Communication and Applied Technologies
Proceedings of ICOMTA 2022
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Preface

This book is composed of the papers written in English and accepted for presentation and discussion at the 2022 International Conference on Communication and Applied Technologies (ICOMTA’22). This conference had the support of the Universidad del Rosario (Bogota, Colombia), Universidad Politécnica Salesiana (Cuenca, Ecuador), Universidade de Vigo (Galicia, Spain), Universidade de Santiago de Compostela- Equipo de Investigaciones Políticas (Galicia, Spain), Red Internacional de Gestión de la Comunicación (XESCOM), Red de Investigadores en Comunicación de Ecuador (RICE), Observatorio Interuniversitario de Medios Ecuatorianos (OIME), Universidad San Francisco de Quito (Ecuador), Universidad Técnica Particular de Loja (Ecuador), Universidad Tecnológica Equinoccial (Ecuador) and Universidad Técnica del Cotopaxi (Ecuador). It will take place at Cuenca, Ecuador, during September 7–9, 2022.

The 2022 International Conference on Communication and Applied Technologies (ICOMTA’22), in its second edition called “Information ecology in the network society,” invites all those within the scientific, academic and professional communities to present and discuss the latest innovations, results, experiences and concerns in the various fields of communication and technologies related to it.

The Program Committee of ICOMTA’22 was composed of a multidisciplinary group of 112 experts and those who are intimately concerned with communication and technologies. They have had the responsibility for evaluating, in a “double-blind review” process, the papers received for each of the main themes proposed for the conference: (A) Digital communication and processes; (B) Communication, health, politics and technology. The other pandemic: disinformation in the age of coronavirus. Automation, bots and algorithms; (C) Fact-checking experiences in Europe and Latin America at the service of journalism: a comparative perspective; (D) Persuasion and emotion: language and content analysis, and artificial intelligence; (E) Freedom of speech, ethics and transparency in digital society; (F) Digital social media; (G) Software, big data, data mining and intelligent systems; (H) Innovation, university and technology; (I) Miscellaneous (journalism, communication, advertising and public relations, political science and other aspects of social and human sciences derived from the information and communication technologies).
ICOMTA’22 received 194 contributions from 14 countries around the world. The papers written in English and accepted for presentation and discussion at the conference will be published by Springer (this book) and will be submitted for indexing by ISI, Ei Compendex, Scopus, DBLP and/or Google Scholar, among others.

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Part I

Digital Communication, Systems and Processes
Chapter 1  
Support System to Predict Student Dropout in Universities

D. Rivero-Albarrán, L. Guerra Torrealba, S. Arciniegas Aguirre, and Ortiz Alexander

Abstract  The objective of this research was to provide a prediction system for the possibility of student dropout at the Pontificia Universidad Católica del Ecuador Sede Ibarra. It is applied research with a mixed approach. It was developed in two phases. In the first phase, the KDD methodology and the Scikit-Learn tool were applied to select the best prediction algorithm (KNN, Decision Tree, Random Forest, SVM, and Neural Network). In the second phase, the information system was built to make use of the model obtained in the first phase, where users will be able to consult the possibility of risks of academic dropout of students. Technologies such as Django, Python, HTML, JavaScript, and MySQL, among others, were used in this study. The results show an information system that allows consultation by the student, by the level of schooling, or by subject, based on neural networks that provide an accuracy of 92%.

1.1 Introduction

Student desertion is understood as the definitive and voluntary abandonment of academic training, and it is a complex problem that affects universities worldwide. [1–3]. This causes economic costs to the country, the educational institution, the
family, low graduation rate, loss of prestige of the institution, and emotional problems of the student, which in some cases, prevent them from returning to studies, increasing the inequality gap in the country [4].

Student desertion is determined by several factors; for Tinto [5], the success of a student is given by their degree of integration in the academic and social environment, which contributes to a higher degree of institutional commitment. This directly affects whether the student stays or drops out of their studies. According to Bean and Metzner [6], external factors such as the family, and stress, among others, are determining elements in the permanence of the student. For Bethencourt et al. [7], the psychological characteristics of the student, the teaching staff, and the efforts made by the student to finish the degree, as well as the study strategies and activities, are the factors that determine the permanence of the student. These elements are not exclusive, but rather complementary. Therefore, they can be grouped into five aspects: psycho-pedagogical, economic, institutional, family, and social.

