Adapting the Hypermedia Structure in a Generic Multimedia Adaptation Framework

Sébastien Laborie and Jérôme Euzenat

SMAP’06

INRIA
RHÔNE-ALPES
A multimedia document example

A movie trailer presentation

Temporal-hypermedia dimension

Poster $\rightarrow$ Trailer

Abstract $\rightarrow$ Characters $\rightarrow$ Dates

$l_1$, $l_2$, $l_3$
Multimedia document adaptation

Motivations

Laptop

Initial multimedia document

Adapted document

Setup box

PDA

Mobile phone

Low bandwidth

Low CPU
Multimedia document adaptation

- Laptop
- Mobile phone (small screen)
- PDA (low bandwidth)
- Setup box (low CPU)

Initial multimedia document

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Multimedia document adaptation

Laptop

Initial multimedia document

Adaptation

Mobile phone

Adapted document

PDA

Adapted document'

Setup box

Adapted document"
Our adaptation approach

- Adaptation of the multimedia document structure.

Initial document

Adapted document

adaptation
Our adaptation approach

- Adaptation of the multimedia document structure.
- A multimedia document specification is composed of:
  - A set of multimedia objects.

---

**Initial specification**

<table>
<thead>
<tr>
<th>Poster</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characters</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Adapted specification**

<table>
<thead>
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<th>Poster</th>
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Our adaptation approach

- Adaptation of the multimedia document structure.
- A multimedia document specification is composed of:
  - A set of multimedia objects.
  - A set of relations between multimedia objects.
Our adaptation approach

- Adaptation of the multimedia document structure.
- A multimedia document specification is composed of:
  - A set of multimedia objects.
  - A set of relations between multimedia objects.

Initial relation graph:
- Poster -> Trailer
- Poster -> Abstract
- Characters -> Dates
- Characters -> Abstract
- Dates -> Abstract
- Dates -> Trailer
- Poster meets Characters
- Poster overlaps Dates
- Characters meets Dates
- Dates meets Characters
- Dates overlaps Characters
- Poster before Characters
- Poster before Dates
- Characters before Dates
- Dates before Characters
- Characters overlaps Dates
- Dates meets Characters
- Dates meets Poster
- Characters meets Poster
- Characters meets Trailer
- Dates meets Poster
- Dates meets Characters
- Trailer meets Abstract
- Trailer overlaps Poster
- Poster before Poster
- Dates before Dates

Adapted relation graph:
- Poster -> Trailer
- Poster -> Abstract
- Characters -> Dates
- Characters -> Abstract
- Dates -> Abstract
- Dates -> Trailer
- Poster meets Characters
- Poster overlaps Dates
- Characters meets Dates
- Dates meets Characters
- Dates overlaps Characters
- Poster before Characters
- Poster before Dates
- Characters before Dates
- Dates before Characters
- Characters overlaps Dates
- Dates meets Characters
- Dates meets Poster
- Characters meets Poster
- Characters meets Trailer
- Dates meets Characters
- Dates meets Poster
- Trailer meets Abstract
- Trailer overlaps Poster
- Poster before Poster
- Dates before Dates

Our adaptation approach

- Adaptation of the multimedia document structure.
- A multimedia document specification is composed of:
  - A set of multimedia objects.
  - A set of relations between multimedia objects.
- The adapted document should be close to the initial one.

![Initial relation graph](image1)

![Adapted relation graph](image2)
What is new in this paper?

- Adapt the hypermedia dimension.
- Temporal-Hypermedia adaptation.
- Propose an incremental adaptation which takes into account the user interactions.
Outline

1. Adaptation of the Hypermedia Dimension
   - Hypermedia specification
   - Hypermedia adaptation

2. Adaptation based on the Hypermedia Structure

3. Adapting the Hypermedia Structure according to user interactions

4. Conclusion
Outline

1. Adaptation of the Hypermedia Dimension
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Adapting the hypermedia structure in an adaptation framework
Adaptation of the Hypermedia Dimension

Hypermedia specification

Temporal-hypermedia dimension

Poster

\[ I_1 \]

Trailer

\[ I_2 \]

Abstract

Allen interval algebra

<table>
<thead>
<tr>
<th>( x ) ( r ) ( y )</th>
<th>( x / y )</th>
<th>( y r^{-1} x )</th>
</tr>
</thead>
<tbody>
<tr>
<td>before ( b )</td>
<td>___</td>
<td>( bi ) after</td>
</tr>
<tr>
<td>meets ( m )</td>
<td>___</td>
<td>( mi ) met-by</td>
</tr>
<tr>
<td>during ( d )</td>
<td>___</td>
<td>( di ) contains</td>
</tr>
<tr>
<td>overlaps ( o )</td>
<td>___</td>
<td>( oi ) overlapped-by</td>
</tr>
<tr>
<td>starts ( s )</td>
<td>___</td>
<td>( si ) started-by</td>
</tr>
<tr>
<td>finishes ( f )</td>
<td>___</td>
<td>( fi ) finished-by</td>
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<tr>
<td>equals ( e )</td>
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Initial relation graph

