

Annotations: Enriching a Digital Library

Maristella Agosti and Nicola Ferro

Department of Information Engineering
University of Padua

Via Gradenigo, 6/B – 35131 Padova (PD) – Italy
{maristella.agosti, nicola.ferro}@unipd.it

Abstract. This paper presents the results of a study on the semantics of the concept of annotation. It specifically deals with annotations in the context of digital libraries. In the light of those considerations, general characteristics and features of an annotation service are introduced. The OpenDLib digital library is adopted as a framework of reference for our ongoing research, so the paper presents the annotations extension to the OpenDLib digital library, where the extension regards both the adopted document model and the architecture. The final part of the paper discusses and evaluates if OpenDLib has the expressive power of representing the presented semantics of annotations.

1 Introduction

This paper reports on a study on annotations conducted in the context of the *Technologies and Services for Enhanced Content Delivery* project, which is also known as *Enhanced Content Delivery*¹ (ECD). ECD is a research project launched by the Italian National Council of Research (CNR) in 2002 with the aim of developing methods and technologies for the enhanced delivery of contents to final users. Several academic, research, and industrial partners are participating nationwide on the project.

The final target of this research is to face in general the concept of annotation focusing on digital libraries services. General findings are then adapted to a specific digital library, such as OpenDLib, to demonstrate their use and validity.

The presentation of findings is structured as follows: Section 2 presents considerations on the semantics of the concept of annotation, this section constitutes the conceptual basis for the definition of the annotation service to be developed. Section 3 illustrates what are the aspects to be considered in annotating digital libraries. In Section 4 we briefly present OpenDLib, which is the reference digital library of ECD, Section 5 presents our proposal of extension of OpenDLib to support built-in annotations functionalities. Section 6 presents the architecture and the characteristics of the prototype annotation service. Finally, Section 7 reports some conclusions on the work.

¹ <http://www-eed.cnuce.cnr.it/>

2 Semantics of the Annotation Concept

The first part of the conducted study on annotations has been devoted to the analysis and understanding of the complex semantics which is behind the concept of annotation.

A lot of interesting research papers have been published over the years on this theme, see for example [7,8], where the viewpoint of understanding users' practice in annotating and of pointing out annotations patterns is addressed. Keeping in mind the previously published papers, we would like briefly to discuss the concept of annotation from a slightly different point of view, considering that the annotation is a concept which has been enriched and stratified in our cultural heritage with the passing of time.

If we look up the meaning of the following words: *annotation*, *gloss* and *note*, we can find that they are tightly connected with the concept of annotation itself. These words are used in order to express: explanation and clarification of words or passages of a text, therefore we can expounding on it, provide a commentary on it, and finally complete it with personal observations and ideas. We can form an opinion about the evolution and the rich semantics of the concept of annotation looking at the term *gloss*. The term *gloss*², at the time of the ancient Greeks, meant an obscure locution that required an additional explanation and it was also used as an explanation itself of words that were not clearly understood. While during the Middle Ages it meant an interlinear or marginal note to a biblical or juridical codex and also the collection of annotations of a glossarist; and we arrive today at its current meaning: note and annotation.

This brief description of the concept of annotation, together with the knowledge of previous research, helps us in understanding how its semantics can be complex and the role in which the concept of annotation is played out in our cultural heritage: annotations were not only a way of explaining and enriching a text with personal observations, but also a means of transmitting and sharing ideas about a concept.

We are interested in grasping and focusing our attention on three main aspects concerning the concept of annotation:

- *comprehension and study*: while studying, annotating a text is a way to investigate and understand a concept better. This process principally involves a private dimension, because the recipient of an annotation is the person who made it, although other people reading an annotated text could benefit from existing annotations;
- *interpretation and divulgation*: annotating a text could be a way of adding comments and explaining sentences of a text. The aim is to make it more comprehensible and to exchange ideas on a topic; an example could be an expert in literature who explains and annotates the Divine Comedy. This process principally involves a public dimension, because the recipients of an

² The ancient Greek word γλῶσσα (*gloss*) means language, idiom, spoken word, foreign or obsolete word or language.

annotation are people who are not necessarily related to the author of the annotation;

- *cooperation and revision*: a team of people could annotate a text for various purposes, as they are working on a common text or they are reviewing someone else’s work; annotating a text is thus a way of sharing ideas and opinions in order to improve a text. This process principally involves a collective dimension, because the recipient of an annotation is a team of people working together on a given subject.

