Multimedia Document Summarization based on a Semantic Adaptation Framework

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INRIA Rhône-Alpes
A multimedia document example

A movie trailer presentation

- specified with a multimedia description language (SMIL).
- designed for a laptop.

Temporal dimension

- Poster (Image)
- Trailer (Video)
- Abstract (Text)
- Characters (Video)
- Dates (Text)
Multimedia document adaptation

Different devices ⇒ Different profiles
Multimedia document adaptation

- Laptop
  - Initial multimedia document
  - Adaptation
  - Mobile phone
  - Adapted document

- PDA
  - Adapted document'

- Setup box
  - Adapted document”
Our adaptation approach

A multimedia document specification is composed of:
- A set of multimedia objects.
- A set of relations between multimedia objects.
  Represented with a relation graph.

Adaptation of the multimedia document composition.

The adapted document should be close to the initial one.

Initial document

- Poster (Image)
- Trailer (Video)
- Abstract (Text)
- Characters (Video)
- Dates (Text)
Our adaptation approach

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

Initial specification

- Trailer
- Poster
- Abstract
- Characters
- Dates
Our adaptation approach

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

Initial specification

Diagram showing the relationships between multimedia objects:
- Poster
- Abstract
- Characters
- Dates
- Trailer

Relations:
- overlaps
- before
- after
- meets

Adaptation of the multimedia document composition.
The adapted document should be close to the initial one.
A multimedia document specification is composed of:
- A set of multimedia objects.
- A set of relations between multimedia objects.
- Represented with a relation graph.

Initial relation graph:
- Poster overlaps Abstract
- Poster overlaps Dates
- Characters meets Dates
- Characters overlaps Poster
- Dates overlaps Abstract
- Poster meets Dates
- Dates meets Poster
- Abstract meets Poster
- Abstract overlaps Dates
- Characters overlaps Poster
Our adaptation approach

- A multimedia document specification is composed of:
  - A set of multimedia objects.
  - A set of relations between multimedia objects.
  - Represented with a relation graph.

- Adaptation of the multimedia document composition.

---

Initial relation graph:

```
Poster -> Abstract
  /     \
/      \ overlaps
before  before
/      \
|      |
|      |
after  after

Characters <-> Dates

overlap
```

Adapted relation graph:

```
Poster -> Abstract
  /     \
/      \ meets
before  before
/      \
|      |
|      |
meets after

Characters <-> Dates

before
```

---

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Multimedia Document Summarization
Our adaptation approach

- A multimedia document specification is composed of:
  - A set of multimedia objects.
  - A set of relations between multimedia objects.
  - Represented with a relation graph.

- Adaptation of the multimedia document composition.
- The adapted document should be close to the initial one.

**Initial relation graph**

**Adapted relation graph**
Our contribution

- Capability of suppressing multimedia objects.

- 2 applications may result:
  - Profiles express that some multimedia objects are forbidden. → Remove forbidden multimedia objects.
  - Profiles express that only a certain number of multimedia objects are allowed. → Summarize multimedia documents.
Outline

1. Removing Multimedia Objects
   - Multimedia Document Specification
   - Multimedia Document Adaptation

2. Summarizing Multimedia Document

3. Conclusion
Outline

1. Removing Multimedia Objects
   - Multimedia Document Specification
   - Multimedia Document Adaptation

2. Summarizing Multimedia Document

3. Conclusion
Multimedia Document Specification

Temporal dimension

- Poster (Image)
- Trailer (Video)
- Abstract (Text)
- Characters (Video)
- Dates (Text)

Initial relation graph

- Trailer
- Poster
- Abstract
- Characters
- Dates
Multimedia Document Specification

Temporal dimension

<table>
<thead>
<tr>
<th>Poster (Image)</th>
<th>Trailer (Video)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract (Text)</td>
<td>Characters (Video)</td>
</tr>
<tr>
<td>Dates (Text)</td>
<td></td>
</tr>
</tbody>
</table>

