# Identifying Learning Styles in Learning Management Systems by Using Indications from Students' Behaviour

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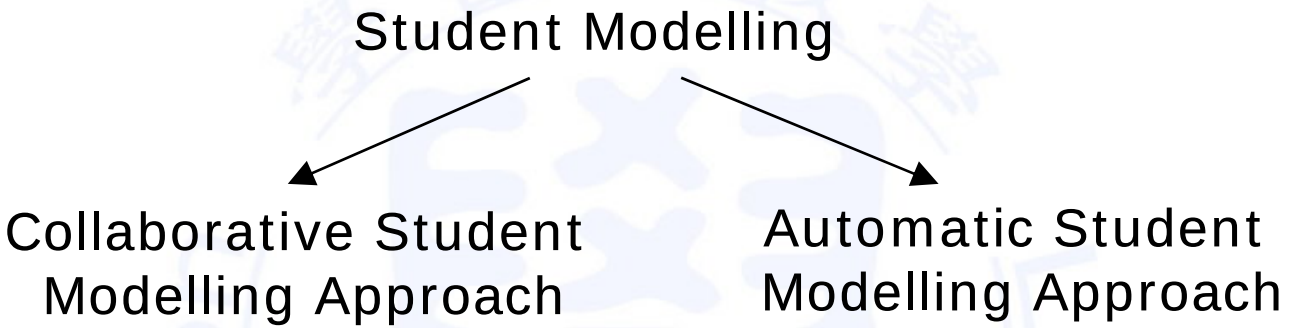
# Why shall we use learning styles?

- Learners have different learning styles
- Considering learning styles has potential to make learning easier for learners
  - By making students aware of their learning styles as well as the related stengths and weaknesses
  - By providing students with learning material that fits their learning styles

# How to identify learning styles?




- Advantages of Automatic Student Modelling
  - *no additional work for students*
  - *direct and free from the problem of inaccurate self-conceptions of students*
  - *analyses data from a specific time span → more accurate & allows tracking changes in learning styles*

# Research Question

How to automatically identify learning styles in learning management systems (LMS)?

- General aims
  - Selected LMSs because they are commonly used in technology enhanced learning
  - Developing an approach for LMSs in general
  - Implementing and evaluating this approach in Moodle

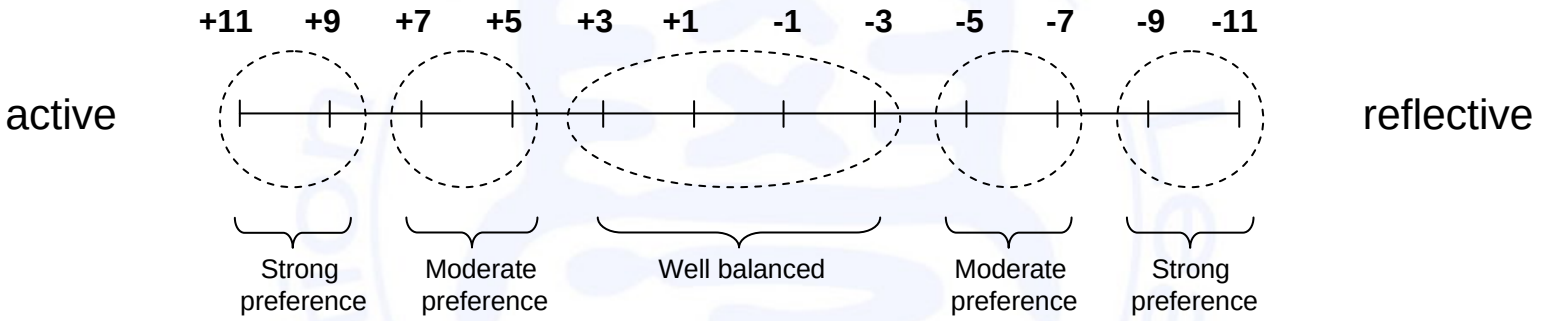
# Felder-Silverman Learning Style Model

- Each learner has a preference on each of the four 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:



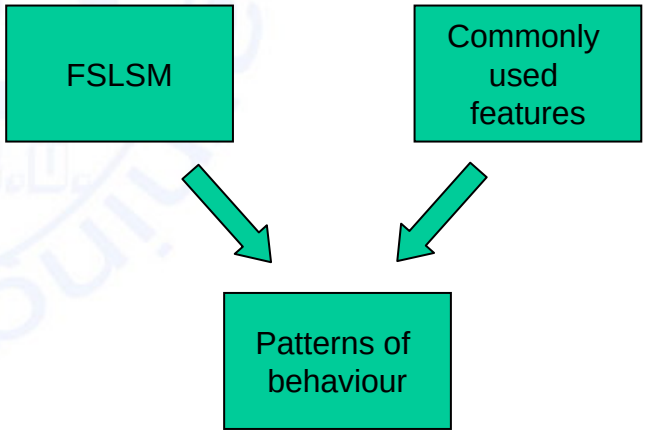

- Differences to other learning style models:
  - describes learning style in more detail
  - represents also balanced preferences
  - describes tendencies