Student desertion hinders the correct articulation between the educational system of a nation with the development of its society. This coordination seeks to improve the quality of life of its inhabitants through adequate technological and scientific development, which can only be achieved with a quality education. In Latin America, the dropout rate varies between 8 and 26%. In Colombia, for example, studies have shown that university dropout after using strategies to reduce this rate is 9.3% [8]. In Chile, the dropout rate stands at 25% [9]. In Mexico, university student desertion (high school) is located at 14%, while in higher education in 8.2% [10]. In Peru, the rate is 10.2% [4], and in Ecuador, the student dropout rate in the first semesters is 26%, data reported by the Ministry of Higher Education, Science, Technology and Innovation [11].

Quality as a process is measurable, and for this, the organizations responsible for its evaluation, such as the dependencies of the Ministry of Education, define a set of indicators such as the climate of school coexistence, school attendance, gender equity, average schooling age, school retention, and technical–professional qualification. The retention rate assesses the level of permanence of enrolled students and indirectly the rate of student dropout. To improve this indicator, higher education institutes have designed strategies, such as early warning systems for dropouts (EWS for its acronym of English), systems to predict abandonment continuous accompaniment, and academic follow-ups in order to create conditions where students can increase their self-esteem and self-worth, among others. All to ensure that student enrollment is maintained until the successful completion of their studies [9–12].

Warning and predictive systems are used to identify students with the possibility of leaving school early [10]. Statistical or mathematical models are used to identify them, based on a set of characteristics. These systems allow those responsible for student monitoring and well-being to take initial action to reduce the dropout rate.

Currently, higher education institutions have automated systems that support educational processes, such as e-learning, administrative systems, student registration, academic monitoring, and Web-based teaching systems, among others, which generate a great amount of data, which with exponential growth, it can be transformed into new knowledge that can benefit students, teachers, and administrators.
However, for its analysis, it is necessary to have tools that automatically analyze this type of data, to find behavior patterns. Two different trends have been developed in this field: Education Data Mining (EDM), used to respond to issues related to educational processes, and Learning Analytics (LA) focused on understanding and optimizing teaching processes [13].

In the field of EDM, different predictive models have been used to identify the population at risk of desertion. Martínez and Mateus [14] used a set of data of a social, academic, personal, labor type, income to e-learning platforms, etc. To train a Supervised Regression deep learning model, Márquez-Vera et al. [10] used a genetic algorithm based on Grammar-Based Genetic Programming (GBGP), a grammar was defined, and an evolutionary process was developed, where each generated individual had to comply with the rules of the grammar. Data from students from the first semester were used. This is based on the fact that several studies have shown that it is at this stage that there are more cases of abandonment. The program was executed in different stages, before the beginning of the semester, at the beginning of the semester, mid-semester, and at the end of it. The algorithm was compared with some classification methods (C45-CS, SVM-SMOTE, Naive Bayes, among others), obtaining better results in the predictions of the first stages.

Lopez et al. [15] present a list of the data mining methods used for the development of EDW together with the number of works that have used them; in this, it is observed that decision trees (J48), Random Forest, Support Vector Machines, Naive Bayes, and logistic regression are the most used methods. Regarding accuracy, it was obtained that Random Forest had an accuracy of 96.1%, 96.2% accuracy with linear regression, 82% accuracy with decision trees (J48) and 92.6% accuracy with logistic regression.

Under this order of ideas, in this study, the objective was to develop an information system to predict which students are at risk of desertion, at the Pontifical Catholic University of Ecuador, Ibarra (PUCE-SI), so that the institution could make a correct student follow-up and take actions before events of this type occur.

The rest of the work is organized as follows: In Sect. 1.2, the data and methodology used for the development of the system are presented. In Sect. 1.3, the results are presented, and finally, the conclusions derived from this work are given.

