Semantic Adaptation of Multimedia Documents

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Abstract: *A multimedia document should be presented on different platforms, for this adaptation of its content is necessary. In this contribution, we make some proposals to improve and extend the semantic approach based on conceptual neighborhoods graphs in order to best preserve the proximity between the adapted and the original documents and to deal with models that define delays and distances.*

Keywords: *Multimedia document adaptation, semantic adaptation, conceptual neighborhood graph, relaxation graph.*

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1. Introduction

The ongoing developments in communication technology and computing systems make the communication dominated by multimedia data. The heterogeneous nature of the devices used to access the multimedia content may be not able to render correctly the document. The user preferences like language, educational level handicap [7], etc., also make it necessary to adapt the documents. A lot of works have been conducted in the multimedia documents adaptation; they can be grouped into four categories: 1). Specification of alternatives, 2). Using transformation rules, 3). Using flexible models, 4). Semantic and dynamic approaches. In the approaches based on alternatives specification and transformation rules, the adaptation is explicit: the author knows all the target profiles and then, specifies directly the different versions of his document according to those profiles. In this case, it's extremely difficult and hard to foresee all the possibilities in advance. In the systems based on flexible models, the adaptation depends mostly on the description languages and standards. Another approach proposed in [15], tries to overpass those issues by using the relations specification and the Conceptual Neighborhood Graphs (CNG) of the relations [9]. The CNG is used for searching the relations that can substitute the ones that do not comply with the target profile (device capabilities and user preferences). However, most of the time those relations are not replaced by the closest one, since the weights of the CNG arcs are implicitly set to one. This means that a relation can be replaced by any one of its neighbors. Moreover, the relations defined within the used temporal and spatial models do not consider the delays and the distances whereas the documents are generally produced using more complex models to insure a high expressiveness level, a highly prized quality in the multimedia document authoring systems.

In this paper, we propose an improvement of the latter approach to insure greater proximity between the adapted and the initial documents and to deal with models that define delays and distances. To position our contribution, we present in section 2 the similar works. In section 3, we give an example of a multimedia document. In section 4, the CNG extension proposal is presented. Section 5 validates the proposition and presents the adaptation procedure along with an illustrative. Section 6 concludes this paper and gives some perspectives.

2. Related Works

Several approaches have been proposed for the multimedia documents adaptation and we group them into four categories.

2.1. Specification of Alternatives

The author of the document specifies a set of presentation alternatives by defining criteria on some media. If the media satisfy the criteria then, they are selected and presented else, they are deleted from the presentation. In this category, we can find three types of approaches.

The first type is called beforehand adaptation. The author specifies different versions of the document according to the target profiles. SMIL is an example; it uses the operator switch to specify the alternatives that are played only if they comply with the target profile.

The second type is the a posteriori adaptation, based on the content of the presentation. The author uses annotations to identify the pertinent parts of his document and then, a filter is applied to the document to select the parts that comply with the established selection criteria. The language proposed in [19] is an example. It is based on a temporal extension of HTML that offers new tags and attributes. The adaptation is done by applying style sheets as proposed in [21] like

XSLT for XML documents and CSS for HTML document. The last type concerns the hybrid approaches that merge the two precedent types. The author does not only use the specification of alternatives according to the different profiles but also, adds annotations to the document. The Amsterdam Hypermedia Model (AHM) [13], is an example. It is constructed by combining the Dexter Model [12], with the CMIF model [5], to which were added some extensions concerning the hypermedia.

The advantage of this family is that the adaptation is instantly and flexible in some cases. However, the author has to foresee all the possible adaptation constraints (target profiles), specify all the conceivable alternatives and perform an extra effort for the annotation. Furthermore, the selection conditions are strongly dependent on the used annotation language.

