Athabasca University

SCHOOL OF COMPUTING & INFORMATION SYSTEMS

Adaptivity and Personalization in Learning Systems based on Learning Styles

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Adaptivity and Personalization in Learning Systems

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

- Based on a comprehensive student model that combines learner information and context information
- In different settings such as desktop-based, mobile and ubiquitous settings
- In different situations such as for formal, informal and non-formal learning
- Supporting learners as well as teachers
- Develop approaches, add-ons and mechanisms that extend existing learning systems

Adaptivity and Personalization in Learning Systems

- Adaptivity based on learning styles
  - Automatic identification of learning styles based on students' behaviour
  - Dynamic identification and updating of learning styles
  - Adaptive course provision based on learning styles

Active experimentation

Competitive learning

Exploratory learning

Learning from listening

Learning from theories

Reflecting

Why Learning Styles?

Collaborative learning

Learning from examples

Learning from written text

Need for guidance

Learning from pictures

Why Learning Styles?

- Complex and partially inconsistent research area
- Learners have different ways in which they prefer to learn
- If these preferences are not supported, learners can have difficulties in learning
- Previous studies showed that providing learners with courses that fit their learning styles has potential to help learners in learning

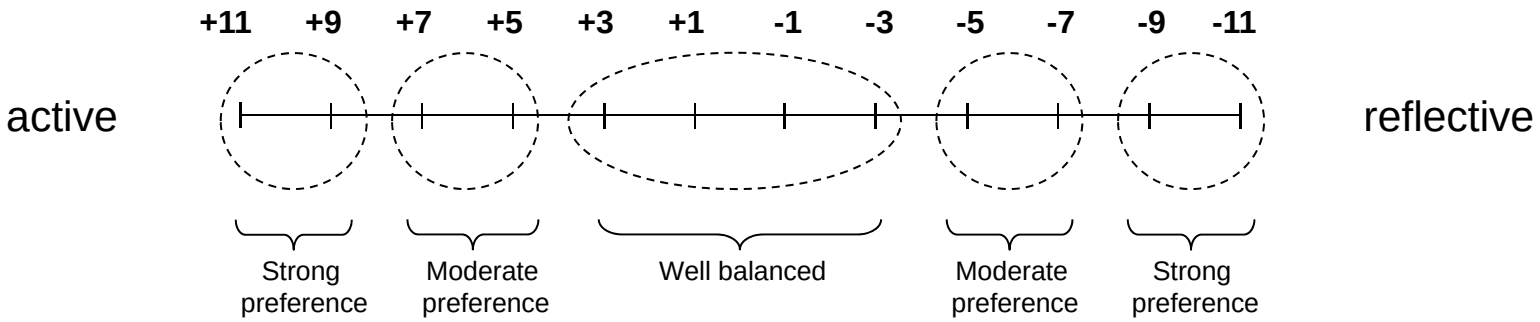
Felder-Silverman Learning Style Model

- Each learner has a preference on each of the dimensions
- Dimensions:
  - Active – Reflective
    learning by doing – learning by thinking things through
    group work – work alone
  - Sensing – Intuitive
    concrete material – abstract material
    more practical – more innovative and creative
    patient / not patient with details
    standard procedures – challenges

  - Visual – Verbal
    learning from pictures – learning from words
  - Sequential – Global
    learn in linear steps – learn in large leaps
    good in using partial knowledge – need „big picture“

Felder-Silverman Learning Style Model

- Scales of the dimensions:



→ Strong preference but no support → problems

Felder-Silverman Learning Style Model

- Differences to other learning style models:
  - Combines major learning style models (Kolb, Pask, Myers-Briggs Type Indicator)
  - New way of combining and describing learning styles
  - Describes learning style in more detail (Types <-> Scale)
  - Represents also balanced preferences
  - Describes tendencies
  - Domain-independent
  - Are “flexible-stable” over time

How to Identify Learning Styles?

How to identify learning styles?

- Collaborative student modelling
  - "Index of Learning Styles" (ILS) questionnaire
    - 44 questions (11 for each dimension)
    - Online available
  - Problems with questionnaires
    - Motivate students to fill it out
    - Non-intentional influences
    - Can be done only once

How to identify learning styles?