# Index of Learning Styles (ILS)

- Developed by Felder and Soloman to identify learning styles
- 44 questions
- 11 questions for each dimension
- Each question allows two possible answers indicating a preference for either the one or the other pole of the learning style dimension; e.g. active (+1) or reflective (-1)
- Result: a value between +11 and -11 for each dimension

# Determining Relevant Behaviour

- Felder and Silverman describe how learners with specific preferences act in learning situations
- Mapped the behaviour to online learning
- Only commonly used features are considered:
  - Content objects
  - Outlines
  - Examples
  - Self-assessment tests
  - Exercises
  - Discussion Forum



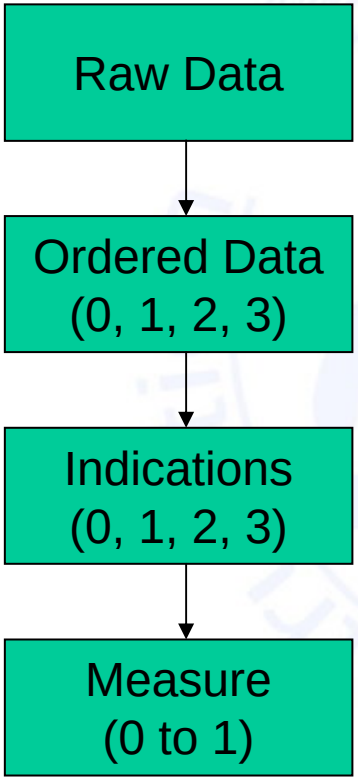
# Determining Relevant Behaviour

- Content objects
  - Visits, time
- Outlines
  - Visits, time
- Examples
  - Visits, time
- Self-assessment tests
  - Visits, time on test, time on results
  - Revisions, answering a question twice wrong
  - Performance on questions about facts or concepts, details or overview, graphics or text, interpreting or developing solutions
- Exercises
  - Visits, time on exercises, time on results
  - Revisions
  - Performance on questions about interpreting and developing solutions
- Discussion Forum
  - Visits, time, postings
- Navigation
  - Skipping learning objects
  - Visits and time on course overview page

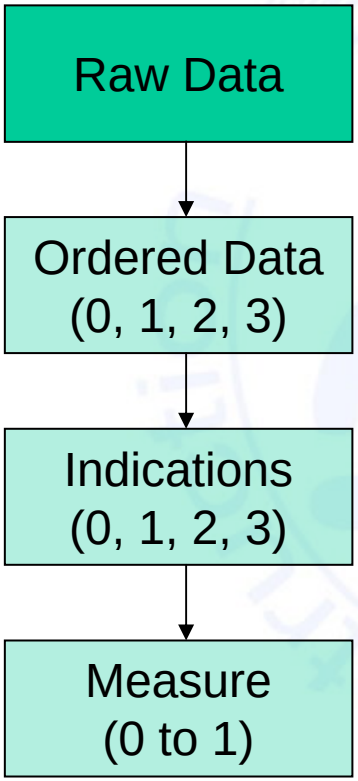
# Determining Relevant Behaviour

| Active/Reflective | Sensing/Intuitive | Visual/Verbal | Sequential/Global |
|---|---|---|---|
| selfass_visit (+) | ques_detail (+) | forum_visit (-) | ques_detail (+) |
| exercise_visit (+) | ques_facts (+) | forum_stay (-) | ques_overview (-) |
| exercise_stay (+) | ques_concepts (-) | forum_post (-) | ques_interpret (-) |
| example_stay (-) | selfass_visit (+) | ques_graphics (+) | ques_develop (-) |
| content_visit (-) | selfass_result_duration (+) | ques_text (-) | outline_visit (-) |
| content_stay (-) | selfass_duration (+) | content_visit (-) | outline_stay (-) |
| outline_stay (-) | exercise_visit (+) | | navigation_skip (-) |
| selfass_duration (-) | ques_rev_later (+) | | overview_visit (-) |
| selfass_result_duration (-) | ques_develop (-) | | overview_stay (-) |
| selfass_twice_wrong (+) | example_visit (+) | | |
| forum_visit (-) | example_stay (+) | | |
| forum_post (+) | content_visit (-) | | |
| | content_stay (-) | | |

