Women's Postgraduate College for Internet Technologies

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Semantic Relation Analysis and Its Application in Cognitive Profiling

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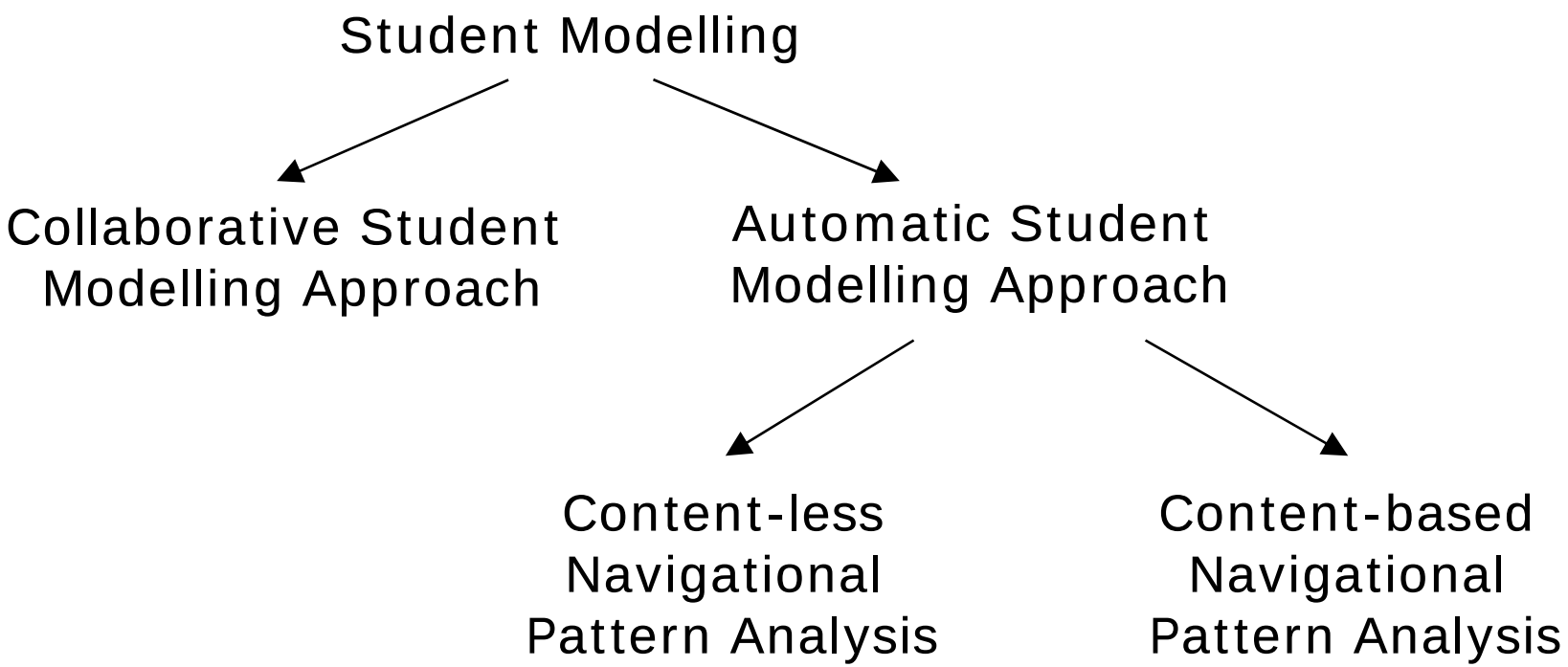
Motivation

- What is cognitive profiling?
  Process of detecting the cognitive abilities of learners such as
  - Working memory capacity
  - Inductive reasoning ability
  - Associative learning skills
  - ...
- Why do we need cognitive profiling?
  - Avoid cognitive overload for learners
  - Using information about learners for adapting courses with respect to the learners' cognitive abilities

How to get information about the learners?



Content-less navigational pattern analysis

- Every webpage is treated as a node
- Every webpage is treated equally regardless of its content
- Relationships between the nodes are not defined
- Focus is on the navigational behaviour (certain navigation patterns indicate navigation approaches such as searching or browsing)
- domain-independence
  - Reusable across different domains
  - Inaccurate in specific situations

