Self-Regulated Learning Detectors
Pennesota R&D Team - Zhang, J., Hutt, S., and Nasiar, N.
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Self-Regulated Learning Detectors

These detectors identify the presence of behaviors which indicate student engagement of cognitive operations involved in self-regulation, as well as associated skills used during mathematical problem-solving.

Purpose

- The Pennesota team trained models to automatically detect the presence or absence of two sets of indicator behaviors, using back-end log data in student learning platforms:
    - There are six self-regulated learning (SRL) indicators: (1) numerical representation, (2) contextual representation, (3) outcome orientation, (4) data translation, (5) incorporating information, (6) following plans, and (7) strategy invention. Each indicator aligns with one of the five cognitive operations (Zhang, et al., 2022).
    - The strategy-invention indicator (Nasiar et al., 2023) provides insight into students' monitoring and evaluation skills, as well as their ability to adapt and invent strategies for problem-solving. The automated detector indicates the presence or absence of this behavior based on students' log data.

Measure Details

- These detectors run via code embedded within student learning platforms or on collected log data. There is no direct administration of measures to students.

Contribution to the Field

- Research has identified a set of five cognitive operations typically involved in self-regulation: searching, monitoring, assembling, rehearsing, and translating (SMART model; Winne & Hadwin). Due to their dynamic, momentary nature, measurement of these behaviors has been a persistent challenge in the field.
- To investigate students' engagement in self-regulated learning (SRL) behaviors, the Pennesota team identified and operationalized six SRL indicators, using machine learning, based on the design of and available data from a mathematics learning platform focused on building students' problem solving skills. Together, the six indicators provide insight into the types of SRL behaviors students engage in during the problem-solving process.
- A knowledge-engineering model of strategy invention was developed to capture the invention of strategies by learners while problem-solving. Inventing a new problem-solving strategy is a valuable 21st-century skill that involves creativity, critical thinking, and is associated with improved learning outcomes. The invention of strategies has been shown to be linked to the SRL SMART model behaviors of monitoring and evaluating existing strategies.

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Development History and Previous Uses

- Data from the SRL detectors have been used to gather data to examine how students' engagement in SRL varies across experimental conditions.
- The SRL detectors have primarily been integrated into a math learning platform which aims to build students' problem-solving skills. In this platform, the values from the SRL detectors are combined with log data to determine if students are effectively responding to feature sets in the platform and inform how students receive additional supports throughout their problem solving process.
- The strategy-invention detector has been used to identify and study how this behavior appears and interactions with other SRL behaviors in students' problem-solving processes.

Accessing the Measure

- You may access the code for the detectors and their usage instructions here:
    - https://github.com/JZ2655/CueThink_SRL_detectors.git
- For additional information, please contact:
    - Joyce Zhang at joycez@upenn.edu regarding the SRL measurements and use of the SRL detectors
    - Nidhi Nasiar at nasiar@upenn.edu regarding the strategy-invention measurement and use of the Knowledge-Engineering model

Associated Publications

Zhang, J., Andres, J. M. A. L., Hutt, S., Baker, R. S., Ocumpaugh, J., Nasiar, N., Mills, C., Brooks, J., Sethuraman, S., & Young, T. (2022). Using machine learning to detect SMART model cognitive operations in mathematical problem-solving process. *Journal of Educational Data Mining, 14*(3), 76–108. https://doi.org/10.5281/zenodo.7304763

Nasiar, N., Baker, R.S., Zou, Y., Zhang, J., & Hutt, S. (2023). Modeling problem-solving strategy invention (PSSI) behavior in an online math environment. In N. Wang, G. Rebolledo-Mendez, V. Dimitrova, N. Matsuda, & O.C. Santos (Eds.), Artificial Intelligence in Education: Posters and Late Breaking Results, Workshops and Tutorials, Industry and Innovation Tracks, Practitioners, Doctoral Consortium and Blue Sky. AIED 2023. *Communications in Computer and Information Science, 1831*, 453-459. https://doi.org/10.1007/978-3-031-36336-8_70