Introduction of a Dynamic Assistance to the Creative Process of Adding Dimensions to Multistructured Documents *

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ABSTRACT

We consider documents as the results of dynamic processes of documentary fragments' associations. We have experienced that once a substantial number of associations exist, users need some synoptic views. One possible way of providing such views relies in the organization of associations into relevant subsets that we call "dimensions". Thus, dimensions offer orders along which a documentary archive can be traversed. Many works have proposed efficient ways of presenting combinations of dimensions through graphical user interfaces. Moreover, there are studies on the structural properties of dimensional hypertexts. However, the problem of the origins and evolution of dimensions has not yet received a similar attention. Thus, we propose a mechanism based on a simple structural constraint for helping users in the construction of dimensions: if a cycle appears *within* a dimension while a user is creating a new dimension by the aggregation of existing ones, he will be encouraged (and assisted in his task) to restructure the dimensions in order to cut the cycle. This is a first step towards a rational control of the emergence and evolution of dimensions.

Categories and Subject Descriptors

H.3.7 [**Information Storage And Retrieval**]: Digital Libraries—*User issues*

General Terms

Human factors, Design

Keywords

dimensions, hyperstructures, multistructured documents

*This work was co-funded by the National Research Agency under the AOC project: ANR-08-CORD-009.

DocEng'11, September 19–22, 2011, Mountain View, California, USA.

1. INTRODUCTION

The ideas we would like to introduce appeared to us while working with members of the Jean-Toussaint Desanti Institute[1] (ENS-Lyon[2]). Philosophers from the Institute are building a digital edition of the handwritten archives of French philosopher Jean-Toussaint Desanti (1914-2002).

Digital editing covers the whole editorial, scientific and critical process that leads, eventually, to the publication of an electronic resource. In case of manuscripts, the editing process mainly consists in the transcription and critical analysis of digital facsimiles. In terms of computations, such an analysis comprises at least two aspects. The first one is the association of an annotated textual document with the images of a handwritten manuscript. The second one is the formalization of the uncovering of interesting associations between fragments of the archive. For example, a set of pages is identified as a first version of a well-known published work.

In the context of our main use case, users, with a strong philosophical background, are studying a large collection (90170 handwritten pages organized hierarchically in 1288 collections) of handwritten documents. Their main concern is in finding meaningful orderings for the documents of the archive. Without this preliminary work, the archive could hardly reach the many potentially interested readers. In order to fulfill this ordering task, the users have to find associations between heterogeneous documentary fragments (images of manuscript pages, transcriptions, intervals of text, polygonal zones extracted from the images, etc.).

Therefore, the system we developed (DINAH) let the users create ternary relations for representing associations between documentary fragments (see Figure 1).

In this work, we will be interested in finding an effective way for the users to manage the growing complexity of the associations they create between documentary fragments.

2. A NEED FOR SYNOPSIS

As far as our experiments with the users of the J.T. Desanti's Institute can tell us, when a substantial number of associations have been created, the naive graph representation implied by the SVO (Subject-Verb-Object) metaphor fails at providing the synoptic views the users need.

One possible way for providing such views relies in the

[1]http://institutdesanti.ens-lyon.fr/
[2]http://www.ens-lyon.eu/

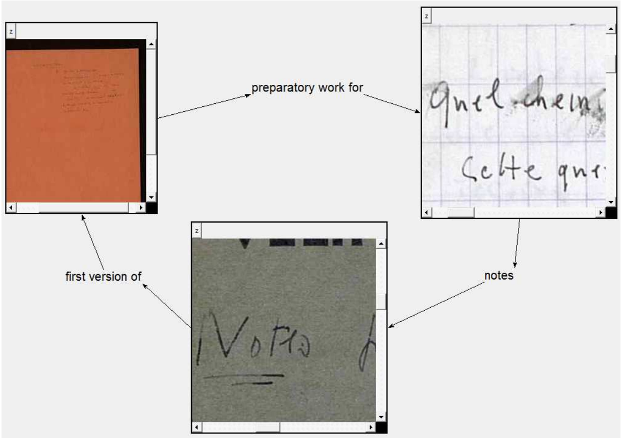

Figure 1: Screenshot of the graph-oriented module for the creation and the visualization of associations

