TECHNOLOGIES FOR LEARNING

Sergey Sosnovsky (presented by Johan Jeuring)
Goals of the Course (1)

Learn about Computer-based technologies for learning

- Adaptation
- Collaboration Support
- New Learning Paradigms
- Formal Theories and Methods
Goals of the Course (2)

- Identify, relate and explain fundamental concepts in the field of computer-based education with a particular focus on adaptive and intelligent technologies.
- Apply these concepts in practice by designing and developing components of adaptive and intelligent educational systems.
- Use relevant literature to analyse existing projects and form an opinion about innovations in the field.
- Investigate a problem within the field of computer-based educational technologies and set up a plan for a group project targeting it.
Goals of the Course (3)

- **Develop analytical reading skills**
  - will have to read about 10 research papers
  - and be prepared to either ask/answer questions about them

- **Develop presentation skills**
  - presenting your paper / topic

- **Develop scientific discussion skills**
  - asking questions
  - answering questions
  - engaging in a discussion
Structure of the course

- **Kick-off meeting (you are at it)**
  - Choose your topic(s) – up to three
  - Report your choice by 11/09/2018 (link on the website)

- **8 topic clusters**
  - **Core lectures (mostly) on Thu:**
    - Before: read a core paper, prepare for a quiz;
    - During: listen and ask questions
  - **Reading sessions on Tue:**
    - Before: if you present a related topic, prepare your presentation
    - During: present your topic, engage in discussion topics of your peers

- **Project**
  - Team-up and pick a topic. Deadline: 13/09
  - Implement, meet weekly with the teacher
  - Present the results. Presentation day: 1/11 (and possibly 6/11)
  - Write a report. Deadline: 6/11

- **Exam**
  - Preparation Session: 6/11
  - Exam: 8/11
Grading

- Quizzes + Presentations + Discussions (20%)
  - Attendance matters!!!
    - If you are not in class = you are not participating
  - Quiz preparation: a core paper and a core lecture
  - Presentation: make an effort presenting a topic (not just a paper)

- Group Project (50%)
  - The list of possible ideas is on the Web-site. Pick your poison
    - Some are implementation-oriented
    - Some are analysis and modeling-oriented
    - Or you can suggest your own (but, discuss with a teacher)
  - Report + code + presentation

- Final Exam (30%)
  - Writing exam verifying your understanding of the core notions learnt in the course
Intelligent Adaptive e-Learning Systems: Main Components

- Instructional Content
- Interaction
- 0..1..1. 0..1..1...
- User Model
- Pedagogical Model
- Adaptation
- Domain Model
- Instructional Content
- Interaction

Image shows a diagram with the main components of an intelligent adaptive e-learning system, including instructional content, interaction, user model, pedagogical model, adaptation, domain model, and instructional content with a tree-like structure.
Student Modeling
What is a Student Model?

• A representation of the computer’s understanding or estimation of the student’s state.
  • What does the student know?
  • How does the student learn?
  • How does the student feel?
 • How can the system engage student in student modeling?
 • How can the system make a good prediction?
Student Modeling Break Down

- Modeling Knowledge
- Modeling Metacognitive State
- Modeling Affective State
- Open Student Modeling
- Modeling Uncertainty
Modeling Knowledge

• What to model?
  • Conceptual knowledge
  • Procedural skills
  • Errors, bugs and misconception

• How to model it?
  • Stereotype models
  • Overlay models
  • Buggy models
Modeling Metacognitive State

- Modeling a learner’s understanding of their own knowledge and skills and helping them to guide their own learning

- Types of Metacognitive Skills, Knowledge, Processes:
  - Knowledge:
    - What is my current knowledge state?
    - Can I solve this exercise?
    - Where do I have a gap?
  - Regulation Skills:
    - Planning
    - Monitoring
    - Evaluating
  - Strategies:
    - Help seeking
    - Self-explanation
    - Problem solving
Modeling Affective State

- Modeling a learner’s attitudes and feelings while they are learning.

- There is a complex interplay between cognition and affect in our brain
  - Emotions influence the way we learn

- What are important emotions related to learning?
  - frustration, anxiety, boredom, confusion

- How can the system recognize these emotions?
- What should be done, once the emotion is recognized?
Open Student Modeling

• Opening student model to a student increases:
  • Engagement
  • Reflection
  • Trust
  • System’s understanding of the student

• How to present/visualize the model?
• How much control should the student have?
• How much should the system trust the student?
Adaptive learning support
Model-tracing Tutors
Constraint-based Tutors

• Based on Ohlsson’s theory of learning from performance errors.
• Students detect errors with declarative knowledge and correct errors with procedural knowledge.
• CBM amplifies the process of error detection: it helps the student to find the errors they cannot find due to the missing declarative knowledge.
• It gives feedbacks according to the violation of constraints.
Adaptive Sequencing and Course Generation

The process of selecting learning activities from a digital repository and sequencing them in a way which is appropriate for an individual student.

