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Estimating of student success with artificial neural networks

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Abstract

Purpose of the study is classifying students' success of Information and Communication Technology-ICT courses by using Artificial-Neural-Networks-ANNs models. To classify success of 161 students, a three-layer-feed-forward-ANNs model is used. 3 parameters which contain demographic data and 27 parameters which contain ICT-Usage data captured by a questionnaire chosen as input layer parameters. Hidden nodes are determined experimentally. Logic-0 and Logic-1 are the output level values which define success of the students in ICT courses. The Back-Propagation algorithm is used for training of ANN. The mean squares of the errors are used as a performance (error) function with its goal set to zero. In conclusion, the application done with success ratio of 96%. If same variables are used, realistic estimations will be reached. It is recommended that a research with same parameters would be better results with higher participation.

Keywords: Artificial Neural network, backpropagation, student success, classification, ICT.

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1. Introduction

In the information age in which we live, students at the higher education level, who are requested to be the information and communication technology (ICT) literates, are expected to succeed at ICT courses. Success means to grades and test scores, which make progress through the lectures and are given according to lecturers' opinion (Good, 1959). Students receiving lower grades than the passing grade for the course or final grade, are considered unsuccessful.

There are several studies verifying university students' failure in ICT (Adetimirin, 2012; Egan & Katz, 2007; Hilberg & Meiselwitz, 2008; Katz & Macklin, 2007; Kumar, Nair, & Devarajan, 2015; OECD, 2013). In practice, higher education institutions spread on effort to upskill students on ICT by having ICT equipment and infrastructure. To get an effective usage of ICT this effort is essential but not sufficient. It is very important to support this effort with proper consultancy. At this point, in order to get students' failure in ICT under control, it is necessary to focus on 1- determination of variables affecting the ICT success, and 2- prediction of success.

Researches undercore the importance of variables that affect success for the success consultation (Cırak & Cokluk 2013; Guneri & Apaydin, 2004). In this context, lots of variables related to the success of ICT students have been examined in the field's literature (Taylor, Goede & Steyn, 2011). One of these variables is age. It is asserted that the success in information and communication technologies is positively correlated with the age of the individuals. For example, Higgins (2003) indicates that the higher age level of individuals, the more success in word processors. Similarly, Lau and Sim (2008) and Hsu Hao Chang and Yen (2009) argue that the individuals with higher age become more successful in ICT. Novak and Knowles (1991) emphasizes that the younger age groups, the more problems are observed.

It is seen that the computer success is frequently examined within the framework of gender mainstreaming. According to Ojeniyi and Adetimirin (2013), there is a significantly positive correlation between gender and the ICT use of students of higher education. Okebukola (2003) states that the male students have high ICT success; Houtz and Gupta (2001) argue that the male students are more likely to be expert in technology; Kay (2006) reports that statistically the computer skills of the male students are highly significant. It is possible to find many other studies on that subject (Lu, Li, Stevens, & Ye, 2016; Patrick & Ngozi 2014; Rekabdarkolae & Amuei, 2008).

The second of the most researched topics in the field's literature is the computer success and use of computer (Kay, 2006). In researches, use of computer refers to experience and the frequency of use. It is stated that as individuals get more experienced on use of computer and Internet, their computer and internet skills improve (Akcayir, Dundar & Akcayir 2016; Cassidy & Eachus, 2002; Kuhlemeier & Hemker, 2007). On the other hand, Atan, Sulaiman, Rahmana and Idrus (2002), argue that there is a relation between computer success and the frequency of computer use. Papastergiou and Solomonidou (2005), emphasize in their study that computer use in a broad sense is one of the factors that determine the success and failure. Similarly, Cuban and Cuban (2009) also points out the positive effect of the ICT use on success.

Studies on ICT success related to ICT applications in more detail are also remarkable (Kuhlemeier & Hemker, 2007; Samuel et al, 2004). Colley & Comber (2003) in their study examine the ICT success in terms of many variables, evaluated the results according to some basic ICT applications such as word processors and spreadsheets. Paraskeva, Bouta and Papagianni (2009) indicate that the usage frequency of different ICT applications improves the application experience. In his study, Buabeng-Andoh (2012) while categorizing ICT applications as word processors, spreadsheet, presentation programs, database design programs, search engines and communication programs, emphasizes that the use of word processor is more important that the other applications.