- Automatic student modelling
  - What are students really doing in an online course?
  - Infer their learning styles from their behaviour
  - Advantages:
    - Students have no additional effort
    - Approach is direct and free from the problem of inaccurate self-conceptions
    - Data are gathered over a period of time → more accurate
    - Dynamic aspects can be considered
  - Challenge:
    - Get enough reliable information to build a robust student model

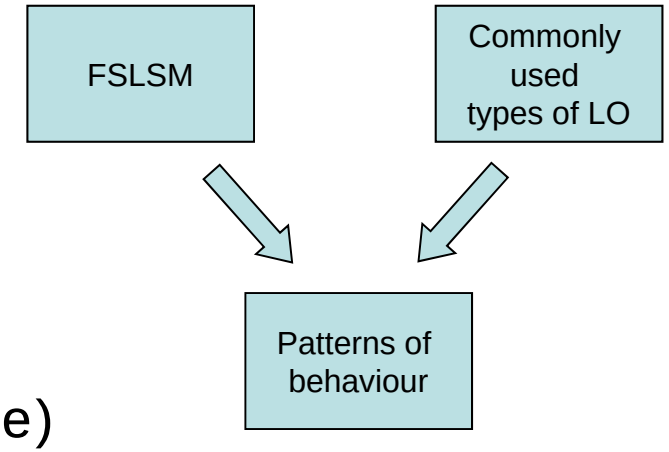
Research Question

How to automatically identify learning styles in learning systems?

- General goals
  - Developing an approach for learning systems in general
  - Implementing and evaluating this approach in Moodle
  - Developing a tool which can be used by teachers in order to identify students' learning styles

Approach for Automatically Identifying Learning Styles

- Identifying learning styles is based on patterns of behaviour
- Commonly used types of learning objects were used (Content objects, Outlines, Examples, Self-assessment tests, Exercises, Discussion forum) and relevant patterns were derived from these types of learning objects
- Overall, 27 patterns were used for the four learning style dimensions
- Calculation of learning styles is based on hints from patterns
- A simple rule-based mechanism is used for this calculation (similar to the approach used in the questionnaire)



Evaluation

- Study with 75 students
  - Let them fill out the ILS questionnaire
  - Tracked their behaviour in an online course
- Aim was to identify learning styles on a 3-item scale (e.g., active, balanced, reflective)
- Using a measure of precision

$$\text{Precision} = \frac{\sum_{i=1}^{n} Sim(LS_{predicted}, LS_{ILS})}{n}$$

- Looking at the difference between results from ILS and automatic approach

Evaluation

- Results:

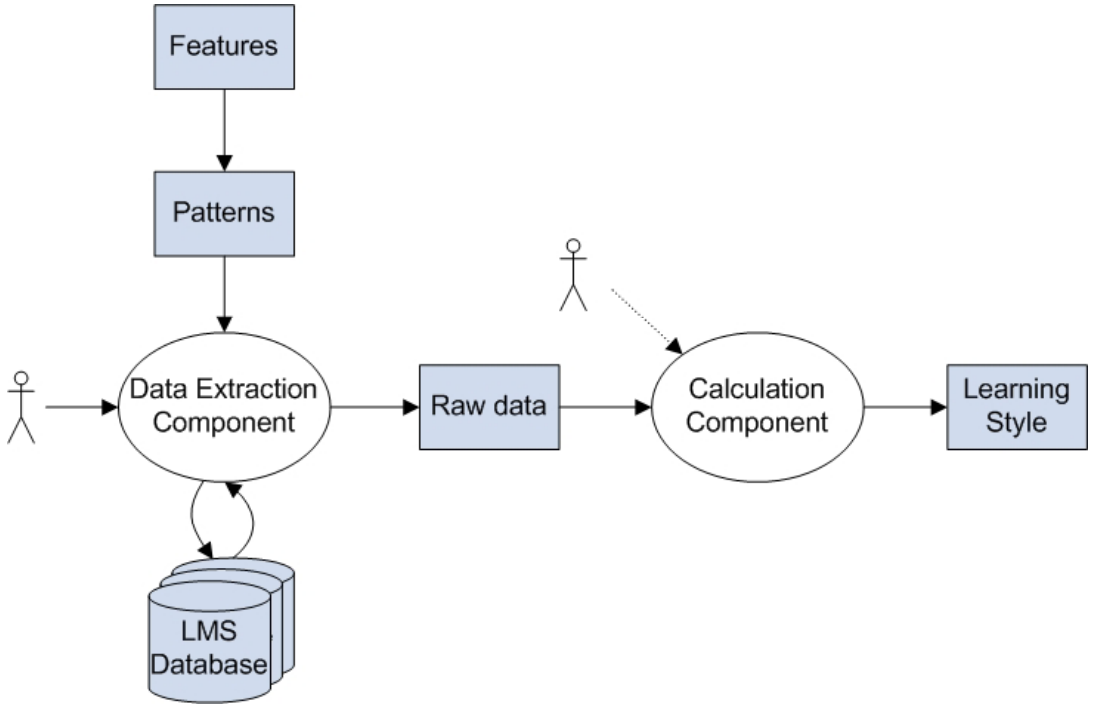
	act/ref	sen/int	vis/ver	seq/glo
comparison between ILS and automatic approach	79.33%	77.33%	76.67%	73.33%

