Application of Spreadsheets and Neural Networks for Assessing the Knowledge and Skills of Distance Learning Students

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Abstract

One feature of distance learning in Operations Management is the need for a frequent verification of the students' knowledge and skills. This is important both for students and lecturers. Ensuring an intensive two-way connection between the student and the lecturer is of particular importance for guaranteeing successful learning. This report provides a method for automating the evaluation of students' assignments. The method is a result of a summary of the author's experience in distance education for Business Administration students in the subject of Operations Management. The method uses two tools. The first one requires development of a specific form in spreadsheet software. The student completes the form by performing the required calculations, answers and explains how he has solved the tasks. Every task contains one parameter that is dependent on the last few digits of each student's faculty number. Thus tasks are different for each student. When done, the student sends his file through the distance learning platform. Through a simple VBA program the teacher summarizes the results obtained. A model was developed to calculate the correct answer for each task and compare it with the student's answers. Logically, the software can evaluate only the correctness of the calculations, but not the text responses. This is the lecturer's responsibility. The second tool of the presented method requires development of a neural network model. For this purpose, the lecturer has accumulated sufficient number of evaluated students' papers with their answers and the grades. The neural network can be "trained" with the array of students' work. The more evaluated papers exist, the more accurate the results will be. The lecturer can ask the model to assess the students' papers and compare the models' grades with his own evaluations. If the rate of matching is high enough, the lecturer may use the model for further student papers evaluation.

Keywords: *Students' papers evaluation, distance learning, spreadsheets, neural network.*

1. The Issue

Distance learning in Operations Management for Bachelor's degree course has certain peculiarities. They should be taken into account to ensure qualitative education and good results. One of the most important requirements for achieving a high quality learning process in distance learning is to ensure constant students' effort throughout the semester.

The need for a frequent assessment of the knowledge and skills is important for the students themselves who need to be able to identify their personal achievements and make the necessary adjustments if required. The assessment is also important for the lecturers. They should stimulate students to work intensively throughout the semester. They also need to see the progress of their students and undertake corrective measures if necessary.

In the practice of the International Business School (IBS) in Sofia one of the Bachelors' duties is course assignment for every subject. It has a weight of 30% in determining the student's final semester grade.

Lecturers are highly involved in both teaching activities, research projects, and administrative activities. In many cases, the students are a lot, up to a few hundred a year. In such situations, assessment of students work is a real challenge. The lecturer has to perform a thorough examination and accurately evaluate the students' work for a very short time. That is why there is a clear need for tools to enable a quick and yet accurate assessment of student work.

2. Methodology

Course assignment typically requires a series of calculations with quantitative answers. Additionally, the student should write texts, such as an essay on a topical issue, algorithms explanation, and results of the calculations interpretation. The assessment also takes into account the degree of autonomy of the student's work. Turnitin anti-plagiarism software is used in the IBS, which makes it possible to determine the similarity of the presented text with other texts.

One can use successfully information technologies in assessing quantitative data – obtained results of calculations and degree of similarity of the presented text. However automated assessment of verbal

information, such as essay, explanation of algorithms, and interpretation of calculation results is an extremely complex process that goes beyond the scope of this paper. Student assessment issues have been a matter of interest for researchers for many years, [1], [2] and [3] are just a few examples of numerous literary sources exploring different aspects of student performance assessment.
The idea of artificial intelligence creation has been seriously discussed since the 1950s of the last century (see, for example [4]). With the development of neural networks, the idea acquires real dimensions [5]. Nowadays, neural networks are used in different spheres of human activity [6], [7], [9]. Neural networks are also being used in different areas of student achievement assessment [3], [8], [10].
The main goals that I place with application of assignments as a tool for verifying students' achievements are to check: students' knowledge, their skills to solve calculation problems, skills for interpretational of calculations results, skills to perform simple analyzes of real objects, skills for presenting their personal opinion on topical issues of the Operations management, ability for written expression of own thoughts. To achieve these goals, the following requirements for the students are provided in the course assignment: development of an essay on a topic relevant to the subject, presentation of examples referring to important terms of the subject, accompanied with the necessary explanations, solving problems, exploring and analysis of a real production system.

