A Framework for Media Adaptation Using the Web and the Semantic Web

Sébastien Laborie and Antoine Zimmermann

SMAP’07
Information Anytime Anywhere

Mona Lisa Image

PNG format
560 x 864
Information Anytime Anywhere

Mona Lisa Image

PNG format
560 x 864
Information Anytime Anywhere

Mona Lisa Image

PNG format
560 x 864

Web

Profile

Format = \{JPG,BMP,3GP\}
Max resolution = 400 x 600

NOT SUPPORTED

Sebastien Laborie and Antoine Zimmermann
Media Adaptation using the Web and the Semantic Web
Information Anytime Anywhere

Mona Lisa Image
PNG format
560 x 864

Web

Mona Lisa Image
JPG format
386 x 600
Information Anytime Anywhere

Movie trailer
AVI format
Information Anytime Anywhere

Movie trailer
AVI format

Web

No Videos

NOT SUPPORTED
Information Anytime Anywhere

Movie trailer
AVI format

Web

Movie poster

Motivations

Information Anytime Anywhere

3 Sébastien Laborie and Antoine Zimmermann Media Adaptation using the Web and the Semantic Web
Introduction

Motivations

Information Anytime Anywhere

Movie trailer
AVI format

Web

Movie poster

No Videos
No Images

NOT SUPPORTED

Information Anytime Anywhere

Motivations

Introduction

Movie trailer
AVI format

Web

Movie poster

Movie synopsis

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Media Adaptation using the Web and the Semantic Web
Our adaptation approach

<table>
<thead>
<tr>
<th>Approach</th>
<th>Solutions</th>
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**Automatize this process!**
Outline

1. Software Architecture

2. Simulating with current technologies

3. Improving the process with Semantic Web technologies
Software Architecture

World Wide Web

\[ m \]

\[ \text{Descriptions} \]

\[ d_1 \]

\[ d_2 \]

\[ d_3 \rightarrow m_1 \]

\[ d_4 \rightarrow m_2 \]

\[ d_5 \rightarrow m_3 \]
Software Architecture

World Wide Web

Descriptions

Media items

Adaptation component

$d_1 \rightarrow d_3 \rightarrow m_1$

$d_2 \rightarrow d_4 \rightarrow \rightarrow m_2$

$d_5 \rightarrow m_3$

$m$

$m_1, \ldots, d_j$

$m_1$

$m_2$

$m_3$

$a \rightarrow b \rightarrow c \rightarrow d$

Media items

Adaptation component
World Wide Web

Descriptions

Media items

Adaptation component

\( m \)

\( d_1 \)
- height: “864”
- width: “560”
- format: PNG

\( d_2 \)
- title: “Mona Lisa”
- author: “Da Vinci”

\( d_3 \)
- date: “17/12/2007”
- title: “Mona Lisa”
- format: PNG

\( d_4 \)
- height: “600”
- width: “386”
- format: JPG

\( d_5 \)
- title: “Mona Lisa”
- author: “Da Vinci”

\( \text{a): Description association} \)
Software Architecture

World Wide Web

Descriptions

\[ d_1, d_2, d_3, d_4, d_5 \]

Media items

\[ m_1, m_2, m_3 \]

Adaptation component

\[ a, b, c, d \]

\( m \)

- height: “864”
- width: “560”
- format: PNG
- title: “Mona Lisa”
- author: “Da Vinci”

\( d' \)

- height: “864”
- width: “560”
- format: PNG
- title: “Mona Lisa”
- author: “Da Vinci”

\( m_1 \)

- date: “17/12/2007”
- title: “Mona Lisa”
- format: PNG

\( m_2 \)

- height: “600”
- width: “386”
- format: JPG
- title: “Mona Lisa”
- author: “Da Vinci”

\( m_3 \)

Description aggregation

⑩: Description aggregation
Software Architecture

World Wide Web

Descriptions

Media items

Adaptation component

\( m \)

\( d_1 \)

\( d_2 \)

\( d_3 \)

\( d_4 \)

\( d_5 \)

\( m_1 \)

\( m_2 \)

\( m_3 \)

\( a \)

\( b \)

\( c \)

\( d \)

\( m_i, \{d_0, \ldots, d_j\} \)

\( m_i, d'_i \)

\( \text{Sim}(d'_k, d'_l) \)

\( \bigcirc \): Description similarity

\( m \)