We can consider these three main aspects of annotation as a conceptual difference identified as *meaning of annotation*.

Even if these three main aspects of the concept of annotation are, in some way, similar to the dimensions of annotation as stated in [8], they differ because they are in fact different conceptual meanings of annotation. While dimensions of annotation are a categorization that reflects the form which they may take on.

Now that we have seen the main meanings of the concept of annotation, we have to investigate how they can appear and be represented. Basically there are three ways of representing the meaning of annotation:

- *textual sign*: is a textual materialization of the semantics of an annotation and it is expressed by a piece of text added to a document or a piece of a document;
- *graphic sign*: is the graphical materialization of the semantics of an annotation and it is expressed by a graphic mark added to a document or a piece of a document;
- *reference sign*: is the hypertextual materialization of the semantics of an annotation and it is expressed by a link between two texts.

The three basic ways, in which the meaning of annotation takes shape, can be called *sign of annotation*, keeping in mind that a sign is a formation of a meaning.

Those basic signs can be combined together to express more complex signs of annotation. For example if we take a textual sign, which is an additional explanation of a concept, it can also be combined with a type of mark, which is called a graphic sign, in order to highlight the content which it refers to, as shown in Figure 1(a). Another example could be a reference to another text, which is a reference sign, and it can be used with an arrow, which is a graphic sign. You will note that this arrow is pointing to the referred text; in addition it can be combined with a further explanation, which is a textual sign, as shown in Figure 1(b).

It is worth observing that the combination and compounding of those basic signs allows us express all the meanings of annotation, explained above: for example if a person is studying a document he simply can use a graphic sign to highlight the important content, and so the “comprehension and study” meaning of annotation can be expressed. During the revision of an article the author can use a graphic sign to delete an incorrect phrase, a textual sign is used to correct

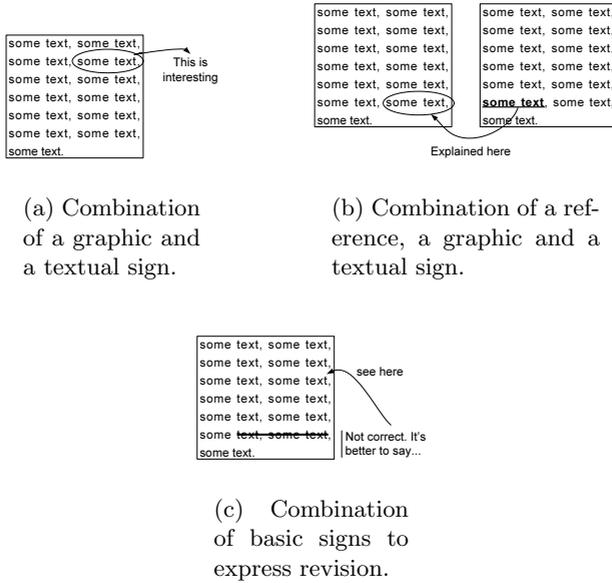


Fig. 1. Combination of basic signs.

the phrase and a reference sign can be compounded with a graphic sign to indicate another piece of text justifying the correction he made, as shown in Figure 1(c). In conclusion the “cooperation and revision” meaning of annotation can be expressed in this way.

The semantic complexity of an annotation entails an intrinsic dualism between annotation as content enrichment or as a stand-alone document.

That twofold nature of the annotation is clear if we think about the process of studying a document: firstly, we can start annotating some interesting passages that require an in depth investigation, which is an annotation as content enrichment; then we can reconsider and collect our annotations and we can use them as a starting point for a new document, covering the points we would like to explain better³, which is an annotation as a stand-alone document. In this case the annotation process can be seen as an informal, unstructured elaboration that could lead to a rethinking of the annotated document and to the creation of a new one.

³ A famous annotation, which bewitched generations of mathematicians, is “I have discovered a truly remarkable proof which this margin is too small to contain”, made by Fermat in the margin of Bachet’s translation of Diophantus’s *Arithmetica* and speaking about the famous Fermat’s Last Theorem.