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>
</tr>
<tr>
<td>equals $(e)$</td>
<td>— —</td>
<td>$(e)$</td>
</tr>
</tbody>
</table>

Initial relation graph

- Poster $\rightarrow$ Abstract
  - {overlaps}
  - {before} {before}
  - {overlaps}
- Characters $\rightarrow$ Dates
  - {meets}
  - {after}
- Trailer $\rightarrow$ Poster
  - {overlaps}
  - {before}
  - {meets}
- Abstract $\rightarrow$ Dates
  - {after}
Removing Multimedia Objects

Multimedia Document Specification

Temporal dimension

- Poster (Image)
- Trailer (Video)
- Abstract (Text)
- Characters (Video)
- Dates (Text)

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>
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</tr>
<tr>
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<td>(si) started-by</td>
</tr>
<tr>
<td>finishes (f)</td>
<td>– –</td>
<td>(fi) finished-by</td>
</tr>
<tr>
<td>equals (e)</td>
<td>– –</td>
<td>(e)</td>
</tr>
</tbody>
</table>

Initial relation graph

Poster → Abstract

Characters → Dates

{b} → {oi} → {bi}

{m} → {o}

{b} → {e}

{bi} → {o}

{m} → {b}
Identify the target device profile: no video & no simultaneity.

Initial relation graph:

- Poster
  - Abstract
  - Characters
  - Dates
- Trailer
  - Abstract
  - Characters
  - Dates

Possible relation graph:

- Poster
  - Abstract
  - Characters
  - Dates

Multimedia Document Summarization
Identify the target device profile: no video & no simultaneity.

Identify the possible relations according to the profile:

Initial relation graph:
- Poster → Abstract
- Characters → Dates
- Trailer

Possible relation graph:
- Poster → Abstract
- Characters → Dates
- Trailer
Multimedia Document Adaptation

- Identify the target device profile: no video & no simultaneity.
- Identify the possible relations according to the profile:
  - Videos are forbidden: suppress Characters and Trailer.

Initial relation graph

Possible relation graph
Identify the target device profile: no video & no simultaneity.
Identify the possible relations according to the profile:
- Videos are forbidden: suppress Characters and Trailer.
- Overlapping objects are impossible at a time.

Initial relation graph

Possible relation graph
Multimedia Document Adaptation

- Identify the target device profile: no video & no simultaneity.
- Identify the possible relations according to the profile:
  - Videos are forbidden: suppress Characters and Trailer.
  - Overlapping objects are impossible at a time.
- Compute adapted solutions close to the initial document.
- Problem: different nodes number in both graphs.

Initial relation graph

Possible relation graph
Multimedia Document Adaptation

- Identify the target device profile: no video & no simultaneity.
- Identify the possible relations according to the profile:
  - Videos are forbidden: suppress Characters and Trailer.

Initial relation graph

Possible relation graph
Multimedia Document Adaptation

- Identify the target device profile: no video & no simultaneity.
- Identify the possible relations according to the profile:
  - Videos are forbidden: suppress Characters and Trailer.
  - Overlapping objects are impossible at a time.

**Initial relation graph**

- Poster → Characters: {o}
- Poster → Abstract: {b}
- Abstract → Characters: {b}
- Characters → Dates: {o}
- Dates → Characters: {m}
- Characters → Trailer: {bi}
- Dates → Trailer: {bi}
- Trailer → Poster: {o}
- Trailer → Abstract: {b}

**Possible relation graph**

- Poster → Characters: all
- Poster → Abstract: {m, mi, b, bi}
- Abstract → Characters: {m, mi, b, bi}
- Characters → Dates: all
- Characters → Trailer: all
- Dates → Characters: all
- Dates → Trailer: all
- Trailer → Poster: all
- Trailer → Abstract: all
Multimedia Document Adaptation

- Identify the target device profile: no video & no simultaneity.
- Identify the possible relations according to the profile:
  - Videos are forbidden: suppress Characters and Trailer.
  - Overlapping objects are impossible at a time.
- Compute adapted solutions close to the initial document.
- Preserve a maximum of initial relations.