Poster \( \{o\} \rightarrow \) Abstract \( \{b\} \rightarrow \) Trailer

Adapting the hypermedia structure in an adaptation framework
Hypermedia specification

Temporal-hypermedia dimension

Poster → Trailer

Abstract

Allen interval algebra

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Initial relation graph

Trailer

Poster

Abstract

l₁

l₂

{b}

{o}

{m}
Adaptation of the Hypermedia Dimension

Hypermedia specification

Temporal-hypermedia dimension

Poster

Abstract

Trailer

Allen interval algebra

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Initial relation graph

Poster

Abstract

Trailer

\( l_1 \)

\( l_2 \)
Hypermedia specification

Temporal-hypermedia dimension

Allen interval algebra

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Initial relation graph

Trailer

Poster

Abstract

before (b)
meets (m)
during (d)
overlaps (o)
starts (s)
finishes (f)
equals (e)
Hypermedia specification

Temporal-hypermedia dimension

- Poster
- Abstract
- Trailer

Allen interval algebra

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Initial relation graph
Hypermedia adaptation

- Identify the target device profile (e.g., only one button).

Initial relation graph

```
Poster ← Trailer
/b/ ← /b/ ← /b/ ← /b/
{o} ← /m/ ← /b/
{e} ← /fi/ ← /oi/
{l1} ← /fi/ ← /l2
```

Possible relation graph

```
Poster ← Abstract
/s/ , /f/ , /d/ , /e/ ← /s/ , /f/ , /d/ , /e/
{m} , {mi} , {b} , {bi} ← {m} , {mi} , {b} , {bi}
{l1} ← {l1} ← {l1} ← {l1}
```

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Adapting the hypermedia structure in an adaptation framework
Hypermedia adaptation

- Identify the target device profile (e.g., only one button).
- Identify the possible relations according to the profile:
  - Overlapping links are impossible at a time.
Hypermedia adaptation

- Identify the target device profile (e.g., only one button).
- Identify the possible relations according to the profile:
  - Overlapping links are impossible at a time.
  - A link belongs to a multimedia object.

Initial relation graph

Possible relation graph
Hypermedia adaptation

- Identify the target device profile (e.g., only one button).
- Identify the possible relations according to the profile:
  - Overlapping links are impossible at a time.
  - A link belongs to a multimedia object.
- Compute adapted solutions close to the initial document.
- Preserve a maximum of relations.
Temporal proximities

- contains
- finished-by
- started-by
- overlaps
- equals
- overlapped-by
- met-by
- after
- starts
- finishes
- during
Temporal proximities

contains

finished-by  started-by

overlaps  equals  overlapped-by  met-by  after

starts  finishes

during
Temporal proximities

- contains
  - finished-by
  - started-by
  - meets
  - overlaps
  - equals
  - overlapped-by
  - met-by
  - after
  - starts
  - finishes
  - during
Temporal proximities

\[ \delta(\text{before}, \text{overlaps}) = 2 \]
Hypermedia adaptation

- Compute adapted solutions close to the initial document.

**Initial relation graph**

- Poster $\rightarrow$ Abstract
- Trailer
- $l_1 \rightarrow l_2$

**Possible relation graph**

- Poster $\rightarrow$ Abstract
- Trailer
- $l_1 \rightarrow l_2$

$$\text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i).$$
Hypermedia adaptation

- Compute adapted solutions close to the initial document.
- Generate consistent possible relation graphs.

Initial relation graph

Consistent possible relation graph

\[ \text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i). \]
Hypermedia adaptation

- Compute adapted solutions close to the initial document.
  - Generate consistent possible relation graphs.
  - $distance = \sum_{i=1}^{n} \delta(r_i, p_i)$.

Initial relation graph

Consistent possible relation graph

$distance = 2 + 1 + 1 = 4$ (minimal)
Hypermedia adaptation

- Compute adapted solutions close to the initial document.
  - Generate consistent possible relation graphs.
  - \( \text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i) \).

Initial relation graph

- \( \text{distance} = 2 \)

Consistent possible relation graph

- \( \text{distance} = 2 \)
Hypermedia adaptation

- Compute adapted solutions close to the initial document.
- Generate consistent possible relation graphs.
- $\text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i)$.

Initial relation graph

Consistent possible relation graph

\[
\text{distance} = 2 + 1
\]
Hypermedia adaptation

- Compute adapted solutions close to the initial document.
  - Generate consistent possible relation graphs.
  - \( \text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i) \).

Initial relation graph

Consistent possible relation graph

\[
\text{distance} = 2 + 1 + 1
\]
Hypermedia adaptation

- Compute adapted solutions close to the initial document.
  - Generate consistent possible relation graphs.
  - $distance = \sum_{i=1}^{n} \delta(r_i, p_i)$.

