Semantic Annotation of Documents: A Comparative Study

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Abstract*—Semantic annotation, which is considered one of the semantic web applicative aspects, has been adopted by researchers from different communities as a paramount solution that improves searching and retrieval of information by promoting the richness of the content. However, researchers are facing challenges concerning both the quality and the relevance of the semantic annotations attached to the annotated document against its content as well as its semantics, without ignoring those regarding automation process which is supposed to ensure an optimal system for information indexing and retrieval. In this article, we will introduce the semantic annotation concept by presenting a state of the art including definitions, features and a classification of annotation systems. Systems and proposed approaches in the field will be cited, as well as a study of some existing annotation tools. This study will also pinpoint various problems and limitations related to the annotation in order to offer solutions for our future work.*

Keywords— ***Document, Semantic Annotation, Metadata, Information Retrieval.***

I. INTRODUCTION

Nowadays, the amount of digital data reaches an unprecedented stage and keeps growing each day. However, the volume is not the only factor that leads digital data to explosion; evidently, the richness of contents and also the remarkable heterogeneity of structures have a significant impact. So, faced with that explosion, the challenge is how we can provide an improved management, a better exploitation and an efficient understanding of the information contained in these digital sources. Well, semantic annotation became one of the treated alternatives in this regard, that may handle these requirements by ensuring a good comprehension of document contents, thus allowing an easy exploitation, exchange, and shareability.

Otherwise, semantic annotation is the practical solution that may promote the information retrieval either on the web or in large databases by calling upon ontologies, thesauri and data extraction and segmentation algorithms, in order to enhance the richness of contents through the attachment of descriptive notes by considering different contexts from which these notes may come, the various structures that can represent them and the relationship that links both of them while continuously safeguarding strict separation between the resources and their annotations [1].

Different application domains appeal the semantic annotation as a recent research field to evaluate its efficiency on various content types and structures. For instance, the electronic Medical Records (EMR) used in the healthcare industry [2] [3] is one of these application fields. As a matter of fact, an EMR can be created by a set of experts in different medical sub-domains and who may have varying levels of expertise, which explains the abundance and the diversity of contained information in a patient's record, such as epidemiological studies, medical history, lab work, etc. Practically, the collaborative annotation of the EMR by those practitioners facilitates the access to the needed information without having to study or analyze the entire record.

This paper is organized as follows: in the second section, we shall survey different definitions of annotation in the literature and its different features. We shall also distinguish between annotation and metadata. We then present and compare three types of annotation, and complete the section by listing and comparing various annotation tools available nowadays. The third section will present examples from recent studies of several annotation systems. They shall be categorized according to the types of documents they aim to annotate. Finally, in the fourth section, we present a synthesis of the survey.

II. STATE OF THE ART

2.1 Annotation: what does it mean?

In the literature, annotation is defined as a critical or explanatory note accompanying the text. In computer science, different definitions are often cited. Authors in [4] define the annotation as graphical or textual information attached to a document or simply placed on it. Evidently, when we talk about an electronic document, it may be mono-media, multimedia or a web page within the semantic web. Hence, the forms of annotation differ depending on the interest and the purpose of the annotator. It might, for instance, be that a resource user or reader who wishes to annotate a paragraph in order to simplify its next reading, or facilitate the access to the information according to the intended use.

In this case, the annotation will probably be non-textual i.e. graphical and expressed by underlining, highlighting

or pinpointing elements, so as to create a personalized re-segmentation and reorganization of the document or the paragraph. However, if the annotator is the resource's author, an expert or even a simple user wishing to enrich the document by associating other information, this latter will certainly be textual information selected according to a well-defined context.

Similarly, the author in [5], believes that the form of the annotation depends on its function, distinguishing between two forms of textual annotation: (i) personal annotations – called also individual annotations– that are used to translate a term, highlight it by providing more definitions, rephrase a passage, etc; and (ii) collective annotations that introduce the notion of sharing and exchanging which allow annotators – readers and/or experts analyzing a document – to ask questions, provide answers, and give feedback in the form of annotations.