**Initial relation graph**
- Poster
- Abstract
- Characters
- Dates
- Trailer

**Possible relation graph**
- Poster
- Abstract
- Characters
- Dates
- Trailer
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
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Temporal proximities

- before
- meets
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- overlapped-by
- met-by
- after
- starts
- finishes
- during

contains

finished-by
started-by

equals

during
Temporal proximities

\[ \delta(\text{before, overlaps}) = 2 \]
Compute adapted solutions close to the initial document.
Removing Multimedia Objects

Multimedia Document Adaptation

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

Initial relation graph

Consistent possible relation graph
Compute adapted solutions close to the initial document.

- Select consistent possible relation graphs.
- \[ \text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i) \]
### Removing Multimedia Objects

#### Multimedia Document Adaptation

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

---

**Initial relation graph**

- Poster → Abstract
- Characters → Dates
- Trailer
- $\{o\}$
- $\{b\}$
- $\{bi\}$
- $\{m\}$

**Consistent possible relation graph**

- Poster → Abstract
- Characters → Dates
- Trailer
- $\{o\}$
- $\{b\}$
- $\{bi\}$
- $\{m\}$

---

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Multimedia Document Summarization
Removing Multimedia Objects

Multimedia Document Adaptation

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

Initial relation graph

Consistent possible relation graph

An adapted solution

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Multimedia Document Summarization
Multimedia Document Adaptation

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

---

**Initial relation graph**

- Poster \( \{o\} \) \( \rightarrow \) Trailer \( \{o\} \) \( \leftarrow \) Abstract \( \{o\} \)
- Characters \( \{b\} \) \( \rightarrow \) Abstract \( \{b\} \)
- Dates \( \{b\} \) \( \rightarrow \) Abstract \( \{b\} \)
- \{m\} \( \rightarrow \) Dates \( \{m\} \)

**Consistent possible relation graph**

- An adapted solution
  - Poster \( \{m\} \) \( \rightarrow \) Abstract
  - Dates \( \{bi\} \) \( \rightarrow \) Abstract
  - Distance \( \rightarrow \) distance

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Multimedia Document Summarization
Removing Multimedia Objects

Multimedia Document Adaptation

A possible adapted execution

**Initial document**
- Poster (Image)
- Trailer (Video)
- Abstract (Text)
- Characters (Video)
- Dates (Text)

**Adapted document**
- Poster (Image)
- Abstract (Text)
- Dates (Text)

Gaps are meaningless for end users.

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Multimedia Document Summarization
A possible adapted execution

Initial document

- Poster (Image)
- Abstract (Text)
- Characters (Video)
- Dates (Text)
- Trailer (Video)

Adapted document

- Poster (Image)
- Abstract (Text)
- Dates (Text)
A possible adapted execution

Gaps are meaningless for end users.
Compute adapted solutions close to the initial document.
Select consistent possible relation graphs.
Removing Multimedia Objects

Multimedia Document Adaptation

- Compute adapted solutions close to the initial document.
  - Select consistent possible relation graphs.
  - Verify contiguity between non-forbidden multimedia objects.

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

\[ = 1 + 1 = 2 \text{ (minimal)} \]

Initial relation graph

Consistent possible relation graph

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Multimedia Document Summarization
Removing Multimedia Objects

Multimedia Document Adaptation

- Compute adapted solutions close to the initial document.
- Select consistent possible relation graphs.
- Verify contiguity between non-forbidden multimedia objects.

