MANAGEMENT OF LATENT LEARNING NEEDS IN ADAPTIVE E-LEARNING SYSTEMS

NICOLA CAPUANO, SAVERIO SALERNO
University of Salerno

GIUSEPPINA RITA MANGIONE, ANNA PIERRI
Centre for Research in Pure and Applied Mathematics

3rd International Workshop on Adaptive Learning via Interactive, Collaborative and Emotional approaches
July 3-5, 2013, Taichung, Taiwan

Kindly Presented by: ANIELLO CASTIGLIONE

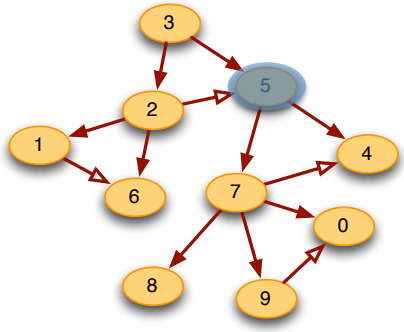
Adaptive Learning Systems

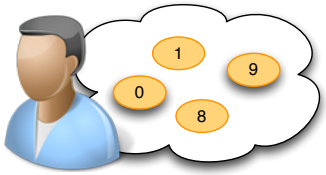
- They provide **individualized instruction** for each learner
- They are able to generate personalized courses taking into account:
  - the **learning goals** to be achieved
  - the **existing knowledge** of each learner
  - the **learning style** of each learner
  - the **context** where the learning takes place

- In past researches we defined and experimented an adaptive learning system named **IWT** (Intelligent Web Teacher)
  - Sangineto, Capuano, Gaeta, Micarelli. *Adaptive Course Generation through Learning Styles Representation*. UAIS I. J., Springer, 7(1/2), 1-23 (2008)

How IWT Works

- Starting from a **formal representation** of a teaching domain through concept graphs
- A teacher selects a **learning goal** for a target student
- The system generates a **personalized sequence** of concepts to be taught
- Concepts already known by the target student are **removed**
- Learning resources are then selected according to student's **learning style**
- Concepts learnt by a student are maintained in structures named **learner models**
- That are updated after each **testing activity**





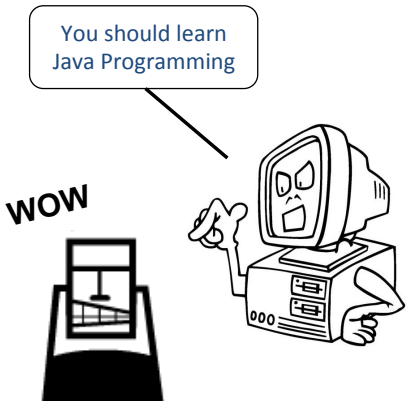
Improvements Made So far

- We improved IWT by providing **self-regulated learning** features
  - Capuano et al. *On-Demand Construction of Personalized Learning Experiences Using Semantic Web and Web 2.0 Techniques*. Proc. ICALT 2009.
- To do that we have added the possibility to generate a course starting form an **explicit request** made by a learner
  - A learner specifies his/her **learning needs** in natural language
  - **Sentence similarity** algorithms are applied to find the best matching concept(s) from available domains
  - A **personalized course** is generated starting from best matching concepts

Aim of This Work

- To improve IWT to let it generate a personalized course starting form an **implicit request** rather then from an explicit one

- **Motivations**
  - To anticipate and **spread needs**, knowledge and learning paths
  - To serve as a pedagogical **advance organizer** for the learners' community
  - To support the development of **self-regulated** learning



Methodology

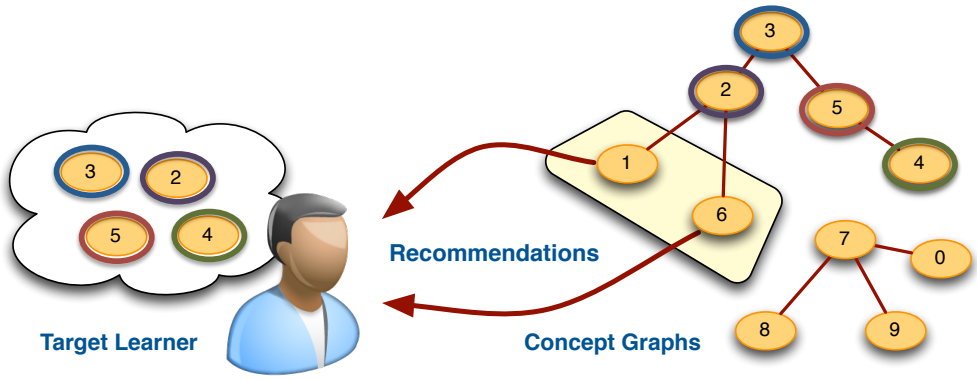
- A methodology to **recommend learning goals** has been defined
- It consists of the following steps:
  - **Concept mapping**: for each learner, known concepts plus concepts currently under learning are identified
  - **Concept utility estimation**: for each learner, the utility of each unknown concept is estimated
  - **Learning Goals Suggestion**: concepts with the greater utility for each learner are suggested to him
  - **Course Building**: if the learner selects one or more concepts among those suggested, the system generates a course covering them