2.2 From Annotation to Semantic Annotation

With the appearance of the semantic web and during its evolution, an annotation treats and concerns more specifically semantics, since it remains one of the applicative aspects of the semantic web, then called semantic annotation. In the same context, the W3C (World Wide Web Consortium) defines a semantic annotation as a comment, an explanation or any other external note that can be attached to a web document or a part of it. According to [22], semantic annotation designates both the activity which consists of affixing a note regarding a part of a document and also that resulting note; and it's reflected in the definition of a semantic information layer that gives meaning and sense to the text. In [8] [7], authors added that these notes assigned to the entities to annotate have a well-structured and a formally described semantic which is already defined within the ontology and presented as a set of concepts, instances of concepts and relations between them, by indicating that these annotations and metadata can be stored within the document itself or in a separate one by using the URI (Universal Resource Identifier) referencing the annotated entity.

2.3 Semantic annotation versus Metadata

However, when analyzing different definitions presented in the literature, we note that semantic annotation is often related to another term which is metadata. True to its name, the latter is a data about other data i.e. a data about the document. Metadata is considered as a label attached to a document that describes sufficiently its content, eventually its main features without needing to open it for consultation. According to [6], metadata help to identify, describe and localize electronic resources. Not too far from this, [23] links metadata to an easy access, share, and reusability of information.

Nevertheless, a distinction is made in [1] between semantic annotation and metadata. The metadata term is more independent than annotations and can itself be a resource attached to the annotated resource as additional information. A good example would be a summary prepared separately for an article, a publication date for a document, the duration of an audio or video clip, an artist's name, or even the names of the instruments played in a musical piece. While metadata is external, though possibly attached, to the document, annotations lie within the annotated resource and are written during the reading/annotation process. In this case, it may be the lyrics of a song, a sound played at a certain point in a presentation, a textual string of words, sentences or even a paragraph.

2.4 A Semantic Annotation Systems Classification

A semantic annotation process, regardless of the annotated resources type, can be manual, semi-automatic or automatic. In other words, it concerns the annotation system's automation level. In the following, we shall introduce those three categories, weighing their pros and cons, then concluding the subsection by comparing the most commonly used annotation tools.

2.4.1 Manual Annotation

As its name indicates, manual annotation requires the intervention of a human annotator who must provide descriptive keywords. This intervention may be made at several levels:

(i) In the resource drafting phase: in this case, the author represents the annotator.

(ii) At the time of resource loading/tagging: in this instance, generally, an appeal to an expert or group of experts performing semantic, contextual and collaborative annotation is needed; as in the case of the patient records example that requires a collaborative and manual annotation by a group of experts.

(iii) During consultation or final resource-use: here, it concerns a complementary annotation for personal use by adding notes and comments. As in the context of E-learning or video-conferences, annotations can be used in order to
facilitate note-taking, navigation platform, sequencing courses, etc.

2.4.2 Semi-automatic Annotation

Semi-automatic annotation is the combination of both: manual and automatic annotation. It's based on a human intervention during an automatic process, by taking advantage of this latter's efficiency on one side and the accuracy of the manual annotation on the other. The user may intervene at the beginning of the process as a resource annotator, by providing keywords and basic annotations that the system must exploit to produce final annotations. (Figure1.a). The annotator can intervene by the end as well, but this time, as an expert that must validate or cancel the annotations automatically proposed by the system before generating final annotations (Figure 1.b).