**Initial relation graph**

- Poster → Abstract → Trailer
- Characters → Dates
- {o} → {b} → {o} → {b} → {o} → {b}
- {m} → {m} → {m}

**Consistent possible relation graph**

- Poster → Abstract → Trailer
- Characters → Dates
- {o} → {b} → {m} → {b} → {m} → {b}
- {o} → {m} → {m} → {m}
Multimedia Document Adaptation

- Compute adapted solutions close to the initial document.
- Select consistent possible relation graphs.
- Verify contiguity between non-forbidden multimedia objects.
- \[ \text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i) \]

**Initial relation graph**

- Poster \(\rightarrow\) Trailer
  - \{o\}
- Abstract \(\leftarrow\) Poster
  - \{b\}
- Characters \(\rightarrow\) Dates
  - \{bi\}
- Dates \(\rightarrow\) Characters
  - \{m\}

**Consistent possible relation graph**

- Poster \(\rightarrow\) Trailer
  - \{o\}
- Trailer \(\leftarrow\) Poster
  - \{o\}
- Dates \(\rightarrow\) Characters
  - \{m\}
- Characters \(\rightarrow\) Dates
  - \{m\}
Multimedia Document Adaptation

- Compute adapted solutions close to the initial document.
  - Select consistent possible relation graphs.
  - Verify contiguity between non-forbidden multimedia objects.
  - \( \text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i) = 1 \)

Initial relation graph

Consistent possible relation graph
Multimedia Document Adaptation

- Compute adapted solutions close to the initial document.
  - Select consistent possible relation graphs.
  - Verify contiguity between non-forbidden multimedia objects.
  - \[ \text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i) = 1 + 1 = 2 \]

Initial relation graph

Consistent possible relation graph

- Remove forbidden multimedia objects.
- Initial relation graph:
  - Poster \rightarrow Trailer
  - Abstract \rightarrow Characters
  - Dates

- Consistent possible relation graph:
  - Poster \rightarrow Trailer
  - Abstract \rightarrow Characters
  - Dates

\{o\}, \{b\}, \{m\}, \{bi\}
Multimedia Document Adaptation

- Compute adapted solutions close to the initial document.
  - Select consistent possible relation graphs.
  - Verify contiguity between non-forbidden multimedia objects.
  - $distance = \sum_{i=1}^{n} \delta(r_i, p_i) = 1 + 1 = 2$ (minimal)

---

**Initial relation graph**

- Poster → Characters → Dates → Abstract → Trailer
- \{\text{o}\}, \{\text{b}\}, \{\text{bi}\}, \{\text{m}\}

**Consistent possible relation graph**

- Poster → Characters → Dates → Trailer
- \{\text{o}\}, \{\text{b}\}, \{\text{bi}\}, \{\text{m}\}

**An adapted solution**

- Poster → Characters → Dates → Abstract → Trailer
- \{\text{o}\}, \{\text{b}\}, \{\text{bi}\}, \{\text{m}\}, \{\text{mi}\}
Multimedia Document Adaptation

- Compute adapted solutions close to the initial document.
  - Select consistent possible relation graphs.
  - Verify contiguity between non-forbidden multimedia objects.
  - $\text{distance} = \sum_{i=1}^{n} \delta(r_i, p_i) = 1 + 1 = 2$ (minimal)
  - Remove forbidden multimedia objects.

Initial relation graph

Consistent possible relation graph
A possible adapted execution

The adapted document:
- satisfies the profile & objects contiguity
- is close to the initial one.
Outline

1. Removing Multimedia Objects
   - Multimedia Document Specification
   - Multimedia Document Adaptation

2. Summarizing Multimedia Document

3. Conclusion
Identify the target profile: only 1 video & no simultaneity.
Multimedia Document Summarization

- Identify the target profile: only 1 video & no simultaneity.
- Identify the possible relation graphs according to the profile:

**Initial relation graph**

- Poster → Abstract
- Characters → Dates

**Possible relation graph 1**

- Poster → Abstract
- Characters → Dates
Identify the target profile: only 1 video & no simultaneity.
Identify the possible relation graphs according to the profile:
- Only 1 video: suppress Characters

**Initial relation graph**

- Poster → Abstract
- Characters → Dates
- Characters → Trailer
- Dates → Trailer

**Possible relation graph 1**

- Poster → Abstract
- Characters → Dates
- Characters → Trailer
- Dates → Trailer
Identify the target profile: only 1 video & no simultaneity.