2.2. Using Transformation Rules

In this category, the adaptation consists on selecting (from a set of rules) and applying rules to transform the document to satisfy the target profile. For example, the software infrastructure NAC (Negotiation and Adaptation Core) [16], defines components that take part in the negotiation and the content adaptation process. NAC provides two adaptation types: structural adaptation and media adaptation. For the first type, NAC uses the transformation language XSLT. However, to avoid the definition of a transformation sheet for each target profile, generic templates are defined. Nevertheless, all the transformations should be specified in the transformation rules base. We can name also, the MPEG-21 standard, Xadaptor [14] and AHA [6].

The advantage of this approach is that the author has not to care about the execution context of his document. Furthermore, these rules can be completed if new contexts appear. However, the entire transformation rules should be specified to ensure an efficient adaptation.

2.3. Flexible Documents Models

The adapted document is generated automatically from a non-composed set of media represented by a model defining an abstraction of the document. Thanks to a formatting model, a multimedia presentation may be generated. In this category, we can find four models:

- *First Model:* Uses the concept of Customizable Virtual Document (CVD) [20]. The virtual document is considered as customizable if the document composition methods permit its adaptation for a given reader.
- *Second Model:* Guypers [10], aims to generate web-based presentation for multimedia databases. It uses the semantic relations between media and ontologies [11]. The aim of this model is to generate multimedia documents to meet the capabilities of the used platform.
- *Third Model:* Is MM4U [4], it uses different modules related to the user profile, the multimedia data, the media composition and the document generation. Then, the multimedia document specification can be adapted according to the execution context and generated in different formats like SMIL or HTML. The inconvenient is that the framework uses proprietary languages.
- *Fourth Model:* Synchronized Templates for Adaptable Multimedia Presentations (STAMP) [3], aims to dynamically generate multimedia presentations from semi-structured content. This approach is based on the construction of templates describing the spatial, the temporal and the hypermedia organizations where the content may vary. During the presentation generation, the presentation model is adapted automatically to satisfy the target profile constraints. However, the adaptation is limited to the exclusion of media or the sequencing of the media that cannot be played simultaneously.

2.4. Semantic and Dynamic Approaches

In [15], an approach based on the specification of the document was proposed. This approach extends the temporal adaptation approach proposed in [8], to the spatial and hypermedia dimensions. Each document is considered as a set of potential executions and each profile is considered as a set of possible executions. The adaptation is done at run time according to the context. It consists on calculating the intersection between the potential and the possible executions corresponding to the target profile. Its advantage is it does not restrict the profile constraints and its independence from description languages. However, the use of the CNG where all the weights of the arcs are set to 1 assumes that a relation may be replaced by any one of its immediate neighbors while there are substantial differences between them; especially when using complex relations models. Furthermore, in the used model [1], the delays and the distances are not considered.

3. Example of a Multimedia Document

A multimedia document is a set of different types of media objects (image, text, audio and video) with temporal, spatial and hypermedia relations defining their synchronization and their spatial placement. For instance, the multimedia document of Figure 1 presents a research unit. It starts by a welcome video (Message) of the director, presented simultaneously with two other videos: Overview giving an overview of the unit and history giving its chronological history. At the same time with History, a text (Dates) is displayed and gives the important dates of the unit. After that, an audio (Laboratories) giving a presentation of the laboratories is played. During the oral presentation, two images (Lab 1, Lab 2) of the laboratories are displayed sequentially. On each one of them, a text (respectively, projects 1 and projects 2) is incrusted and describe the projects of each laboratory. In addition, a hypermedia link (Link) is defined on a spatial region of the video "Overview" during the period (60, 120) and points to "laboratories". The document of this Figure 1 was edited using the MediaStudio system [17] developed at the Research Center on Scientific and Technical Information (CERIST), to which we added an adaptation module that handle the proposed adaptation procedure.

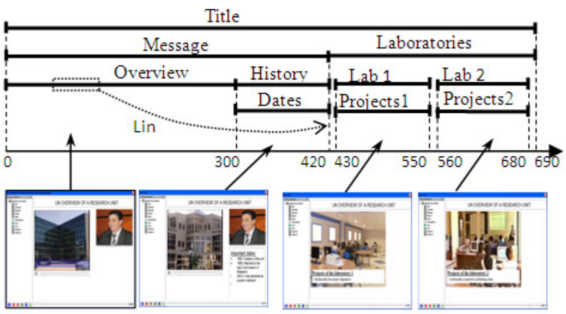

Figure 1. Representation of the initial document.