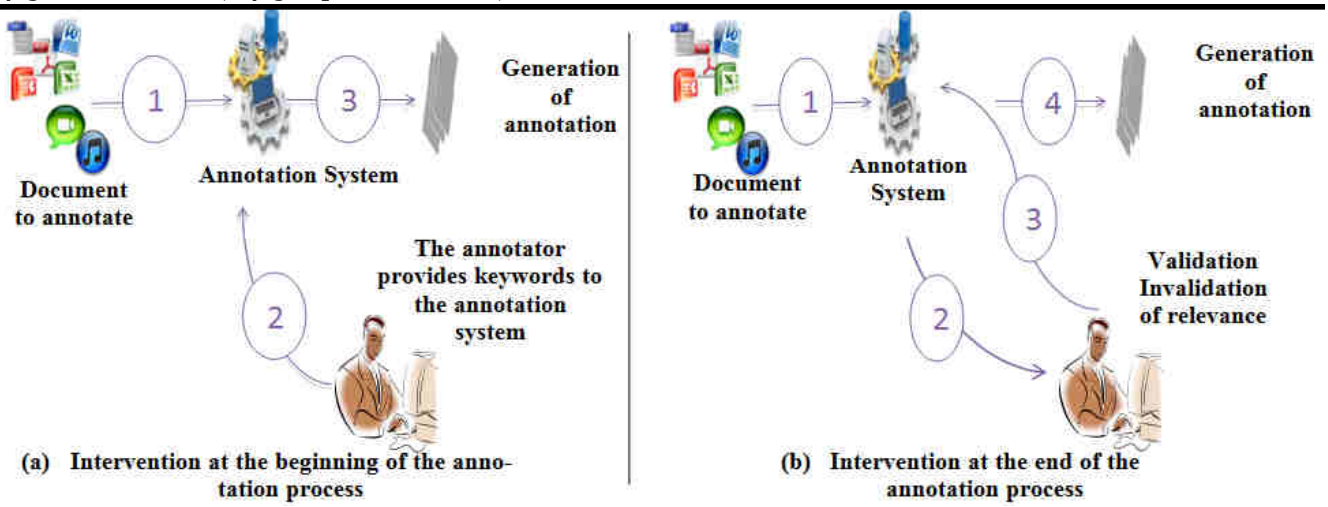

Fig.1: Semi-Automatic Annotation

2.4.3 Automatic Annotation

Automatic annotation is performed by automated annotation tools without human intervention and relies on information extraction heuristics and techniques (e.g. by exploiting redundancy), indexing and simple segmentation (data stream processing, character strings, etc.) [7][8].

Table.1: Compares the three types cited above by summarizing their cons and pros:

TABLE I. A Comparison of Annotation Types

Annotation type	Advantages	Disadvantages
Manual Annotation	. Superior in terms of quality: well targeted, relevant and semantically precise. . Selected keywords based on a human determination of the resource semantic content.	Very time-consuming. Being done by humans, it is highly error-prone and can easily result in syntactic errors and incorrect references.
Semi-automatic Annotation	. Ensures accurate and relevant annotation by combining human understanding with systematic efficiency. . More efficient and less time consuming compared to the manual annotation. . More precise and leads to relevant and accurate results compared to automatic annotation. . Recommended for dynamic databases.	Still dependent on human intervention, what makes it arduous and expensive process in terms of time and used resources.
Automatic Annotation	. Suitable for resources that have a large amount of data to make a decision according to that to deduce the qualified information to be annotations.	Lowering of quality and accuracy of annotation if compared to manual and semi-automatic annotation.

By weighing cons and pros of the three system categories cited above, we notice that each one can be evoked in a well-defined operating environment regardless of the resource type. However, choosing the appropriate system automation level depends on others criteria that we briefly mention:

- Volume and number of resources to annotate: we can only think about manual or semi-automatic annotation as long as these two factors are reasonable and don't increase over time.
- Expected goal from these annotations: sometimes, we look for detailed and more subtle semantic annotations but other times, just simple and general annotations are sufficient. Moreover, data and annotations granularity is still believed to be the major limit for automatic annotation since it's hard to annotate data using a high and fine enough level of granularity.
- If the resource to annotate already has minimal semantic information on which an automatic annotation system would be based to produce semantic annotations: Here, we're going beyond the resource itself by treating its structures, in order to extract all useful deemed information for a profitable automatic annotation process in terms of efficiency and quality. In the op-

posite case, human intervention providing this information would be needed either individually or collectively.

- Sometimes, even the resource can provide semantic information by using information extraction tools and treated through TAL (the natural Language's Automatic Treatment) tools, the process may be limited or even blocked during data's operational phase. That blockage is often linked to the resource domain specificity, for example, the lack of domain ontologies or semantic networks, etc. Several related works faced this problem, such as [24] having as objective to annotate images semantically by using keywords in gastroenterology, so the domain specificity had prompted researchers to conceive and develop their own polyps ontology in conjunction with standard reasonings in description logic SHOIQ+. The same problem was mentioned in [25], when researchers were forced to create a lexico-semantic network linked to radiology in the absence of a french version of radiology anthologies as RadLex, a bilingual one offering just English and German versions. So, in the two and other similar cases, the annotator has to intervene to validate the suggested annotations since that concerns new reasonings and semantic models.

