

An Investigation of Knowledge Tracing Algorithms as Learner Simulators

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Abstract

The development and research of adaptive learning systems is greatly hindered by the requirement for significant amounts of learners to interact with the systems. Many adaptive learning systems are built using machine learning technologies and require a significant number of learners' interactions to train and evaluate the systems. The use of knowledge tracing algorithms as learner simulators offers a potential solution to this problem, in particular for recommendation systems that recommend questions to a learner according to how the learner responds to other questions. Knowledge tracing algorithms can be used as learner simulators to simulate learners' responses to questions. It is hoped that knowledge tracing algorithms can realistically simulate how learners respond to questions and reduce the number of real learners and responses per learner required to train and evaluate these adaptive learning recommendation systems.

Current research fails to evaluate knowledge tracing algorithms as learner simulators. Research focuses on evaluating the performance of knowledge tracing algorithms for knowledge tracing as opposed to learner simulation. It is currently unknown how accurately learner simulators can simulate the responses of learners to questions. This dissertation investigates the use of knowledge tracing algorithms as learner simulators to simulate the responses of learners to questions. The research seeks to discover how well knowledge tracing algorithms can perform as learner simulators.

In an extensive evaluation of knowledge tracing algorithms as learner simulators, it was found that the best performing learner simulators can simulate the responses of learners with an average accuracy of 76% for the two learner simulation tasks defined. The two learner simulation tasks defined reflect the number of responses that would be required to be simulated during training and evaluation of these adaptive learning recommendation systems. The evaluation and analysis conducted also produced a number of other interesting findings including how the accuracy of learner simulators can be increased further, how the performance of knowledge tracing algorithms for knowledge tracing can inform us about their performance as learner simulators and which knowledge tracing algorithms are most suitable for the simulation of learners' responses.

Overall, the accuracy achieved by the best performing learner simulators is a promising indication that knowledge tracing algorithms have the ability to realistically simulate learners' responses to questions. It is hoped that this level of accuracy is suitable for reducing the number of real learners and responses per learner required for the training and evaluation of adaptive learning recommendation systems that recommend questions according to learners' responses.