Tables 1 and 2 give respectively the temporal and spatial relation between the document media objects. The diagonal of the table corresponds to the relation while (0, 0) which means that used relation is equal and the cells bellow the diagonal correspond to the converse of the other relations. The hypermedia relation between the link and its anchor (Overview) is translated to the temporal relation Link While (60, 570) Overview and the spatial relation Link <While (100, 250), While (100, 150)> Overview.

4. Proposed Approach

In the proposed approach, we use the CNG of the relations. To best preserve the proximity between the adapted document and the initial document and to deal with models with delays and distances, we propose a new construction of the CNG. In the reminder of this paper, we use the Wahl and Rothermel model [22] for the temporal relations and the directional model [18] for the spatial relations.

4.1. Weighting of the CNG

In [15], the authors used the Allen's model and assigned the value of 1 to all the CNG arcs as show in Figure 2.

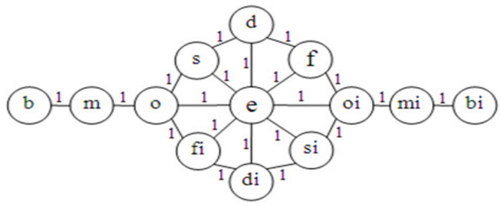

Figure 2. CNG of Allen relations.

In order to replace a relation that does not comply with a profile by the closest one, we propose a new weighting of the CNG. For this, we start by identifying all the information items characterizing a relation which will serve as criteria of the comparison between the relations.

Table 1. The temporal relations of the initial document.

	Title	Message	Overview	History	Dates	Laboratories	Lab 1	Projects 1	Lab 2	Projects 2
Title		C(0,270)	C(0,390)	C(300,270)	C(300,270)	C(420,0)	C(430,140)	C(430,140)	C(560,10)	C(560,10)
Message			Cb(0)	C(300,0)	C(300,0)	B(0)	B(10)	B(10)	B(140)	B(140)
Overview				B(0)	B(0)	B(120)	B(130)	B(130)	B(260)	B(260)
History					W(0,0)	B(0)	B(10)	B(10)	B(140)	B(140)
Dates						B(0)	B(10)	B(10)	B(140)	B(140)
Laboratories							W(10,140)	W(10,440)	W(140,10)	W(140,10)
Lab1								W(0,0)	B(10)	B(10)
Projects1									B(10)	B(10)
Lab2										W(0,0)
Projects2										

Table 2. The spatial relations of the initial document.

	Title	Overview	Message	History	Dates	Lab 1	Projets 1	Lab 2	Projets 2
Title		c(0,350),b(10)	c(500,0), b(10)	c(0,350), b(10)	c(500,0), b(200)	c(450,0), b(10)	c(450,0), b(260)	c(450,0), b(10)	c(450,0), b(260)
Overview			b(50), c(0,150)	W(0,0), W(0,0)	B(50), O(210,140,160)	B(0), W(0,0)	B(0), C(250,0)	B(0), W(0,0)	B(0), C(250,0)
Message				b-1(50), w(0,150)	W(0,0), B(10)	W(50,0), W(0,150)	W(50,0), B(50)	W(50,0), W(0,150)	W(50,0), B(50)
History					B(50), O(210,140,160)	B(0), W(0,0)	B(0), C(250,0)	B(0), W(0,0)	B(0), C(250,0)
Dates						W(50,0), cb(210)	W(50,0), C(40,160)	W(50,0), cb(210)	W(50,0), C(40,160)
Lab 1							W(0,0), C(250,0)	W(0,0), W(0,0)	W(0,0), C(250,0)
Projects 1								W(0,0), w(250,0)	W(0,0), W(0,0)
Lab 2									W(0,0), C(250,0)
Projects 2									

4.1.1. Information Elements of a Relation

The analysis of a relation between two media A and B as shown in Figure 3 on a time axis showed that the positioning is done according to the values and the order (precedes (>), succeeds (<) or equal (=)) of their respective edges (beginning and ending instants). Table 3 gives the 16 selected information items that characterize a relation. For each relation, we attribute the value 01 when the information is contained and 0 elsewhere. Table 4 gives the 16 information items of the Wahl and Rothermel model relations.