2.4.4 Annotation tools comparison

In this subsection, we shall compare the most commonly used annotation tools and often cited in the literature. We compare them using different criteria, namely the automation level, the resource types that they can annotate, and the languages and schemas used to generate annotations. In fact, the majority of these tools are used in the context of the semantic web, as they treat web pages as resources. Some tools are limited to adding free text as comments or notes. Others on the other hand aim to semantically clarify the resource content. All of them, however, use RDF (Resource Description Framework) as a basic language for the formal description of resources. Still, the formats used in domain ontologies differ from one tool to another. Generally, they vary between predetermined ontologies implemented in RDFS (RDF Schema) and DAML + OIL (DARPA Agent Markup Language and Ontology Inference Layer) later superseded by OWL (Web Ontology Language).

Other tools are reserved for the annotation of audio-visual documents. For these, the annotation is manual and involves adding comments to documentary content, usually collaboratively. Note that manual annotation systems despite their precision are far from ideal, especially in the context of the web, where we need to treat a huge amount of resources and information. On the other hand, semi-automatic and automatic systems may yield relatively inferior results, depending on the information extraction tools and the learning techniques they use.

In fact, these information extraction tools and the different learning algorithms cited in this regard – which are the basis of semi-automatic and automatic annotation tools and systems – will be the object of our future research in which we try to explore the possibilities in view of improving the annotation process. But at this point, we have restricted our attention to the related works on annotation to elucidate the problem of annotation and information retrieval in various types of resources, adopting various forms of architectures.

Table.2 shows a detailed comparison of annotation tools according to already mentioned criteria.

Software tool	**Type Of annotation**	**Types of resources annotated**	**Information extraction tool**	**Metadata schema and ontology used**	**Language used for generating annotations**	**Observations**
Annotea [9]	Manual annotation	HTML, XML documents	—	- uses elements/terms from DublinCore (author, date, title, corpus…). - free-text annotation (comments, notes). - domain ontology formatted in RDFS.	Annotations output as RDF triplets and linked to documents with XPointers	- Designed for W3C. Allows simple text annotations of web page content, structured and non-structured. - No explicit semantics on content or the concepts in it.

V-Annotea [10]		Audiovisual documents	—	- Uses simple elements/terms from DublinCore. - free-text annotations: comments, remarks, etc.	Description of document elements in MPEG-7	- Allows collaborative indexation, navigation, annotation and discussion of video contents amongst several groups in geographically dispersed locations
The CREAM Model [11]		HTML, XML documents	—	- Uses domain ontologies DAML+OIL / OWL.	Annotations saved in document file as RDF tags/attachments.	- It's a general open and complete model allowing the development of annotation tools from ontologies.
Ontomat Annotizer		Web page fragments (HTML, XML)	—	- Uses domain ontologies DAML+OIL / OWL.	Annotations written out in RDF.	-A tool implementing the CREAM model. - M-Ontomat-Annotizer is also based on this model but it's meant for multimedia documents.
MnM same principle as Mellita	Semi-automatic annotation	HTML/ XML documents	Amilcare	- RDF. - uses predefined ontologies DAML+OIL and OCML	Generates annotations in RDF, XML	- Learning and information extraction is done by Amilcare, while correction and validation of the annotations are manual
S-CREAM [13]		HTML documents	Amilcare	- uses ontologies in DAML+OIL	DAML+OIL	- manual annotation using CREAM.
Armadillo [12]	Automatic annotation	HTML documents	Amilcare	- uses domain ontologies in RDFS.	Annotations in RDF triplets	- Uses redundancy on the web to establish relationships between instances.
AeroDAML [14]		HTML documents	AeroText	- uses ontologies in DAML+OIL.	Generation of automatic annotations in DAML.	- The web version uses a generic ontology. The client/server version supports annotations with custom-built ontologies.