Concept Utility Estimation

- For each learner, the **utility** of unknown concepts is estimated
  - A **collaborative component** calculates the concept utility basing on what similar learners know
  - Learners with **similar learner models** are identified
  - Unknown concepts that are known by similar learners are **recommended**

Concept Utility Estimation

- For each learner, the **utility** of unknown concepts is estimated
  - A **cognitive component** calculates the concept utility basing on the analysis of the learner model of the target learner
  - Known concepts are identified on available **concept graphs**
  - Concepts that complement current knowledge are **recommended**

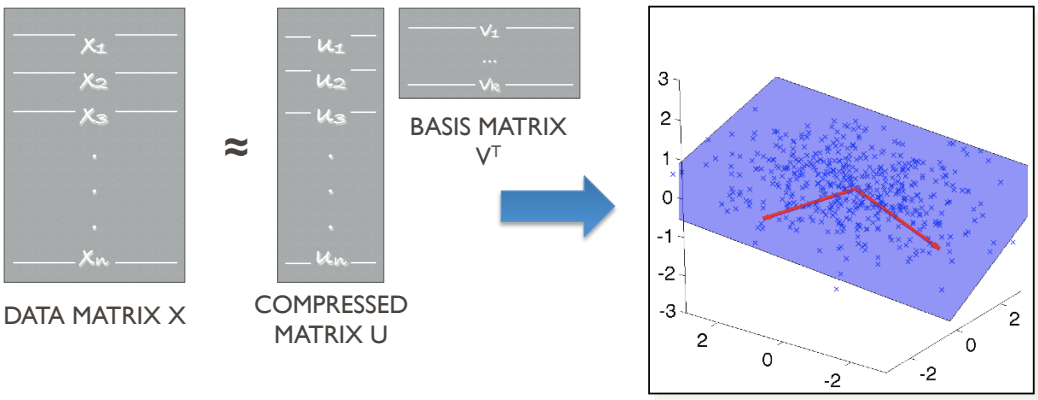


Hybridization

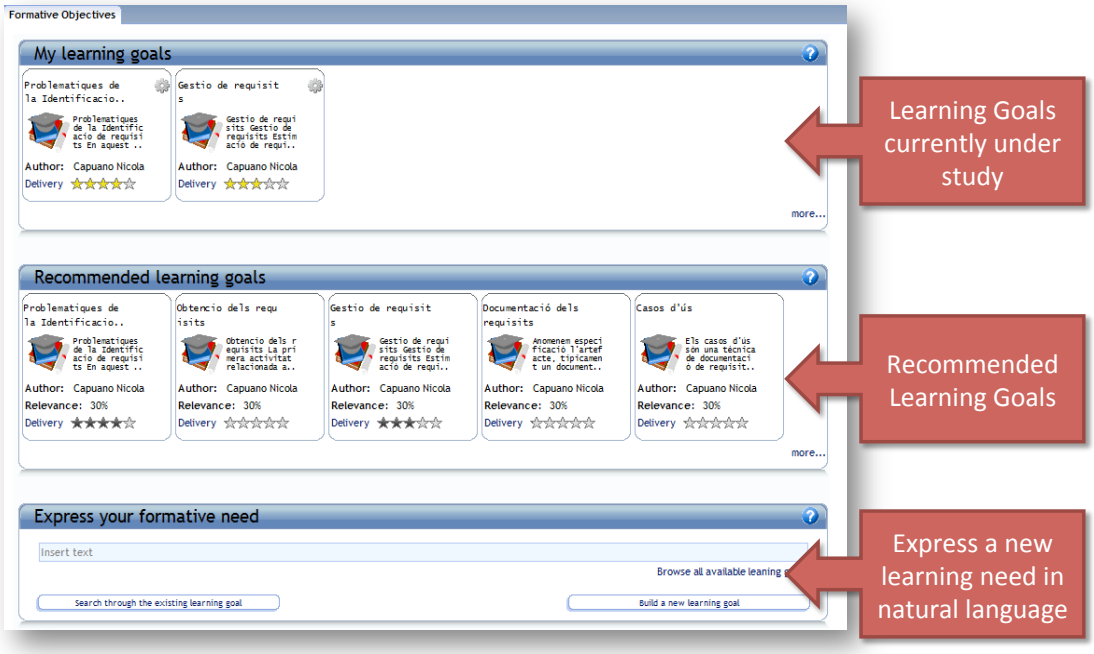
- **Collaborative approaches**
  - Provide less obvious advice allowing **serendipity**: the chance to discover useful things even if they differ from one's preferences
  - Inaccurate recommendations when few data is available (**cold start problem**) e.g. in the early days of life of a system
- **Cognitive approaches**
  - First useful recommendations are available **immediately**, with only one assessment made by the user
  - Basing only on the user's **past history** the recommendations tend to follow his preferences too closely and do not allow serendipity
- **Applied Solution**
  - **Hybridize** the two approaches to sum advantages and mitigate drawbacks