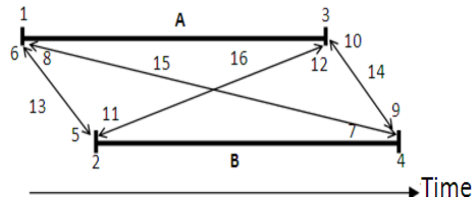

Figure 3. Information of a relation.

Table 3. Information characterizing a relation.

Information	1	2	3	4	5	6	7	8
Signification	b(A)	b(B)	e(A)	e(B)	1>2	1<2	1>4	1<4
Information	9	10	11	12	13	14	15	16
Signification	3>4	3<4	3>2	3<2	1=2	3=4	1=4	3=2

Table 4. Information of the temporal relations.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Before	0	1	1	0	0	1	0	1	0	1	0	1	0	0	0	0
Overlaps	1	1	1	1	0	1	0	1	0	1	1	0	0	0	0	0
Endin	0	1	1	1	0	1	0	1	0	1	1	0	0	0	0	0
Cobegin	1	1	0	0	0	1	0	1	0	1	1	0	0	0	0	0
Coend	0	0	1	1	0	1	0	1	0	1	1	0	0	0	0	0
Beforeendof^{-1}	0	1	1	0	0	1	0	1	0	1	1	0	0	0	0	0
Cross^{-1}	1	1	1	1	0	1	0	1	0	1	1	0	0	0	0	0
Delayed^{-1}	1	1	1	1	0	1	0	1	0	1	1	0	0	0	0	0
Startin^{-1}	1	1	1	0	0	1	0	1	0	1	1	0	0	0	0	0
While	1	1	1	1	1	0	0	1	0	1	1	0	0	0	0	0
Contains	1	1	1	1	0	1	0	1	1	0	1	0	0	0	0	0
Beforeendof	1	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0
Cross	1	1	1	1	1	0	0	1	1	0	1	0	0	0	0	0
Delayed	1	1	1	1	1	0	0	1	1	0	1	0	0	0	0	0
Startin	1	1	0	1	1	0	0	1	1	0	1	0	0	0	0	0
Cobegin^{-1}	1	1	0	0	1	0	0	1	1	0	1	0	0	0	0	0
Endin^{-1}	1	0	1	1	1	0	0	1	1	0	1	0	0	0	0	0
Coend^{-1}	0	0	1	1	1	0	0	1	1	0	1	0	0	0	0	0
Overlaps^{-1}	1	1	1	1	1	0	0	1	1	0	1	0	0	0	0	0
Before^{-1}	1	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0

4.1.2. Calculation of the Similarity Degree between Relations

To calculate the similarity degree between a relation r and its immediate neighbor r', we use the Manhattan distance defined as follows: $d\ (r, r') = \sum_{i=1}^{16} |v_i - u_i|$ where v_i and u_i are respectively the 16 information items of *r* and *r'*. Table 5 gives the distances between each relation and its neighbors.

Table 5. Distances between the relations and theirs neighbors.

	b	**o**	**ei**	**cb**	**ce**	**be^{-1}**	**c^{-1}**	**d^{-1}**	**si^{-1}**	**w**	**cn**	**be**	**c**	**d**	**si**	**cb^{-1}**	**ei^{-1}**	**ce^{-1}**	**o^{-1}**	**b^{-1}**
b	-	4	3	4	4	2	4	4	3	-	-	-	-	-	-	-	-	-	-	-
o	4	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
ei	3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
cb	4	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
ce	4	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
be^{-1}	2	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
c^{-1}	4	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
d^{-1}	4	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
si^{-1}	3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-
w	-	2	3	4	4	4	2	2	3	-	-	4	2	2	3	4	3	4	2	-
cn	-	2	3	4	4	4	2	2	3	-	-	4	2	2	3	4	3	4	2	-
be	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	2
c	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	4
d	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	4
si	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	3
cb^{-1}	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	4
ei^{-1}	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	3
ce^{-1}	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	4
o^{-1}	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	4
b^{-1}	-	-	-	-	-	-	-	-	-	-	-	2	4	4	3	4	3	4	4	-

