Problem Statement

Sometimes is difficult for teachers to find a correct, fluid and comprehensive sequence of learning activities covering a given topic and able to fit any learners’ need

• This may be due to several reasons:
  – complex nature of the topic
  – different needs of involved learners
  – lack of knowledge about prerequisite concepts
  – different learning styles

• This may result in unappealing and inefficient learning experiences
Individualized Teaching

• Learning is a **journey** that is different for each learner
• The best sequence of learning activities is selected for each learner according to **learning needs** and preferences

• **Drawback**: it tends to force the learner to follow a **fixed**, optimized, sequence of activities allowing few crossing possibilities

Intuitive Guided Learning

• Learners are **not forced down** a particular sequence of activities
• The experience is **non-linear**: the learner can deviate from the intended path through the learning experience
Intuitive Guided Learning

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Intuitive Guided Learning

• Learning happens in a **incidental manner**, through:
  – the **exploration**
  – the finding of a **personal key** of understanding

• It is particularly suitable for **digital natives**:
  – they are **curious** and driven by the pleasure of discovering something new
  – they consider this kind of interaction as more **natural** and **stimulating**

• **Drawbacks**:
  – the learner may feel lost within the course
  – sometimes it can be **difficult to reach** the required information

Our Approach

Combining Individualized Teaching and Intuitive Guided Learning

• **Compound Learning Resources** (CLRs)
  – are composed by a set of learning activities linked with **semantic connections**
  – can be **browsed in different ways** by different learners

• **Semantic connections**
  – guide the learner during the resource navigation
  – are used to adapt CLRs with respect to learning needs and preferences
ALICE is a project co-funded by the European Commission under the 7th Framework Programme for Research and Technology Development.
Components

• **Semantic Connection Model**
  – To formally describe the **meaning** of semantic connections

• **Compound Learning Resource Model**
  – To formally describe a CLR as a **graph** where:
    • *nodes* are learning activities
    • *arcs* are semantic connection between activities

• **Adaptation Algorithm**
  – To automatically adapt CLR connections with respect to:
    • teaching preferences, learning preferences, context information

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**Semantic Connection Model**

• Describes a connection with a set of **attributes:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Specifies the nature of the connection. It is composed by three sub-parameters: group, name, colour.</td>
</tr>
<tr>
<td>Scope</td>
<td>Specifies the part of resource text on which the connection is applied. If blank it applies to the whole resource.</td>
</tr>
<tr>
<td>Optionality</td>
<td>Specifies if a connection is optional or mandatory. Optional connections can be removed by the system while mandatory ones can’t be.</td>
</tr>
<tr>
<td>Tooltip</td>
<td>Provides a brief description of the connected content and is shown to the learner when he places the cursor over the connection activator.</td>
</tr>
<tr>
<td>Target</td>
<td>It is the target content to be shown when the connection is clicked by the learner. It can be internal (i.e. a resource page) or external (i.e. another resource or a URL)</td>
</tr>
</tbody>
</table>
Connections **between** learning resources

*from rhetorical structure theory and learning objects networks*

<table>
<thead>
<tr>
<th>Connection Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elaboration</td>
<td>The referenced resource elaborates the content of the described resource or of a part of it.</td>
</tr>
<tr>
<td>Evidence</td>
<td>The referenced resource provides information to increase the belief in the claim mentioned in the described resource or in a part of it.</td>
</tr>
<tr>
<td>Interpretation</td>
<td>The referenced resource interprets or explains the described resource or a part of it.</td>
</tr>
<tr>
<td>Justification</td>
<td>The referenced resource justifies the described resource or a part of it.</td>
</tr>
<tr>
<td>Summary</td>
<td>The referenced resource summarises the described resource or a part of it.</td>
</tr>
<tr>
<td>Contrast/Opposite</td>
<td>The content of the described resource (or a part of it) and of the referenced resource are opposites.</td>
</tr>
<tr>
<td>Condition/Restriction</td>
<td>The referenced resource limits the content of the described resource or of a part of it.</td>
</tr>
<tr>
<td>Restatement/Alternative</td>
<td>The referenced resource provides an alternative of presenting the described resource or a part of it.</td>
</tr>
<tr>
<td>Sequence</td>
<td>The referenced resource is the sequence or chronology of the described resource.</td>
</tr>
</tbody>
</table>


Connections **within** a learning resource

*from the theory of conditions of learning and the educational rationale metadata initiative*

