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Machine Learning Predictions for the Advancement of the Online Education in the Higher Education Institutions in Jordan

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Abstract: The major objective of the study is to identify and rank in terms of relative importance selected principles in online education in the higher education institutions, their means for achieving an effective and online education in higher education institutions in Jordan. To achieve these objectives, the online survey research design was employed within the applied practice in the research. Survey questionnaires were used in the study to determine the perspectives of 6500 facility members, students, and administrators from the higher education universities in Jordan. The results showed that the participants mainly experienced online education, which is useful in promoting Internet research methodologies, connecting practitioners in online education with the global online education community environment, and obtaining wide-ranging knowledge resources. It also provides that online education in Jordan is successful. Higher education institutions can reach international standards in universities through online education and become part of the online knowledge-based educational community. This is the first study in which three algorithms were used to predict and determine the extent of online education in Jordan.

Keywords: online education, higher education institution, prediction, machine learning, internet research methodologies.

机器学习对约旦高等教育机构在线教育发展的预测

摘要：该研究的主要目标是确定高等教育机构在线教育中选择的原则的相对重要性并对其进行排名，这些原则是在约旦高等教育机构实现有效在线教育的手段。为了实现这些目标，在研究的应用实践中采用了在线调查研究设计。该研究使用调查问卷来确定来自约旦高等教育大学的6500名设施成员、学生和管理人员的观点。结果表明，参与者主要体验在线教育，这有助于推广互联网研究方法，将在线教育从业者与全球在线教育社区环境联系起来，获得广泛的知识资源。它还提供了约旦的在线教育是成功的。高等教育机构可以通过在线教育在大学达到国际标准，成为在线知识型教育社区的一部分。这是第一项使用三种算法来预测和确定约旦在线教育程度的研究。

关键词：在线教育、高等教育机构、预测、机器学习、互联网研究方法。

1. Introduction

Information communication technology (ICT) plays a vital role in education, especially among higher learning institutions. It is beneficial for both students and educators. It assists the instructor in preparing, presenting, and evaluating their lessons, and students easily access the information and understand their lessons. Therefore, educational institutions should adopt technology-based learning by shifting from conventional teaching methods to online teaching methods. Besides the online teaching method, institutions that employ ICT in teaching and learning will develop better e-communication between students and teachers. Nowadays, most universities are using

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computer-based teaching and learning environment platforms. According to [1], online education is an innovative approach for delivering instruction to students in remote places; online learning also includes all kinds of learning transmitted across the computer. Recently the use of online education has dramatically increased around the world [2]. However, online education is still not yet well utilized in developing countries.

2. Literature Review

Due to several constraints, online education in teaching and learning is still not being used widely. These barriers include poor access to the internet, upgrading the network, updating recourses such as software, and lack of ability and confidence.

Resulting from a shortage of training courses [3], with COVID-19's surge as a contagious disease, so effective at spreading through communities reaching about 213 countries [4], many questions remain unanswered and concerns to be addressed regarding its short-term and long-term repercussions. The education system was among the hardest-hit sectors worldwide [5], [6]. The pandemic's lockdown period made it necessary for higher education institutions to keep their students engaged in the learning process. In Jordan, higher education institutions have opted for online learning and integrate their teaching as online internet research methodologies [7].

Numerous researches have been conducted on barriers to online learning. However, the online concept is still in the infant stage in developing countries, particularly in Jordan. Most past studies discussed the barriers to online education from faculty staff members or teachers, or students separately. No single study combined all aspects of the impact of online education [6], [8], [9], [10].

In this study, we will focus on knowing the effect of online education in all sectors and all those concerned with the online education process, whether students, faculty members, or administrators, and even the economic impacts on the university in all universities in Jordan, and we will also focus on predicting the extent spread of online education within a year in Jordan. We have devoted this kind of research to analyze data related to data science to connect with how new technology effect online education in higher education institutions and using artificial intelligence (AI) to know the efficiency of the done online education and if it should be expanded and becoming suitable and reliable for the future reference in online educational environment platforms.

3. The Methodological Aspects

This section discusses the methods used to carry out the fieldwork of this study, suggests methods for identifying research problems, and providing a structure for solving these problems in stages. Each step is based on rules and guidelines. According to [11], the research method is comprehensive for researching the question of interest, including specific research methods and tools used to achieve fixed research objectives [11]. Believe that this methodology is a procedure for collecting and analyzing the necessary data to select appropriate research methods and determine data collection techniques, it is necessary to clearly state the purpose of the research and its integration of Internet research methodologies for the advancement of online education in the higher education institutions.

