On Providing Automated Support to Students Based on Their Personal Preferences

Sylvia Encheva

**Faculty of Technology, Business and Maritime Educatuion, Stord/Haugesund University College
Haugesund, 5528, Norway**

Abstract

Students are often suggested to provide feedback to teachers on lectures, learning materials and tests among other things. While such information can considerably improve the learning process it is necessary to find an effective way to obtain feedback and at the same time decrease the amount of time students use to deliver it. This article is a step towards extracting maximal knowledge with minimal efforts.

Keywords: *Decision support services, orderings, response clustering, help functions.*

1. Introduction

Intelligent tutoring systems as such are meant to enable, support and improve students' knowledge and skills. One of the important tasks of an intelligent tutoring system is to provide automated help to students while they solve problems without presence of a human tutor. In order to improve the efficacy of such a system students' opinions are usually collected, analysed and incorporated into the system's rules. Feedback from students is daubtlesly invaluable. At the same time it is necessary to find a way for reducing the amount of feedback related work required from students since the goal is to provide the best possible learning environment and not to overloud them with requests for evaluation.

In this paper we focus on presenting an approach where information about students' preferences can be obtained when they complete one or at most two comparisons of two items (sometimes refered to as elements) at a time. To the rest of this work we will often use 'elements' instead of 'items'. This is in a way more appropriate for application of set theory methods where the convention is to speak about elements of a set.

The initial set of elements that are under consideration in our case contains four elements. They are placed in two sets of two elements each according to a subject's presentation flow. A distinct advantage of such representations of orderings is the opportunity to accommodate information obtained from one comparison as well as from two comparisons. Feedback is usually incomplete since users are free to deliver partial information and this approach incorporates all the data users are willing to provide.

Rules from partialy ordered sets theory [7] are employed for handling orderings resulting from students feedback.

The rest of the paper is organised as follows. Section 2 contains definitions of terms used later on. Section 3 presents the main results of this article. Section 4 contains the conclusion of this work.

2. Background

A quasiordered set is a set with a reflexive and transitiverelation $\leq$. An equivalence relation $\equiv$ on a quasiorderedset $\mathsf{P} = (P, \leq)$ is defined by

$$x \equiv y :\Leftrightarrow x \leq y \;\; and \;\; y \leq x.$$

A relation defined by $[x]_{\equiv} ([y]_{\equiv} :\Leftrightarrow x \leq y,$ is an order relation on the set of all $\equiv$-equivalence classes. The poset $\mathsf{P}^{å} := (P/\equiv, ()$ is called the factor poset of the quasiordered set P.

The cardinal sum of two disjoint quasiordered sets $(P, \leq_P)$ and $(Q, \leq_Q)$ is the quasiordered set $(P, \leq_P) + (Q, \leq_Q) := (P \cup Q, \leq_P \cup \leq_Q)$.

A pair (R, S) where $R \subseteq P \times Q$ and $S \subseteq Q \times P$ is called a merging of the disjoint quasiordered sets $(P, \leq_P)$ and $(Q, \leq_Q)$ if the relation $\leq_{R,S} := \{\leq_P, \leq_Q, R, S\}$ is a quasiorder on $P \cup Q$. A merging (R, S) is called proper if $R \cap S^{-1}$ is empty. For more details on quasiordered sets see [5] and [7].

Co-adaptation between technologies and human learning was the main theme of [10]. Two specific challenges are pointed there, one is technical and is formulated as 'unprecedented speed of innovation in Information and Communication Technologies', where the other one is educational. The latter one refers to 'the impact of ICT innovation onto unexpected changes in human practices in any domain including learning, modifying substantially the classical human learning cycle that since the nineteenth century was mainly centered on formal teaching institutions such as the schools'.

Learning materials can be evaluated applying f. ex. majority voting [3], fuzzy logics [8] and grey theory [6]. Hints delivering and computer supported learning has been discussed in [1], [2], [4], [11], [12], [13], and [14].

3. Our Approach

Providing automated support to students via an intelligent tutoring system works much more effectively when help functions are adjusted to individual needs. This is challenging both pedagogically and technically. On the one hand there are no two students with the same needs and on the other hand developing a set of rules that can cover all eventualities in a learning process is practically not feasable. If all eventualities are not known before hand and they are most certainly not how can then anyone create a complete system of rules to support these eventualities?

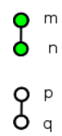

Fig. 1 Two couples of ordered elements.

We propose use of four help functions (elements) divided in two sets with two elements in each set, i. e. (*m*, *n*) and (*p*, *q*), Fig. 1. To facilitate a better visualization one of the sets is represented with shaded points and the other without shaded points. Two elements in a set appear in a particular order because they address two problems that come in a consecutive order in a topic presentation flow. All the initial work related to these elements is done by the content developer where she usually relies on her own perceptions of the learning process. Students' opinions, however, might differ quite a lot from developer's way of looking at the situation. It is important to keep in mind that students are the ones who actually benefit from these help functions. Therefore by incorporating their opinions with modifying both content and ordering of these functions, the developer can provide automated assistance that is tailored to students' needs.

