Detecting Learners’ Profiles based on the Index of Learning Styles Data

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Motivation

- Learners have different needs and characteristics
- Considering the individual needs and characteristics of learners has potential to make learning easier for them
- Learning styles play an important role in education
  - Learners might have difficulties in learning when the learning style does not match with the teaching style
  - Considering learning styles makes learning easier and increases the learning progress
Adaptive systems aim at providing adaptivity
- AHA!
- CS383
- TANGOW
- INSPIRE
- ...

However, for providing adaptivity, information about learners has to be identified first
- Most adaptive systems considering learning styles are using a questionnaire for identifying learning styles
Learning Style Questionnaires

- The correct identification of learning styles is a crucial issue for providing proper adaptivity.
- Some studies (e.g., Coffield et al., 2004) showed that some questionnaires lack in reliability and validity.
- In a previous study, we conducted a in-depth analysis of the Index of Learning Styles Questionnaire (ILS) based on the Felder-Silverman Learning Style Model:
  - Found correlations between dimensions.
  - Found out that poles of dimensions might be not fully opposite of each other.
  - Found the existence of latent dimensions.
Aim of this study

- Introduce a model for detecting learning styles that overcomes the limitations of the ILS questionnaire by incorporating dependencies and latent dimensions
- Model is based on a data-driven approach, using Multiple Correspondence Analysis
- Aims at improving authenticity of learner profiling
  - Detection of the most likely learning style of the learner
  - Detection of main characteristics of the learner profiles
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“
    - serial – holistic
Felder-Silverman Learning Style Model

- Scales of the dimensions:

  - Active:
    - +11: Strong preference
    - +9: Strong preference
    - +7: Moderate preference
    - +5: Moderate preference
    - +3: Well balanced
    - +1: Well balanced
    - -1: Moderate preference
    - -3: Moderate preference
    - -5: Strong preference
    - -7: Strong preference
    - -9: Strong preference
    - -11: Strong preference

  - Reflective:

  \[ \rightarrow \text{Strong preference but no support} \rightarrow \text{problems} \]

- Differences to other learning style models:
  - describes learning style in more detail
  - represents also balanced preferences
  - describes tendencies
  - Felder-Silverman learning style model is quite often used in technology enhanced learning
Index of Learning Styles (ILS)

- Developed by Felder and Soloman (1997) 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, with steps +/-2
Study Design

- Asked students to fill out the ILS questionnaire
- Participants: 469 students from Vienna University of Technology (Austria) and Massey University (New Zealand)

Conducted Investigations
- General analysis of frequencies
- Built a model that shows characteristics of learning styles
- Developed an approach for detecting learner profiles based on discovered characteristics of learning styles
- Investigated characteristics of the profiles
## General Analysis of Frequencies

### Frequencies of Dimensions

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### Frequencies of ILS Questions

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Building a Model showing Characteristics of Learning Styles

- Transformed data from ILS answers to frequencies and applied Multiple Correspondence Analysis (MCA) algorithm
- MCA plane shows characteristics of learning styles
- Closeness indicates shared characteristics of styles, given by shared answers
Building a Model showing Characteristics of Learning Styles

- Dependencies between styles affect the reliability for detecting learning style preference of learners.

- Associations between two styles are based on many shared answers.
  - difficulty in distinguishing a clear preference for each of the learning styles.
Learners’ Profiles

- Include learners in the MCA plane → the closer the learner to a style the stronger the impact of this learning style on the learner
- For detecting these influences, a suitable proximity measure is necessary
- We tested different measures such as
  - Euclidean distance
  - Infinity norm distance
  - Weighted Euclidean distances
  - Cosines
- Cosines was most stable and was therefore selected
  - Positive sign of cosines → positive association
  - Negative sign of cosines → negative association
  - Absolute values indicates strength of associations
### Learners’ Profiles

- Calculated cosines between the points representing styles and the learners

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Learners’ Profiles

- Results show that our model can be considered as reliable for all styles except the active and reflective style.

- Thresholds for cosines are a critical parameter and need to be selected carefully.
Characteristics of Profiles

- Most frequent ILS answers for each learning style based on the answers of the 25 learners that are closest to each learning style according to the model

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Characteristics of Profiles

- Profiles show dependencies within learning styles

- Due to reciprocal influences between styles, profiles partially overlap each other, which makes the identification of styles more difficult
Conclusions

- We introduced an approach for profiling learners based on data from ILS questionnaire.
- Since data show dependencies between styles, the approach for profiling learners aims at incorporating these dependencies.
- The proposed approach showed sufficient reliable results for all styles except active and reflective learning style.
- Looking at the characteristics of the profiles, it can be seen that the discovered dependencies are incorporated.
- Incorporating these dependencies leads to a more accurate model of students’ learning styles.