39] and [7]. As an example, let us describe the typology of [7]. This latter suggests the classification at the following three levels (semantic level, reference level, operational level).
4) Representation formalism level: In relation to the level of the formalism of representation of the language used the ontology operational. [53] suggest a classification understanding on four categories: casual, semi-informal, semi-formal, formal [22]

5.2 Ontology Domains

In addition to the above ontology classification approaches, it is possible to categorize ontologies according to their application domains. Figure 4 presents a cartography of existing projects concerning different ontology application domains. There are several important ontologies developed by the artificial intelligence and the language engineering communities. These ontologies cover several domains whose features have been defined in [17] as:
- *General* : (1) The objective for which the ontology was created (general or specific), (2) the size expressed by the number of used concepts, rules and linkers, (3) the formalism, (3) the used language and platform of implementation (4) scientific communications, etc. - *Conception Process* : How has the ontology been constructed? Is there any evaluation formalism? What is the general taxonomy of the ontology organization? - *Taxonomy*: What is the general taxonomy of ontology organization? Are there several taxonomies or only one? What is the composition of this taxonomy?
- *Internal Structure of concepts and their relations:* Do concepts have specific internal structures? Are there roles and properties? Are there other types of relation between concepts? How are part-whole relations represented?
- *Axioms*: Are there any explicit axioms? How are axioms expressed?
- *Mechanism of inference*: How is the reasoning made (if any)? What are the processes of going beyond first-order logic?
- *Applications*: research mechanisms, user-interface, the application in which the ontology has been used.
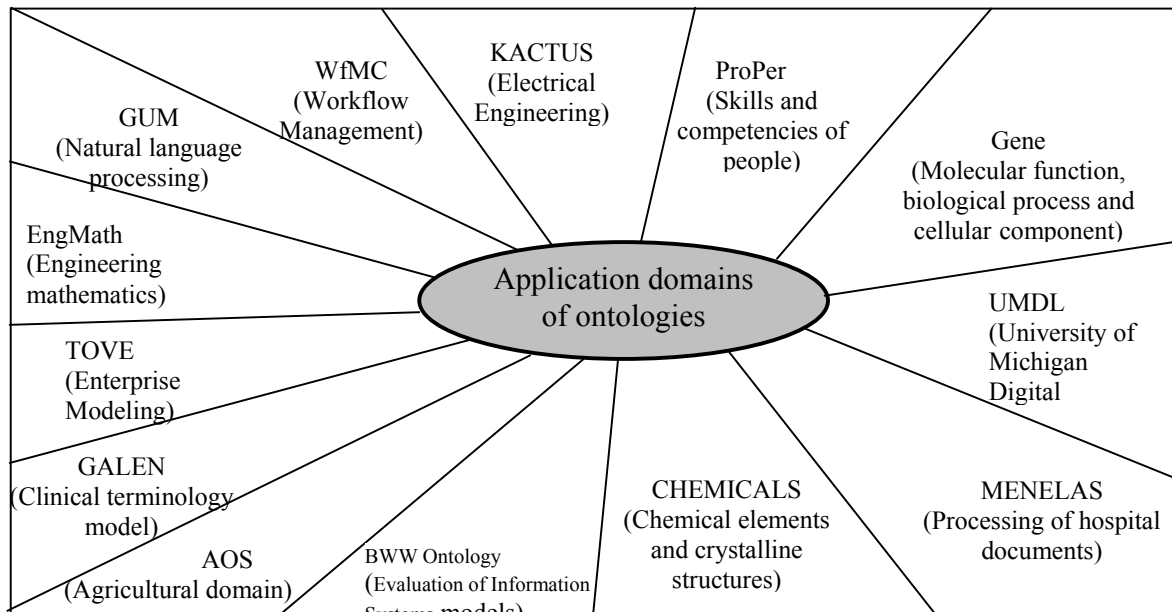- *Contributions*: Major strengths and contributions, weakness and araised problems.

Figure 4: Cartography of ontology application domains.

6 APPLICATION FIELDS OF ONTOLOGIES

Instead of being a mere laboratory subject, ontologies are used today in many real application fields where knowledge conceptualization and representation is needed. The object in this section is to present some applications (Figure 5) integrating the ontologies and, more precisely, the role of ontologies in knowledge based systems and in the semantic Web.

6.1 Knowledge Based Systems

The main application of ontologies is data management for knowledge based systems. The are many operational projects in different domains. We can mention the MENELAS project [19], led in the computer services of the PUBLIC HOSPITALS OF PARIS. Its role consists in helping the management of medical reports and their analysis by a system using the conceptual graph model. Graphs are used here to represent the inclusive medical knowledge in reports. They are generated from texts and then stocked. The use of adapted reasoning mechanisms permits the interactive consultation of knowledge. Other projects, dedicated to the management of enterprise, are currently in progress. The TOVE project [19],[15] has for a goal to create a model of enterprise expressed through an ontology, allowing a system using this ontology to manage knowledge related to the organization and activities of enterprises. The CoMMA project [18], realised in the INRIA of

Sophia-Antipolis, aims at permitting the management of a shared knowledge memory inside an enterprise. The use of ontologies within systems offering real possibilities of reasoning is not well developed till now. This can be explained by the inadequate existing representation of languages.

