PREDICTION OF COLOMBIAN STUDENTS' ACADEMIC SUCCESS USING DECISION TREES ALGORITHMS

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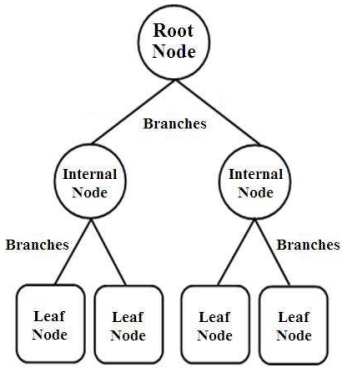
ABSTRACT

The paper uses a decision trees algorithm to predict the performance of Colombians' in the Saber Pro national standardized test based on data from their Saber 11. All this to identify which variables are influential in students' academic success and conclude about Colombia's education system.

1. INTRODUCTION

Colombia's Ministry of Education has established several standardized tests that are taken by students from different age ranges throughout the whole country. During his/her academic life, a Colombian student must undergo three different standardized exams: "Pruebas Saber" performed by students in fifth and ninth grade, "Prueba saber 11" also known as "ICFES" carried out by students in eleventh grade or their last year of high school, and finally "ECAES" or "Prueba Saber Pro" which focuses in the field of study of university students who are about to finish their professional career. These exams allow the government to easily identify strengths, weaknesses, and progress within the education system.[1]

A decision tree is a technique used in programming to separate observations in a specific problem. It classifies each element of the observation in different branches depending on the attribute in question. The process of classifying is repeated with the remaining attributes using the algorithm of recursion. This technique constructs a tree made up of nodes and branches. Nodes are the points in the diagram where the pathways branch and are subdivided into three different types: the root node, the internal nodes, and the leaf nodes. The root node is the initial node placed on the top of the diagram and is the origin of all ramifications. The internal nodes are all the nodes inside the diagram, that is to say, all the nodes that come from the root node and lead to other nodes. The leaf nodes are the nodes at the end of the diagram, these are the ones that output the prediction of the results. [2]



(a)

[9]

Each node has a variable that is compared to the dataset using a separation algorithm. The number of branches that fall of each node depends on the separation algorithm used and the variables selected. [2]

The decision tree method was chosen over other techniques such as neural networks because it is more practical, agile in terms of processing time, and has a higher accuracy predicting results for academic success. [4]

2. PROBLEM

The main purpose of this project is to predict whether a student will be successful in the exam "Saber Pro" or not. For the development of the project, academic success was defined as obtaining a score that is above the average score of the student's respective cohort. To get a prediction that resembles reality, data from the exam "Prueba saber 11" has been collected providing information

regarding the individuals' social, economic and academic context, in addition to the score obtained in this previous exam.

3. RELATED WORK

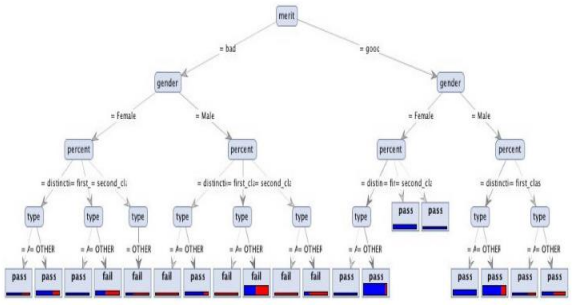
3.1. ID3

ID3 is an algorithm invented by Ross Quinlan. It produces a decision through the construction of a decision tree that classifies each tuple in the database. ID3 is commonly applied in problems related to machine learning and processing of natural language. [3]

Firstly, the algorithm calculates the entropy of every attribute of the dataset. Then, it splits the set into subsets using the attribute with maximum information gain (minimal entropy). Next, it makes a decision tree node containing that attribute. Finally, it recurses on subsets using the remaining attributes. [8]

The study conducted by Adhatrao, Gaykar, Dhawan, Jha, and Honrao (2013) [3], whose objective was to predict the general and singular performance in future academics of enrolled students, developed prediction systems using decision trees.