III. RELATED WORKS

As stated previously, annotation is becoming an essential activity for an easy resources exploitation and management, thanks to its simple data manipulation and its low time-consuming and that what makes it more and more use in various research fields, such as e-learning, healthcare, etc. In the following, we examine some annotation related works from different categories in order to summarize various adopted techniques and concepts.

3.1 Annotation in the semantic web

In the context of the semantic web, [15] proposes an annotation system in three phases for web pages.

A web page annotation system is proposed in [15] by using three phases: First, it starts with the marking and automatic identification of relevant elements brought together in a corpus in order to associate them with predetermined ontology concepts. Then comes the learning process, which exploits the tree structure of the web page provided by DOM (Document Object Model) in order to deduce for each ontology concept and role an assimilated parallel path from the web page. Finally, it comes up with an annotation based on the generation of ontology instances by direct application of the obtained assimilated paths. One of the major advantages of this approach is that it generates not only instances of concepts but also instances of the roles of concepts in ontology. However, the use of the tree structure is usually limited by the degree of regularity in the web page and the extent of its conformity with the hierarchy represented in the ontology. In the same context, [16] opts for a semi-automatic annotation always according to the semantics of the web page, but without the use of its DOM structure. Instead, [16] opts for the use of the Semantic Radar tool, which performs automatic metadata extraction, defining the semantics of the page with descriptor types FOAF (Friend of a friend), SIOC (Semantically-Interlinked Online Communities), DOAP (Description of A Project) and RDFa (Resource Description Framework in attributes) with the purpose of generating an initial source of analysis for each page. The next step is to reinforce the relevance of the annotation by pairing the obtained results with others offered by domain ontology, according to the rules of equivalence and an annotation model. At this point, two types of ontologies are considered: (i) an enriched domain ontology (OWL) and (ii) a FOAF and SIOC ontology (.RDF). Finally, we get for each web page, a file containing metadata in RDF format. The experimental results are quite satisfactory according to [16]: 45% of web pages are annotated especially in a vast environment, containing heterogeneous resources such as the web.

In [17], another annotation system is presented: 'DYNOSYS'. It has a distributed architecture that supports collaborative work and it is platform-independent. Unlike the system in [16], generated annotations in [17] are in XML format.

3.2 Annotation of multimedia documents

As for the area of multimedia documents, we look at various studies that are interested in very specific fields, and which, through their proposals and approaches, have been able to satisfactorily meet the varying needs of the practitioners in these fields.

For instance, [19] presents an approach that aims to automating manual annotation tools dealing with the annotation of sign language videos, by proposing architecture capable of providing a distributed system hosting automatic annotation assistants on remote servers. Data description is in XML format and is structured in the form of annotation graphs that annotation tools must be able to import and export.

In the medical field, [18] proposes a method of knowledge creation, that is based on the cooperative annotation of surgical videos by practitioners and domain experts, by building and sharing objects, results and observations which will be useful for the extraction of the video's semantics. To this end, two processes are put in place: one for creating concepts and the other for learning them. Each of the two processes goes through three phases: (i) an individual observation phase which allows the participants to annotate videos, each according to his/her level of expertise, his viewpoint etc. (ii) a group negotiation phase, and finally (iii) a concept elaboration phase. Each process iterates as many times as necessary to achieve a set of common and coherent annotations between group members, which makes the task difficult and complicated despite the proven improvement in practices according to experimental studies. Regarding the semantic data, ontologies and annotations are structured in RDFS / RDF format.

Two other works deal with the annotation and the description of multimedia documents using XML graphs similarly to the previous work. The first system, proposed in [6] is a meta-modeling of semi-structured data by defining a set of metadata for each different medium – text, image, audio and video – in order to have a unified presentation of annotations for multimedia documents based on the content and its semantics. The metadata structuring is done in XML documents called meta-documents containing textual metadata or links to information in the case of non-textual metadata. The second is a video annotation system presented in [20], which proposes to organize and present the annotations in the form of graphs by introducing the description schemas and dimensions of analysis. The aim is to ensure (i) easy management of an extended vocabulary, and (ii) an easy, fast, customized query-and-response construction system when searching for information.

