A Spatial Algebra for Multimedia Document Adaptation

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***Abstract*— The multiplication of execution contexts for multimedia documents requires the adaptation of document specifications. This paper instantiates our previous semantic approach for multimedia document adaptation to the spatial dimension of multimedia documents. Our goal is to find a qualitative spatial representation that computes, in a reasonable time, a set of adaptation solutions close to the initial document satisfying a profile. The quality of an adaptation can be regarded in two respects: expressiveness of adaptation solutions and computation speed. In this context, we propose a new spatial representation sufficiently expressive to adapt multimedia documents faster.**

***Index Terms*— Semantic adaptation, qualitative reasoning.**

I. Introduction

A multimedia document may be played on different devices with different capabilities: phones, PDAs, etc. These introduce different constraints on the presentation itself. For instance, display limitations can prevent overlapping regions from being displayed at the same time for visibility reasons.

To satisfy these constraints, multimedia documents must be adapted, i.e., transformed into documents compatible with the target contexts before being played. Several kinds of adaptation are possible, such as local adaptation (adaptation of media objects individually) and global adaptation (adaptation of the document structure). This paper focuses on the latter.

In [1], we have proposed a framework for adapting a multimedia document based on the qualitative semantics of the documents and constraints. This work has been applied to descriptions based on the Allen algebra [2].

As far as the spatial dimension is concerned (§II), many qualitative representations can be used to describe documents. Some of them are very precise, e.g., the directional representation [3], but with a high adaptation computational cost. Others, like the RCC representation [4], can be used to quickly adapt multimedia documents but lack expressiveness. In order to find an adapted document that is acceptable both in computing time and precision, we introduce a new algebra of relations particularly useful in this context (§III).

II. Multimedia document specification

Multimedia documents are defined by their temporal, spatial, logical and interactive dimensions. This paper focuses on the adaptation of multimedia documents along their spatial dimension. The organization of such a document over space is presented in Fig. 1. It features a multimedia presentation of an Art and Architecture Tour composed of different panels like a Logo, a Text area, a Photo and a Map.

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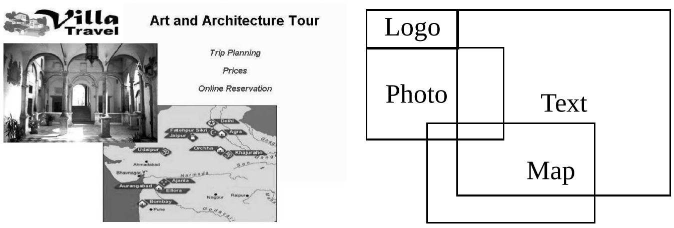

Fig. 1. Multimedia document example (left) and spatial dimension (right).

III. Adaptation of a new spatial representation

We present a new spatial representation called ABLR, adapted to the multimedia adaptation task and illustrate it with the example of Fig. 1.

A. A new spatial representation: ABLR

Preserving the directionality property, i.e., orientation in space, with a sufficient number of relations is our major goal. Thus, we propose to group together some Allen relations expressing the same directionality property.

Suppose two multimedia objects X and Y. On a horizontal point of view, six relations can be identified to specify directive qualitative information between them (idem for the vertical axis). These relations are presented in Fig. 2. The first line is made of the 13 Allen relations, grouped together for preserving the directionality property. For example, the relations before and meets between X and Y specifies that X is on the left of Y (if we consider the horizontal axis). Thus, we can deduce 6^2 spatial relations.

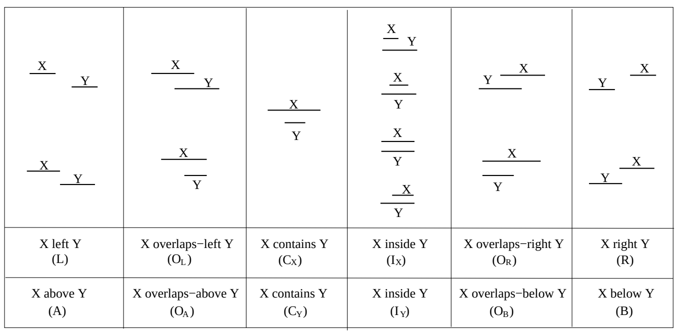

Fig. 2. The ABLR spatial representation.

In Fig. 1, the Logo is on the left (L) and inside vertically (I_y) of the Text (Fig. 3, left). Hence, having the relation $L\ I_y$ between Logo and Text.

B. Semantic adaptation of the ABLR spatial representation

In [1], a semantic approach for multimedia document adaptation is defined. This approach interprets each document as the set of its potential executions, i.e., related to the initial document and a profile as the set of possible executions. In this context, "adapting" amounts to find the set of potential executions that are possible. When none is possible, the goal of adaptation is to find executions as close as possible to potential executions that satisfy the profile. We consider both the multimedia document specifications and the profiles as a set of relations holding between multimedia objects. The potential and possible executions are ideally represented by relation graphs. Fig. 3 presents two relation graphs.