Content-based navigation pattern analysis

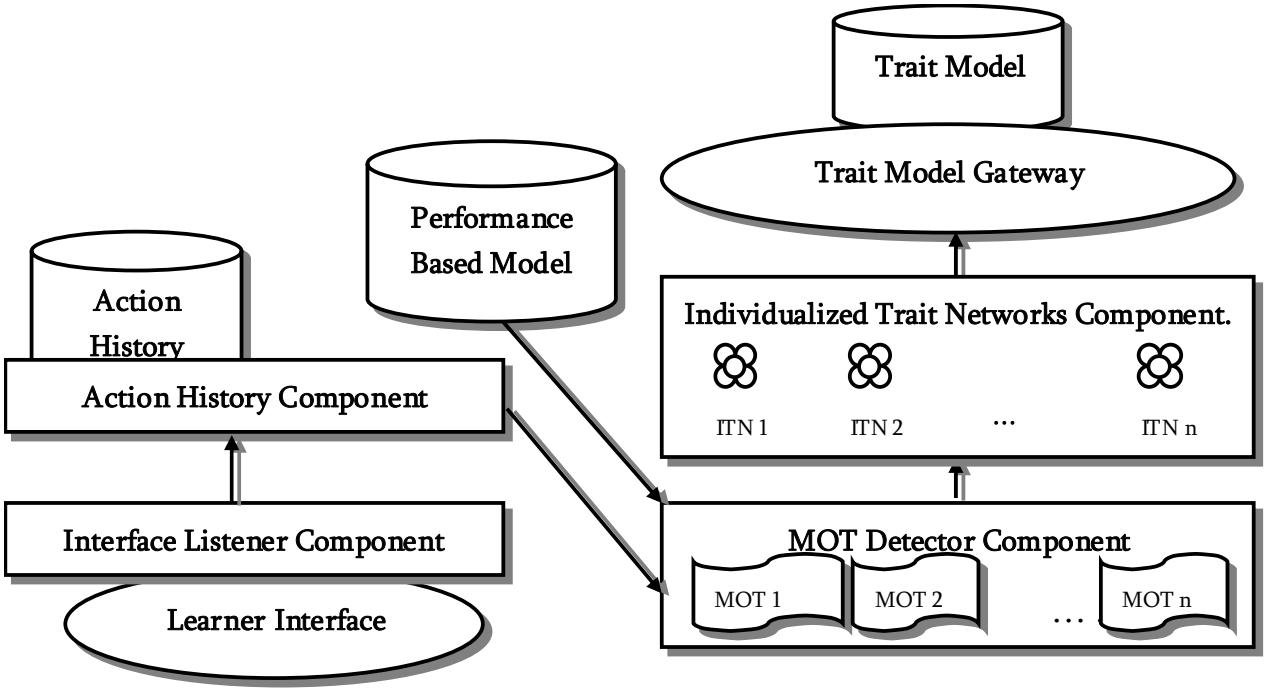
- Primary analysis method for most of the performance-based student models, recording students' progresses and grades
- Contextualised semantic information of every node is recorded (based on domain ontology or concept map)
- Learning system makes inferences about the learners and stores the information in the student model
- Benefit: Accurate due to semantic information
- Drawback: Domain-dependence
  - For a new domain, similar effort of analysis have to be carried out
  - For modifications in the domain ontology, inferences rules have to be re-written

Semantic Relation Analysis (SRA)

- Based on the idea of Semantic Web
- Uses semantic information about relationships between learning objects
- Two learning objects can be related to each other in different ways
- Learning Object Metadata (LOM) already defines 12 different types:
  - *IsPartOf, HasPart*
  - *IsBasedOn, IsBasisFor*
  - *Requires, IsRequiredBy*
  - *References, IsReferencedBy*
  - *IsVersionOf, HasVersion*
  - *IsFormatOf, HasFormat*
- Is extended by Vijver et al. (2002) by the types *HasExample*, *ExcursionTo*, and *Evaluates*
- Through categorising of relationships, SRA is domain independent but contains semantic information

Semantic Relation Analysis for Cognitive Profiling

- Semantic Relation Analysis is applied in the Cognitive Trait Model (CTM) to discover information about the learners' cognitive traits



Empirical Study with respect to Inductive Reasoning Ability

- Participants: 29 students from Massey University, New Zealand (studying in Information Systems course)
- Participants used a learning system that tracked their behaviour
  - Read the descriptions of the concepts
  - Take a quiz consisting of multiple-choice questions
- Participants were asked to perform a web-based inductive reasoning test (Web-IRA)
  - Consists of 30 questions, including 3 types of tasks (series extrapolation, analogical reasoning and exclusion)
  - Questions are presented in a sequential order and must be solved in this order
  - Online accessible
  - Time mechanism is built for detecting abnormalities

Analysis and Results

- The number of correct answered questions in Web-IRA was used as index of inductive reasoning ability
- Inductive reasoning ability was also calculated through the cognitive trait model based on semantic relation analysis
- The conducted rank correlation analysis showed a significantly correlation between the results of both approaches (rho=0.382, p=0.02)

→ Results supports the use of SRA in cognitive profiling

Conclusion

- Introduced a novel approach called Semantic Relation Analysis, which combines the strengths of content-less and content-based navigational pattern analysis by using semantic information about relationships between learning objects
- Demonstrated exemplary application of the Semantic Relation Analysis for identifying inductive reasoning ability
- The result of the empirical study showed a significant correlation between the automatic student modelling approach by semantic relation analysis and the collaborative student modelling approach by using Web-IRA
- This result supports the proposed approach of using SRA for cognitive profiling
- Future work:
  - Identifying more new potential application areas of SRA
  - Exploring how it can be integrated into the tracking service of SCORM in order to provide easy integration mechanism for learning system developers