Since with respect to comparisons humans are most accurate when they compare two items at a time, students are suggested to compare two elements in relation to their usefulness. The obtained information is used for further tuning of the provided automated support.

The ordering in Fig. 2 is obtained after ranking element *n* above element *p*. In practice it means that the set (*m*, *n*) should be suggested first on a student request. When some individuals are not satisfied with the help provided by the set (*m, n*) they can be offered to work with the set (*p, q*). Other forms of students tutor interactions are recommended in case the automated help appears to be insufficient.

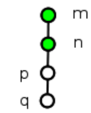

Fig. 2 Ordering as a result of comparing elements *n* and *p*.

The ordering in Fig. 3 is obtained after ranking element *q* above element *m*. It is interesting to find out why students point to the ordering in Fig. 3 or to the ordering in Fig. 2. Could it be that one of them is definitely better than the other or groups of students with similar background express similar preferences?

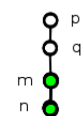

Fig. 3 Ordering as a result of comparing elements *q* and *m*.

Orderings of the four elements after students making one comparison or two comparisons can be seen in Fig. 4 and Fig. 5 respectively. A closer look at clusterings of students' opinions around either of the comparisons could provide useful information for further impruvement of the reasoning applied to automated hints delivering.

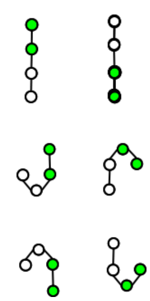

Fig. 4 Orderings as a result of one comparison.

Questions like what causes the reverse ordering can be asked for the last two couples of orderings shown in Fig. 4. Another way to explore students responses is to look at which groups of students prefer rankings from f.ex. two different couples, see f. ex. Fig. 4 where different rankings are placed on different rows.

The cases with two comparisons illustrated in Fig. 5 can be analysed in a similar way like the cases with one comparison.

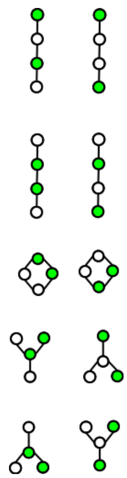

Fig. 5 Orderings as a result of two comparisons.

A summary for all comparisons based on applying rules from quasiordered sets is presented in Fig. 6.

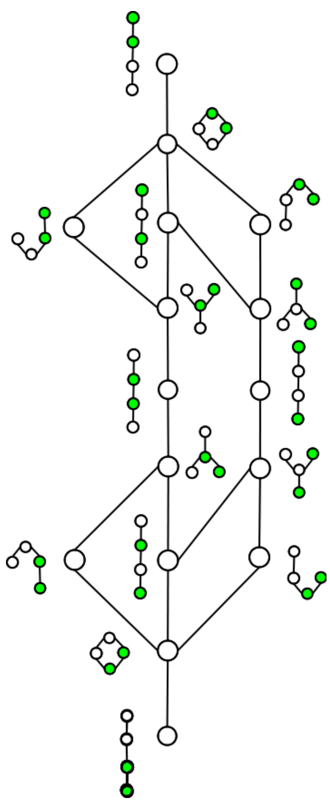

Fig. 6 A summary for all comparisons.

Two ordering are connected by a line if one of them can be obtained by adding or removing one ordering only. Here it is useful to pay attention to which kind of students express preferences to orderings connected by a direct line. Are they students with similar background, similar test results or similar exam results? How about the role of gender representation, any real evidence of differences or just a myth?

A considerably different way of using the graphical representation of orderings in Fig. 6 is to look at group preferences. This can be done by f. ex. placing students in groups according to their midterm tests and then investigate whether their preferences form some clusters. It is also important to know whether two groups of students who differ slightly in their tests performance also differ slightly in their preferences or the orderings they like are very far from one another.

More often than not a group of students working together express similar preferences regardless their personal levels of knowledge. This phenomenon can effect cluster formations. Additional work is needed to neutralize the effect of group influence on individual preferences in the process of pattern recognition.

Once the final exam is over it is a good idea to compare final grades of students and types of rankings they have made. Is there a clear correlation between learning and some of the provided help?

4. Conclusions

Feedback from students is often obtained via questionnaires and student group interviews. Since the main goal of a teaching process is to facilitate students learning there is an obvious need to reduce the amount of time and efforts students spend on evaluating various parts of subject's delivery. In this work we presented an approach for obtaining information about ranking of four learning units where students perform at most two comparisons.

Most of the time students provide incomplete data with respect to evaluation of learning materials. Additional work is needed in order to extend the cases where incomplete feedback can still be used for improving of various learning processes.

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Sylvia Encheva is professor in mathematics and informatics at Stord/Haugesund University College. Her research interests are within decision support systems, non-classical logics, and fuzzy systems.