3 Annotation in the Context of a Digital Library

If we consider annotations in the context of digital libraries, this will call forth new possibilities which will enrich the semantics and expressive power of annotations. We can exploit the digital library by creating cross-linked annotations with a free flow of information between annotations and documents.

It is possible to have different layers of annotations on the same document: a private layer of annotations, which can be accessed only by the annotations author himself; a collective layer of annotations, shared by some users who are working on a document; finally a public layer of annotations, accessible to all users of the digital library. A digital library can encourage cooperative work practices, enabling the sharing of documents and annotations, also with the aid of special devices, such as XLibris [13]. Those themes are investigated and presented in detail in [7,11,9].

In the context of a digital library it is also possible to create automatic annotations, which may help the user in approaching a document. Automatic annotations can be created using topic detection techniques to associate each annotation with its related topic, which forms the context of the annotation. In this way a document can be re-organized and segmented into topics, whose granularity can vary, and annotations can present a brief description of those topics. Then by applying automatic hypertext construction techniques, similar to those presented in [3], those pairs of topics and annotations can be linked together, proposing an alternative way of navigating the content of a digital library.

Finally, as suggested in [10,12], searching, reading and annotating a digital library can be done together with other activities, for example working with colleagues. This can also occur in a mobile context. Merging content and wireless communication can develop ubiquitous access to digital libraries, improving well established cooperative practices of work and exploiting physical and digital resources. The wireless context and the small form factor of handheld devices has challenged our technical horizons for information management and access. A detailed description of those themes can be found in [2].

On the whole this line of reasoning has two main aims:

- developing an in depth comprehension of the semantics of annotations;
- keeping in mind a list of features which a digital library should offer for supporting annotations.

4 OpenDLib and Its Representation of Documents

The Institute of Information Science and Technology (ISTI) of CNR of Pisa has recently designed a model of the architecture and services that enables us to design a digital library service. Based on those architectures and services a Digital Library Service System (DLSS) [1], named OpenDLib, has been developed [6].

OpenDLib is a software toolkit that can be used to create a digital library according to the requirements of a given user community, by instantiating the

software appropriately and then either by loading or harvesting the content to be managed. At present OpenDLib provides a number of interoperating services that implement the basic functions of a digital library. The set of services is not fixed, but it can be extended to provide additional functionalities. To gain further information on the system and the ongoing project, the Web site of OpenDlib can be consulted⁴.

The documents that can be used in OpenDLib have to conform to its document model. This model has been named *Document Model for Digital Library* (DoMDL) and it has been illustrated in [5,4]. DoMDL has the power to represent structured, multilingual and multimedia documents.

DoMDL is based on the following entities, which have been defined in [4]:

- *document*: represents the more general aspect of a document, i.e. the document as a distinct intellectual creation;
- *version*: represents a specific edition of the distinct intellectual creation, i.e. an instance along the time dimension;
- *view*: models a specific intellectual expression of an edition of a document. A view excludes physical aspects that are not integral to the intellectual perception of a document. The entity View is specialized in two sub-entities: Metadata and Content. The former view perceives a version through the conceptualizations given by its metadata representations; the latter is the view of the document content. Content has two sub-entities: Body, and Reference. The Body entity represents a view of the document content that can be either perceived as a whole or as the aggregation of other views. A Reference entity represents a view which is equal to the one that has already been registered and does not need to be explicitly stored;
- *manifestation*: models the physical formats under which a document is disseminated.

DoMDL becomes a central starting point for the research that has to be conducted on an annotation service, since it becomes the document reference model in consideration, therefore DoMDL has been investigated and analysed. We have developed and sketched an example of DoMDL, that can help in understanding its main features.