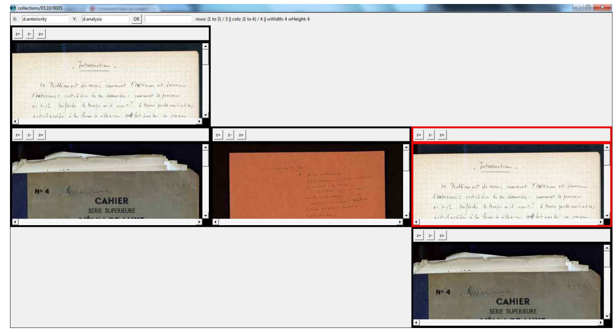

Figure 2: Screenshot of the dimension-based visualization module of DINAH (X: *d.anteriority* **; Y:** *d.analysis***)**

organization of the associations into relevant subsets we call "dimensions". The abstract function of a dimension is to group similar ways of associating documentary fragments. For example, to a dimension named "anteriority" could belong all the instances of the associations labeled "is a draft for", "is a preprint of", "is a first version of", "is a preparatory work for", etc.

How do dimensions appear? What governs the process of their construction? First of all, as far as a specific domain is concerned, one could often find *a priori* and pertinent dimensions. For example, in case of textual documents, the TEI (Text Encoding Initiative) [5] can certainly bring some interesting insights into the set-up of dimensions. However, we are mainly interested by situations with insufficient *a priori* knowledge for managing the complexity of the relations. Thus, while users are creating new associations we would like to help them define meaningful dimensions. To that purpose, we will introduce a new semi-automatic methodology for the construction of dimensions.

3. RELATED WORK ON DIMENSIONS

The dimensions we now introduce are binary relations in a mathematical sense (i.e. sets of pairs). Therefore, the association between two documentary fragments (e.g. A is_a_preparatory_work_for B) is represented by the membership of the pair of documentry fragments to a dimension representing this kind of association (e.g. $(A, B) \in$ d.preparatory_work).

Two dimensional models will differ by the structural constraints the pairs belonging to a dimension have to meet. Thus, by combining a few structural constraints (invertibility, partial functions, cyclic relations, . . .), we now introduce well-known dimensional models.

3.1 Hyperorder

Hyperorders [1] are based on binary relations. A hyperorder is defined by the pair: $< F, \{D_1, D_2, \ldots, D_n\} >$ where the second member of the pair is a set of binary relations called *dimensions*.

3.2 Zzstructure

A zzstructure [4] is a hyperorder with two additional restrictions:

- The dimension are invertible: for each dimension D_m, there is a dimension D_m^{-1}.
- The dimensions are partial functions.

Since the dimensions are partial functions, a cell can only be the subject of at most one association along a specific dimension. Moreover, since the dimensions are invertible, and the inverse dimension must also form a partial function, a cell can only be the object of at most one association along any specific dimension. Thus, a zzstructure offers a linear way of navigating along dimensions (without the need of any hyperlinking engine).

The users can be offered presentations like the one of Figure 2. The computer screen is mapped to a Cartesian space. The dimension "d.anteriority" has been affected to the horizontal axis and grows positively to the right. Since each dimension is invertible, the dimension "inv(d.anteriority)" is affected to the horizontal axis of the screen and grows positively to the left. Similarly, the "d.analysis" dimension has been affected to the vertical axis of the screen.

Finally, in order to interpret unambiguously the representation of a zzstructure, we need to specify the meaning of the fragments on rows and columns others than the ones crossing at the cursor. Two interpretations have been proposed [4]. An illustration of the first one called "H view" is given by the Figure 3. Given this representation one could deduce, for example, that the pairs $(F4, F2)$ and $(F3, F5)$ are members of the dimension $D1$ while the pair of documentary fragments $(F4, F3)$ is a member of the dimension $D0$. However one shouldn't deduce that the pair $(F2, F5)$ is a member of the $D1$ dimension. In other words, in case of the "H view", apart from the two main axes crossing at the cursor, only the vertical juxtapositions of documentary fragments are meaningful. Similarly, in case of the so-called "I view", apart from the two main axes, only the horizontal juxtapositions of fragments are meaningful.

