Enhanced Learning and Teaching Support through Adaptive and Intelligent Systems

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Adaptivity and Personalization in Learning Systems

How can we make learning systems more adaptive, intelligent and personalized

- In different settings such as desktop-based, mobile and ubiquitous settings
- Based on a rich student model that combines learner information and context information
- Supporting learners as well as teachers
- Using techniques from artificial intelligence, data mining, visualization, etc.
- Develop approaches, add-ons and mechanisms that extend existing learning systems
Research Topics

- Adaptivity based on learning styles
  - Automatic and dynamic identification of learning styles based on students’ behaviour [Charles Jason Bernard]
  - Adaptive course provision based on learning styles [Collaboration with Leibniz University Hannover, Alberta Distance Learning Centre; Ting-Wen Chang, Jeff Kurcz]
  - Adaptive recommendations for teachers to make their courses better support students with different learning styles [Moushir El-Bishouty]
Research Topics

- Adaptivity based on cognitive abilities
  - Automatic and dynamic identification of cognitive abilities based on students’ behaviour in an online course [Charles Jason Bernard]
  - Providing teachers with recommendations about how to consider students’ cognitive abilities [Ting-Wen Chang]
  - Adaptive course provision based on students’ cognitive abilities [Ting-Wen Chang, Jeff Kurcz]
Research Topics

■ Adaptivity based on motivation [Paul Maguire]
  ● Integrating techniques for motivating students in learning systems
  ● Investigating effectiveness of motivational techniques for students with different characteristics, situations and contexts
  ● Providing adaptive functionality for motivating students
Research Topics

- Adaptivity based on students’ context
  - Identification of students’ context through sensor technology [Dan Jovicic, Richard Tortorella]
  - Identification of device functionalities and their usage [Renan Lima, Moushir El-Bishouty]
  - Providing adaptivity based on students’ context [Dan Jovicic, Richard Tortorella]
Research Topics

- Combining adaptivity based on students’ context with adaptivity based on students’ characteristics
  - Providing adaptivity based on learning styles and context information for mobile devices [Richard Tortorella]
  - Combine students’ characteristics, context, and learning behaviour [Hazra Imran, Mohammad Belghis-Zadeh]
  - Providing adaptive recommendations based on pedagogical rules, student’s history, and collaborative filtering [Hazra Imran, Mohammad Belghis-Zadeh]
  - Provide visualization of identified data
Research Topics

- Learning Analytics
  - Identification of at-risk students
    - What features are relevant for at-risk student identification and how to use them for at-risk identification [Darin Hobbs, Júlia Marques Carvalho da Silva]
    - Learning styles vs. course content support [Moushir El-Bishouty]
  - Enhancing the Accessibility of Educational Log Data for Investigating Effective Course Design and Teaching Strategies [Jeremie Seanosky, Harza Imran]
Adaptive and Personalized Learning based on Students’ Learning Styles

[Ting-Wen Chang, Jeff Kurcz]
Adaptive Course Provision based on Learning Styles

- Develop a mechanism that enables learning systems to automatically generate adaptive courses

- General goals:
  - Mechanism should be applicable for different learning systems
  - Mechanism should ask teachers for as little as possible additional effort

- Benefits:
  - Teachers can continue using their courses in existing learning systems
  - Students get personalized support with respect to their learning styles
Demo ...

Demo ...
Adaptive and Personalized Learning based on Students’ Working Memory Capacity

[Ting-Wen Chang, Jeff Kurcz]
Why Working Memory Capacity?

- There are several cognitive traits/abilities that are highly relevant for learning (e.g., working memory capacity, inductive reasoning ability, associate learning skills, information processing speed, etc.)

- Working memory capacity (WMC) is a very important trait for learning

- WMC enables humans to keep active a limited amount of information for a very brief period of time.

- Miller (1956) found that people can remember 7+/-2 chunks of information.

- Learners with high WMC can remember almost double the amount of information than learners with low WMC
Automatic Recommendations based on Students’ Cognitive Abilities

- However, typically learning systems do not consider this individual differences in WMC

- Research aim
  - Provide students with automatic recommendations to individually support their learning based on their WMC

- Adaptive mechanism
  - What recommendation shall the system show?
  - When shall the system provide a recommendation?
  - Which recommendation should be provided?
  - Do students follow recommendations?
### What recommendations?

<table>
<thead>
<tr>
<th>No.</th>
<th>Asking the student to</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>take notes when he/she learns a learning object</td>
</tr>
<tr>
<td>R2</td>
<td>request help if he/she have any question by posting or asking teachers about this learning object</td>
</tr>
<tr>
<td>R3</td>
<td>post the ideas, thought, or reflection about what he/she learnt in this learning object</td>
</tr>
<tr>
<td>R4</td>
<td>summarize what he/she learnt about this learning object</td>
</tr>
<tr>
<td>R5</td>
<td>rehearsal by revisiting the content of this learning object</td>
</tr>
<tr>
<td>R6</td>
<td>use concept/mind maps to easier remember content of this learning object</td>
</tr>
</tbody>
</table>
When to show a recommendation?