6.2 Semantic Web

The Web constitutes an ideal land of application of ontologies. Without referring back to the different definitions of ontologies in engineering of knowledge, it is clear that research on is essential for the realization of the semantic Web. Indeed, on the one hand, once constructed the latter and accepted by a particular community, ontology must translate a certain explicit consensus and a certain level of sharing that are essential to permit the exploitation of resources of the Web by different applications or software agents. On the other hand, the formalisation, an other facet of ontologies, is necessary so that these resources can be provided with capacities of reasoning permitting to unload the different users of a part of their task of exploitation and combination of resources of the Web.

From this point of view, the ontology will be crucial for the semantic Web methods and tools contributing to:
- Construct ontologies, that is from primary sources, particularly the textual corpora, or while searching for a certain reusability. The construction of ontologies from the textual corpus analysis is a domain in rapid evolution where a certain number of methodologies and tools are tested by a very active community. The question of the reusability that caused long

proceedings in the community Engineering of knowledge permitted to progress toward the research of some genericity, but it remains a major stake for the semantic Web;

- To manage the access to ontologies, their evolution, with management of versions, and their fusion. Ontologies are often rich with thousands of concepts and, thus they remain directly accessible by their inventor. Their access by users, as well as professionals, requires the management of the relation between concepts of ontologies and terms of the natural language of whether is for a simple understanding or for the indexing and the intended request of information research tasks. Solution implementations until now pass by methodologies separating explicitly terms and concepts of a domain .

- To insure the interoperability of ontologies while managing the heterogeneities representation and the semantic heterogeneities. These latter are the hardest to manage and they require some conjoined reflections of the problematic of the ontology accessibility. Some projects have been achieved or are being realized using concepts of the Semantic Web. Among these projects: PICSEL [37], Xyléme [30], CoMMA [18], ACACIA [31], ESCRIRE [33], COMMONV [51], GEMO [32].
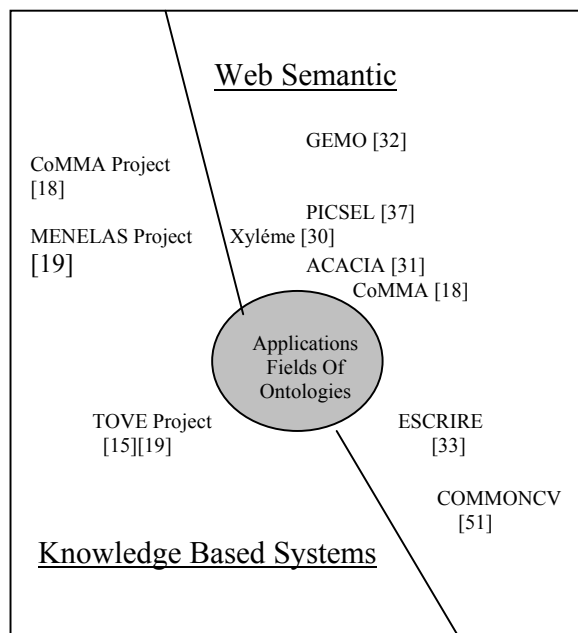

Figure 5: Cartography of some Applications Fields of ontologies

7 SOME PLATFORMS FOR ONTOLOGY CONSTRUCTION

In this section we describe some platforms used for ontology construction.

There are numerous ontological platforms using varied formalisms and offering different functionalities. These platforms offer supports for the construction process of ontology. However they do not offer a great help concerning the conceptualization. We describe here some of the most important ontological platforms:

- Ontolingua: Ontolingua is a set of developed tools written in Common Lisp. It is used to analyze and to transform ontologies that have been developed in the beginning of 20th century at the Knowledge Systems Laboratory of the Stanford University [11]. Ontolingua is composed of a server and a representation language. The server memorizes a set of constructed ontologies in order to assist the development of new ontologies [10].

- WebOnto: WebOnto has been developed by the Knowledge Media Institute of the Open University [44]. WebOnto has been conceived in order to support collaborative research, creation and display of ontologies. WebOnto provides a user interface that displays ontological expressions. It provides also an ontological tool called Tadzebao which is able to support the synchronous and asynchronous communication between ontologies.

- Enterprise Toolsets: It is an agent based platform that integrates several plug-and-play tools. The main components of Enterprise Toolset are: a procedure onstructor used to capture models of a process, agent's Toolkit used to support the development of agents, administrator of tasks used for the integration and the visualization of a process, and a communication tool [55].

- KACTUS / VOID Toolkit: KACTUS is an interactive environment to search, publish and manage ontologies. The VOID tool offers an experimental framework for examining and analysing theoretical ontology concepts. It permits also the organisation of developed ontology libraries and the transformation of different ontology formalisms. The KAKTUS toolkit allows also executing a set practical operation such as searching, publishing and interrogating ontologies developed using different formalisms. In order to support the reuse of ontologies, the toolkit can manipulate several formalisms of ontologies (CML, EXPRESS and Ontolingua) and can manipulate transformations

between these formalisms. Other platforms are mentioned in [10].