3. The Model

To develop their assignment, students use an Excel form prepared by the lecturer. The form contains cells in which the students complete their credentials and then work on the essence. The form specifies the requirements for the student. Cells are provided to enter the results of the analyses and calculations as well as their interpretation. Once finished the student sends his assignment through the education platform. The lecturer gets the files of all the students for check and evaluation.
In 2017, I have developed a simple program using Visual Basic for Applications. It automatically processes the students' files. As a result it creates a new array in an Excel sheet which contains the information needed to check the students' calculations. A separate row exists for each student's work. It contains the student's name, faculty number, the result of his calculations, the correct answers according to the studied algorithm, the total number of faithfully solved problems. The information obtained from the Turnitin software, which evaluates the presence and extent of plagiarism, is added manually to the resulting array. The assignments are assessed after careful reading of the text part of the student's work, review of the calculations and reporting of the overlap. I have used this algorithm to evaluate the 2017 and 2018 assignments – a total of 468 works.
For the purposes of this paper, I developed a neural network model, using the following algorithm. First of all, a database was created based on the students' assignments for 2017 and 2018. There is a series of literature sources that analyze algorithms for neural network data preparation [11], [12]. The database was prepared by clearing some non-evaluative data (such as faculty numbers, file title, paper ID, etc.) The results were merged into a common array. Some independent variables and a dependent variable were selected. Independent variables are: Student Calculus 1, 2 and 3; Real Calculus 1, 2 and 3; Correct Answer 1, 2 and 3; Number of Correct Answers, Overall Overlap, Internet Overlap, Publications Overlap, Student Papers Overlap. The dependent variable is the Student's grade.
Train and testing was done on the model. The values of the dependent variable, i.e. software estimations for students' grades were calculated. The results obtained were compared to the real grades that the students received in 2017 and 2018. It turned out that in 85.2% of the cases, the rounded software estimates were equal to those provided by the lecturer. At the same time, it was found that seven cases were not taken into account by the software for various reasons (blank cells, text entries in fields for numeric variables, etc.). At the end, 86.5% of the estimated grades have been predicted correctly.
The data for the assignments of a part of the students of the same program in 2019 was used for the created model verification. For this purpose, 30 submitted until 21.04.2019 assignments were added to the model. Their grades were predicted by the neural network and were evaluated separately by the lecturer. From the predictions made 21 (or 70%) coincided with the lecturer's grades. After training the model using the new data all 498 assignment grades were predicted again. It turned out that 419 cases (or 84.1%) were predicted correctly.

4. Comments and conclusions

Evaluating the knowledge and skills of Business Administration students is an important process in the course of their education. For the needs of qualitative education it is necessary to do this periodically

throughout the semester. This takes a significant part of the lecturer's time. Contemporary software products make it possible to ease the verification process.
The development and application of neural network models can be useful to help the lecturer's work to evaluate students' assignment. Models can be trained and then used to predict student assessments. Determining a student's grade is, in fact, a multiple criteria decision making. The lecturer should take into account both quantitative information such as results of calculations as well as text answers.
Neural networks can only help the decision-making process to some extent but cannot replace the teacher's functions and responsibility. Accumulating more records to train the built-in model can reduce errors, but they will never become zero. What is the acceptable error rate depends on the lecturer's individual attitude to the risk of error.

References

[1] LaBonty, J., Everts-Danielson, K., "Alternative Assessment and Feedback Techniques in Methods Courses", Clearing House. Jan/Feb 92, Vol. 65 Issue 3, p 186.
[2] Poetter, T., "International assessment of student achievement", Clearing House. Mar/Apr 98, Vol. 71 Issue 4, p 196.
[3] Hoefer, P., Gould, J., "Assessment of Admission Criteria for Predicting Students' Academic Performance in Graduate Business Programs", Journal of Education for Business. Mar/Apr 2000, Vol. 75 Issue 4, p 225.
[4] Rashid, T., "Make Your Own Neural Network", 2016.
[5] Vasilev, I., Slater, D., Spacagna, G., Roelants, P., Zocca, V., "Python Deep Learning", Second Edition, Packt, 2019, p. 34-67.
[6] Fensterstock, A., "The Application of Neural Networks to Credit Scoring", Business Credit, Mar 2001, Vol. 103 Issue 3, p 58.
[7] Gori M., "Diffusion Learning and Regularization", New Directions in Neural Networks", 18th Italian Workshop on Neural Networks: WIRN 2008, Edited by Bruno Apolloni, Simone Bassis, and Maria Marinaro, IOS Press, 2009, p. 127-137.
[8] Schumacher, P., Olinsky, A., Quinn, J., and Smith, R., "A Comparison of Logistic Regression, Neural Networks, and Classification Trees Predicting Success of Actuarial Students", Journal of Education for Business, May/Jun 2010, Vol. 85 Issue 5, p 258-263.
[9] Fallah, N., Mitnitski, A., Rockwood, K., "Applying neural network Poisson regression to predict cognitive score changes", Journal of Applied Statistics. Sep 2011, Vol. 38 Issue 9, p 2051-2062.
[10] Buayananda, N., Srinivasan, R.,"Using Neural Networks to Predict MBA Student Success", College Student Journal. Mar 2004, Vol. 38 Issue 1, p143-149.
[11] Lawrence, J., "Data Preparation for a Neural Network", Neural Network Special Report: A Miller Freeman Publication, 1992.
[12] Yu, L., Wang, S., Lai, K., "An Integrated Data Preparation Scheme for Neural Network Data Analysis", IEEE Transactions on Knowledge and Data Engineering, Vol. 18, No. 2, February 2006.