3.3 Annotation as a part of E-learning

In the e-learning field, some approaches are directed towards resources annotation. They focus on platforms and systems that allow instructors to prepare course materials and make them available to students. [21] is one of works coming in that context. It proposes an annotation model dedicated to teachers based on three facets of learning: cognitive, semantic and contextual. This model, translated into an architecture, gives birth to two subsystems. One of them allows the management of learning contexts while the other takes care of annotations management that are created and transmitted in XML, to ensure seamless communication and exchange between different modules of the model.

In the following, we present a discussion in summary form drawn from the aforementioned works.

IV. SUMMARY AND DISCUSSION

By surveying the literature of semantic annotation, some indispensable requirements come to mind in order, to create a complete and highly performed annotation system that fits the needs and expectations of practitioners. From the perspective of automation level, we notice that manual annotation systems offer a high accuracy. Moreover, they are outdated and consuming in terms of time and manpower. For entirely automated systems, the quality of results remains inferior, which explain the use of semi-automatic annotation systems that combines the strengths of both worlds. In other words, the more a system combines principles of manual annotation – collaborative annotation, manually-made ontologies (generic domain-specific, predefined, or custom-made for a specific need), the definition of concepts, models and rules by human agents – with a well-optimized automation, the better the efficiency and the quality of the annotation. The better integrated the extensions and tools of descriptor semantics and data extraction, the more satisfactory and efficient the annotations are. Regarding the physical architecture, a variety of works emphasize on the distribution concept. A distributed architecture improves the system effectiveness by, (i) guaranteeing the high availability of services against the interruption, (ii) minimizing the critical failure points, (iii) parallelizing tasks and (iv) load-balancing the work over cluster nodes.

In terms of data and resources description, collaborative annotation stands out as the most preferred solution when creating abundant, reliable and very specific annotations for partially or entirely document annotation regardless of the resource type. Certain works suggest to begin with a single annotation before a negotiation step between annotators, to discuss and choose the most semantically appropriate concepts. Others choose the creation of collaborative annotation sessions as forums, to exchange all-out quantity of information and knowledge related to the same resource from different points of view and annotators with different level of expertise, possibly even by using various annotation forms. Concerning the serialization, storage and transformation of semantic data, ontologies are often encoded in RDFS and OWL, while annotations are generated using RDF format. In fact, RDF is defined as the semantic web's greatest achievement. It is by a margin the best resource description standard that fits most significant needs. Its formal description of web resources guarantees efficient machine-readability and automatic processing of metadata and annotation.

As for the annotation of multimedia documents, we noticed that most practitioners opt for an XML graphs based description, due to the need to provide some structure to the document to ensure data communication and exchange while still successfully maintaining document's description.

V. CONCLUSION

Document annotation is becoming more and more crucial and indispensable for a high-performance document managing and exploitation. Although in the current study, we highlight some problems related to both document annotation tools and methods. So, first, we define broadly the concept of annotation, by providing an overview of the state of the art while surveying the main annotation tools and related works in the literature, then we end with a synthesis. Based on that, our own semantic annotation system will be developed according to high quality and performance annotation, having in mind multiples types of media, document structures and the system automation level.

REFERENCES

[1] Y.Prié, S.Garlatti, "Annotations et métadonnées dans le Web sémantique", in Revue I3 Information-Interaction - Intelligence, Numéro Hors-série Web sémantique, 2004, 24 pp.

[2] S. Bringay, C. Barry, J. Charlet, "Un modèle pour les annotations du dossier patient in formatisé", P. Salembier, M. Zacklad (eds.), Vol. Annotations dans les documents pour l'action, pp. 47-67, Hermespublishing, 2006.

[3] S. Bringay, C. Barry, J. Charlet, "Les annotations pour gérer les connaissances du dossier patient", Actes IC 2005, Nice (France): 73-84.

[4] E. Desmontils, C. Jacquin, "Annotations sur le Web : notes de lecture", in Journées Scientifiques Web Sémantique, (Action Spécifique STIC CNRS), Paris, France, 2002, pp 10-11.

[5] G.Cabanac, "Annotation de ressources électroniques sur le Web : formes et usages", Master Report, Paul Sabatier University, June 2005.