Identify the possible relation graphs according to the profile:
- Only 1 video: suppress Characters
- Overlapping objects are impossible at a time.

Initial relation graph

Possible relation graph 1
Multimedia Document Summarization

- Identify the target profile: only 1 video & no simultaneity.
- Identify the possible relation graphs according to the profile:
  - Only 1 video: suppress Characters or suppress Trailer.
  - Overlapping objects are impossible at a time.

Initial relation graph

Possible relation graph 1

Possible relation graph 2
Multimedia Document Summarization

- Identify the target profile: only 1 video & no simultaneity.
- Identify the possible relation graphs according to the profile:
  - Only 1 video: suppress Characters or suppress Trailer.
  - Overlapping objects are impossible at a time.
- Compute adapted solutions close to the initial document.
A possible summarized adapted execution

Initial document

- Poster (Image)
- Trailer (Video)
- Abstract (Text)
- Characters (Video)
- Dates (Text)

Adapted document

- Poster (Image)
- Abstract (Text)
- Characters (Video)
- Dates (Text)
Multimedia Document Summarization

- Identify the target profile: only 1 video & no simultaneity.
- Identify the possible relation graphs according to the profile:
  - Only 1 video: suppress Characters or suppress Trailer.
  - Overlapping objects are impossible at a time.
- Select some preferred possible relation graphs.

Initial relation graph

Possible relation graph 1 (0.6)

Possible relation graph 2 (0.4)
Multimedia Document Summarization

- Identify the target profile: only 1 video & no simultaneity.
- Identify the possible relation graphs according to the profile:
  - Only 1 video: suppress Characters or suppress Trailer.
  - Overlapping objects are impossible at a time.
  - Select some preferred possible relation graphs.

**Initial relation graph**

- **Poster** → **Abstract**
- **Characters** → **Dates**
- **Characters** → **Trailer**
- **Dates** → **Trailer**

**Possible relation graph 1 (0.6)**

- **Poster** → **Abstract**
- **Characters** → **Dates**
- **Characters** → **Trailer**
- **Dates** → **Trailer**

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Multimedia Document Summarization

- Identify the target profile: only 1 video & no simultaneity.
- Identify the possible relation graphs according to the profile:
  - Only 1 video: suppress Characters or suppress Trailer.
  - Overlapping objects are impossible at a time.
  - Select some preferred possible relation graphs.

- Compute adapted solutions close to the initial document.

**Initial relation graph**

- Poster → Abstract
- Abstract ← Trailer
- Poster ← Characters
- Characters → Dates
- Characters ← Dates

**Possible relation graph 1 (0.6)**

- Poster → Abstract
- Abstract ← Trailer
- Poster ← Characters
- Characters → Dates
- Characters ← Dates

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Multimedia Document Summarization
A possible summarized adapted execution

Initial document

- Poster (Image)
- Trailer (Video)
- Abstract (Text)
- Characters (Video)
- Dates (Text)

Adapted document

- Poster (Image)
- Trailer (Video)
- Abstract (Text)
- Dates (Text)
Outline

1. Removing Multimedia Objects
   - Multimedia Document Specification
   - Multimedia Document Adaptation

2. Summarizing Multimedia Document

3. Conclusion
Prototype

- Edit SMIL documents.
- Specify adaptation constraints (i.e., the profile).
- Adapt the multimedia document specification.
- Execute the adapted multimedia document.
Conclusion:

- A uniform approach to deal with forbidden multimedia objects.
- Proposition of a preference-based adaptation which summarize multimedia documents.
- Application to concrete multimedia documents (SMIL).

Future Works:

- Select particular adapted solutions.
- Summarize the spatio-temporal-hypermedia dimension.
Thank you for your attention!

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