**Initial relation graph**

**Consistent possible relation graph**

$distance = 2 + 1 + 1 = 4$
Hypermedia adaptation

- Compute adapted solutions close to the initial document.
  - Generate consistent possible relation graphs.
  - $distance = \sum_{i=1}^{n} \delta(r_i, p_i)$.

Initial relation graph

![Initial relation graph diagram]

Consistent possible relation graph

![Consistent possible relation graph diagram]

An adapted solution

![An adapted solution diagram]

$distance = 2 + 1 + 1 = 4$ (minimal)
A possible adapted execution

Initial document

Poster \( l_1 \) Trailer

Abstract \( l_2 \)

Adapted document

Poster \( l_1 \) Trailer

Abstract \( l_2 \)
Outline

1. Adaptation of the Hypermedia Dimension
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2. Adaptation based on the Hypermedia Structure

3. Adapting the Hypermedia Structure according to user interactions

4. Conclusion
Adapting the hypermedia structure in an adaptation framework

The Hypermedia Structure

Initial Specification

1. Poster
2. Trailer
3. Abstract
4. Characters
5. Dates

$l_1$, $l_2$, $l_3$
The Hypermedia Structure

- Difficult to adapt with our adaptation approach.
  - Different timelines with different relations and objects number.
Identify all sub-specifications to preserve our approach.
Adaptation based on the Hypermedia Structure

Adapting all sub-specifications at once

- Identify the target device profile.

Sub-specification 1

- Poster
- Abstract
- Characters
- Dates

Sub-specification 2

- Trailer
- Characters
- Dates

Sub-specification 3

- Trailer
- Abstract
- Characters
- Dates
Adapting all sub-specifications at once

- Profile = Impossible to select a link during a video.
Adapting the hypermedia structure in an adaptation framework

Adaptation based on the Hypermedia Structure

Adapting all sub-specifications at once

- Adapt each sub-specification.

**Sub-specification 1**

- Poster
- Abstract
- Characters
- Dates

**Sub-specification 2**

- Trailer
- Characters
- Dates

**Sub-specification 3**

- Trailer
- Abstract
- Characters
- Dates

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Adapting the hypermedia structure in an adaptation framework
Adapting all sub-specifications at once

- Adapt each sub-specification.

Sub-specification 1

Sub-specification 2

Sub-specification 3
Adapting all sub-specifications at once

- Adapt each sub-specification.

Sub-specification 1

Poster \( l_1 \) Trailer

Abstract \( l_2 \) Characters \( l_3 \) Dates

Sub-specification 2

Trailer \( l_1, l_2 \) Characters \( l_3 \) Dates

Sub-specification 3

Abstract \( l_2 \) Characters \( l_3 \) Dates
Drawbacks

- Some sub-specifications are adapted even if there are not executed.

- If the profile changes during the user interactions, all sub-specifications have to be adapted again.

- Parts of several sub-specifications are adapted several times.
Outline

1 Adaptation of the Hypermedia Dimension
   • Hypermedia specification
   • Hypermedia adaptation

2 Adaptation based on the Hypermedia Structure

3 Adapting the Hypermedia Structure according to user interactions

4 Conclusion
Incremental adaptation

- Start from an initial sub-specification.

Sub-specification 1

- Poster
- Abstract
- Characters
- Dates
- Trailer

Edges:
- $l_1$: Poster to Trailer
- $l_2$: Abstract to Characters
- $l_3$: Dates to Abstract
Incremental adaptation

- Impossible to select a link during a video.
Incremental adaptation

- Adapt the sub-specification.
Incremental adaptation

- The user selects the link $l_3$.

Sub-specification 1

- $l_1$: Poster → Trailer
- $l_2$: Abstract → Characters
- $l_3$: Characters → Dates
- $l_3$: Dates → Poster

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Adapting the Hypermedia Structure according to user interactions

Incremental adaptation

- Generate the sub-specification according to the previous one.
Incremental adaptation

- Impossible to select a link during a video.
Adapting the Hypermedia Structure according to user interactions

Incremental adaptation

- No adaptation is needed.

Sub-specification 1

Sub-specification 3
Adapting the Hypermedia Structure according to user interactions

Incremental adaptation

- and so on...
Outline

1. Adaptation of the Hypermedia Dimension
   - Hypermedia specification
   - Hypermedia adaptation

2. Adaptation based on the Hypermedia Structure

3. Adapting the Hypermedia Structure according to user interactions

4. Conclusion
Conclusion:

- A uniform approach to deal with the adaptation problem.
  - temporal-hypermedia.
- Proposition of an incremental adaptation which takes into account the user interactions.

Future Works:

- Extend the framework by adding or deleting objects.
- Adapt standard multimedia description languages (e.g., SMIL).
Thank you for your attention!

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