When the studies on ICT applications are carefully examined, it is seen that the applications consist of six modules as explained in terms of software under the name of computer literacy by European Computer Driving License's (ECDL) which is a worldwide known certification system of computer

competence. These modules are Operating systems, word processors, spreadsheet, database, presentation programs and Internet software. Kennedy, Dalgarno, Bennet, Judd, Gray and Chang, (2008) and Callum and Jeffrey (2013) also underline that these applications are the most widely used applications.

Consequently, it can be said that the variables that are frequently examined together with the ICT success are age, gender, ICT experience, ICT level, ICT use frequency, ICT application level, and ICT application use frequency. As previously stated, determination of the variables affecting the ICT success, makes students' future success highly predictable. In other words, the quality of the students (in accordance with the set variables) can be classified correctly as successful and unsuccessful.

Classification is the process of finding a model cluster to identify and classify a set of data. As classes are generated through previously examined data, classification models are called "supervised learning" (Aydin, 2002). To create a classifier to specify the class of an object among a particular set of classes, different analysis techniques (logistic regression analysis, discriminant analysis, artificial neural networks, etc.) are employed. Lately, the most preferred analysis technique has been artificial neural networks (Cirak & Cokluk, 2013; Kim, 2010).

Artificial neural networks are the computer systems having been developed to perform automatically some abilities without any help, such as creating, deriving or discovering new information through learning process which is one of the features of human brain. Artificial neural network method aims at clustering and classifying the given samples and choosing the suitable classes for the new comers (Oztemel, 2012). In the artificial neural network technique, the total input value is multiplied by its weight collected value and processed with the activation function to obtain output (Kumar, 2004; Shanmuganathan & Samarasinghe, 2016). Despite the limited number of its applications in education, the artificial neural networks method is used successfully in many areas such as transport and aviation, biomedical and pharmaceutical industries, finance, stock market, and credit card applications (Cirak & Cokluk, 2013).

The first studies on the use of artificial neural networks to predict students' success were carried out by Gorr, Nagin and Szczypul in 1994. According to the research findings, the predictions derived from the ANN analysis concluded better results. In the literature, a lot of studies have similar findings about the predictions derived from the ANN analysis on student success concluded better results (Ibrahim & Rusli, 2007; Guneri & Apaydin, 2004; Oladokun, Adebanjo & Charles-Owaba, 2008; Subbanarasimha, Arinzeb, & Anandarajanb, 2000; Tosun, 2015) As a result of the literature survey, a study about ANN performance for classification of students' success, especially in computer field, was not observed. Because of that, this study focused on classifying students' success of ICT courses with ANN approach.

2. Method

In this chapter, research model, participant group, data collection tolls, data analysis are described.

2.1. Participant group

Participant group consists of 160 students who are attending Alanya Alaaddin Keykubat University Akseki Vocational School in 2015-2016 fall semester. Their programmes are Accounting and Tax Applications, Computer Programming, Control and Automation, Electric, Furniture and Decoration, Bureu Management and Executive Assistantship. 116 (72%) of students are male and 44(28%) of them are female. The age range of participants is between 17 years old and 21 years old.

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2.2. Data collection tool

The research data were obtained in two stages as data input and output. Input data are collected by «Personal information and ICT usage» questionnaire. The development process of used questionnaire contains several stages. In this direction draft form has been progressed by article survey about ICT usage literacy and preparation of questionnaire items. After preparation of the draft form, when choosing the proper questions of it, seven specialists on education technology field shared their opinions in a free discussion atmosphere. 30 clauses have been chosen like, branch, gender, age, experience of computer usage, skills level of ICTs, usage frequencies, skills level of computer applications. By the purpose of defining, penetrability of statements, compatibility of students' level, and difficulties of implementations, a pilot application realized with students who has similar attributes to the participant group of study. As a result of pilot implementation, it has been observed that 15 – 20 minutes' duration is enough to answer all questions of the questionnaire. After pre-implementation, modifying of some questions, has been decided together with six specialists at educational technologies field and one at statistics field. At this point, development process of the questionnaire for study has been finished, and data collection process has been started. All data collected totally in two weeks. Herein, collection of the input data process of survey has been finished.

At the same time, discussed output data for model classification, gathered from ICT course success grades. Data, which belongs to ICT course for all branch's students as a common course, are accessed over student's automation system software of the University. Average of final scores was obtained. Attainment of output data of the research has been accomplished at this point.

2.3. Research model

A three-layer feed-forward ANN's model is used. Obtained data are analyzed in Matlab R2013a computer program.ANN model's input output level process unit number is formed according to problem's geometry. At the input layer of ANN, totally 30 pieces node, one node for each data, exists. One hidden layer, with ten units, is selected. Output layer has two classes like succesful and unsuccesful.