### 1.2 Materials and Methods

The research is of an applied practical type and was divided into two phases: In the first, called the data analytics phase, the data mining method predicted, with greater precision, whether a student was at risk of dropping out; and in the second phase, the functionalities of the system were defined, and the tool was developed.
1.2.1 Data Analytics Phase

For this phase, the methodology Discovery in Databases (KDD) [16] was used. The processes to follow are data selection, data processing and transformation, and data mining. They are selected, and the algorithms of the data mining methods are developed and trained, and finally, the evaluation of the methods. These processes are described below.

1.2.1.1 Data Selection

To identify students who remain or are not within a higher education institution, three factors were defined: personal-cognitive, socioeconomic, and academic-organizational. For each factor, the characteristics that describe it were selected.

Table 1.1 shows the characteristics of the organizational academic profile, Table 1.2 shows the characteristics of the personal-cognitive factors, and Table 1.3 shows the characteristics of socioeconomic factors.

These characteristics are distributed in the databases of the institution’s academic, new entry registration, and student welfare systems. For this reason, a procedure was created to generate the objective table with the data associated with the characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission examination note</td>
<td>University entrance note</td>
<td>Numeric</td>
</tr>
<tr>
<td>Average bachelor</td>
<td>Average high school grade</td>
<td>Numeric</td>
</tr>
<tr>
<td>Semester subjects</td>
<td>Number of semester subjects</td>
<td>Discrete (1–6)</td>
</tr>
<tr>
<td>Unapproved subjects</td>
<td>Number of subjects is unapproved status</td>
<td>Discrete (0–6)</td>
</tr>
<tr>
<td>Average semester grades</td>
<td>Average grade of the semester up to that moment</td>
<td>Numeric</td>
</tr>
<tr>
<td>Attendance</td>
<td>Value according to range of assists</td>
<td>Categorical</td>
</tr>
</tbody>
</table>

Table 1.2 Characteristics selected for the personal-cognitive factors

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Student’s age</td>
<td>Numeric</td>
</tr>
<tr>
<td>Gender</td>
<td>Student’s gender</td>
<td>Categorical</td>
</tr>
<tr>
<td>School of origin</td>
<td>School where he graduated from high school</td>
<td>Discrete</td>
</tr>
<tr>
<td>Migrant</td>
<td>The student is an immigrant</td>
<td>Categorical</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Student’s ethnicity</td>
<td>Categorical</td>
</tr>
<tr>
<td>Disability</td>
<td>Value according to range of assists</td>
<td>Categorical</td>
</tr>
<tr>
<td>Parent studies</td>
<td>Educational level of the parents</td>
<td>Categorical</td>
</tr>
<tr>
<td>Type of housing</td>
<td>The student lives with his family, with classmates, and alone</td>
<td>Categorical</td>
</tr>
</tbody>
</table>
of the three factors. Each row of the table (sample) contains the data of a student plus an additional field (label) called dropout, discreet type, with values 1 to indicate that they dropped out of school and 0 that they remain enrolled.

1.2.1.2 Data Processing and Transformation

The generated table can bring erroneous, missing data, with values in very wide ranges that affect the models; therefore, they must be cleaned and transformed. First, the missing or erroneous data were treated, where the mean technique was used. This technique replaces the data with the mean obtained from all the valid data of these characteristics.

The objective table presented an imbalance of the classes, that is, the majority class. Class with label 0 contains 75% of the data, which caused the mining methods not to recognize the patterns of the minority classes. In this case, the algorithms of classification would tend to classify them within the majority class, ignoring the minority class. Therefore, to reduce the imbalance, a set of fictitious records with label 1 were randomly generated.

In addition, the numerical type characteristics were normalized as family income, since their range of values was very wide. Also, the categorical type characteristics were transformed into number data, since these are used in most data mining methods.

