Selection of e-learning web service based on QoS and user profile

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Outlines

- Web service
- E-learning Web service
- Web service selection
- Proposed approach
  - Quality attributes of e-learning Web service
  - User profile
  - Selection process
- Case study
- Conclusions and perspectives
Introduction

Instruction  Module  Object  Component  Service  ?


Web service

**Definition:**

A Web service is:

- An autonomous application that works independently without external assistance.
- Considered as the most popular technology of distributed computing.
- A software designed to support interoperable machine-to-machine interaction over a network.
Web service (2)

Service Oriented Architecture

1- Publish

2- Discover

Service Registry

3- Invoke

Service Requester

4- Response

Service Provider

Application

E-commerce, Research, Digital marketing, Big data, Mobile service,

Education

E-learning Web service
An e-learning system can be seen like a **set of specific Web services** in the educational domain.

Every element of the system become a documented, independent and accessible service.
Example:

Educational institutions

Educational technology companies
An e-learning Web service

Pedagogic constraints
Ergonomic constraints
Financial constraints
Technological constraints

Quality attributes (QoS) of the e-learning Web service

QoS: The non functional aspect of a Web service
Web service selection

WS₁
WS₂
WS₃

Web Service Requester
Web service selection (2)

How to select the most appropriate e-learning Web service that satisfies the requester’s requirements?

Web service selection technique’s

- Optimization algorithm (Baldon et al., 2007)
- Linear programming (Talantokite et al., 2008)
- Genetic algorithms (Chang, 2008)
- Heuristics (Yu et al., 2007)
- Multi attribute decision making (Zeng et al., 2003)
- Semantic discovery (Balke et al., 2003)
A new Multi attribute decision making approach for e-learning Web service selection

Proposed approach

Quality of Service (QoS)
Uncertain attribute value's

User profile
Preference Order
Quality attributes of e-learning Web service

- **Cost**: the amount of money paid by the user for consuming the service
- **Response Time**: waiting time + execution time
- **Reliability**: the probability that the service proceed correctly
- **Availability**: the probability that the service is available
- **Reputation**: the trustworthiness of the service
Quality attributes of e-learning Web service (2)

- Negative attributes:
  - Cost
  - Response Time

- Positives attributes:
  - Availability
  - Reliability
  - Reputation

Graphs showing the relationship between:
- Quality and Cost
- Quality and Availability
Quality attributes of e-learning Web service (3)

Quality attributes value’s

- Hosting platform
- Network performance
- ... (omitted)
- Incorrect information
- Non objective manner
- Missing data

Uncertainty
Each attribute can not be represented by a fixed value

Each attribute is represented by a couple $(Values, Probabilities)$

Example

For the attribute $A_1$ (Cost) we have $Values=\{7,6\}$ and $Probabilities=\{0.2, 0.8\}$

- The probability that the attribute $A_1$ has the value 7 is equal to 0.2
- The probability that the attribute $A_1$ has the value 6 is equal to 0.8
An order of preference about different quality attributes

Transformation of this order into numerical weights

Example

$A = \{A_1 (\text{Cost}), \ A_2(\text{Response Time}), \ A_3(\text{Availability}), \ A_4 (\text{Reliability})\}$

The order of preference: $A_2 \geq A_4 \geq A_3 \geq A_1$

<table>
<thead>
<tr>
<th>Attributes</th>
<th>$A_1$</th>
<th>$A_2$</th>
<th>$A_3$</th>
<th>$A_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weights</td>
<td>0.0001</td>
<td>0.699</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Multi attribute decision making

A decision making problem with m criteria and n alternatives

Buying a car is a multiattribute decision:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Car A</th>
<th>Car B</th>
<th>Car C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horsepower</td>
<td>195</td>
<td>320</td>
<td>230</td>
</tr>
<tr>
<td>Transmission</td>
<td>automatic</td>
<td>automatic</td>
<td>manual</td>
</tr>
<tr>
<td>Color</td>
<td>red</td>
<td>blue</td>
<td>gray</td>
</tr>
<tr>
<td>Body style</td>
<td>sedan</td>
<td>coupe</td>
<td>sedan</td>
</tr>
</tbody>
</table>
Principal idea:

**TOPSIS** (The Technique for Order Preference by Similarity to Ideal Solution) (Deng et al., 2000):

The selection of the alternative having the shortest distance to the positive ideal solution and the largest distance to the negative ideal solution.
Selection process (2)