Latent Factor Model

- Utilities of concepts for learners are stored into a huge **data matrix**
- The maintenance of such matrix can decrease **performances**
- A **latent factor model** is applied to factorize the data matrix as a product of two compressed matrices

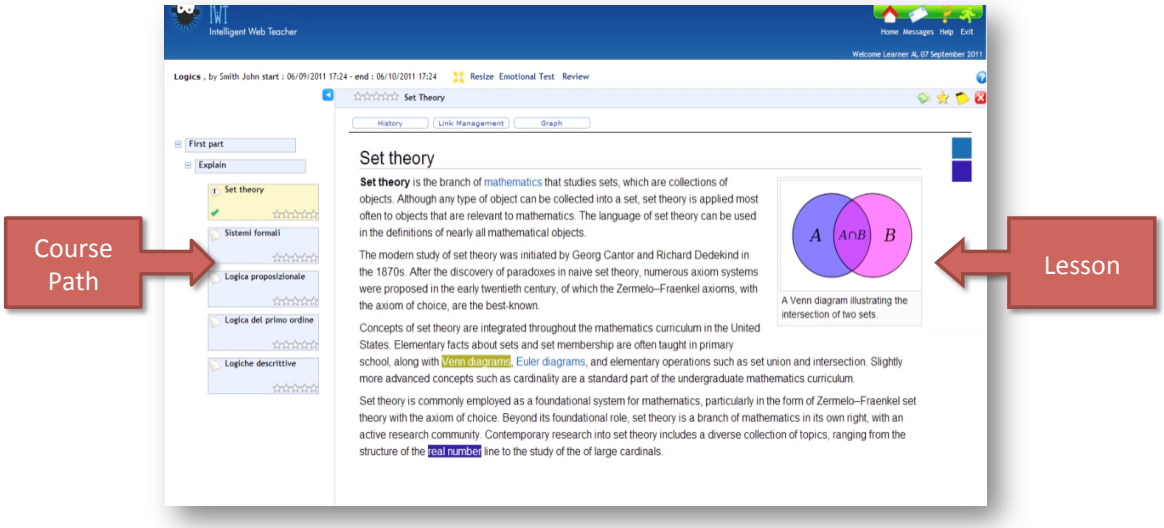


The Prototype



The Prototype

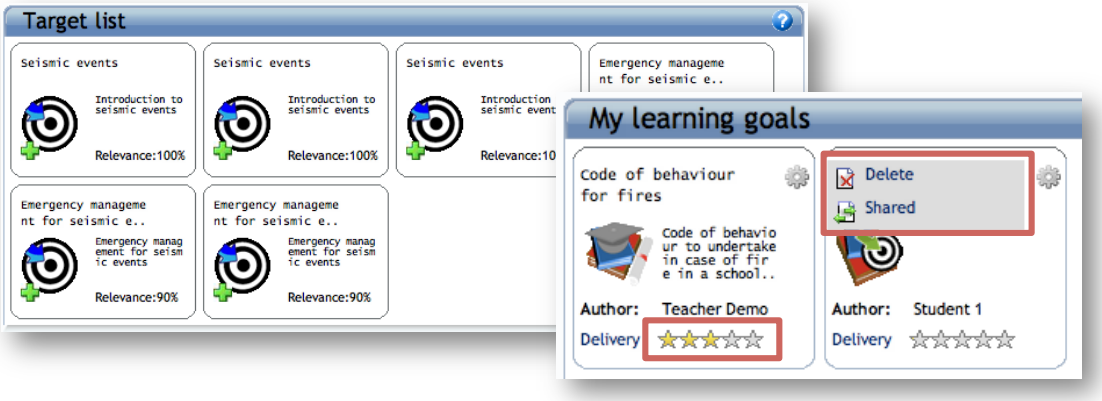
- Once the learning goal has been selected the corresponding **course** is generated and delivered