1.2.1.3 Data Mining

Based on previous works [9–11, 15], it was decided to use a supervised classification model and five methods were chosen: KNN, Decision Trees, Random Forest, Support Vector Machines (SVM), and Networks. Neuronal (NN). The predictive analysis library Scikit-Learn [17] was used. For the training of the methods, the objective table was divided into two tables: the training table and the testing table with 60% and 40% of the data, respectively.
Table 1.4  Method results with test data

<table>
<thead>
<tr>
<th>Method</th>
<th>Accuracy</th>
<th>Precision</th>
<th>Sensitivity</th>
<th>F1-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>KNN</td>
<td>0.77</td>
<td>0.78</td>
<td>0.95</td>
<td>0.86</td>
</tr>
<tr>
<td>Decision Tree</td>
<td>0.81</td>
<td>0.82</td>
<td>0.95</td>
<td>0.88</td>
</tr>
<tr>
<td>Random Forest</td>
<td>0.85</td>
<td>0.83</td>
<td>1.00</td>
<td>0.98</td>
</tr>
<tr>
<td>SVM</td>
<td>0.85</td>
<td>0.89</td>
<td>0.89</td>
<td>0.89</td>
</tr>
<tr>
<td>NN</td>
<td>0.92</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
</tr>
</tbody>
</table>

1.2.1.4  Model Evaluation and Selection

The model to be used in the system was selected after evaluating the behavior of each method with the test data. The confusion matrix of each one was constructed, and several metrics such as precision, accuracy, sensitivity, and F1-score were calculated. Table 1.4 shows the results obtained in each method.

Based on the results obtained in this phase, the model generated by the neural network was selected for the construction of the system.

System development phase

In this phase, the functional requirements to be implemented were specified. These were grouped into data update functions, system services, and query functions. Data updating is a fundamental function, and it is responsible for updating the tables of the system databases with the data that can be modified during the semester, such as average semester grades and the number of subjects not approved, among others.

The queries can be made during the semester. The system users are allowed to make queries about students at risk of desertion in a group form to know the list of students at risk of desertion, or individually form to know the evolution of a certain student. In addition, if the query is a group, the list can be grouped by career, subject, or semester. This query can be done online (on-screen) or on paper. Data can be presented graphically, using pie charts, or by listing each student (Fig. 1.1).

1.3  Results

The system developed to determine the possibility of a student abandoning their university studies involves two roles (user and administrator) and several modules: the user management module, where the permissions for each type of user are established, the student management module to store the data of each student that will be considered in the predictive model; and the career and subject management module, to add, and edit these attributes and the prediction module where the query can be made individually, registering the student’s ID, or in a group, selecting the students of a subject and/or a determined career.
The system services are responsible for the accessibility function and maintenance of the database consistency, that is, of the relationships between the objective table and the data of the student, careers, and subjects.

The dropout component was designed for the prediction module. The public interface contains the query methods (generalSearch, searchBySubject, searchByCourse, SearchByName), and like private method is the model loading and updating method (loadModel, updateModel). The search method is responsible for invoking the UpdateData, the component responsible for creating the objective table. The table contains the characteristics of the students according to the search criteria, Fig. 1.2 presents the system deployment diagram.

The UpdateData component is responsible for creating the objective table with the characteristics of the students according to the type of search based on the search criteria. Figure 1.3 shows the sequence diagram of the generateTable method. The dropout component orchestrates the set of methods to perform the prediction. Figure 1.4 presents the sequence of the general search method.

Finally, the Graphical User Interface (GUI) was designed and three iterations were used to build the system. The interface to carry out a query on student dropout in a group form is shown in Fig. 1.5.

1.4 Conclusions

The student dropout prediction system developed allows users to analyze the possibility of the abandonment of studies using a neural network model and making
the query in different ways such as individually, by subject, and by level; generating graphs and reports that facilitate the visualization of information. This system was validated using functional black box tests to verify its functionality, security, performance, and usability. In this way, it is proven that the use of data analytics in the educational field is relevant because it allows accurate and timely information on academic processes to make decisions that allow the sustainability of the Institutions. The proposed tool can be adapted to any university educational system since the variables can be increased, decreased, or altered depending on the data, its collection method, and the needs of each Institution. However, in subsequent studies, the collinearity of the considered characteristics that impact student dropout should
be studied in-depth to determine whether it is possible to simplify the model by combining characteristics.