\( d'_1 \)

\( m_1 \)

\( m_2 \)

\( m_3 \)

\( 0.76 \)

\( 0.9 \)

\( 0.31 \)

\( d'_2 \)

\( \text{height: “864”} \)

\( \text{width: “560”} \)

\( \text{format: PNG} \)

\( \text{title: “Mona Lisa”} \)

\( \text{author: “Da Vinci”} \)

\( \text{date: “17/12/2007”} \)

\( \text{title: “Mona Lisa”} \)

\( \text{format: PNG} \)

\( \text{height: “600”} \)

\( \text{width: “386”} \)

\( \text{format: JPG} \)

\( \text{title: “Mona Lisa”} \)

\( \text{author: “Da Vinci”} \)
Software Architecture

world Wide Web

Media items

Adaptation component

@d: Description selection

Sim(d′k, d′l)
Software Architecture

World Wide Web

Descriptions

Media items

Adaptation component

$\mathit{m}$

$d_1$

$d_2$

$d_3$

$d_4$

$d_5$

$m_1$

$m_2$

$m_3$

$d'_1$

$d'_2$

$d'_3$

$d'_4$

$d'_5$

$d'_{out}$

$a$

$b$

$c$

$d$

profile

Sim($d'_k$, $d'_l$)
Simulating with current technologies

http://ex.com/mona.png
Simulating with current technologies

La Gioconda

Painting

This page is another example for the paper A Framework for Media Adaptation Using the Web and the Semantic Web. The description is found in the alt attribute.

Alternative Images
Simulating with current technologies

http://ex.com/mona.png

La Gioconda

```html
<div>
  <img src="http://ex.com/mona.png" alt="La Gioconda"/>
  ...
</div>
```
Simulating with current technologies

Simulating with current technologies

http://ex.com/mona.png

La Gioconda

```
<div>
<img src="http://ex.com/mona.png" alt="La Gioconda"/>
...
</div>
```

http://ex.com/mona.png, \{ "La Gioconda" \}
Simulating with current technologies

Simulating with current technologies

La Gioconda

Mona Lisa

Original Image

This page is an example for the paper A Framework for Media Adaptation Using the Web and the Semantic Web, by Sébastien Laborie and Antoine Zimmermann, accepted for publication in SMAP 2007. It contains a picture in PNG format (http://www.arildoen.fr/tony/people/zimmer/smap2007/moonlisa.png) with an alt attribute having value "Mona Lisa". The image format and resolution cannot be displayed by certain devices. For instance, the

Filtering / Preferences

Web search engines partially implement

a
b
c
d

Similarities: String comparison

Vector comparison

. . .

d

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Media Adaptation using the Web and the Semantic Web
Simulating with current technologies

http://ex.com/mona.png

La Gioconda

Mona Lisa

La Gioconda Mona Lisa

Filtering / Preferences
Web search engines partially implement a, b, c, and d.

Similarities: String comparison, Vector comparison, ...

http://ex.com/mona.png, {“La Gioconda”, “Mona Lisa”}
Simulating with current technologies

http://ex.com/mona.png

La Gioconda

Mona Lisa

"La Gioconda Mona Lisa"
Simulating with current technologies

Simulating with current technologies

http://ex.com/mona.png

La Gioconda

Mona Lisa

Similarities: String comparison
Vector comparison

Filtering / Preferences

Web search engines partially implement a, b, c, and d.
Simulating with current technologies

http://ex.com/mona.png

La Gioconda

Mona Lisa

Filtering / Preferences
Simulating with current technologies

http://ex.com/mona.png

La Gioconda

Mona Lisa

Web search engines partially implement ①, ②, ③ and ④
Using current techniques is not enough.

\[\Rightarrow\] Semantic Web technologies can improve this... 

... by adding expressivity:
- e.g., “Da_Vinci is a Painter”.

... by providing deductive capabilities:
- e.g., “Mona_Lisa was painted by Da_Vinci” implies that “Mona_Lisa is a Painting”.

... by solving heterogeneity problems:
- e.g., “La_Gioconda same as Mona_Lisa”.
Using current techniques is not enough.

Semantic Web technologies can improve this. . .

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  - e.g., “Da_Vinci is a Painter”.

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... by solving heterogeneity problems:
  - e.g., “La_Gioconda same as Mona_Lisa”.