- Goal: Best sequence of educational activities
- Information to read
- Example to explore
- Problem to solve
Adaptive Educational Hypermedia
Big Educational Data
<table>
<thead>
<tr>
<th></th>
<th>LA</th>
<th>EDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovery</td>
<td>Supporting human making a discovery is key</td>
<td>Automated discovery is key</td>
</tr>
<tr>
<td>Reduction/holism</td>
<td>Stronger emphasis on integration information and understanding</td>
<td>Stronger emphasis on dissecting systems into component and analyzing each component separately</td>
</tr>
<tr>
<td></td>
<td>learning environment as whole</td>
<td></td>
</tr>
<tr>
<td>Supporting users</td>
<td>Focusing on informing and empowering learners and teachers</td>
<td>Focusing on automated adaptation of learning process</td>
</tr>
</tbody>
</table>
Learning analytics
EDM: Optimization of system behavior

- Is the adaptive educational system effective?
- How can it be improved?
  - Is the domain model precise enough? Are all important concepts identified?
  - Are learning tasks designed well? Are they modelled correctly?
  - Does the user modelling algorithm correctly estimate student knowledge? Does it predict their performance?
  - Is the pedagogical model effective? Does it make the right decisions at the right time? Do students follow its suggestions?
EDM: Detection of important events

- Within system events:
  - Off-task behavior
  - Misuse of system’s functions
  - Gaming the system
  - Important emotions
  - Moment of learning

- More global events:
  - Risk of dropping-out from a university
Social and collaborative learning
Peer-Review and Peer-tutoring

- Students form dyads with different roles of peers:
  - Tutor – tutee
  - Reviewer – reviewee
- There is an evidence that both roles are beneficial for learning
- Important for ill-defined domains

- Systems support this process through:
  - Teaching how to tutor/review;
  - Augmenting peer-tutoring with additional feedback;
  - Using wisdom of the crowds to optimize the results of review;
  - Matching peers.
Computer-supported Collaborative Learning

- In many learning scenarios, students work in teams/groups
- CSCL-systems try to:
  - Improve collaboration by:
    - Direct guidance
    - Regulating collaboration process
    - Raising awareness of the current state of collaboration
  - Use collaboration to facilitate more effective learning
    - By promoting social comparison and self-reflection
    - By utilizing team progress to support individual progress
Social adaptation for learning

- **Social Web**
  - Users are not consumers but provider of information
  - Web of people instead of web of pages
  - Social interaction, engaging interfaces
Advanced Interaction
Summary

- Systems and technologies that rely on particular type of HCI
- The research aspect of these systems is in their interfaces
- Some adaptive, some not

List of Topics:
- Tutorial Dialog Systems
- Pedagogical Agents
- Game-based learning
- Virtual and Augmented Reality Training Environments
**Tutorial Dialog Systems**

- NL-based interface is intuitive
- **Human tutoring:** learn through conversation

- Dialog can involve:
  - Asking questions
  - Answering questions
  - Giving feedback
  - Discussing a topic
  - Refinement of a statement
  - etc.

- Dialog can be:
  - text-based (usually is) or
  - verbal (technologies are improving)
Pedagogical Agents

• ... virtual characters
  • Learning/teaching is a social process => a systems needs a personality

• Benefits:
  • Increased motivation
  • Increased sense of comfort
  • Stimulation of essential learning behaviours
  • Enhanced flow of information and communication
  • ..

• Diversity:
  • virtual vs. robotic
  • animated vs. static
  • teaching vs. teachable
Games are characterized by:
- Fantasy
- Rules/Goals
- Sensory Stimuli
- Challenge
- Mystery
- Control
Augmented and Virtual Reality for e-Learning

- Virtual reality:
  - Immersive experience
  - Access to places and situations not available in reality
- Augmented reality:
  - Merging virtual and real worlds
More topics:

- Adaptive Assessment and Psychometrics
- Intelligent Programming Tutors
- Evaluation of Educational Systems
Even more topics...

- Modeling Groups and Communities for Learning
- Educational Recommender Systems
- Intelligent Support for Learning in MOOCs
- Informal and Exploratory Learning Support
- Mobile learning
- Ubiquitous learning environments
- ...