

## Scalable Online Education using Data Mining, Machine Learning, Crowdsourcing

Learning through online platforms is rapidly rising. It is crucial to make the information available online accurate, helpful, and supportful for learning in an efficient way. This is made possible through some interesting applications using machine learning, crowdsourcing, and data mining. A few such applications include generating explanations to online problems, and demonstrations of online code.

The first application helps generate explanations to online problems at scale, with learner sourcing and machine learning. While online solutions may provide some knowledge about why an answer is correct, the explanations are not always of high quality. “Adaptive Explanation Improvement System” (AXIS) asks learners to provide, revise, and evaluate explanations when they solve problems, and then utilizes machine learning to pick which explanation to showcase to a future learner based on the previous learner inputs. Reinforcement learning is a common technique of machine learning for this use case to determine which explanation is the best, through picking an explanation and observing the results. To determine if the result of the picked explanation was positive or negative, users can provide feedback on how helpful the provided explanation was. While using such a beneficial reinforcement learning technique, it is vital to address the problem of exploitation (picking explanations that have been observed to be effective) vs. exploration (experimenting with different explanations to obtain a better understanding of their usefulness). AXIS takes this into consideration by using the Thompson algorithm, a Bayesian algorithm that captures both the estimates about an explanation's

usefulness, as well as the algorithm's uncertainty about the estimates. Thompson sampling stores an approximate distribution for the rewards of each explanation. Each distribution's parameters are set based on a prior, which showcases our thoughts about the usefulness of explanations that have not yet been shown to users, and then are updated based on the likelihood of the observed evidence. Results from a case study to solve math problems has proved that AXIS provides useful explanations to users that enhance their learning skills. Using AXIS will reduce a significant amount of time and effort from instructors in explaining and providing solutions to problems in coursework.

A similar application of data mining, which achieves a similar result to what AXIS does is the process of generating context relevant, on demand explanations and demonstrations of online code. Programmers very regularly use online resources to solve coding problems. It is extremely common to see that a lot of websites that have example code, assume knowledge of some other languages like html or css for an example. As a solution to this, "Tutorons" automatically detect explainable code on a webpage, parse it, and generate natural language explanations of the code. These explanations are generated using template instantiation, parse tree traversal, and constructing descriptions for co-occurring options. Studies validate and prove that Tutorons reduce the requirement for extra documentation on code, while already looking at code on a particular website.

Such applications that generate explanations for online problems using text data, and machine learning are extremely valuable. They show how important and beneficial text data can be for numerous use cases. In this paper, we understood two applications using text data to make the process of online learning more efficient and helpful for learners. In this day and age, the demand for online learning is growing rapidly. Currently being a part of an online degree, I can

see how valuable these applications would be to us learners. Thanks to processes like data mining and machine learning, which can be used for many such applications to make our lives easier.

Williams, Joseph Jay, et al. *AXIS: Generating Explanations at Scale with Learnersourcing and Machine Learning*. <https://juhokim.com/files/LAS2016-AXIS.pdf>.

Head, Andrew, et al. *Tutorons: Generating Context-Relevant, On-Demand Explanations and Demonstrations of Online Code*. <https://juhokim.com/files/LAS2016-AXIS.pdf>.