4.2. Relations Models with Delays and Distances

Generally, in authoring multimedia systems the used models define delays and distances to enhance their expressiveness degree. Therefore, our approach should deal with this type of models. For this, we replace each node of the CNG by a graph called Relaxation Graph (RG). It is constituted by the different forms that a relation can take according to whether the delay (distance) is or not taken into account. Thus, considering a delay (distance) specification as a strong constraint, the relaxation is defined as a transformation of this constraint to a weaker one. For instance, the relaxation of the relation *A* before (5) *B* would be *A* before (-) *B* where the delay "5" is not taken into account. The RG is obtained by a progressive relaxation of the delays (distances) one by one. Figure 4 gives the RG of the relations with one, two or three delays (distances).

Thus, the relaxation may lead to an adaptation solution without replacement of the relations that do not comply with the target profile; consequently the adapted document will be more close to the initial one.

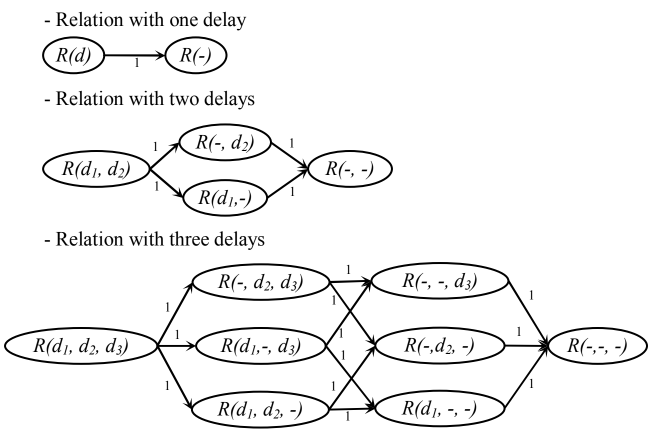

Figure 4. Relaxation groups.

Since the relaxation order does not affect the proximity of a relation with its neighbors in the RG, we set the weights of the arcs to 1.

4.3. CNG Construction and Traversal

To determine the neighbors of a relation, we start by elaborating the CNG as proposed in [9], then we replace each node (relation) by its corresponding RG. When replacing a relation, to determine the closest one, the graph traversal starts from the relation RG. According to delays (distances) specified in that relation, we identify its corresponding node within the RG then we start traversing the entire graph from this node. Once the ending node (node where all the delays (distances) are not taken into account) of the RG of the relation is reached, we move to the node of the following RG having the maximum of similar delays (distances) as in the relation to be replaced. For instance, if we have to replace the relation *A* overlaps (5, 8, 10) *B* by the relation delayed^{-1}, we move directly to the node of the form delayed^{-1} (5, 10). Table 6 gives the destination nodes of the relation Overlaps (d_1, d_2, d_3). The same principle is applied for the other relations.

Table 6. Destination nodes of the relation overlaps.