The Prototype

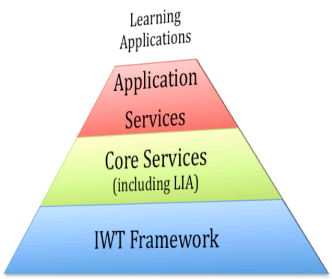
We also introduced **sharing and rating** functions allowing learners to:

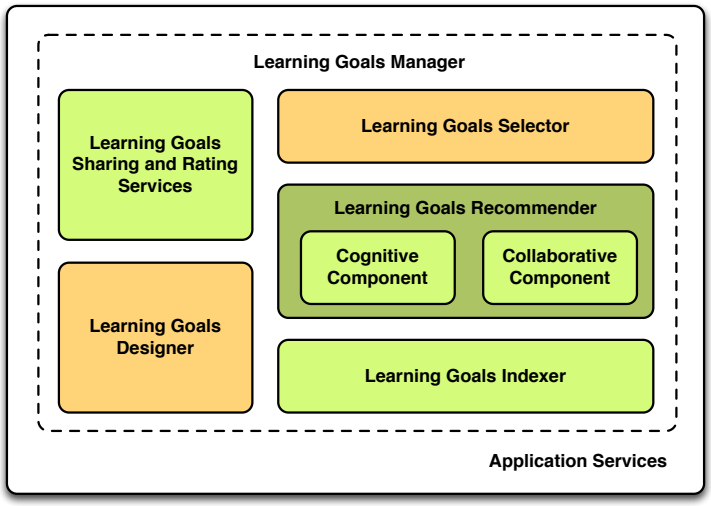
- Create own learning goals by selecting concepts from available ontologies
- Share self-created learning goals with other learners
- Rate learning goals created by teachers or other learners



Architecture

IWT e-Learning System





Developed components

Experimentation

- **Participants:**
  - **61 students** of an online University course on Software Engineering
- **Groups:**
  - The **experimental group** was enabled to the use the "personal learning need panel" to let the system suggest adequate complementary topics
  - The **control group** studied the standard course within the IWT environment
- **Purpose:**
  - To estimate perceived validity of the additional functions
  - To estimate system usability
  - To evaluate improvements on knowledge acquisition

Experimentation

- **Perceived Validity:**
  - Many students have found the recommender system useful for their study (M=**6.21**, SD=2.02, Md=6).
  - Most of them agreed that recommended learning goals correctly complement topics studied within the course (M=**6.17**, SD=2.37, Md=6).
- **Usability:**
  - SUS score of **53.97** on a range between 0 and 100
- **Quantitative Evaluation:**
  - Two open questions evaluated by a teacher

Questions	Experimental group	Control group
Question 1	M=6.11, SD=1.87, Md=6	M=5.84, SD=1.31, Md=6
Question 2	M=7.81, SD=1.28, Md = 8	M=7.32, SD=1.24, Md=7
Overall	**M=6.96, SD=1.57, Md=7**	**M=6.58, SD=1.27, Md=6**

Conclusions

- We defined a **methodology** to recommend learning goals basing on similarities between users and on models representing teaching domains
- A **prototype** component was developed and integrated within an existing e-learning system
- **Experimentation** results have shown that:
  - the students liked the tool and found it interesting and useful to complement their knowledge about topics under study
  - in line with the prototypical nature of the system, the usability was not a barrier when using it
  - grades obtained by students of the experimental group were slightly higher with respect to those belonging to the control group
- **Future work** will focus mainly on the improvement of the usability

A·L·I·C·E
Adaptive Learning via Intuitive/Interactive Collaborative and Emotional systems

HIPPOCRATICA CIVITAS STUDIUM SALERNI

CRMPA CENTRO DI RICERCA IN MATEMATICA PURA ED APPLICATA

Thanks for Your Attention

This research is partially supported by the European Commission under the Collaborative Project ALICE "Adaptive Learning via an Intuitive, interactive, collaborative, Emotional system", 7th Framework Program, Theme ICT-2009.4.2, Grant Agreement n. 257639

www.aliceproject.eu