The researchers used a training dataset consisting of information about the admitted students' background and percentage marks obtained in their board examinations. The relevant information was fed into the database and then ID3 was applied to the training data, resulting in the following decision tree.



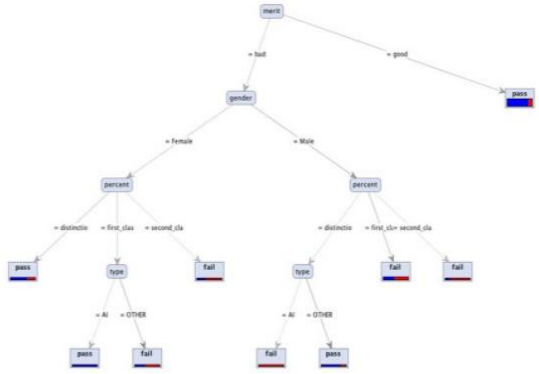
[3]

3.2. C4.5

It is an improved version of the ID3 algorithm. This statistical classifier handles training data with missing values and attributes with discrete and continuous values. Furthermore, it prunes unnecessary branches of the decision tree after its construction. [3]

C4.5 selects the attribute that splits the data in the most effective way to classify each sample into one class or the other. Next, the algorithm makes the decision taking into account the attribute with the highest information gain, and then repeats this process in a recursive way. Finally, it prunes the tree. [5]

Adhatrao, Gaykar, Dhawan, Jha, and Honrao (2013) [3] also used this algorithm to solve the problem mentioned above. The same training data was used, but this time it was applied to C4.5. This new tree had fewer decision nodes. However, both algorithms had the same effectiveness (75.145%).



[3]

3.3. C5

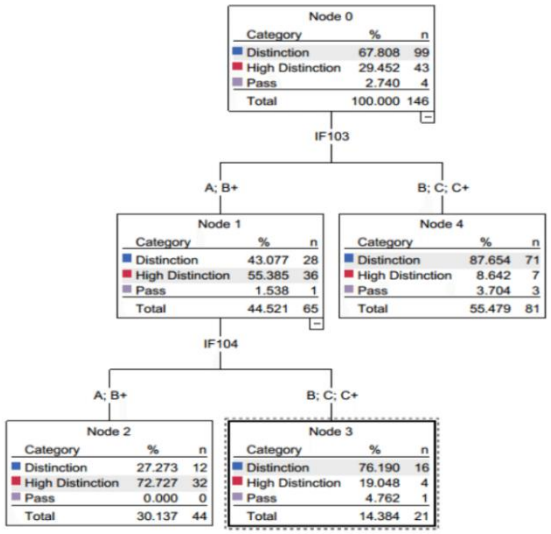
C5 is an extension of C4.5. This updated version produces tree models that are easily transformed into mathematical expressions and less biased, more understandable outputs, making it one of the best options for the solution of machine learning related problems. [6]

Sena and Ucarb (2012) conducted a study that used data from 3047 records taken by Karabük University Computer Engineering Department. The dataset included students' background information and whether the students studying in distance education or regular education. C5 algorithm and neural networks were used to compare the achievements of Computer Engineering Department students in Karabük University based on the given data. The decision tree was the most accurate algorithm, with 97.8107% of precision on 10 fold holdout dataset. [4]

3.4. CART

CART stands for Classification and Regression Trees. It is a non-parametric statistical method for multivariable data that uses binomial splits to correctly classify members of the population. Each variable is analyzed and split for sensitivity and specificity in the classification. Then, the resulting tree is pruned to minimize its size and inaccuracy rate. [6]

Kasih, Ayub, and Susanto (2013) [7] did a work aimed to help the academic advisors by predicting alumni's final results. The study used academic transcripts from 146 students as input data and used the CART algorithm, which produced the following tree.



[7]

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