3.3 Edge-colored graph

It has been proved [3] that a zzstructure is theoretically equivalent to an edge-colored graph. The edges with a same color don't have to form a partial function on the set of nodes. Thus, for example, a documentary fragment can be linked to more than one author by a relation named "author". A zzstructure can't directly model such a situation. However by adding to a zzstructure a "d.clone" dimension

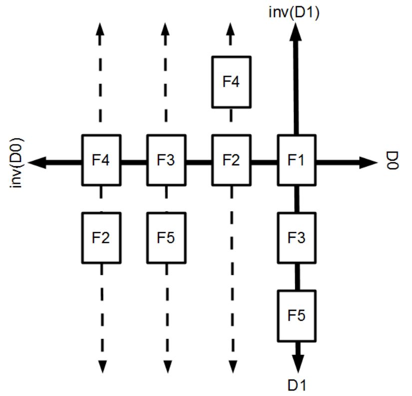

Figure 3: Illustration of the "H view" of zzstructures

along which cells can be cloned, it becomes possible to model multi-pointing links [1].

However, by using edge-colored graph, we are losing some of the good navigational properties of zzstructures: a dimension doesn't have to be a strictly linear structure but branching can occur.

3.4 Semantic Web

Finally, "semantic webs" [2] are edge-colored graph with an additional restriction: the edges with a same color cannot make cycles.

3.5 synthesis

We want to explore how a dimensional data modeling and presentation framework could, at least partially, answer the need for synoptic views. However, none of the dimensional models introduced above are taking into account the problem of the creation of dimensions. Therefore, we introduce a mechanism for helping the users in the process of building meaningful dimensions that will provide powerful synoptic views on the documentary archive.

4. METHODOLOGY FOR THE CONSTRUCTION OF DIMENSIONS

Our dimensional model add to the zzstructure an acyclicity constraint. We have chosen this constraint since its violation is often meaningful. We shall now explain this point in more details.

4.1 The discriminating power of cycles

We are assuming that when two relationships between two given nodes are making a cycle and are not each other inverse, then they don't semantically belong to the same dimension. In other words, it is assumed that the "unity of meaning" of a dimension would be lost if such cycles could occur.

However, the zzstructure model allows dimensions to have a ring structure. Indeed, since a node can only be the subject (resp. object) of at most one association, the only kind of possible intra-dimensional cycle is a ring. But it can be observed that each time such a ring structure is mentioned in the context of zzstructures, it is in a navigational context only. As an example, T.H. Nelson while describing "The main mechanisms of ZigZag" references "wheels" as[4]:

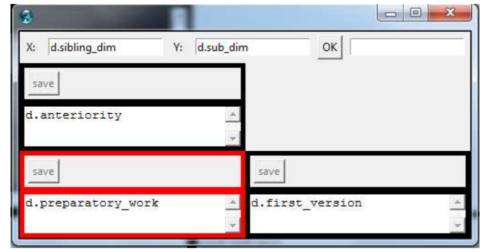

Figure 4: ***d.anteriority*** **is defined as an aggregation of the dimensions** ***d.first_version*** **and** ***d.preparatory_work***

> ringrank of cells that effectively turns, operationally, as one or more pointers step around it. Ringranks with stepping pointers are used for a number of repetitive operations or data: (1) "next dimension" (2) "next view" . . .

If we extend the previous argument to cycles of n nodes with $n > 2$, we can encounter two situations:

- $n - 1$ edges belong to a dimension D while 1 edge belongs to D^{-1}, the inverse of D (this is a form of transitivity).
- At least two different dimensions, which are not each other inverse, are involved in the cycle.