This does not change our software architecture!
Improving the process with Semantic Web technologies

Improvement

Indexing

\[ d_1 \]

height: “864”

width: “560”

format: PNG
Improving the process with Semantic Web technologies

**Improvement**

Indexing RDF (+OWL ontologies)

**O₁**

- Painting
  - Portrait
  - Landscape
    - Abstract

Painting ≡ ∃ hasPainter

- hasTitle

**d₁**

- height: “864”
- width: “560”
- format: PNG

- hasTitle: “Mona Lisa”
- hasPainter: “Da Vinci”

**d₂**

**RDF Merge**

**Similarity**

Semantic similarity based on ontology matching

**Semantic filtering** (e.g., only masterpieces)

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Media Adaptation using the Web and the Semantic Web
Improving the process with Semantic Web technologies

**Improvement**

Indexing RDF (+OWL ontologies)

\[ a \]

**O₁**

- Painting
  - Portrait
  - Landscape
  - Abstract

\[ \text{Painting} \equiv \exists \text{hasPainter} \]
\[ \text{hasTitle} \]

\[ d₁ \]
- height: “864”
- width: “560”
- format: PNG

\[ d₂ \]
- hasTitle: “Mona Lisa”
- hasPainter: “Da Vinci”

\[ \models \text{type: Painting} \]
Improving the process with Semantic Web technologies

**Improvement**

- **a)** Indexing RDF (+OWL ontologies)

**O₁**
- Painting
  - Portrait
  - Landscape
  - Abstract

  Painting $\equiv \exists$ hasPainter
  hasTitle

**O₂**
- ArtWork
  - Drawing
  - Cartoon ↔ MasterPiece

  author
title

$d₁$
- height: “864”
- width: “560”
- format: PNG

$d₂$
- hasTitle: “Mona Lisa”
- hasPainter: “Da Vinci”

$d₃$
- type: Cartoon
- author: “Sato”
- format: JPG

$d₄$
- hasTitle: “La Gioconda”
- represents: ?X
  - type: Woman

$d₅$
- title: “Mona Lisa”
- author: “Da Vinci”
- type: MasterPiece

**RDF Merge**

**Similarity**

- Semantic similarity based on ontology matching
- Semantic filtering (e.g., only masterpieces)

---

Sébastien Laborie and Antoine Zimmermann

Media Adaptation using the Web and the Semantic Web
Improving the process with Semantic Web technologies

Improvement

Indexing RDF (+OWL ontologies)

\( O_1 \)

- Painting
  - Portrait
  - Landscape
  - Abstract
  \( \text{Painting} \equiv \exists \text{hasPainter} \)
  \( \text{hasTitle} \)

\( O_2 \)

- ArtWork
  - Drawing
  - Movie
  - Cartoon
  - MasterPiece
  \( \text{author} \)
  \( \text{title} \)

\( d_1 \) height: “864” width: “560” format: PNG

\( d_2 \) hasTitle: “Mona Lisa” hasPainter: “Da Vinci”

\( d_3 \) type: Cartoon
  author: “Sato”
  format: JPG

\( d_4 \) hasTitle: “La Gioconda”
  represents: ?X
  ?X type: Woman
  \( \text{type: Painting} \)

\( d_5 \) title: “Mona Lisa”
  author: “Da Vinci”
  \( \text{type: MasterPiece} \)
Improving the process with Semantic Web technologies

Improvement

RDF Merge

\[ b \]

\[ O_1 \]

\[ O_2 \]

\[ \text{Painting} \equiv \exists \text{hasPainter} \]

\[ \text{hasTitle} \]

\[ \text{Portrait} \]

\[ \text{Landscape} \]

\[ \text{Abstract} \]

\[ \text{ArtWork} \]

\[ \text{Drawing} \]

\[ \text{Movie} \]

\[ \text{Cartoon} \leftrightarrow \text{MasterPiece} \]

\[ \text{author} \]

\[ \text{title} \]

\[ \text{type: Cartoon} \]

\[ \text{author: “Sato”} \]

\[ \text{format: JPG} \]

\[ \text{hasTitle: “La Gioconda”} \]

\[ \text{represents: ?X} \]

\[ ?X \text{ type Woman} \]

\[ \text{type: Portrait} \]

\[ \text{title: “Mona Lisa”} \]

\[ \text{author: “Da Vinci”} \]

\[ \text{type: MasterPiece} \]

