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*Odessa National Academy
of Food Technologies*



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Information Technology, Automation and Robotics

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Odessa National Academy of Food Technologies, 2021

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bank payment cards in Ukraine. Bulletin of the University of Banking of the National Bank of Ukraine. № 2 (20), 141-148.

4. Національний банк України.(3 листопада 2020).Беззаперечні тренди карткового ринку у 2020 році – розрахунки в Інтернеті та безконтактні платежі. <https://bank.gov.ua/ua/news/all/bezzaperechni-trendi-kartkovogo-rinku-u-2020-rotsi-rozrahunki-v-interneti-ta-bezkontaktni-plateji>.

USE OF K-NEAREST NEIGHBOUR METHOD IN ANALYSIS OF STUDENT DATA FROM SURVEYS

Authors: *Ekaterina Konstantinova, Kamen Kalchev*

Advisor: *Tsankov Tsvetoslav*

Konstantin Preslavsky University of Shumen (Bulgaria)

Abstract. *The purpose of the publication is to analyze the method K-Nearest neighbor and its application in intelligent analysis of student survey data. Examples are given based on student success and satisfaction.*

Keywords: *Educational Data Mining, EDM, K-Nearest neighbor.*

I. INTRODUCTION

Educational Data Mining (EDM) is a new scientific branch with applications in data acquisition education. EDM is “Applying Data Mining techniques to a specific set of data obtained from educational settings to address important educational issues” [5].

The search for dependencies and connections between the data and education will lead to forecasts, evaluation of the factors related to the candidate management method, students’ success ratio, the quality of the learning process, and others [3].

The choice of the “K-Nearest neighbor” method in data analysis for students is dictated by the information of the top 10 algorithms for data extraction identified by the International Conference on Data Mining (ICDM) of the IEEE in December 2006, are C4.5 (Decision Tree), k-Means, SVM, Apriori, EM, PageRank, AdaBoost, kNN, Naive Bayes and CART [6].

II. K-NEAREST NEIGHBORS – KNN

The K-nearest neighbor algorithm is an object classification algorithm that calculates the distance between each pair of objects from the training set by using an appropriate function to measure the distance between the two points. The algorithm uses a majority vote of the k nearest neighbors of the object to classify it [1].

Function for measuring distance:

Euclidean

$$\rho(x_i, x_j) = \sqrt{\sum_{k=1}^m w_k} \quad (1)$$

where:

$x_i = (x_i^{(1)}, x_i^{(2)}, \dots, x_i^{(m)})$ – vector of m-features of the i-th object

$x_j = (x_j^{(1)}, x_j^{(2)}, \dots, x_j^{(m)})$ – vector of m-features of the j-th object

Other known functions for measuring distance between two points are: L_p – metric, L_1 – metric, L_1 – metric, Lance-Williams function.

An important question when using the k-nearest neighbor algorithm is the choice of the number K - this is the number of the nearest neighbors. Heuristic techniques, such as cross-validation, can help with obtaining the appropriate K values.

If the K value is high, the classifier is more precise and more new data sets are correctly classified, but the recognition takes a long time. In the case of a low K value, the algorithm completes fast but produces a great recognition error.

III. STUDENT DATA ANALYSIS SURVEYS

The analytical survey is one source needed for data study. The research results largely depend on it, and it is of great importance to the further stages of the data extraction process.

A variety of rules should be followed when developing surveys. The compilers of the reviews can base the questions on existing methodological research or their practical experience as specialists.

When planning questions [2], it is recommended to use understandable vocabulary, simple syntax, lack of jargon, dialects, and terms. When composing the specific questions, it is necessary to avoid complex grammatical constructions, nested sentences, negations, double negations, etc.

It is important that the inquiry is managed in an acceptable, meaningful, specific, and focused manner. The answers to the closed questions must be mutually exclusive, covering all possibilities.

When compiling a survey, an important decision to make is if the type of questions asked should contain only closed questions, only open questions, or a combination of both.

When developing surveys, compilers usually include mostly closed questions. This type of survey is faster and easier to process, and those who fill it out also prefer it.

