ComprehEnRank: Estimating Comprehension in Classroom by Absorbing Random Walks on a Cognitive Graph

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Abstract. We develop a graph-theoretic framework for estimating comprehension in classroom. To deal with imprecise data gathered in classroom, we propose multi-step comprehension propagation over a semantic graph. Random walks on the graph measure students’ comprehension with probabilities absorbed at student nodes.

Motivation

- Why not let us directly report our comprehension to you in an identified or anonymous manner?
- Why?
  - To adapt teaching strategies in real-time
  - To improve lecture materials

Empirical Characteristics

Prerequisite Effect
- When \( d = 1 \), we trust \( w_i \) as much as \( w_j \) (consistency validation).
- When \( d = \infty \), we completely trust students’ rating data (our model subsumes the baseline approach, and is adaptive depending on \( d \)).

Limitation
- Our model is predictive, not deductive.
- Concepts \( c_1 \) and \( c_2 \) are closely related. Chances are that this student understands \( c_2 \) after \( c_1 \) or both at the same time.

Datasets

- We collected slides from two lectures of a digital image processing course taught in Japanese at Kyoto University.
- The ideal cognitive graph has 43 slide nodes, 9 concept nodes, 12 links of referTo, and 20 links of explainably (top 5 relevant slides).
- Students’ rating data were acquired by questionnaires in the classroom.

Preliminary Evaluation

- Concept comprehension is usually evaluated by test scores.
- We measure correlation between test scores and the measures:
  - % Understood: How many concepts a student understands (concept comprehension \( \geq 0.8 \))
  - % Not Understood: How many concepts a student does not understand (concept comprehension \( < 0.4 \))
  - Avg. Comprehension: Concept comprehension averaged over all concepts in the cognitive graph
  - % Lowest/Low/Highest: How many slides with a particular rating

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