Relation	Destination Nodes
Overlaps (d_1, d_2, d_3)	Before (-) Cobegin (d_1) Endin (d_2, d_3) Coend (d_3) Beforeendof^{-1} (d_2) Cross^{-1}(-, d_2) Delayed^{-1}(d_1, d_3) Startin^{-1} (d_1, d_2) While (-, d_3) Contains (d_1, -) Beforeendof (-) Cross (-, d_2) Delayed (-, -) Startin (-, -) Cobegin^{-1} (-) Endin^{-1} (-, -) Coend^{-1} (-) Overlaps^{-1} (-, -, -) Before^{-1} (-)

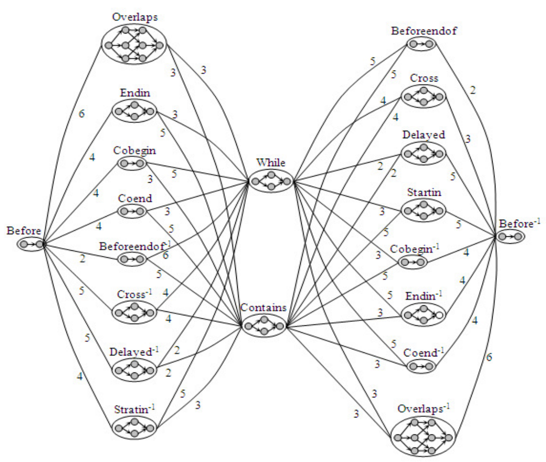

Figure 5. The CNG of the wahl and rothermel model relations.

4.3.1. CNG of the Temporal Relations

We present in the Figure 5, the proposed CNG of the Wahl and Rothermel temporal relations obtained by following the proposed approach.

4.3.2. CNG of the Spatial Relations

In the directional model of the spatial relations [18] a media is represented by two intervals corresponding to its projections on the horizontal and vertical axes. To homogenize the temporal and the spatial representation and to have a high integration level of the two dimensions (spatial and temporal) treatment, the spatial relations are represented by using the temporal relations obtained by the combination of the media intervals on the horizontal and the vertical axes. There are 20 relations (Wahl and Rothermel model) between two intervals on each axis, which gives us 20^2 possible relations between two media.

For instance, in our document example of Figure 1, the media object "Message" is 50 pixels at the right of the media object "Overview". This relation (right) is transformed to the two relations overview before (50) message (on the horizontal axis) and overview Cobegin^{-1} (d_2, d_3) Message (on the vertical axis). Consequently, the CNG of the spatial relations is obtained by the square product of the CNG of temporal relations.

4.3.3. Conceptual Neighborhood Graph of the Hypermedia Relations

For the same integration purpose, we consider a hypermedia link as a media as well as any other media of the document. In Figure 6, the media "history" of the document of Figure 1 has an internal hypermedia link (the dotted area) to the instant of the beginning of the audio "laboratories". It is enabled from the 60th to the 120th second of the media "history". This link can be specified by the temporal relation Link While (60, 570) *Overview* and the spatial relation Link <*While* (100, 250), *While* (100, 150)> *Overview*.

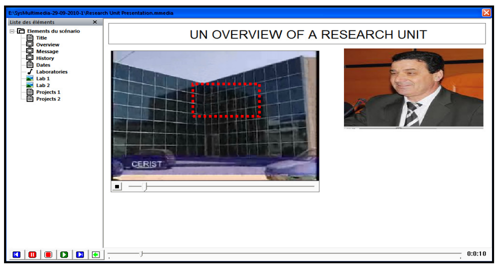

Figure 6. Hypermedia link between two media.

Therefore, the same adaptation procedure of the temporal and spatial dimensions can be applied to the hypermedia adaptation. However, as a hypermedia link is spatially and temporally included in its anchor, only the relations of inclusion can be used; and in the Wahl and Rothermel's model, only the relation While specify the inclusion property. Thus, we perform the hypermedia adaptation using solely the relaxation of the relation while.

5. Adaptation Procedure

The semantic adaptation of multimedia documents is achieved by modifying the specification of the initial document. This involves finding another set of solutions satisfying the constraints of the target profile. This set of relations is obtained by combining the candidate relations to the replacement of each relation of the initial document. The adapted document will correspond to the coherent solution with the smallest conceptual distance [14] defined as follows: $dc\left(sol\right)_k = \sum_{i=1}^{n} dc(r_i, r_j)$ with n is the document relations number, r_j is a candidate relation to the replacement of the relation r_i and $dc(r_i,r_j)$ is the conceptual distance r_i between and r_j. For the temporal relations, $dc(r_i,r_j)$ is calculated as the shortest path between the two relations in the CNG. For instance, *dc(Before(-), while(-,-))=dc (before(-), endin(-))+dc(endin(-), while(-,-))=4+3=7*.