In Fig. 2 the example of DoMDL for a document of thesis type is shown. We can observe that:

- we have a document, called “Thesis”;
- this document has two versions, one is called “Draft”, the other is called “Final”. The final version has some bibliographic metadata, represented in the view named “Bibdata”. This view has a manifestation, which refers to the file `dcq_final.xml`, and this is actually where the bibliographic records for the thesis are stored;
- the draft version of the thesis is organized into parts and chapters, represented respectively by the views “Parts” and “Chapters”. There are two

⁴ <http://www.opendlib.com/>

- parts, “Part 1” and “Part 2”. We can see that “Part 1” contains two chapters “Chapter 1” and “Chapter 2”, that are the same chapters contained in the view “Chapters”. So we do not have to duplicate these views, but we put a *reference* in the view “Parts” to the views “Chapter 1” and “Chapter 2” contained in the view “Chapters”. The view “Chapter 2” has many different manifestations, i.e. `chapter2.ps`, `chapter2.tex` and `ftp://.../chapter2.pdf`, and some metadata, represented by the view “Metadata Chapter 2” and stored in the manifestation `dc_chapter2.xml`;
- the final version of the thesis is organized into chapters, view “Chapters”, and we can notice that the second chapter, view “Chapter 2”, has not changed from the draft version, so we can make a *reference* to its manifestation `chapter2.tex`.

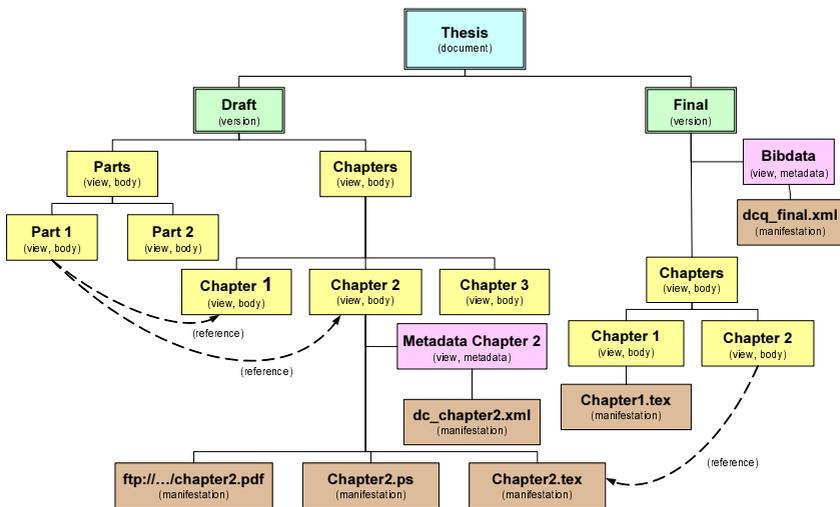


Fig. 2. Example of DoMDL.

5 The Annotation and the OpenDLib Digital Library

According to the constructs of DoMDL, annotations are modelled in two levels: the first level is representing the annotation as another kind of view, so the DoMDL is extended, containing not only a *metadata view* and a *body view* but also an *annotation view*; the second level is representing the annotation as a *manifestation*.

This extension of the model is consistent with the approach taken in defining the DoMDL, preserving the way of representing the structure of a document and of its metadata. So the DoMDL comes out seamlessly extended and this way of

extending the DoMDL could be used as an example of transparent addition of new features to the DoMDL.

Furthermore the actual content of an annotation can be stored in the *Repository*, which is the storage service of OpenDLib, and can be modelled in the same way as any other manifestation of a document. This means that also annotations can benefit from all those features, such as delivering, dissemination, transcoding, that standard documents of OpenDLib benefit from. This extension also maintains the possibility of creating *references* in order to avoid the duplication of information.

Finally this choice of representing and storing annotations give us the possibility of exploiting the search functionalities already implemented in OpenDLib. Indeed the annotation is seen as any other part of the structure of a document in OpenDLib. Therefore it can be searched as any other document in OpenDLib.

After we have made sure that this extension of the DoMDL is well integrated in the existing DoMDL, we have to evaluate if the DoMDL offers us a powerful enough means of representing and modelling the semantics of the concept of annotation and if this choice can be a good compromise between the richness of the concept of annotation and necessity of making annotations manageable by a software.

This choice preserves the distinction between the meaning of annotation and the sign of annotation, introduced in Section 2, because the function of representing the concept of annotation is entrusted to *view* level, while the function of representing the sign of annotation is committed to the *manifestation* level.

Note that we have directly specialized the *view* and not the *metadata view* or the *body view*, because, as explained in Section 2, there is an intrinsic dualism in the concept of annotation between content enrichment and stand-alone document. Thus it would not be correct to specialize the annotation either from the *metadata view* or from the *body view*, because one of the two aspects of the concept of annotation would be omitted.

