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Learning Analytics – Using Action Sequences for Learner Support

Computer-based learning environments (CBLEs) should be able to adapt to learners' different levels of knowledge and skills: teachers can't assess and assist every student and using online systems to learn requires higher responsibility and self-regulation. In systems teaching long or complex tasks, like programming or lab procedures, learners benefit from fine-grained and timely support, instead of at the end of the task. Using learning analytics in the form of sequential analysis can increase precision of continuous assessment and to provide support adapted to the learner, their current trajectory and context.
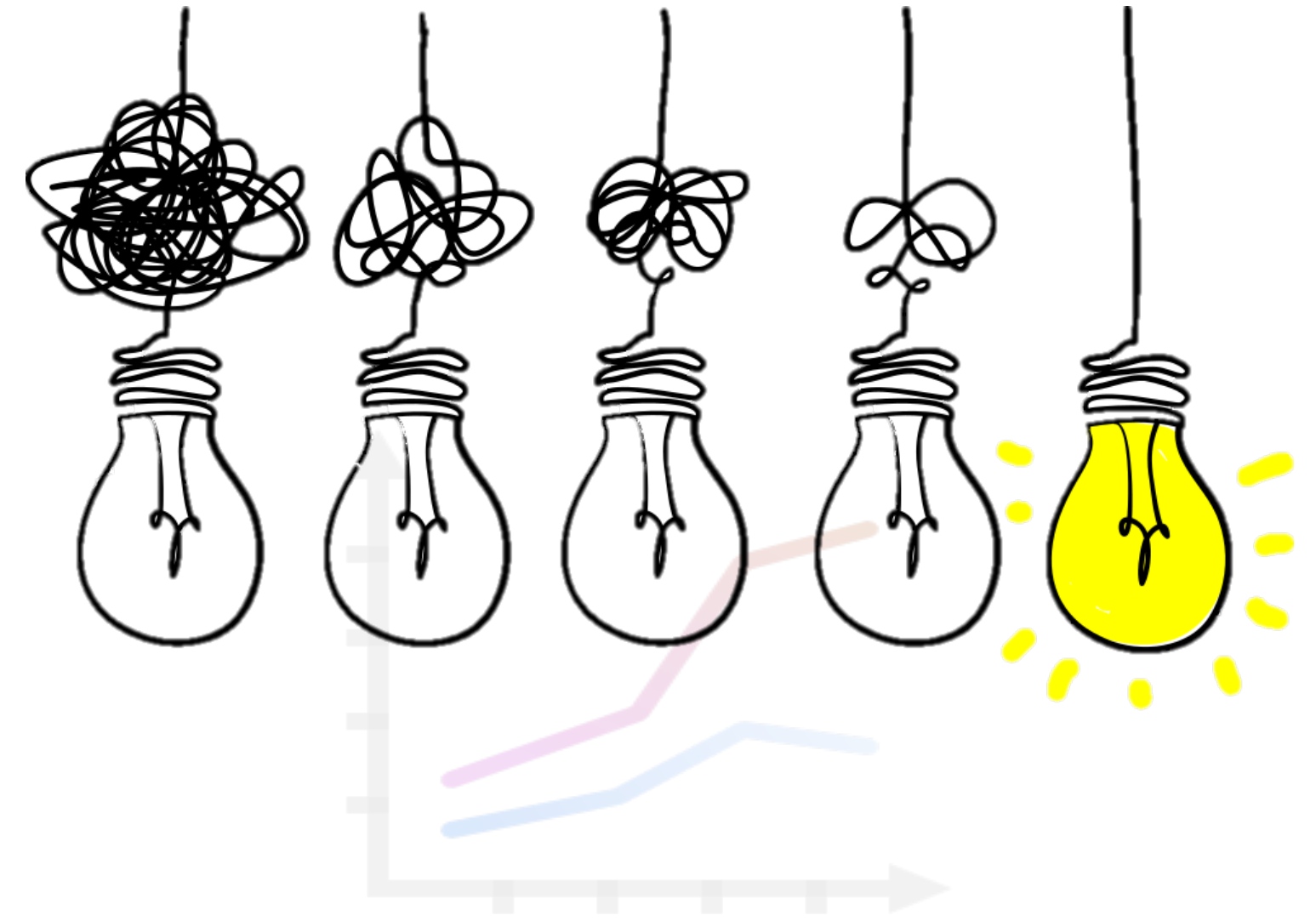
Research Question and Direction

Using sequences of data traces to assess and understand learners' skill and behavior has been researched in fields such as Educational Data Mining, Learning Analytics, Intelligent Tutoring Systems; with converging methodologies and approaches in recent works.
What is the next step for wide adoption in CBLEs?
How to model learning sequences, supported by cognitive and pedagogical theory?
In which scenarios is it beneficial to intervene during a learning sequence?

Work in Progress – May 2022

- Literature Review: How are sequences of actions in complex learning tasks analyzed to model learners' characteristics and behavior to provide support in online systems?
- Expected result: decision framework, which methods to use for different scenarios
- From 620 articles, 44 met the criteria of empirical research executed in a learning environment with focus on sequences of learner actions. Preliminary findings:
  - Mapping data traces to learning activities: contextual information improves prediction precision, aggregation works well with theoretical grounding e.g., grouping certain logs into self-regulated learning actions
  - Methods depend on research objective and granularity of the sequence e.g., probabilistic models to explore population behavior, sequential pattern mining to find micro-strategies

Future Work

- Intervention and Validation: Sequence analysis scenario with intervention – feedback, hints, scaffolding – using the decision framework from the literature review
- From needs to data: Bottom-up analysis of learners' information needs
  - Mixed-methods qualitative and quantitative study with learners in the center of the design process of LA Dashboards

Publications and Takeaways

- Ioana Jivet, Jacqueline Wong, Maren Scheffel, Manuel Valle Torre, Marcus Specht, and Hendrik Drachsler. 2021. "Quantum of Choice: How learners' feedback monitoring decisions, goals and self-regulated learning skills are related". *LAK21*
Students were provided with a visualization where they could choose 3-6 indicators from 12 available. The indicator selection was compared with student goals and self-regulated learning skills. Learners preferred indicators about completing content, some skills predict selection of indicators, but there was no relationship with goal selection.

Student-facing dashboards should be part of a feedback process, adaptable to different levels of self-regulation and personalizable to student preferences.

- Manuel Valle Torre, Esther Tan, and Claudia Hauff. 2020. "EdX log data analysis made easy: introducing ELAT: An open-source, privacy-aware and browser-based edX log data analysis tool." *LAK20*
Development of a pre-processing and visualization tool for edX log data. Based on the MOOCdb schema, ELAT generates a database of learning sessions: time periods where then student is assumed to be active in the MOOC, with specific categories such as watching videos or taking a quiz. ELAT was evaluated for usability with potential end users. Visualizations with theoretical grounding were considered most useful.

Teachers (users) should be involved in the development of LA tools: they know the course and their students' needs. Transparency, purpose and policy are key.