A Dynamic Higher-Order DINA Model to Trace Multiple Skills

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6 Abstract

Knowledge tracing (KT) ^[1] models a skill as a hidden state, and estimates the changing probability of this state based on its sequential observed attempts in an intelligent tutor system. It becomes a challenge for KT when the attempt requires multiple skills. Using Logistic regression in a dynamic Bayes net (LR-DBN) ^[2] solves the problem with a half error rate comparing to previous methods. ^[3] It estimates each skill distinctly per student. But does it really need so many parameters, i.e. having separate coefficients for K skills for N student (K×N in total)? Is student learning lower (unidimensional, such as the static higher-order Deterministic Inputs, Noisy "And" gate (DINA) ^[4] modeling student general ability?

We propose a dynamic higher-order DINA model that traces the students' changing abilities. We model student knowledge as unidimensional data points on a scale of skill difficulties. It assumes the skills tend to be learned in an order and reduces to N student ability parameters, 2K skill discrimination and difficulty parameters (N+2K in total).

We use Markov chain Monte Carlo (MCMC) algorithm to estimate the parameters. To investigate how accurately the parameters can be recovered from the MCMC algorithm, we simulate 1000 examinees with 50 practices on 30 items. Besides, we also apply the proposed model on real data that was recorded by Project LISTEN's Reading Tutor [5] during the 2005-2006 school year. It is used to predict if a word can be read fluently, which means it was read without help or hesitation and accepted by the automated speech recognizer.

References

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