<table>
<thead>
<tr>
<th>Connection Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>The referenced content is an activator i.e. it strongly motivates and justifies the importance of the topic explained in the described resource or in a part of it.</td>
</tr>
<tr>
<td>Critique</td>
<td>The referenced content presents a critical review of the issues included in the described resource or in a part of it.</td>
</tr>
<tr>
<td>Collaboration</td>
<td>The referenced content includes spaces for discussion or cooperation about the topic described within the described resource or a part of it.</td>
</tr>
<tr>
<td>Engaging</td>
<td>The referenced content leads students to discover the validity of what they are studying by displaying bad behaviours held by those who do not know the topic explained within a resource or a part of it.</td>
</tr>
<tr>
<td>Integration</td>
<td>The referenced content is purposed to deepen (from several viewpoints) the theme explained in the described resource or in a part of it.</td>
</tr>
<tr>
<td>Anchor</td>
<td>The referenced content is purposed to anchor the knowledge explained in the described resource (or in a part of it) within an authentic context.</td>
</tr>
<tr>
<td>Perspective</td>
<td>The referenced content explains the knowledge provided by the described resource (or by a part of it) from a different perspective.</td>
</tr>
</tbody>
</table>


**Connections Customisation**

- **Optional connections** of a given type \( c \) are **removed** if:
  - the CLR is use by a **learner** whose preference degree for that type is less then a given threshold i.e. \( p(c) < \theta \)
  - the CLR is used in a **course** that do not allow connections of that type i.e. \( c \notin C_{Crs} \)
  - the CLR is used in a **context** that do not allow connections of that type i.e. \( c \notin C_{Ctx} \)

- **Page connections** are **reordered** according to the preference degrees of the learner that is using the CLR

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**Connections Customisation**

- Learner **preference degrees** of connections are inferred by the system
- A **machine learning** algorithm is used to analyse learner behaviour during the compound learning resource navigation

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### History-Based Component

Which connections have been preferred in the past by the same user?

### Collaborative Component

Which connections similar users prefer?
ALICE is a project co-funded by the European Commission under the 7th Framework Programme for Research and Technology Development.
The Prototype Player

Set theory

Set theory is the branch of mathematics that studies sets, which are collections of objects. Although any type of object can be collected into a set, set theory is applied most often to objects that are relevant to mathematics. The language of set theory can be used in the definitions of nearly all mathematical objects.

The modern study of set theory was initiated by Georg Cantor and Richard Dedekind in the 1870s. After the discovery of paradoxes in naive set theory, numerous axiom systems were proposed in the early twentieth century, of which the Zermelo-Fraenkel axioms, with the axioms of choice, are the best-known.

Concepts of set theory are integrated throughout the mathematics curriculum in the United States. Elementary facts about sets and set membership are often taught in primary school, along with Venn diagrams, Euler diagrams, and elementary operations such as set union and intersection. Slightly more advanced concepts such as cardinality are a standard part of the undergraduate mathematics curriculum.

Set theory is commonly employed as a foundational system for mathematics, particularly in the form of Zermelo-Fraenkel set theory with the axioms of choice. Beyond its foundational role, set theory is a branch of mathematics in its own right, with an active research community. Contemporary research into set theory includes a diverse collection of topics, ranging from the structure of the natural numbers to the study of the large cardinals.
68 students were enrolled in an on-line course on Software Engineering

The topic Requirements was modelled with a standard lesson and with a CLR

- Students had to choose between the standard lesson or the CLR
- Students selecting the CLR (41) had to fill a questionnaire basing on the SUS

<table>
<thead>
<tr>
<th>Participants</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Satisfaction Questionnaire (range: 0-10)</td>
<td>M = 6.59, SD = 2.17, Md = 7</td>
<td></td>
</tr>
<tr>
<td>Perceived Usefulness of CLR as Learning Resource Questionnaire (range: 0-10)</td>
<td>M=7.08, SD=2.87, Md=8.5</td>
<td></td>
</tr>
<tr>
<td>Usability SUS Score (range: 0-100)</td>
<td>60,78</td>
<td></td>
</tr>
<tr>
<td>Student Performances Assessment (range: 0-10)</td>
<td>M = 7.83, SD = 0.78, Md = 8</td>
<td>M = 6.33, SD = 1.28, Md = 6</td>
</tr>
</tbody>
</table>

Conclusions

- Experimentation results are promising considering the prototypical nature of software components
- An additional experimentation involving both learner’s and teacher’s points of view is currently running
- We are working on the improvement of the user interface both for students (during the delivery phase) and for teachers (in the authoring phase)
- This research is partially supported by the European Commission under the Collaborative Project “Adaptive Learning via an Intuitive, interactive, Collaborative, Emotional system”, ALICE, VII Framework Program, Theme ICT-2009.4.2, Grant Agreement n. 257639
Thanks for Your Attention

www.aliceproject.eu

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