Local and Overall Similarities in Educational Design

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Abstract

Increased rate of exam failure in mathematics is observed at many educational institutions in the last years. Various approaches have been applied to resolve that problem. Some of them like e-learning methodologies and intelligent tutoring systems are more technologically oriented while others focus on face to face communications and group study techniques. In this work we consider a way to adjust teaching set up by involving students' recommendations and requests in the educational design. Increased rate of exam failure in mathematics is observed at many educational institutions in the last years. Various approaches have been applied to resolve that problem. Some of them like e-learning methodologies and intelligent tutoring systems are more technologically oriented while others focus on face to face communications and group study techniques. In this work we consider a way to adjust teaching set up by involving students' recommendations and requests in the educational design.

Keywords: *Similarities, Education, Design.*

1. Introduction

Students problems related to studying mathematics have been discussed by both educators and researchers for more than a century [14] and [15]. More recently formulated external and internal reasons are listed in [12] and [13]. The former refer to lack of human and material resources, poor teachers, poor teaching methods, etc. and the latter points to laziness, lack of interest and absenteeism. Educators are also seriously concerned about students' lack of conceptual understanding and their inability to master a number of objectives while a curriculum moves quickly away. It is necessary to keep in mind that "our schools have failed to produce mathematically literate citizens that can function well with quantitative acumen", [6].

Introducing radical changes in education is difficult for many reasons, but a redesign of curriculum is within the reach even of single educator. In this work we suggest use of distances as in extension theory to settle collisions of students opinions based on kansei engineering, [10]. Local similarity as well as overall similarity are to be applied for placing students recommendations and requests in a set with others or in a separate set indicating exceptions. In [16] weights in overall similarity are calculated applying Analytical Hierarchy Process (AHP), [8], and [9]. The AHP however has received serious critics related to rank reversal, i.e. changes in the ranks of the alternatives, upon changing the structure of the decision, [5]. To avoid rank reversal in the process of establishing weights values we suggest using experts' opinions instead of AHP.

The rest of the paper goes as follows. Related work is presented in Section 2. The current approach takes place in Section 3. The paper ends with a conclusion in Section 4.

2. Related Work

The concept of side-distance including left and right side-distance in extension theory is introduced [2] and improved in [16]. Left and right side-distances are as in [16].

A local similarity between customers' requirements and a product, addressing a single attribute of that product is defined as:

$$sim(A,B)=1-|d(A,B)|$$

where A and B represent numerical or interval values. The global similarity combines all local similarities

$$sim(R,E_i)=\sum_{j=1}^{m} w_j\, sim(R_i,E_i), j=1,2,\ldots,m, j=1,2,\ldots,n$$

where R stands for customer requirements and $sim(R_i,E_i)$ is the similarity of any attribute value between any product E_i case and customer performance requirements R, and the wights w_j are defined by experts.

Kansei engineering is as a method to translate the (measured) kansei of users (also described as the user's subjective impression into a design, [11]. Kansei engineering aims at aligning design details in relation to a user's kansei in order to determine and evaluate new design solutions, [4].

A lattice is a partially ordered set, closed under least upper and greatest lower bounds. The least upper bound of *x* and y is called the join of *x* and *y*, and is sometimes written as *x*+*y*; the greatest lower bound is called the meet and is sometimes written as $\dot{x}y$, [3].

The semantic characterization of a four-valued logic for expressing practical deductive processes has been developed, [1]. In most information systems the management of databases is not considered to include neither explicit nor hidden inconsistencies. In real life situation information often come from different contradicting sources. Thus different sources can provide inconsistent data while deductive reasoning may result in hidden inconsistencies. The idea in Belnap's approach is to develop a logic that can handle some inconsistencies. The Belnap's logic has four truth values 'T, F, Both, None'. The meaning of these values can be described as follows:

- an atomic sentence is stated to be true only (T),
- an atomic sentence is stated to be false only (F),
- an atomic sentence is stated to be both true and false, for instance, by different sources, or in different points of time (Both), and
- an atomic sentences status is unknown. That is, neither true, nor false (None).