3.1. Data Science (Collection, Methods)

The collected data is related to online education, which was collected within the research discourse in more than one way, including all stakeholders (students, faculty members, and administrators) to know the effectiveness of online learning. The questionnaire was prepared after reviewing relevant publications and online opinion polls related to online education matters and their effect on the online education environment platforms. Questions are formulated based on the author's personal experience in handling administrative issues related to the implementation of online education in higher education (including administration, educational objectives, and course content).

The research introduced informal discussions with colleagues interested in implementing online learning in higher education institutions and its measures for the effectiveness and informative discourse in formulating the elements of the questionnaire in the research. The questionnaire was completed in three categories of stakeholders (lecturers, students, administrators, and technicians), as shown in fig. 1.

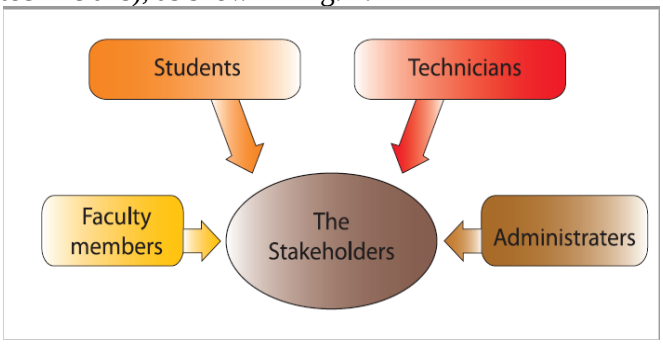

Fig. 1 The stakeholders of universities in Jordan

The researcher developed the questionnaires in English and Arabic and sent them forward to the participants via e-mail and Facebook pages with 1400 faculty members, 1100 administration members, and 4000 students in various Jordanian higher education institutions.

The questionnaire was designed to research issues of reliability [12], validity and, and the trinity [11], reliability, and sustainability [7].

Reliability can be described as a tool for measuring the consistency of queries. Therefore, the questions

should contain reliable information, which means that similar results can be obtained when using the questionnaire [12], including that the results can be achieved by any researchers that adopt the same procedures in the research [7]. The questions in the questionnaire should be designed in simple terms so that there is ambiguity and ease of understanding and follow-up. A clear sequence of formulating questions must be followed with careful planning to avoid confusion [1]. Vague questions can be considered a threat to the reliability of the questionnaire. Validity and Bias - Reliability was described as accurate and unambiguous question data included in the questionnaire [1]. Therefore, the validity of the questionnaire is determined by the examination of the questionnaire.

Questionnaire discourse content to ensure that questions are asked to measure multiple variables to find survey objectives. In other words, the questions must be unbiased [13] to achieve the purpose of the questionnaire validation and sustainability [7].

Dependability: The need to explain the nature of any change in the social environment during the research period was considered. The researcher's responsibility is to clearly describe the nature of any change in the studied context affecting the research method as the Corona pandemic has made more interest in online education and the integration of the higher education institution in the online platforms.

Ethical - Ethical consideration issues are considered to measure educational and professional activities. In this study, ethical considerations were applied throughout the research process. Ethical consideration must be conducted and measures before the practice phase being conducted in the research [7].

3.2. Artificial Neural Network for Prediction

Inspired by the biological neural networks that make up our human brain, Artificial Neural Network (ANN) systems simulate basic logic by creating a set of interconnected nodes that exchange information between them. Input, hidden and output layers derived from our neuron architecture, which receive signals from dendrites and output signals using exons to exchange information. Like how children gain skills from watching their parents, neural networks can learn to perform various tasks and look for new examples, usually decision tree classifiers, rather than a set of programs and rules. A neural network can improve its model replication and summarize data evenly as we can think, research, and perform body parts simultaneously. Fig. 2 shows a standard three-layer neural network interconnected with a set of ganglia.

Each spherical node in the figure indicates an artificial neuron, and the crossed arrows between these nodes represent a signal communication that transfers information from one nerve cell to another. In general, nerve communication signals, also known as "edge". It is a real number, and based on its value and some nonlinear function; we can compute, receive and pass new information to the next network layer as an output. The function usually specifies an accurate weight that absorbs those artificial neurons as the learning progresses. The neural network learns and corrects itself during the learning process by adjusting weights and other parameters to predict correct class designations for new input features [13]. Weight increases or decreases signal strength when communicating. In addition, different layers can also occur in ANN performing different types of conversions on the input it is own [14], [15], [16].