→ suitable instrument for identifying learning styles

- Investigations on usage of data-driven approaches
  - Bayesian Networks
  - Neural Networks & Particle Swarm Optimization

Tool for Identifying Learning Styles

- Developed a stand-alone tool for identifying learning styles in learning systems



How to Consider Dynamic Aspects?

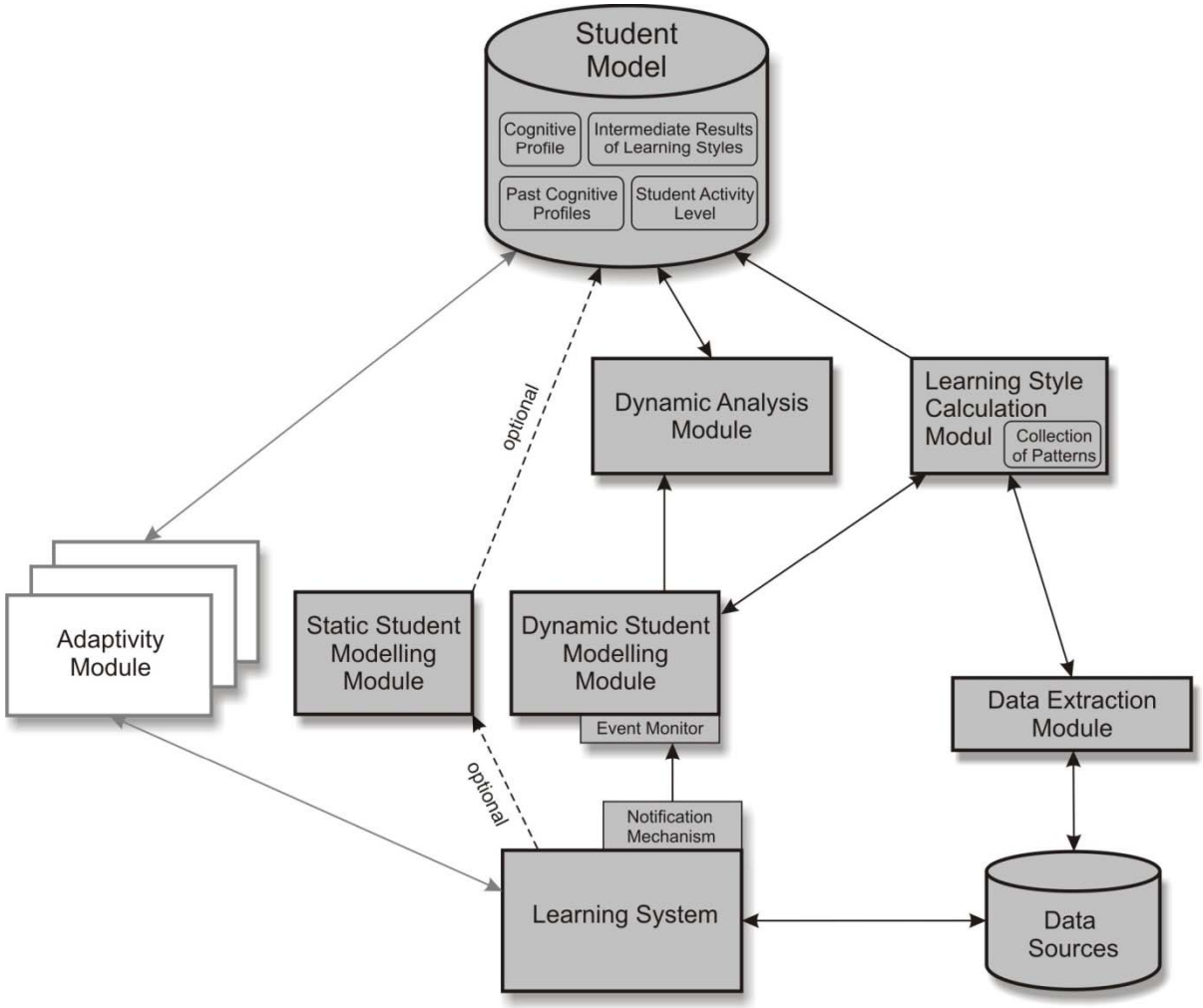
Dynamic Student Modelling

- Information about students' behaviour and actions is used for updating the student model frequently
- A main issue is to frequently check whether the new information about students' behaviour hints for revising the information stored in the student model
- Two objectives:
  - The currently stored learning style should reflect the current learning style of students as good as possible → updating as soon as a revision can be done
  - Considering deviations of students' behaviour and having as less as possible revisions which are then taken back shortly afterwards

Dynamic Student Modelling

- Procedure:
  - Monitoring students' behaviour and actions
  - Once enough evidence is available, revise information in the student model considering deviations in students' behaviour
- Advantages:
  - Allows to revise information about students' learning styles based on their current behaviour and actions and "learn" students' learning styles over time
  - Allows to detect changes in students' learning styles and response respectively

Dynamic Student Modelling



How to Automatically Generate Adaptive Courses?

Adaptive Course Provision

- 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

Adaptive Course Provision

- Incorporates only common types of learning objects
  - Content
  - Outlines
  - Conclusions
  - Examples
  - Self-assessment tests
  - Exercises
- Adaptation Features
  - Adaptive sequencing of examples, exercises, self-assessment tests, outlines and conclusions