2.4. Data analysis

Output data are classificitation of ICT success of students. If success grades are equal to or greater than 60 is succesful (Logic-1) else unsuccesful (Logic-0). Branch, gender, age, computer usage experiance, level of skills on Internet and Computer, usage frequency, level of skills on computer application, variables include usage frequency are added to research as input variables for ANN.
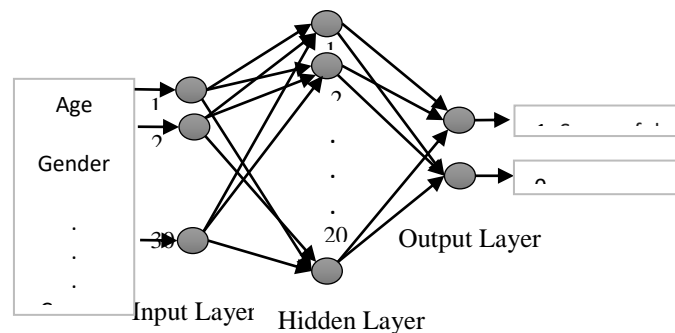

Figure 1. Multilayered artificial neural network

Validation and test data sets are each set to 15% of the original data. With these settings, the input vectors and target vectors will be randomly divided into three sets as follows:

- 70% (n=112) are used for training.
- 15% (n=24) are used to validate that the network is generalizing and to stop training before overfitting.
- The last 15% (n=24) are used as a completely independent test of network generalization.

In the training network process, transfer function is tansig. Its initial weight collected randomly. Training algorithm is Levenberg-Marquardt backpropagation (Trainlm). Average error square method is used for error calculation .

3. Results

Is presenting findings from analyzed data related to classify academic success of students by ANN.

Table 1. Correct Classification Success of Artificial Neural Network Model

ANN	Status	Target	Output	Correct Classification
Training	Logic 1	99	99	100%
	Logic 0	14	14	
Test	Logic 1	21	19	79.2%
	Logic 0	3	0	
Validation	Logic 1	19	19	95.8%
	Logic 0	5	4	
Total	Logic 1	139	137	96.3%
	Logic 0	22	18	

Focusing on Table 1 in details, 99 successful students correctly calssified as successful, and 14 unsuccessful students correctly classified as unsuccessful in the training set. Correct classification rate for training set is 100%. In the test set, 19 of 21 successful students are classified correctly but 2 are not. All 3 unsuccessful students are misclassified. Correct classification rate for test set is 79.2%. In validation set, all of 19 successful students corectly classified. 1 of 5 unsuccessful students is incorrectly classified but 4 students are corretly classified. Correct classification rate for validation set is 95.8%. Overall correct classification rate is 96.3%

4. Discussion and Conclusion

In this research, input data such as branch, gender, age, experience of computer usage, skills level of ICTs, usage frequencies, skills level of computer applications etc. ICT course success of students has been classified by using ANN. This classification possibility is 96.3% for obtained data by application with ANN.

In our study, correct classifying rates upto 96%, is parallel to Asogwa and Oladugba (2015)'s results; İbrahim and Rusli (2007)'s; and Oladokun, Adebanjo and Charles-Owaba (2008)'s results. For example, in Asogwa ve Oladugba (2015)'s results ANN model classify the performance of students with Mean Correct Classification Rate CCR of 97.07%. On the other hand, Tosun (2015) compares ANN and

decision tree techniques for success classification. In the results of his study, when using decision tree technique, correct classification rate 86% for classifying success. With the same dataset ANN technique results is 92%. Oladokun, Adebanjo and Charles-Owaba (2008), in their studies, aimed to test ANN analyze for defining explanatory variables on student's success, and for prediction of students's performance. Predict one additional new student's success in future for model, possibility of prediction is determined as 74% with ANN. In a study, multilayered artificial neural network model's correct classification rate was obtained as 70.16% (Cirak & Cokluk, 2013).

In conclusion, it achieved an accuracy of over 96.30%, which shows the potential efficacy of Artificial Neural Network for classifying students ICT success. As a result, ANN' correct classification rate of the research results of this research should be preferred, as seen in both the literature can be classified correctly with high rates of student success. In conclusion, this paper has shown the potential of the Artificial Neural Network for correct classification of the ICT success of students in higher education institutions. However, the results of generalization of the order to be stated that the search results, this technique is more successful, more extensive studies (large data sets, studies with real and simulative data etc.) seems to be needed.

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