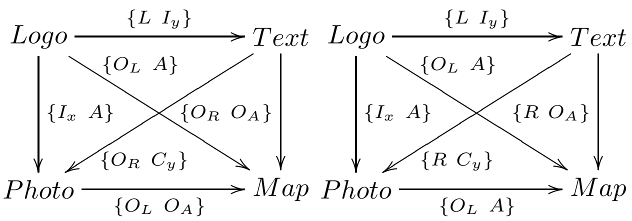

Fig. 3. Initial relation graph (left) and adapted relation graph (right).

The potential executions (left) include, in particular, the execution of Fig.1. The possible executions correspond to the following profile: overlapping visible objects are impossible at a time. It may occur that some potential relations are not possible (e.g., Text $O_R\ C_y$ Photo). In this context, adapting consists of finding a set of relation graphs corresponding to possible executions (i.e., respecting adaptation constraints) at a minimal distance from the relation graph of potential executions (i.e., the initial document specification).

Proximity between two relation graphs depends on the proximity between relations beared by the same edge in both graphs. This proximity relies on the conceptual neighborhood between these relations and is measured by the shortest path distance in the corresponding conceptual neighborhood graph (Fig. 4 presents the one of ABLR).

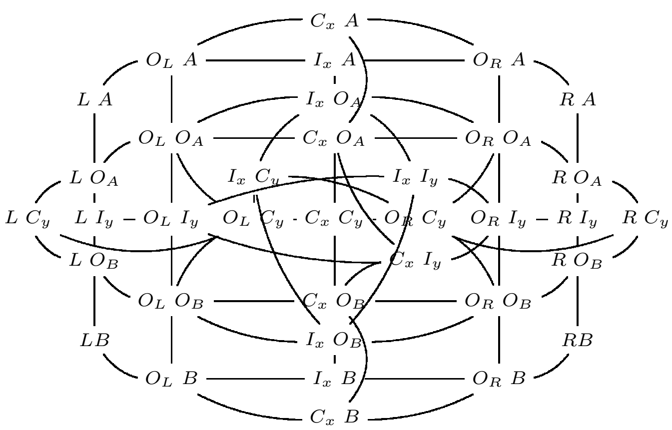

Fig. 4. Conceptual neighborhood graph of the ABLR relations.

Fig. 3 (right) presents the adapted relation graph of Fig. 3 (left) with the non-overlapping adaptation constraint. The distance between the initial and the adapted graphs is 3. Fig 5 (left) presents an adapted execution of Fig. 3 (right).

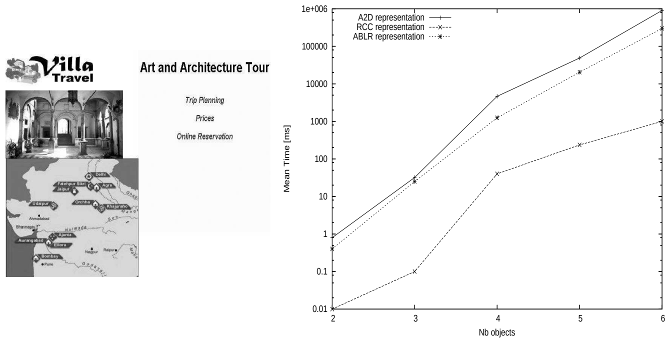

Fig. 5. An adapted execution of Fig. 3, right (left) and experimental results with a logarithmic scale (right).

IV. Experimental results

We evaluate our spatial adaptation framework on SMIL documents [5] with the non-overlapping constraint. We have compared experimentally three spatial representations, namely the directional one [3] (A2D), RCC [4] and ABLR. Our benchmark was composed of 50 SMIL documents with $i \in [2, 6]$ multimedia objects. Results are provided in Fig. 5 (right).

As we can see the RCC representation is the most efficient spatial representation for adapting multimedia documents. However, this one is not precise enough. Our spatial representation, which is a compromise between all the expressiveness of the directional representation and the number of spatial relations, provides much better results than the directional representation. Moreover, we also observe that for each adaptation the order of efficiency presented in Fig. 5 (right) is respected.

V. Conclusion

We have presented a way of applying our semantic adaptation framework to the spatial dimension of multimedia documents. A new spatial representation, called ABLR, has been introduced which ensures a compromise between expressiveness and computation speed.

This work is limited to the spatial dimension, while adaptation can take advantage of the other dimensions. We are currently working on the extension of both the generic solutions provided by the framework and the SMIL instantiations.

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