- Show recommendation either before or after a learning object has been viewed
- Two methods for deciding on when to show a recommendation
  - Time-based (how much time has a student spent on a learning object)
  - Probability-based (based on students’ WMC)
## When to show a recommendation?

<table>
<thead>
<tr>
<th>No.</th>
<th>Asking the student to</th>
<th>When (before/after learning)</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td><strong>take notes</strong> when he/she learns a learning object</td>
<td>before</td>
<td>probability-based</td>
</tr>
<tr>
<td>R2</td>
<td><strong>request help</strong> if he/she have any question by posting or asking teachers about this learning object</td>
<td>after</td>
<td>probability-based time-based</td>
</tr>
<tr>
<td>R3</td>
<td><strong>post the ideas</strong>, thought, or reflection about what he/she learnt in this learning object</td>
<td>after</td>
<td>probability-based</td>
</tr>
<tr>
<td>R4</td>
<td><strong>summarize</strong> what he/she learnt about this learning object</td>
<td>after</td>
<td>probability-based time-based</td>
</tr>
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<td>R5</td>
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<td>after</td>
<td>time-based</td>
</tr>
<tr>
<td>R6</td>
<td><strong>use concept/mind maps</strong> to easier remember content of this learning object</td>
<td>after</td>
<td>probability-based</td>
</tr>
</tbody>
</table>
When to present which recommendations?

- For each type of learning object, it has been determined whether a recommendation makes sense or not.
- For each type of learning object, recommendations are ranked based on how well they fit for a learning object.
- Consider whether time-based or probability-based method is activated.
- Consider whether a recommendation has been followed or not.
Demo

Demo ...

Introduction to Computing and Information Systems

Unit 1 - Section 1: Why Study Information Systems

After learning this learning object:

Can you summarize in your own words what you learnt about this learning object?

- back to content
- process to next page
Academic Analytics
Enhancing the Accessibility of Educational Log Data

[Jeremie Seanosky, Harza Imran]
What is academic analytics?

- Analysis of data to support educational institutions, including faculty/teachers, learning designers, decision makers, etc.
- Institution-wide and cross-course/cross-department analysis
- Includes research related to
  - Effectiveness of teaching strategies
  - Effectiveness of course designs
  - Teacher Dashboards
  - Retention and at-risk identification
  - ...
In online education, educators and learning designers typically don’t get much feedback on whether or not their teaching strategies and course designs are successful/helpful for students.

Learning Management Systems (LMSs) generate a lot of data

But learning designers and educators don’t have skills to use these data (e.g.: SQL)
How to provide support for users without computer science background to access complex LMS data?

General aim:
- Design, develop and evaluate a tool that provides users with easy access to complex educational log data
- Allow users to ask “questions” to the data
- Allow users to start with easy queries and then build upon them
- Work for different LMS
- Facilitate teachers’ learning about their teaching strategies and course designers’ learning about their learning designs
Procedure

Building a profile

- Select a learning system to connect to
- Create/Select a data set (courses)
- Create/Select a patterns (queries)
Demo

I want to create a new pattern from scratch.
I want to create a new pattern from an existing pattern.
I want to join two existing patterns.
I want to perform an analysis on an existing pattern.

What would you like to do?

Select this if you want to create an entirely new pattern.
Select this if you want to create a new pattern, but start with an existing pattern.
Select this if you want to join two existing patterns.
Select this if you want to perform an analysis on an existing pattern.

Active Database: ODBdevl
Selected Datasets: COUP300, COUP301

At this point, the concepts are listed along with filter types based on the data type of the attribute.
- < >: Search (returns first 10 matches)
- =: Range where only one value is entered then it is the lower or upper bound, else equals (but not to key level).
- < >: Range where if only one value is entered then it is the lower or upper bound.

Filter options are set only when filter radio button selected, either data type depends on data type and filter type will have no validity based on data type of attribute.

Active Database: ODBdevl
Selected Datasets: COUP300, COUP301

Choose Concepts + Choose Attributes + Add Limits + Define Sorting + Save

Do you want to define limits to the attributes?

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Limit Type</th>
<th>Last Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Name</td>
<td>Exactly</td>
<td>Yes</td>
</tr>
<tr>
<td>Course Open Date</td>
<td>Equal To</td>
<td>123</td>
</tr>
<tr>
<td>Course Duration</td>
<td>Equal To</td>
<td>90</td>
</tr>
<tr>
<td>Student Name</td>
<td>Exactly</td>
<td>Yes</td>
</tr>
</tbody>
</table>

I want ALL of the limits I define to apply to this pattern (returns results)
I want AT LEAST ONE limit to apply to this pattern (returns results)

Pattern Results (top 10 rows only)

<table>
<thead>
<tr>
<th>Course Name</th>
<th>Course Open Date</th>
<th>Course Duration</th>
<th>Student Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM300</td>
<td>Sep 1, 2012</td>
<td>123</td>
<td>Stephen Klasky</td>
</tr>
<tr>
<td>COM301</td>
<td>Oct 12, 2012</td>
<td>123</td>
<td>Kristoffel</td>
</tr>
</tbody>
</table>

SQL Query

SELECT * FROM Tab1 WHERE Tab2 = 123

Demo