**Step 1**: Compute the positive and the negative ideal solution

**Step 2**: Compute the weighted Euclidean distance to the positive and to the negative ideal solutions

**Step 3**: Compute the degree of membership of each Web service to the positive ideal solution

**Step 4**: Select the best Web service that has the highest value of the degree of membership
### Case study

Let $S_1$, $S_2$ and $S_3$ be three similar e-learning Web service

<table>
<thead>
<tr>
<th></th>
<th>$\mathbf{A}_1$</th>
<th>$\mathbf{A}_2$</th>
<th>$\mathbf{A}_3$</th>
<th>$\mathbf{A}_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$</td>
<td>$V_{11} = {7,6}$</td>
<td>$V_{21} = {5,6}$</td>
<td>$V_{31} = {60,70}$</td>
<td>$V_{41} = {90,65}$</td>
</tr>
<tr>
<td></td>
<td>$Pr_{11} = {0.2, 0.8}$</td>
<td>$Pr_{21} = {0.3, 0.7}$</td>
<td>$Pr_{31} = {0.9, 0.1}$</td>
<td>$Pr_{41} = {0.4, 0.6}$</td>
</tr>
<tr>
<td>$S_2$</td>
<td>$V_{12} = {5}$</td>
<td>$V_{22} = {8}$</td>
<td>$V_{32} = {20}$</td>
<td>$V_{42} = {80}$</td>
</tr>
<tr>
<td></td>
<td>$Pr_{12} = {1}$</td>
<td>$Pr_{22} = {1}$</td>
<td>$Pr_{32} = {1}$</td>
<td>$Pr_{42} = {1}$</td>
</tr>
<tr>
<td>$S_3$</td>
<td>$V_{13} = {8,5}$</td>
<td>$V_{23} = {5}$</td>
<td>$V_{33} = {7,6}$</td>
<td>$V_{43} = {7,6}$</td>
</tr>
<tr>
<td></td>
<td>$Pr_{13} = {0.5, 0.5}$</td>
<td>$Pr_{23} = {1}$</td>
<td>$Pr_{33} = {0.2, 0.8}$</td>
<td>$Pr_{43} = {0.2, 0.8}$</td>
</tr>
</tbody>
</table>
## Case study (2)

Expected Values of each service:

<table>
<thead>
<tr>
<th></th>
<th>$A_1$</th>
<th>$A_2$</th>
<th>$A_3$</th>
<th>$A_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$</td>
<td>6.2</td>
<td>5.7</td>
<td>61</td>
<td>75</td>
</tr>
<tr>
<td>$S_2$</td>
<td>5</td>
<td>8</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>$S_3$</td>
<td>6.5</td>
<td>5</td>
<td>59.5</td>
<td>73</td>
</tr>
</tbody>
</table>
The positive and negative ideal solution

<table>
<thead>
<tr>
<th></th>
<th>(A_1)</th>
<th>(A_2)</th>
<th>(A_3)</th>
<th>(A_4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive idSol</td>
<td>6.5</td>
<td>8</td>
<td>61</td>
<td>80</td>
</tr>
<tr>
<td>Negative idSol</td>
<td>5</td>
<td>5</td>
<td>20</td>
<td>73</td>
</tr>
</tbody>
</table>

The degree of membership to positive solution

<table>
<thead>
<tr>
<th></th>
<th>(\mu(D_j))</th>
</tr>
</thead>
<tbody>
<tr>
<td>(S_1)</td>
<td>0.696</td>
</tr>
<tr>
<td>(S_2)</td>
<td>0.9174</td>
</tr>
<tr>
<td>(S_3)</td>
<td>0.0361</td>
</tr>
</tbody>
</table>

\(S^* = S_2\)
Conclusions and perspectives

E-learning Web services provide an essential technology to develop dynamic systems:

- Application-to–application interaction
- Flexible integration
- Interoperability and
- Efficient communication

Our approach is based on the MADM method:

- Preferences concerning quality attributes
- Uncertainty about quality attributes value’s
- Expected values of Web services
Conclusions and perspectives (2)

- Use utility function for positive and negative attributes to represent real utility of each attribute value’s


- Integration of semantic aspect through the use of ontologies and policy languages.

- Use graphical decision models to represent the problem of e-learning Web services selection.
Thank you for your attention