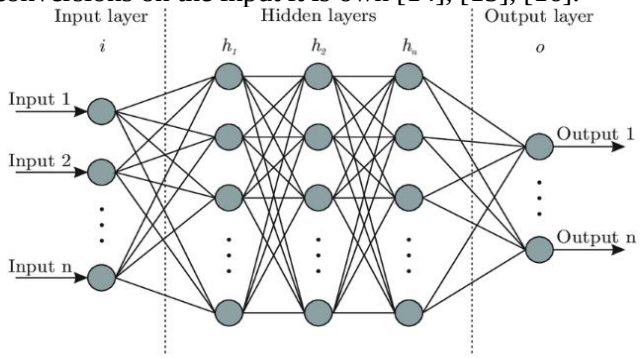

Fig. 2 Standard neural networks structure

With all this architecture, the goal is to solve whatever is known in many business applications, such as forecasting stock of trends, playing chess with human speech, and translating the real people. For example, the prediction statement that; he is so powerful that he can control all things, deriving the potential relationship between the features of these meetings.

3.2.1. k-Nearest Neighbor's Algorithm (KNN) for Prediction

We used KNN, where we predicted the specific traits of unknown organisms by calibrating the trait values of the closest neighbors in group x. To do this, we calculated the distance between the unknown object and all objects in X, and k to the closest neighbors are used to predict the characteristics of the unknown object, which is calculated as a weighted average. For the value of the adjacent element, see Equation 1.

$$\hat{y} = \sum_{i=1}^{k} W d_i y_i \quad (1)$$

where Yt is the value of the attribute assigned to an unknown object. It is the closest neighboring attribute (i = 1,2, ..., k), k is the number of closest neighbors included in the prediction, and di is the closest. The distance between the neighbor and the unknown is X.

This method uses simple orthogonality (DO) before kNN prediction. DO cancels out the contributions of y to irrelevant X and thus improves the relationship between the variable contributions of X and y.In this way, the multidimensional distance of the object's neighbors is better related to the attribute model. In DO KNN, the k value kNN and the number of coefficients used in the DO phase should be optimized.

We used a prediction of the spread of online education during the next year, where the data that we collected was entered through a questionnaire of students. Then we analyzed and transformed it, creating an algorithm capable of using it and predicting the effectiveness and spread of education via the internet.

Prediction with KNN in the data collected by the identification of students was useful because it is simple and new from a conceptual and computational point of view. We were able to add objects to the training data without the need to recalculate the model. Moreover, we considered KNN an approach to reverse titration since it was unnecessary to know all the species in our sample to predict the characteristic of interest. It can be used as a nonparametric method, as KNN does not require knowledge of the probability distribution function of the data. Another interesting feature is its power due to the presence of outliers in X.

3.2.2. Nonlinear Autoregressive Exogenous Algorithm (NARX) for Prediction

In the NARX network, the estimated output is a function of the previous outputs and inputs of the time series, as shown in Equation 3.3:

$$\hat{Y}(t+1) = (y(t), y(t-1), ..., y(t-dy), u(t+1), u(t), ..., u(t-du)) \quad (2)$$

Fig. 3 shows a basic NARX network. The external input in the current time step and the previous time steps are fed through the network's hidden layers to produce a prediction that flies back to serve as additional inputs. The experiment included communication weights between nodes in subsequent layers and activation functions in the hidden and output layers. A commonly used activation function is the sigmoid activation function described in Equation 4, and it is used as a continuously differentiable monotone function.

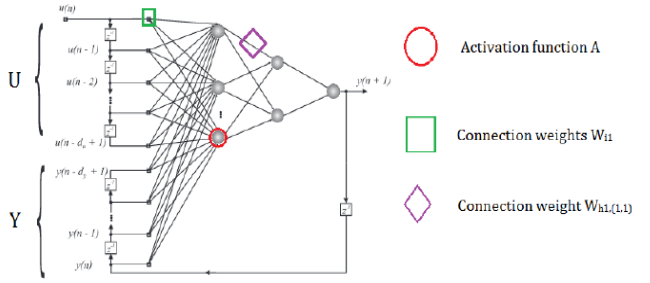

Fig. 3 NARX neural network with dy output delays du input delays, and two layers are hidden

Each hidden layer transforms its inputs using the activation function A (Equation 3).

Each link is weighted from entering the hidden layer by the WI component. The connection weights are summed from the hidden layer to the next layer in the WH-matrix, which consists of one layer, the weight Wh1, (1, 1) imposed on node 1 from the first hidden layer to node 1 is distinguished from the second hidden layer.

Continuous differentiation enables gradient-based optimization methods, while it has been demonstrated that nonlinearity in the activation function enables neural networks to approximate any continuous function to arbitrary limits. Matrix notation for single-layer NARX mapping is given in Equation 4.