The open questions in the surveys often give complete and reliable information. They are preferable to the closed ones when collecting quantitative measurements (number, arithmetic mean, minimum, maximum). Processing such surveys take more time, human resource, and can lead to mistakes.

The issues usually occur when the answers overestimate the information given by some respondents. The completed question with more answers may receive more weight than others who answered with one. Another problem is that respondents may miss these questions or answer "I can't answer" or "I don't know.", which lowers the chances of acquiring the data needed for the analysis.

IV. APPLICATION OF K-NEAREST NEIGHBOR IN STUDENT DATA ANALYSIS

When studying student data, it is crucial to predict the students' success and satisfaction with their studies at the University.

The classification process analyzes the influence of different input variables. They might include: high school success, year of admission, year of graduation from high school type of high school, the profile of the high school, presence or absence of entrance exam, grade from the entrance exam, total score when applying, city of residence, attendance at lectures, attendance at exercises, attendance at lectures, self-

preparation, employment, age, gender, and others [3].

The collected data is divided into a training and a test sample. The training information “trains” the test data. The cross-validation method is used to evaluate the classifier, which equates to the number of participants of each object in the training sample and exactly one participation in the test sample. The essence of the method comprises the following: all sets are divided into k parts, each appearing as a test. Here, it is necessary to choose k . According to researchers in text classification, $k = 5$ or $k = 10$ is preferred [4].

The K-Nearest neighbor method is a technique that makes the classification of new objects based on experience and includes determining the values of a variable (success, satisfaction) based on the values of predictive variables.

The application of the method consists of finding the required K number of the closest objects to the object of the unknown class using a function for measuring the distance between two objects. The definition of the required class is based on the so-called “democratic principle”, i.e. the class received the most votes.

The classification quality can be evaluated through selected assessment measures: accuracy, error, precision, sensitivity, and others.

V. CONCLUSION

The application of intelligent data analysis in the field of higher education in predicting student achievement and satisfaction can help various problems, such as reducing the dropout rate, providing additional help to needy students, predicting enrollment of students in certain specialties, marketing, and management of candidate-student campaigns, improving the functioning of universities and others.

VI. REFERENCES

- [1. Arabadzieva-Kalcheva N. A. Comparative Analysis of Algorithms for Classification of Text in the Bulgarian Language in Machine Learning. // International Conference “Applied Computer Technologies” ACT 2018 – Ohrid, Macedonia, ISBN 978-608-66225-0-3, S. 6-11.](#)
- [2. Fowler F. Jr. Improving Survey Questions: Design and Evaluation. // London: SAGE Publications, 1995, Lyberg.](#)
- [3. Kalchev K., Tsankov Ts. Use of the Decision Tree method in analysis of student data from surveys. // Annual of Konstantin Preslavski University of Shumen, 2020, Vol. X E, Faculty of Technical Sciences, ISSN 1311-834X, S. 72-83.](#)
- [4. Kalcheva N., Karova M., Penev I. Comparison of the accuracy of SVM kernel functions in text classification. // Proceedings of the International Conference on Biomedical Innovations and Applications, BIA 2020, Institute of Electrical and Electronics Engineers Inc., 2020, ISBN 978-172817073-2, S. 141-145.](#)
- [5. Romero C., Ventura S. Educational Data Mining: A Review of the State of the Art. // IEEE Transactions on Systems, Man, and Cybernetics, Part C, Vol. 40, Issue 6, Nov. 2010, S. 601-618.](#)
- [6. Xindong Wu, Vipin Kumar, J. Ross Quinlan, Joydeep Ghosh, Qiang Yang, Hiroshi Motoda, Geoffrey J. McLachlan, Angus Ng, Bing Liu, \[3\] Philip S. Yu, Zhi-Hua Zhou, Michael Steinbach, David J. Hand, and Dan Steinberg. Top 10 algorithms in data mining. // Knowl. Inf. Syst., vol. 14, No. 1, Dec. 2007, S. 1-37.](#)

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The collection includes student works of the participants of the competition, which were not included in the number of prize-winners. The texts of the competitive works are published in the form in which they were submitted by the authors. The authors of the articles are responsible for the content and form of submission of the material.

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Computer typesetting and layout: Oksana Sokolova

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