For a spatial relation, the conceptual distance is given by the sum of the conceptual distances between the horizontal components and vertical components of the two relations. For instance, for the two relations r_i=*{before, cobegin}* and r_j=*{endin,while}*, we have $dc(r_i,r_j)=dc_x(r_i,r_j)+dc_y(r_i,r_j)$*=dc(before,endin)+dc(cobegin,while)=4+5=9*.

5.1. Adaptation Algorithm

The algorithm takes as input the matrix MI_{ij}: matrix of the complete relations graph of the initial specification (Tables 1 and 2). Once the substitution matrix MS_{ij}- which gives for each relation of the matrix MI_{ij} the relations candidates for its substitution from those that meet the target profile among the relations of the model- is identified, we determine by combinations, all the possible solutions C_i from the matrix MS_{ij}. Next, we perform an ascending sort of all solutions of C_i ("quick sort") using the conceptual distances calculated by using the Dijkstra's shortest path algorithm. This will ensure that the solutions are sorted from the closest specification to the farthest from the original. Finally, we call the constraints solver (cassowary [2]) for the consistency verification and the calculation of the solution for each specification in the order defined by the sort. The first verification that gives a consistency stops the process and the adapted document is generated.

```
Adaptation Algorithms
Input : MI1j:  //matrix of the document relations
// replacement relations search
For i = 0 to n-1 do // n number of media
  For j = 0 to n-1 do
    For k=1 to NR do // NR:  number of  the relations  of  the
    model
      if respecteProfil (Rm [k]) then // Rm set of the model
      relations
        MS [i, j]  ← MS [i, j]  ∪ {Rm [k]};
      End if
    End for
  End for
End for
// Elaboration of the possible combinations
//output : combinations list  Cp
Cp = Elaboratecombinationsmatrix(MSij);
// Sort combinations according to the conceptual distance
For i=0 to n combinations -1 do
  d[i]  ← 0;  // matrix of the conceptual distances
  For j=0 to n-1 do
    d[i] = d[i] + Djikstra(C[i,j], MR[i,j]);
  End for
End for
QuickSort Combinations(C[i], d[i]);
// consistency verification
Found ← false;
For i = 0 to nCombinations -1 do
  if Consistency (C[i]) Then
  Solution ← (C[i]);
  found ← true ; break ;
  End if
End for
If found = false Then ('no possible adaptation');
```

5.2. An Adaptation Example

Let us consider the initial multimedia document of Figure 1 and the following profile:

1. The memory capabilities of the device cannot support a video with duration greater than 8 minutes.
2. Media objects cannot be overlapped.
3. A hypermedia link must remain active during entire presentation of its anchor.

Thus, the following relations do not comply with the target profile:

1. Message Cobegin (0) Overview: the videos "Message" and "Overview" are played simultaneously and beyond t=4mn, their volume exceeds the capabilities of the device.
2. (*Lab1* <*While* (0,0), *Contains* (250,0)> *Project1*) and (*Lab2* <*While* (0,0), *Contains* (250,0)> *Project2*): define spatial overlaps.
3. The relation Link While (60, 570) Overview de not comply with the third constraint of the profile.

Thus, the document must be adapted. After execution of the adaptation algorithm, we obtain the solution given by Tables 7 and 8 and its presentation of the adapted document is shown in Figure 7.

The hypermedia relation is transformed to the relations Link *While* (0, 0) *Overview* and *Link* <*While* (*100, 250*), *While* (*100, 150*)> *Overview.*

In this solution, we have 10 (2 temporal and 8 spatial) replacement and 28 relaxations (22 temporal, 6 spatial and 1 hypermedia).

Table 7. Matrix of the temporal relation graph of the adapted document.