On the other hand we can consider that the annotation view models the link between an annotation and a document, therefore the annotation view renders the annotation as content enrichment, while the annotation manifestation renders the annotations as stand-alone document. This is not contrary to what has been explained above, because the annotation view is neither a metadata nor a body view, which would have forced the annotation to be either a content enrichment or a stand-alone document, but only maintains the possibility of having a link between an annotation and a document.

Furthermore many of these annotation manifestations can be included in the same annotation view and this renders the compounding of signs of annotations, which is the basic mechanism in order to express the meaning of annotation, illustrated in Section 2.

Finally this representation of annotation allows us to easily manage both threads of annotations, i.e. an annotation made in response or comment to another annotation, because we simply nest an annotation view into another, as it is naturally done with DoMDL, and sets of annotation, i.e. a bundle of anno-

tations on the same passage of text, because we simply put all the annotation views in the view of the passage of text or the annotation they refer to.

So we can conclude that this extension to the DoMDL fairly represents the semantic of an annotation, discussed in Section 2.

Figure 3 reports an example of the extended DoMDL. We can observe that:

- we have added an annotation to the whole final version, represented by the view named “Annotation 1”, whose content is stored in the manifestation `ann1_final.xml`.
- also “Chapter 2” as an annotation, represented by the view named “Annotation 2” and stored in the manifestation `annotation2.xml`, but this annotation is shared with “Chapter 1”, so we can put a *reference* to it.
- on “Annotation 2” there is a “discussion thread”, because there is another nested annotation, represented by the view named “Annotation 3” and stored in the manifestation `annotation2.xml`. Notice that by means of the *reference* also “Chapter 1” is linked to the “discussion thread” on “Annotation 2”.

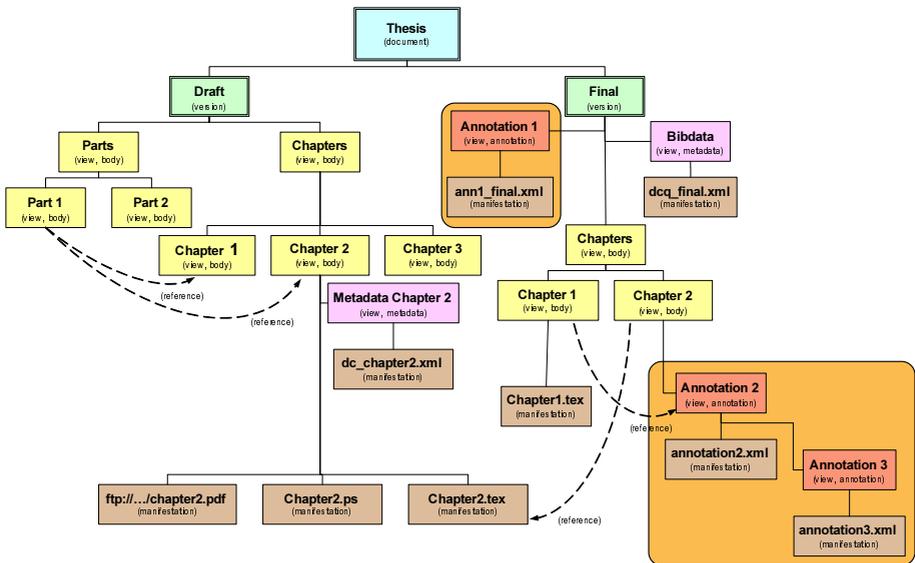


Fig. 3. Example of DoMDL with annotations.

6 OpenDLib Architecture and Annotation Service

The OpenDLib architecture has been introduced in [6,4], the reader interested in gaining an in depth understanding of the architecture is invited to refer to those

papers. Since we work to develop a prototype annotation service for extending the OpenDLib digital library, we have chosen to extend its architecture as depicted in Figure 4 where the general architecture of this service is shown.