# From Behaviour to Learning Styles

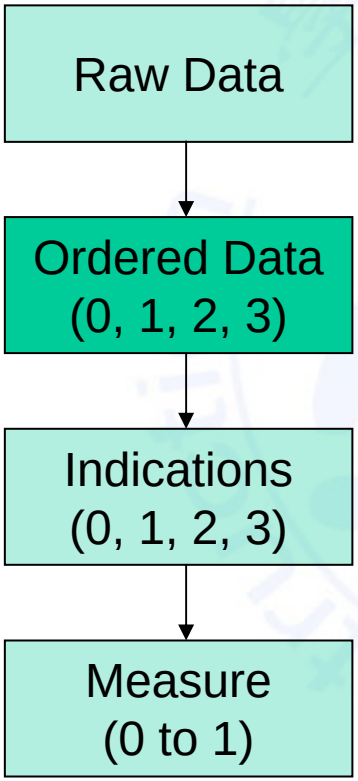


# From Behaviour to Learning Styles



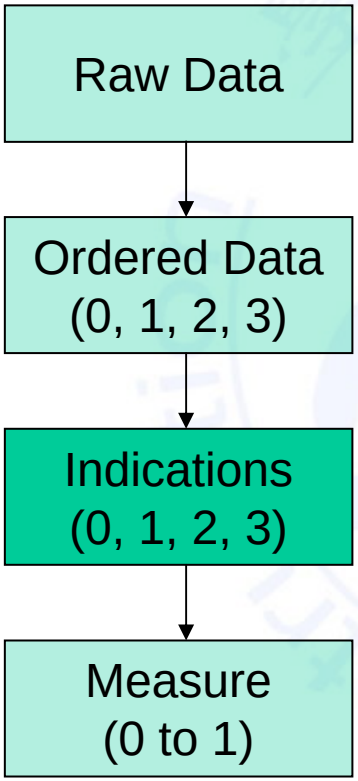

- Based on the previously introduced patterns
- Data are extracted from the LMS database

# From Behaviour to Learning Styles



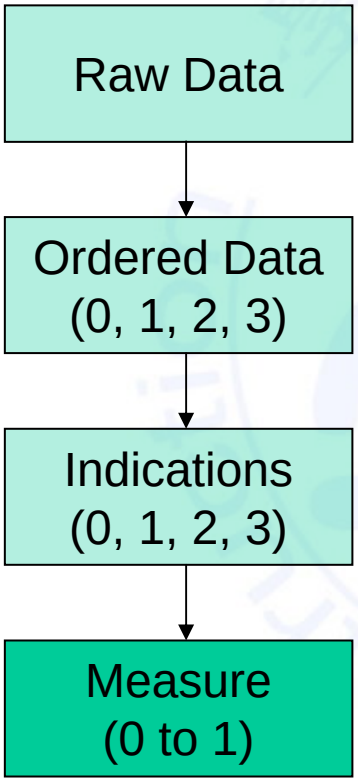

- Four values are possible:
  - 3 … the respective behaviour occurs often
  - 2 … the respective behaviour is average
  - 1 … the respective behaviour occurs only few times
  - 0 … no information about the respective behaviour is available
- Values are calculated based on thresholds, which are derived from literature and can be adapted to the characteristics of the respective course

# From Behaviour to Learning Styles




- Patterns provide indications about learning styles
- Four values are possible:
  - 3 ... the student‘s behaviour gives a strong indication for the respective learning style
  - 2 ... the student‘s behaviour is average and therefore does not provide a specific hint
  - 1 ... the student‘s behaviour is in disagreement with the respective learning style
  - 0 ... no information about student‘s behaviour is available

# From Behaviour to Learning Styles




- All indication values are summed up and divided by the number of patterns where information was available
- The results were normalised on a range from 0 to 1
  - 0 ... the student has a strong negative preference for this learning style
  - 1 ... the student has a strong positive preference for this learning style
- If no indications are available, no conclusions about the student's learning style can be drawn

# Evaluation

- University course about object oriented modelling
- 127 students participated
- All types of learning objects described before were included
- Moodle was used and extended by few tracking functions

# Evaluation

- Students filled out the ILS questionnaire and learned in the online course
- Results of ILS were compared with the results of our approach based on a 3-item scale (distinguishing e.g. between an active, balanced, and reflective learning style)
  - Automatic Approach:
    - Calculated measures based on indications → values between 0 and 1
    - Divided results in three groups (using thresholds of 0.25 and 0.75)
  - ILS:
    - Results of ILS were normalised → values between 0 and 1
    - Values between 0 and 1 were grouped into three groups (using thresholds of 0.25 and 0.75)

# Evaluation

Sim ($LS_{predicted}$, $LS_{ILS}$) = 1 ... if both are equal
0.5 ... if one is balanced
0 ... if both are opposite

$$\text{Precision} = \frac{\sum_{i=1}^{n} Sim(LS_{predicted}, LS_{ILS})}{n} \cdot 100$$

# Results

| act/ref | sen/int | vis/ver | seq/glo |
|---|---|---|---|
| 79% | 77% | 77% | 73% |

→ showing that our approach is a suitable instrument for automatically identifying learning styles

# Conclusions and Future Work

- Developed an approach for automatically identifying learning styles
- Approach is developed for LMSs in general

Future Work

- Dynamic Automatic Student Modelling
  Allowing modifying and updating the student model on the fly and therefore to response immediately
- Tool
  Continuing to develop a tool that allows teachers to easily integrate our approach in their courses