	Title	Message	Overview	History	Dates	Laboratories	Lab1	Projects1	Lab2	Projects2
Title		c(-,-)	c(0,-)	c(-,270)	c(-,270)	c(-,0)	c(-,140)	c(-,140)	c(-,10)	c(-,10)
Message			Cb(-)	O(-,-,-)	O(-,-,-)	B(-)	B(-)	B(-)	B(-)	B(-)
Overview				B(-)	B(-)	B(-)	B(-)	B(-)	B(-)	B(-)
History					W(0,0)	B(0)	B(10)	B(10)	B(140)	B(140)
Dates						B(0)	B(10)	B(10)	B(140)	B(140)
Laboratories							W(10,140)	W(10,440)	W(140,10)	W(140,10)
Lab1								W(0,0)	B(10)	B(10)
Projects1									B(10)	B(10)
Lab2										W(0,0)
Projects2										

Table 8. Matrix of the spatial relation graph of the adapted document.

	Title	Overview	Message	History	Dates	Lab1	Projects1	Lab2	Projects2
Title		c(0,350), b(10)	c(500,0), b(10)	c(0,350), b(10)	c(500,0), b(200)	c(450,0), b(10)	c(450,0), B(-)	c(450,0), b(10)	c(450,0), B(-0)
Overview			b(50), c(0,150)	W(0,0), W(0,0)	B(50), O(210,140,160)	B(0), W(0,0)	B(0), B(-)	B(0), W(0,0)	B(0), B(-)
Message				b-1(50), w(0,150)	W(0,0), B(10)	W(50,0), W(0,150)	W(50,0), B(-)	W(50,0), W(0,150)	W(50,0), B(-)
History					B(50), O(210,140,160)	B(0), W(0,0)	B(0), B(-)	B(0), W(0,0)	B(0), B(-)
Dates						W(50,0), cb(210)	W(50,0), C(-,-)	W(50,0), cb(210)	W(50,0), C(-,-)
Lab1							W(0,0), B(-)	W(0,0), W(0,0)	W(0,0), B(-)
Projects1								W(0,0), B-1(-)	W(0,0), W(0,0)
Lab2									W(0,0), B(-)
Projects2									

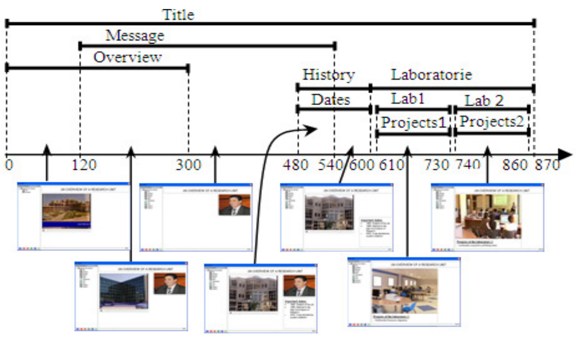

Figure 7. Temporal and spatial representation of the adapted document.

6. Conclusions

In this paper, we proposed a semantic approach of the temporal, spatial and hypermedia adaptation of multimedia documents. The originality of this approach is that, from one side, that the adapted document is semantically as close as possible to the initial document, and from the other side, the extension of the conceptual neighborhood graph permits to deal with models that use delays and distances.

We have shown how to best differentiate the similarity degree of the relations by proposing a new way of building the conceptual neighborhood graph and we introduced the concept of the relation relaxation that permits to keep the relations or otherwise to replace them while maintaining the maximum number of delays (distances).

Moreover, as the objective is primarily to preserve the message intended by the author of the initial document, it seems quite rightful to ask the following question: Is it appropriate to deliver the adapted document even though the message of the initial document may be changed? Otherwise what are the parameters should be taken into account?

The first direction of our future work would be to determine a similitude measure between the adapted document and the initial one by using some extra information (annotations) like relations weights in the document to determine the relations to be modified or deleted if it's necessary.

Furthermore, as the calculation of the replacement candidates is of quadratic complexity, we will test heuristics for pre-filtering candidates before iterating over all possible combinations of relations.

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