\[ d_1' \]

\[ \text{height: “864”} \]

\[ \text{width: “560”} \]

\[ \text{format: PNG} \]

\[ \text{hasTitle: “Mona Lisa”} \]

\[ \text{hasPainter: “Da Vinci”} \]

\[ d_2' \]

\[ \text{hasTitle: “La Gioconda”} \]

\[ \text{represents: ?X} \]

\[ ?X \text{ type Woman} \]

\[ \text{type: Portrait} \]

\[ \text{title: “Mona Lisa”} \]

\[ \text{author: “Da Vinci”} \]

\[ \text{type: MasterPiece} \]

\[ d_3' \]

Indexing

RDF Merge

RDF Merge

Similarity

Semantic similarity

based on

ontology matching

Semantic filtering

(e.g., only masterpieces)
Improving the process with Semantic Web technologies

### Improvement

**C**

**Similarity**

\[ \exists \text{hasPainter} \]

\[ \exists \text{hasTitle} \]

\[ \text{Painting} \equiv \exists \text{hasPainter} \]

\[ \text{hasTitle} \]

\[ \text{O}_1 \]

- **Painting**: Portrait, Landscape, Abstract

\[ \text{O}_2 \]

- **ArtWork**: Drawing, Movie

\[ \text{Cartoon} \leftrightarrow \text{MasterPiece} \]

**author**

**title**

- **d**
  - **type**: Cartoon
  - **author**: “Sato”
  - **format**: JPG

- **d’**
  - **type**: Cartoon
  - **hasTitle**: “La Gioconda”
  - **represents**: ?X
  - ?X **type**: Woman

- **d**
  - **type**: Painting
  - **hasTitle**: “Mona Lisa”
  - **hasPainter**: “Da Vinci”
  - **height**: “864”
  - **width**: “560”
  - **format**: PNG

- **d’**
  - **hasTitle**: “La Gioconda”
  - **represents**: ?X
  - ?X **type**: Woman

- **d’’**
  - **title**: “Mona Lisa”
  - **author**: “Da Vinci”
  - **type**: MasterPiece

**Indexing**

- **RDF Merge**

- **Similarity**
  - Semantic similarity based on ontology matching

- **Semantic filtering**
  - (e.g., only masterpieces)
Improving the process with Semantic Web technologies

Improvement

Semantic similarity based on ontology matching

$O_1$

Painting

Portrait

Landscape

Abstract

Painting $\equiv \exists$ hasPainter $\equiv$ hasTitle

$O_2$

ArtWork

Drawing

Cartoon $\leftrightarrow$ MasterPiece

Drawing $\equiv$ hasPainter $\equiv$ author $\equiv$ hasTitle $\equiv$ title

$d_1'$ height: "864" width: "560" format: PNG
hasTitle: "Mona Lisa" hasPainter: "Da Vinci"

$d_2'$

type: Cartoon author: "Sato" format: JPG

$d_3'$

hasTitle: "La Gioconda" represents: ?X ?X type Woman

hasTitle: "Mona Lisa" author: "Da Vinci" type: MasterPiece

0.2

0.8
Improving the process with Semantic Web technologies

Improvement

Semantic filtering (e.g., only masterpieces)

![Diagram showing semantic filtering with examples of paintings and drawings, including properties like height, width, format, title, and author.]

Example:

- $d_1'$: Painting, height: "864", width: "560", format: PNG, hasTitle: "Mona Lisa", hasPainter: "Da Vinci"
- $d_2$: Painting, hasTitle: "Mona Lisa", hasPainter: "Da Vinci"
- $d_3'$: MasterPiece, type: Portrait, title: "Mona Lisa", author: "Da Vinci"

Semantic similarity based on ontology matching: 0.8

Semantic filtering (e.g., only masterpieces)
Limitations

😊 Limited efficiency for:
- private media items;
- multimedia document.

😊 The semantic implementation needs further research:
- automatic semantic annotations;
- merging semantic annotations;
- semantic similarity.

😊 Not implemented yet
It is practically implementable;

The approach is flexible:
- no need to implement it for each new format;
- it encompasses cross-media adaptation.

It is potentially an efficient solution:
- fast (everything is pre-computed);
- use information profusion on the Web.
Thank you for your attention!

sebastien.laborie@inrialpes.fr
antoine.zimmermann@inrialpes.fr