[6] A. JEDIDI, "Modélisation Générique de Documents Multimédia Par des Métadonnées : Mécanismes d'Annotation et d'Interrogation", PhD thesis, Paul Sabatier University, July 2005.

[7] Y. Toussaint, S. Tenier, "Annotation sémantique par classification", Francky Trichet. Ingénierie des Connaissances, Jul 2007, Grenoble, France. Cépadues éditions, 2, pp.85-96, 2007, Ingénierie des Connaissances - 18èmes journées francophones.

[8] M. Thiam, "Annotation sémantique de documents semi-structurés pour la recherche d'information", PhD thesis, Paris Sud University , 2010.

[9] Kahan, M.R. Koivunen, E. Prud'Hommeaux, R. Swick, "Annotea: an open RDF infrastructure for shared Web annotations", in Proceedings of the 10th international conference on World Wide Web pp. 623-632, 2002.

[10] R.Schroeter, J.HunterD.Kosovic, "Vannotea – A Collaborative Video Indexing, Annotation and Discussion System For Broadband Networks", In K-CAP 2003 Workshop on Knowledge Markup and Semantic Annotation.

[11] S. Handschuh, S.Staab, A.Maedche, "CREAM-Creating relational metadata with a component-based, ontology-driven annotation framework", in the 1st international conference on Knowledge capture, K-CAP 2001, Victoria, British Columbia, Canada.

[12] S.Chapman, B.Norton, F.Ciravegna, "Armadillo Integrating Knowledge for the Semantic Web", in Proceedings of the Dagstuhl Seminar in Machine Learning for the Semantic Web 2005.

[13] S.Handschuh, S. Staab, F.Ciravegna, "S-CREAM — Semi-automatic Creation of Metadata", 2002.

[14] P.Kogut, W.Holmes, "AeroDAML - Applying Information Extraction to Generate DAML Annotations from Web Pages", First International Conference on Knowledge Capture (K-CAP 2001),Workshop on Knowledge Markup and Semantic Annotation, 2001.

[15] S.Tenier, A. Napoli, X. Polanco, Y. Toussaint, "Annotation sémantique de pages web", 2006, pp. 305-310.

[16] S.Maalej Dammak, A.Jedidi, R.Bouaziz, "Automation and evaluation of the semantic annotation of Web resources", in Internet Technology and Secured Transactions (ICITST), 2013 8th International Conference for , 2013 , pp. 443 – 448.

[17] E. Desmontils, C. Jacquin, L.Simon ,"Annotation sur le web : types et architectures" .

[18] P.Dayre, H.Batatia, "Annotation collaborative de médias pour l'émergence et l'apprentissage de concepts dans le milieu médical", In proceedings of SIIM'2011 (2011).

[19] C.Collet, M.Gonzalez, F.Milachon, "Architecture d'un Système Distribué pour l'Annotation Assistée de Corpus Vidéo", In Automaticprocessing of naturallanguage,processingautomatic of signlanguages(NLP - Provincewide 2010), Montreal.

[20] E.EGYED-ZSIGMOND, "E-SIA : un système d'annotation Et de recherche de documents audio-visuels", In INFORSID 2003,pp. 369-383.

[21] A.Ouadah,F.Azouaou, C.Desmoulins, "Modèles et Architecture d'une Mémoire d'Annotation context-aware pour l'Enseignant", In Proceedings of the 2nd Conférence Internationale sur l'Informatique et ses Applications (CIIA'09), Algeria, 3-4, 2009.

[22] GuisseA.,Levy F.,Nazarenko A.,SzulmanS.:Annotation semantique pour l'indexation de reglesmetiers, Conference Internationale sur la Terminologie et l'Intelligence Arti_cielle (TIA 2009).

[23] A.Idarrou "Rentreposage de documents multimédias : comparaison de structures". Thèse –2013.

[24] Y.Chabane, C.Rey(2013). "Annotation et recherche sémantique d'images en gastro-entérologie".

[25] L.Ramadier, M.Zerrouk, M.Lafourcade, A.Micheau (2014). "Annotation et inférences de relations dans un réseau Lexico- sémantique: application à la radiologie".