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Natural Language Processing Based Analytics Dashboard for Online Learning Platforms

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Abstract The emergence of remote education and online platforms for massive open online courses (MOOCs) even before the COVID-19 pandemic has led to increased text data such as course materials and video transcripts related to online education. While there are several learning analytics dashboards currently existing in literature, those that focus on processing text data are far and few in between. A prototype for an instructor-facing learning analytics dashboard that uses text data for learners and instructors is presented in this work. Aside from finding use for an underutilized yet abundant resource, the problem of working with other online education tools is also addressed in this work. The learning analytics dashboard is not constricted to a particular subject area or population; thus, it can be applied to various fields and settings with minimal adjustment.

Keyword learning analytics dashboard, online education, natural language processing, feedback

1. Introduction

In a traditional classroom, an instructor is present to give instruction and observe if any learner is experiencing difficulty or boredom. For some online classrooms, discussion forums along with other data such as attendance and performance may provide insights to the instructors in the absence of face-to-face interaction.

One important concept in systems engineering, and in education, is feedback. In education, we often regard feedback to be the assessment we give to the learners so that they can adjust their learning. Equally important is the feedback provided to the instructors so that they can adjust their instruction and make learning more optimal beyond the individual level. Thus, in the scenario discussed, what we are mostly interested in is gathering feedback for the instructor.

2. NLP for MOOC Quality Assurance

Instructor feedback is mostly important for quality assurance, may it be for improving their course or as input to other administrative decision making. However, in practice, quality assurance activities for online courses are done typically only just before a course is released or after a course has ended. Because of that, instructors do not have enough opportunities to make the needed interventions while the course is ongoing. This is a dilemma Tokyo Institute of Technology (Tokyo Tech) is particularly interested to investigate. Tokyo Tech produces MOOCs on the edX platform as TokyoTechX and has been doing learning analytics research to improve their online courses.

With NLP, Tokyo Tech can use text data that are available from the start such as the course content and those that continue to evolve throughout the course such as discussion forum posts. This quality assurance process was done for a mechanical engineering course designed to teach the concept of monozukuri where NLP was used to check the overall sentiment of the learners as well as the content type distribution (i.e., ratio of text, quizzes, and videos) to ensure that there is sufficient material to cater to different learning modalities [1]. Data for these analyses were gathered using web crawlers designed specifically for the associated learning management system (LMS): in this case, Open edX.

3. POALS Analytics Dashboard

The crux of online learning is to enable learners to learn on their own as interaction with fellow learners or instructors can be limited. Nevertheless, the instructor remains the subject matter expert and should not be excluded after the course has been built.

To empower learners to learn on their own, the Personalized Online Adaptive Learning System (POALS) was developed. POALS is made up of several components, including a metacognitive tutor

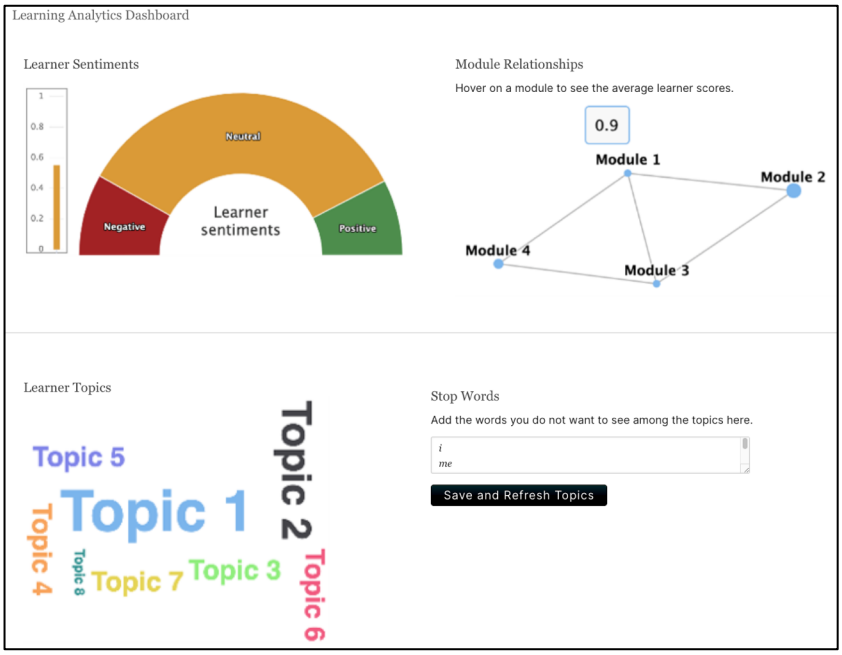

Figure 1: POALS Analytics Dashboard Prototype User Interface

intended to develop the learners' metacognitive skills by posing open-response questions during quizzes designed to trigger deeper learning. POALS also has an analytics dashboard which uses inputs from the metacognitive tutor to show NLP-based analytics such as learner sentiments, topics frequently discussed in the metacognitive prompts, and a network graph showing the similarity of the course modules along with the learner scores [2]. The user interface prototype is shown in Figure 1.

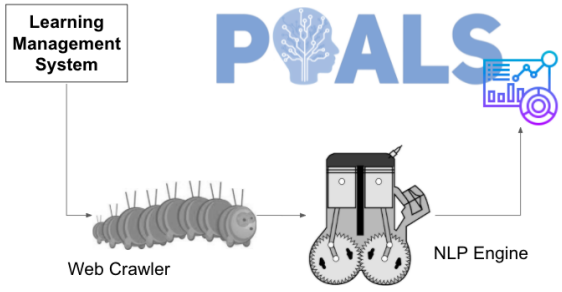

Figure 2: POALS Analytics Dashboard Ecosystem

However, even though the metacognitive training is designed to be domain-independent, some courses may just not require quizzes invoking deep thinking for measuring learning outcomes, and thus are not ideal platforms for metacognitive tutors [3]. Nevertheless, the analytics dashboard has its own merits: for instance, knowing what the learners are discussing can help the instructor discuss modules not well understood, or introduce new materials more aligned to the learners' interests [4]. Hence, not being able to use the metacognitive tutor should not prevent the use of the analytics dashboard.

To decouple the analytics dashboard from the metacognitive tutor, the analytics dashboard was redesigned to use the result of the MOOC web crawlers instead as shown in Figure 2. The underlying NLP engine was tested with Japanese and English inputs, but not a mixture of both. The new analytics dashboard then uses the discussion forum posts as the source data for NLP analysis. Since the analytics dashboard is now usable with the typical features of an LMS, it can now be used in more varied conditions.

4. Future Work

Interactivity that will allow drill-down analytics will be added to the POALS Analytics Dashboard. Afterwards, usability tests will be conducted. Another function that can be considered is notifying instructors when potential learner issues are detected.

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