

Automated sequencing of learning items in item-based Adaptive Learning Systems: Specification of the problem

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Abstract

Item-based Adaptive Learning Systems start from a number of learning goals to provide learners with an optimized sequence of small stand alone exercises. Generic software methodologies that provide such optimized sequences have not been developed yet. In this abstract we describe the problem of sequencing learning items by specifying the most important constraints involved and by explaining how the problem can be split up into two successive computational problems.

Keywords: adaptive learning system, sequencing, learning item

1 The item sequencing problem

A great part of the technological research in e-learning is focussed on architectures for adaptive learning systems, e.g. [1]. Here in contrast we try to fill in one of the most common building blocks of such architecture by describing a methodology to automatically assign the most suitable exercises (items) to a learner given a pool of exercises. Examples of items include multiple choice and word translation questions.

In our case the optimal choice and order of items depend on the learning goal, knowledge model, learning model, item properties, learning characteristics and adaptive learning strategy. A typical learning goal is achieving a certain ability level in some knowledge domain. Such domain can be modelled by a tree with the low-level knowledge concepts at the leafs and the high-level concepts at the nodes. Each edge in the tree has a weight expressing the lower node's importance in the context of the upper node. The tree can

be supplemented with precondition relationships. The learning model includes an update formula for the learner's ability level based on the properties of both the learner and the item that was answered. The simple properties of the items include difficulty and learning subject, but there are also more complex ones such as pre-requisite and post-requisite relations between items and also, certain items have some ability requisites. The dynamic learner characteristics consist of the ability levels for multiple learning subjects as well as a measure for the learning speed of the learner. Finally, the adaptive learning strategy stipulates additional sequencing constraints which are based on pedagogical evidence, for instance aiming for a predefined item success probability, e.g. 70 %, which seems to be a good balance between motivation and challenge.

2 Our two stage solution approach

In the past most implementations highly simplified the problem by focussing on a single adaptivity dimension (e.g. learning style [2]). We will handle the problem as a whole. To solve the problem we introduce a two stage approach. In the first stage we extract the most appropriate learning subject by combining the learning goal with the knowledge model, thereby automatically formulating a low-level learning goal with relation to the chosen learning subject. In the next stage we will make a schedule of the next learning items (e.g. 10) to offer to the learner. This schedule is the result of an optimization problem trying to respect the constraints as good as possible. Especially the item requisites, learning model and adaptive learning strategy are of importance. Also, the schedule can be updated when the learning has already began. This could be done by monitoring the learner's ability level by using Item Response Theory based updating algorithms. If the ability estimate diverges from the ability estimation used by the scheduling algorithm resulting from the learning model, the schedule can be updated or regenerated.

3 Conclusion

We presented our learning item sequencing problem and explained a high-level two stage approach to find a solution. Future work involves the design and implementation of appropriate heuristic combinatorial solution methodologies for both stages.

References

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