For other many valued logics see [7].

3. Incorporating Different Opinions

Students opinions based on kansei engineering are to be collected first.

Opinions are expressed applying five points Likert scale with the following numerical values:

5 - satisfied,
4 - somewhat satisfied,
3 - neutral,
2 - somewhat dissatisfied,
1 - dissatisfied.

In this work students final grades are following the European Credit Transfer and Accumulation System (ECTS), where A stands for excellent, B for very good, C for good, D for satisfactory, E for sufficient, and F for fail. We propose use of an interval instead. One of the end points represents satisfaction level of students with grades A and B while the other end point represents satisfaction level of students with grades C, D and E.

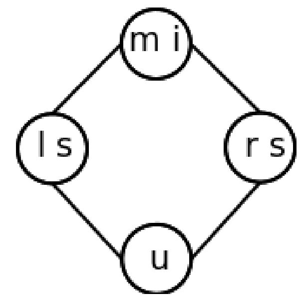

Fig. 1 Four nodes lattice

Each student's kansei about an educational setting is later on placed in a lattice with four nodes, Fig. 1. The top node contains users expressing opinions within the main interval (m i), the two nodes below contain users expressing opinions placed respectively on the left sid(l s) and on the right side of the interval (r s), while the lower node contains users who provided incomplete responses (i), Fig. 2. The main interval is constituted by opinions of students who have passed their final exam.

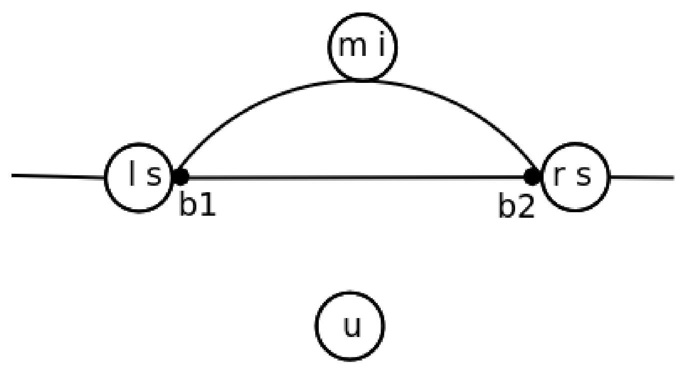

Fig. 2 Four nodes lattice with the main interval values

Local and overall similarities are applied to facilitate the process of placing users in appropriate nodes. In accordance with extension theory local similarities are used while discussing satisfaction level with a single topic presentation or a type of learning material and overall similarity is used for considering a subject as a whole.

A number of important questions can be asked once students who failed their exam are placed in the four nodes of the lattice in Fig. 1. Consider the group in the top node. If their perceptions are similar to the ones who pass then the reason to fail might be outside of the subject set up, like for example lack of preliminary knowledge and insufficient amount of efforts devoted to the current study. In case they belong to the right lower node one can assume that some personal reasons contributed for their poor performance. The most interesting group is the one placed in the left side lower node. Their opinions can help to identify which parts of the study should be reconsidered in order to improve satisfaction and learning. The remaining group is not very likely to be informative due to missing responses. At the same time their opinions should also be taken into account because they might point to particular places that are in need of improvement. We have to keep in mind that some students prefer omitting answering if they feel uncertain.

Thus obtained results can be used to compare satisfaction level with performance outcomes and answer questions like: How is dissatisfaction related to failure rate? What can be done to improve it?

For further mathematical operations with elements placed in the nodes of the lattice in Fig. 1 we suggest four valued logic, [1].

4. Conclusion and Future Work

Different reasons for exam failure have been identified through the years. If one refers to f. ex. possible misalignment between exam questions and curriculum then this can be easily avoided next time. When however it comes to experiencing serious difficulties in building students conceptual understanding it is much more difficult to find an appropriate solution. Incorporating students' requests and recommendations into teaching materials will also contribute for a higher level of mathematical literacy. Selection of constructive students' requests is a complicated decision processes. The latter can be automated by involvement of lattices and many valued logics.

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