Personalized Exercises Recommending for Limited Time Learning

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The objective of adaptive navigation is to help the student choose the best topics or learning objects to focus on, in order to maximize the learning efficiency. In this project we focus on exercises as an important part of preparing for an exam. Since the time for preparation is limited by the date of the exam or midterm, it might be not sufficient for learning all required concepts perfectly, especially for students who started preparing late. Our goal is to help the student to achieve as good exam result as possible. A strategy used by many students is going through all topics in the course very quickly and learning every topic at least to some extent, rather than learning few topics in detail. Our recommending method is designed to help the students to prepare for the exam using the former strategy.

To achieve proper learning time distribution between all required concepts, we attempt to determine optimal knowledge levels of all concepts at the end of learning time, which are achievable at the current learning speed. Using the overall knowledge level increase from the learning start (the sum of knowledge level increases through all concepts), we estimate the knowledge level increase from present time to the end of learning. The overall increase is then divided between all concepts in such way, that the final estimated knowledge levels of concepts correspond with the concepts importance given by the teacher. In an extreme case, where the student's knowledge was very low and there was little time left, the estimated knowledge level increase would be almost zero for every concept. Such learning strategy cannot be successful because the student cannot pass the test with almost no knowledge of all concepts. To prevent this condition, we set a minimal concept knowledge level – the estimated knowledge level for every concept is never lower than this limit.

To make a recommendation for a student, we compute an appropriateness value for each exercise in the course. Then, a predefined number of exercises with largest appropriateness values are recommended. Three criteria are used for each exercise evaluation: concept appropriateness, exercise difficulty appropriateness and time

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period since the student's last attempt to solve the exercise. These criteria are orthogonal and for an ideal recommendation, all of them are supposed to be met. Therefore, the final appropriateness of the exercise for the student is computed as the minimum of the three partial results.

The purpose of concept appropriateness evaluation is to decide, whether the student should learn the concepts covered by the particular exercise. A vector of concept appropriateness values for the student is constructed and compared to the exercise's related concepts vector. The appropriateness value of a concept depends on:

– the teacher-given concept importance,
– the student's current knowledge level of the concept (the concept appropriateness falls rapidly after the student reaches the estimated optimal level – over-learning a concept would result in less achievable knowledge of other concepts),
– concept prerequisites (other concepts' knowledge that should be achieved before learning the particular concept – a concept is not appropriate for learning before its prerequisites are met).

The second criterion – exercise difficulty appropriateness – ensures that the difficulty of the recommended exercise matches the student's knowledge level. This prevents the student from being uninterested or discouraged.

The final criterion suppresses recommending of recently viewed exercises. After visiting an exercise, its appropriateness value produced by this criterion drops to zero and gradually returns to 1 over time.

The student knowledge model is represented by a vector of concept knowledge levels. Updating of the knowledge model is based on explicit user feedback – the student chooses one from a set of replies (from *solved* to *not understood*) and the knowledge levels are updated using the Computer-Adaptive Testing method [1].

Our solution is currently evaluated in controlled experiments within the Functional and logic programming course, using the ALEF framework for adaptive web-based learning [2]. Experiments consist of a pre-test, a learning session and a post-test to verify the adaptive navigation impact on students' learning performance.

Since our method uses weighted relations and fuzzy logic rather than strict rejection rules, we expect it to be able to deal with imperfections in the domain model. This can make the method usable with automatic generated domain models.

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References

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