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MŰEGYETEM 1782

Discrete Bayesian Networks and their application in educational setting

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The main contribution of this work is that we apply Bayesian Networks in the traditional educational setting, aiming to support students and decision-makers to increase the success rate of students in their early academic years. Furthermore, we give a thorough description of the applied algorithms and we also point out some limitations of this modeling approach.

In the first section, we give an overview of the history and general literature of Bayesian Networks. Next, we describe relevant probability and graph theory components, introduce Bayesian Networks, and outline how they simplify the joint probability distribution of random variables. We show how they can reveal dependencies between variables, and we give a detailed description of some of the most important structure and parameter learning algorithms.

In the application section, we want to identify key features of academic performance and use these to predict the results of students in higher education. We demonstrate the applicability of Bayesian Networks in the educational domain both based on recent literature and based on the academic data of students from the Mechanical Engineering Bachelors program of the Budapest University of Technology and Economics.

We describe the properties of the dataset and we use a variety of techniques to overcome the difficulties presented by the incomplete data and the computational difficulty of learning Bayesian Networks. We separate variables into three disjoint sets based on their time of availability: pre-enrollment achievements, first- and second-semester subject results. We use a Bayesian Network based iterative technique to impute some of the missing data, and we build networks on natural subsets of the full dataset.

We describe several evaluation methods for model complexity and predictive performance, calculate F1 scores for our networks, and analyze the constructed models' underlying graph structures. We draw conclusions from the received results and compare the structures of networks created on different sets of variables. We briefly mention some options for how this research can be expanded.