World Academy of Science, Engineering and Technology
International Journal of Educational and Pedagogical Sciences
Vol:14, No:12, 2020

Evaluation of the Effect of Learning Disabilities and Accommodations on the Prediction of the Exam Performance: Ordinal Decision-Tree Algorithm

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Abstract : Providing students with learning disabilities (LD) with extra time to grant them equal access to the exam is a necessary but insufficient condition to compensate for their LD; there should also be a clear indication that the additional time was actually used. For example, if students with LD use more time than students without LD and yet receive lower grades, this may indicate that a different accommodation is required. If they achieve higher grades but use the same amount of time, then the effectiveness of the accommodation has not been demonstrated. The main goal of this study is to evaluate the effect of including parameters related to LD and extended exam time, along with other commonly-used characteristics (e.g., student background and ability measures such as high-school grades), on the ability of ordinal decision-tree algorithms to predict exam performance. We use naturally-occurring data collected from hundreds of undergraduate engineering students. The sub-goals are i) to examine the improvement in prediction accuracy when the indicator of exam performance includes 'actual time used' in addition to the conventional indicator (exam grade) employed in most research; ii) to explore the effectiveness of extended exam time on exam performance for different courses and for LD students with different profiles (i.e., sets of characteristics). This is achieved by using the patterns (i.e., subgroups) generated by the algorithms to identify pairs of subgroups that differ in just one characteristic (e.g., course or type of LD) but have different outcomes in terms of exam performance (grade and time used). Since grade and time used to exhibit an ordering form, we propose a method based on ordinal decision-trees, which applies a weighted information-gain ratio (WIGR) measure for selecting the classifying attributes. Unlike other known ordinal algorithms, our method does not assume monotonicity in the data. The proposed WIGR is an extension of an information-theoretic measure, in the sense that it adjusts to the case of an ordinal target and takes into account the error severity between two different target classes. Specifically, we use ordinal C4.5, random-forest, and AdaBoost algorithms, as well as an ensemble technique composed of ordinal and non-ordinal classifiers. Firstly, we find that the inclusion of LD and extended exam-time parameters improves prediction of exam performance (compared to specifications of the algorithms that do not include these variables). Secondly, when the indicator of exam performance includes 'actual time used' together with grade (as opposed to grade only), the prediction accuracy improves. Thirdly, our subgroup analyses show clear differences in the effect of extended exam time on exam performance among different courses and different student profiles. From a methodological perspective, we find that the ordinal decision-tree based algorithms outperform their conventional, non-ordinal counterparts. Further, we demonstrate that the ensemble-based approach leverages the strengths of each type of classifier (ordinal and non-ordinal) and yields better performance than each classifier individually.

Keywords : actual exam time usage, ensemble learning, learning disabilities, ordinal classification, time extension
Conference Title : ICEDM 2020 : International Conference on Educational Data Mining
Conference Location : London, United Kingdom
Conference Dates : December 10-11, 2020