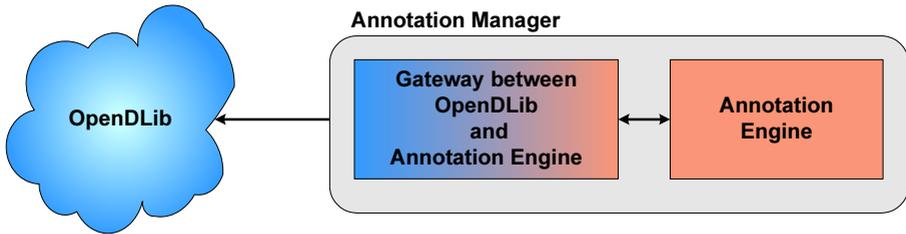


Fig. 4. Architecture of the Annotation Service in OpenDLib.

The service has been named *Annotation Manager* and it is organized in two blocks:

- *gateway*: this server provides functionalities of mediator between the back-end server, which creates and manages annotations, and the OpenDLib federation. From the standpoint of OpenDLib this is a usual service of OpenDLib and so, on the whole, the Annotation Manager appears to OpenDLib as an usual service, although in reality it is made up of two different servers;
- *annotation engine*: this back-end server provides the core functionalities of annotation representation, annotation management and annotation creation, in the case of automatic annotations.

Please note that this architecture gives us high flexibility, because the core features of the annotation service are separated from the actual integration in a specific digital library. This architectural decision allows the service to be available for another digital library, which means only creating a new gateway.

The functioning of the Annotation Manager differs if we are dealing with a manual annotation or a automatic annotation. In the former case the Annotation Manager interacts with the Repository for inserting the annotation view into the instance of DoMDL of the desired document and for returning the annotation manifestation to be stored in the Repository.

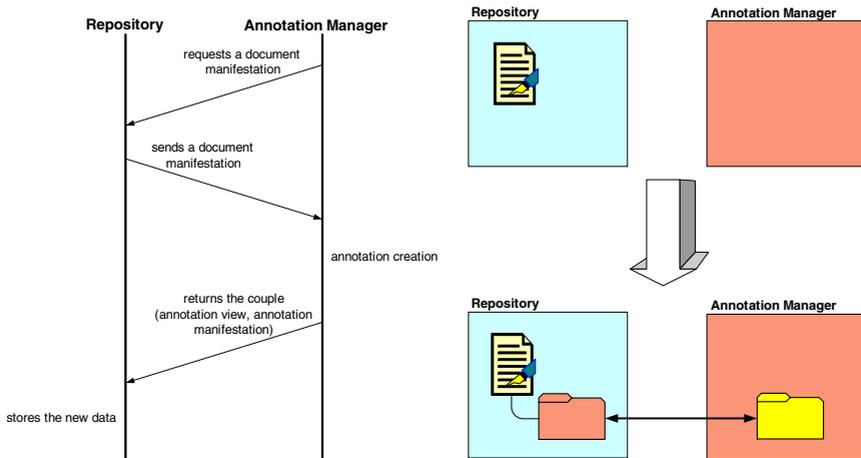
In the latter case the Annotation Manager:

- requests and receives the manifestation of a document from the *Repository*;
- elaborates and indexes the received document and creates the annotation, representing it with an annotation view and an annotation manifestation;
- returns to the Repository the annotation view to be inserted into the DoMDL and the manifestation of the annotation.

The annotation view is going to contain all data that are necessary to link the annotation view itself, stored in the Repository, with the information about

the annotation, stored in the Annotation Manager. It needs to be noted that the last item of the previous list is also the same as the manual annotation case.

The annotation creation process is shown in Fig. 5(a) and the relationships between the different objects are shown in Fig. 5(b).



(a) Annotation creation process.

(b) The *Repository* and the *Annotation Manager* before and after the creation of an annotation.

Fig. 5. Creation and management of annotations.

A final remark: the chosen way of inserting the annotation service in the architecture of OpenDLib is a good choice, because it enables all of the features described in Section 3 to be feasible. Furthermore it is flexible enough to be extended in supporting particular apparatuses, such as XLibris, and handheld devices.

7 Conclusion

We have presented in this paper our findings on a general study on annotations and on relevant aspects of designing and developing an innovative service for annotating a digital library. The work is conducted in the context of the ECD national ongoing project which is due to be completed by the end of 2004. By then the final annotation service is going to be released.

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