8 An ontology dedicated project memory

In this section we present some definitions of the project memory, the objective of his utilization, its relation with the ontologies and architecture of our ontology.

For [79], "A project memory is defined as being a memory of knowledge and information acquired and produced during the realization of projects". [80] defines "the project memory as being lessons and descended experiences of projects given". [81] defines it as "the definition of activities of the project, his history and his results".

[82] defines it like "an explicit representation of knowledge acquired and produced during the project". These definitions focus on the subject "Project Memory" rather than on its finalities. These later remain implicit. The objectives of this relative work have the project memory of conception of products, as concern and the traceability of all the elements manipulated during the project: product, process, actor, organization, etc. The storage of these pieces of information and their relation permits to find the different possible conception choices, namely the retained solution, the author of these choices, his justifications, and the concerned documentations. This information can also be used like a basis of knowledge for new projects in the setting of routine conception. They provide the basis of knowledge and replicate existing projects. In the setting of an innovating project, they help to extract different element from the knowledge base to combine them, to improve them, and to elaborate a new product.

We suggest the following definition: the project memory is the memory of product elements and its process of conception in view of an ulterior utilization. [62] presented the relation that can exist between an ontology level and a project level. For us, we will confound the project level with the concept of project memory. A summary of this proposition is in the figure 6. It is caught in three levels.

- Ontology level: any concepts/propositions that apply to all types of projects should be located in the ontology level.
- Domain level: it specifies the projects types. This is carried out by specializing the required classes corresponding abstract classes in the ontology level and by instantiating objects from industry.

- Project memory level: consists of objects that store information about particular projects according to the specification of the classes in the domain level. In our case it is about projects of conception.
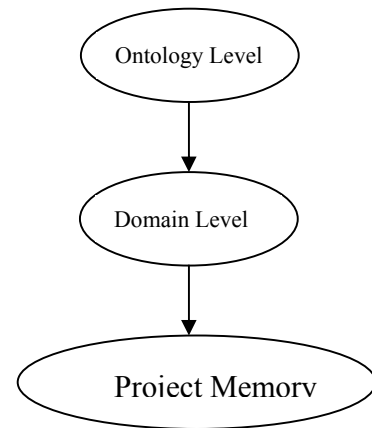

Figure 6. Relation between Ontology and Project memory

Figure 6 permits the passage from Meta meta model (ontology level) to Meta model (domain level) and to model (project memory level).

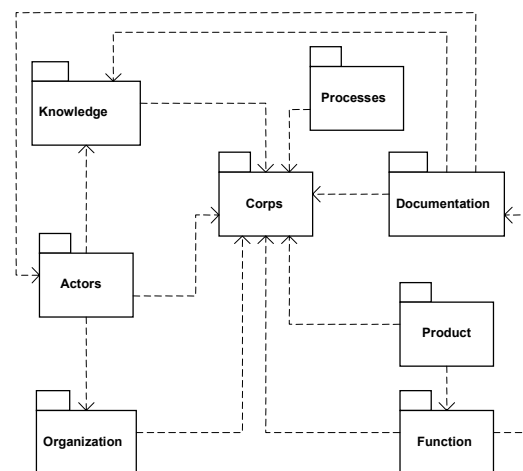The architecture of our project memory is in Figure 7.

Figure 7. Global Arcitecture of ontology dedicated Project memory

The figure 7 presents the global architecture of the project memory. This latter is organized around eight packages:
- Process: organization of the different stages of a process,
- Product: structural decomposition of the product,

- Function: management of the load notebook that the product must satisfy,
- Organization: management of the structure of the team project,
- Documentation: management of the structure, the content, the technical choice justification of credentials to all support of information (picture, text, hypertext link…),
- Actors: management of actors intervening on the project, authorizations of access,
- Knowledge: structuring of different levels of knowledge.

These packages are all join to the package intended Corps to manage the common attributes and relations between all classes as well as views.

CONCLUSION

The notion of ontology stems from the discipline of Philosophy. It has evolved to its current meaning in the context of Computer and Information Science where it refers to a designed artefact which formally represents agreed semantics in a computer resource.
Ontologies are becoming increasingly important in various fields. They are used to describe diverse domains in order to treat information automatically.
In this paper we tried to present some concepts bound to ontologies but from a new approach: the cartography. This study will allow readers to situate their ontological needs while referring to the suitable concepts.
This paper has permitted to browse in a rather exhaustive way the state of the art relative to ontologies. Thus, we introduced several cartographies relative to definitions, languages, classification approaches and application domains. An approach of link between the ontology and the project memory is presented. The architecture of this project memory is described via a shape of package. This ontological survey has been supported by a progressing study that we are leading. In fact, we have finished the conceptualization of ontology dedicated to the management of a project memory [5]. For the future of our researches, the development of this ontology is in progress. We intend to experiment it in the case of French and Tunisian companies.

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