We didn't take into account the case of an identity relation. For example, if "x is-a y" and "y is-a x", it may seem like we have a cycle inside a dimension. . . But really, x is obviously equals to y.

Therefore, from this analysis, it appears clearly that[2]:

> where cyclicity exists, it is always asymmetric

So, it is at least reasonable to emphasize our acyclicity constraint in the context of the zzstructure dimensional model.

By design, the dimensional interface of Figure 2 will not allow the creation of a cycle inside a dimension. But then, how can we claim that this additional constraint will help the users for the creation of meaningful dimensions? In order to answer this, we have to introduce one last component of our dimensional model: a way of building new dimensions from the composition of old ones.

4.2 The composition of dimensions

A new dimension can be created by aggregation of other dimensions. This ability combined with dimensional representations (e.g. Figure 2) truly reveals the synopsis power of dimensions. For example, a dimension *d.anteriority* can be defined as an aggregation of the dimensions *d.first_version* and *d.preparatory_work*. We introduced two new dimensions (*d.sub_dim* and *d.sibling_dim*) for the users to manipulate this aggregation structure (see Figure 4).

4.3 An interactive use of the acyclicity constraint

We let the users create associations between documentary fragments of the archive with the dimensional framework introduced above. For example, they may have used the dimensions *d.first_version* and *d.preparatory_work* as in Figure 5.

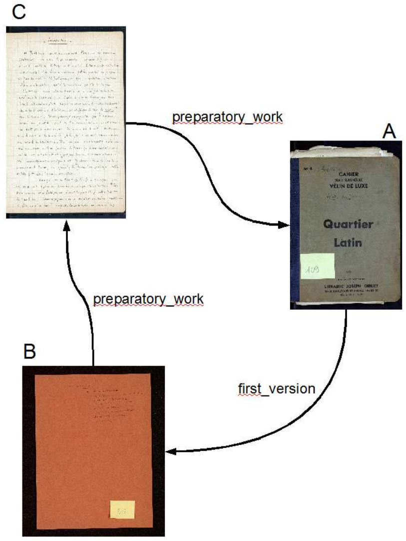

Figure 5: An example use of the dimensions *d.first_version* **and** *d.preparatory_work*

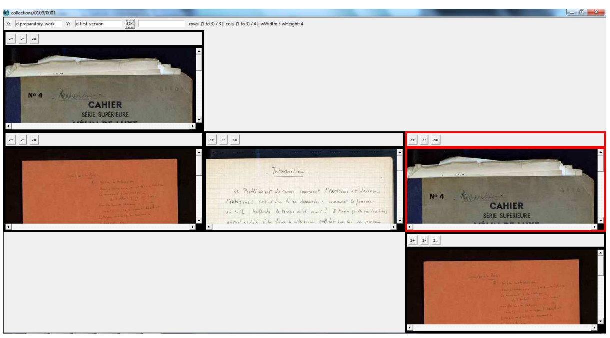

Figure 6: When a cycle occurs, the users are offered a dimensional view centered on the conflicting situation. (X: *d.preparatory_work* **; Y:** *d.first_version***)**

For building synoptic views, they can group dimensions with the aggregation mechanism introduced above. However, this can make a cycle appear within the newly created dimension... This would happen on our previous example (Figure 5) if it was decided to aggregate *d.first_version* and *d.preparatory_work* into a *d.anteriority* dimension.

When such a cycle is detected, the aggregation process is suspended and the user is offered a dimensional view centered on the conflict (see Figure 6). We have been able to see that each time such a restructuring opportunity is offered to the users, interesting and meaningful information is formalized!

5. CONCLUSION

Our lightweight methodology offers a simple mechanism for dynamically promoting a rational structuring of the dimensions. From the reduction of intra-dimensional cycles, knowledge is gained either about the inverse of dimensions or about the structuring of the dimensions. This work is a first step towards a generic mechanism for assisting the users in creating multistructured documents in the context of dimensional hypertext systems.

6. ACKNOWLEDGMENTS

We would like to thank the team of researchers from the Jean-Toussaint Desanti Institute for their collaboration during the development of DINAH.

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