  - Adapting the number of examples and exercises
- Teachers have to:
  - Provide learning objects
  - Annotate learning objects (distinguish between the objects)

Evaluation of the Concept

- Implemented add-on for Moodle
- Evaluated with 437 students participating in a course about object-oriented modelling
- Randomly assigned to 3 groups:
  - Courses that fit to the students' learning styles (matched group)
  - Courses that do not fit to the students' learning styles (mismatched group)
  - Standard course which includes all learning objects (standard group)
- Procedure
  - Students filled out a learning style questionnaire
  - Adaptive course is automatically generated and presented
  - Students were nevertheless able to access all learning objects and take a different learning path

Results

- Matched Group:

  less time and equal grades

- Mismatched Group:

  ask more often for additional learning objects

→ Demonstrates positive effect of adaptivity

Detailed Analysis Considering Learning Styles

- Investigated effectiveness and effects of adaptive courses for students with different learning styles
- Adaptivity seems to have different effects for learners with different learning styles
- Findings show that for some learning styles adaptivity works better than for others, in terms of encouraging them to use the course more intensively and/or letting them achieve better scores.

Extension of adaptive mechanism

Make adaptive mechanism more generic and easy to apply for different types of courses

- Added more types of learning objects (overall 12)
- Having as little restrictions as possible for teachers
  - → Teachers can add many different types of LOs in their courses
  - → Teachers can add types of LOs whereever they feel they fit (as they usually do in LMSs)
  - → Teachers does not have to add types of LOs
  - → However, the more LOs are available in the course, the more adaptivity can be provided