Continuous differentiation enables gradient-based optimization methods, while it has been demonstrated that nonlinearity in the activation function enables neural networks to approximate any continuous function to arbitrary limits. Matrix notation for single-layer NARX mapping is given in Equation 4.

$$A(v_i) = \frac{1}{1+e^{-v_i}} \quad (3)$$

$$\tau = W_H\, A(W_I[Y\ U]) \quad (4)$$

where:

A - sigmoid activation function

τ - nonlinear mapping from network inputs to the network output

W_H - connection weights on links between hidden layer nodes and outputs

W_I - connection weights on links between inputs to the network and hidden layer nodes

Y - input vector of past outputs

U - vector of current and past control inputs

The parameters to optimize in a NARX type neural network are the connection between weights WH and WI. Since the monotonicity of a sigmoid activation function renders the optimization Problem convex, least-squares optimization techniques are applicable.

3.2.3. Recurrent Neural Networks (RNNs)

Recurrent Neural Networks (RNNs) are a subclass of Artificial Neural Networks units that create periodic charts. The network allows the internal state memory to handle the input sequence.

By doing time tasks this way, RNNs accumulate prior activity in activating modules. It is a form of targeted cycles; there is no need for prime energy history of previous inputs and outputs as in TDNN. Instead of approximating the function, RNN attempts to model the process. And therefore, predicting the future results of the operation can be described as

$$\mathrm{Output}_{t+1} \approx Preduction_{RNN}(Network\ State, Input_t, Output_t) \quad (5)$$

where *Network State* is the activity of the modules that make up the targeted sessions.

RRN resembles a three-layer frontal power grid because its architecture consists of input, batch, and output layers and a contextual layer. Design the input and context layers on the hidden layer from which the layer is derived. The context layer is a copy of the activation of the hidden layer in the previous time step and thus acts as network storage for the previous activity. The repeated network output at time t is calculated in four steps:

1. The input vector is copied to activate the input layer modules

2. The activation of the hidden layer units is repeated at time t - 1 to the current "Activate the Units Context layer".

3. Hidden layer units calculate their activations.

4. Output layer units calculate their activations and copy them to the network that went out.

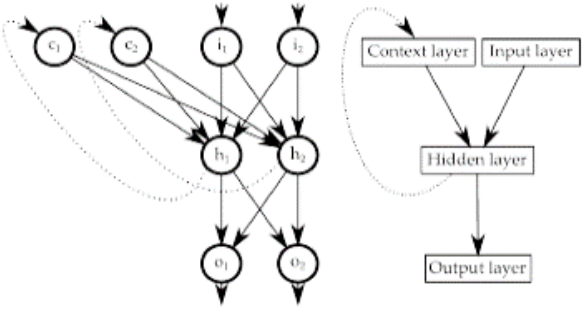

Fig. 4 Recurrent neural network with input hidden, context, and output layer, each containing two modules. On the right, the layers diagram in Elman's grid. The dotted link denotes transcription source units' activity on target units [17]

4. Results

In this thesis, three methods were used to predict the spread of online learning within one year in Jordan, where data were collected through questionnaires and then analyzed for prediction where three algorithms Knn, Rnn, and Narx, were used. In this section, the results of each algorithm will be presented.

4.1. KNN Methods for Student Data Prediction

KNN algorithms were used to predict the extent and speed of online education spread within one year in Jordan using student data collected to predict the prevalence and efficacy of online education. Python Code was used to build a prediction module.

4.1.1. Training and Testing Data for the Prediction Model

Student training data in 2021 was collected through questionnaires distributed to students to find out their opinion on online education and its effectiveness. It was converted into numbers and entered into the system through an excel file. 4000 student data is used as master data.

Table 1 Sample of training data

Student	MT	EC	TE	EV	In
1	3	3	0	4	1
2	4	4	4	4	4
3	3	3	3	3	2
4	3	3	3	3	4
5	3	2	3	2	2
6	3	3	3	4	1
7	2	3	2	1	4
8	3	0	3	4	3
9	2	0	2	4	1
10	4	1	4	0	2
11	3	3	3	3	3

Many columns were used as sources of training data. Therefore not all columns are used. The research must determine the selected columns as attributes to predict the spread of online education. Based on research methodology their are5 columns were selected; MT (Means and techniques), EC (Electronic content), TE (Teaching Effectiveness), IN (Interactive), and EV (Evaluation).

It can be seen in Table 1. The columns were divided into two groups and named as attributes or predictor variables and label/class. This research defines MT, EC, TE, EV, and IN in as predictor variables.

Donated data must be preprocessed to gain the best accuracy. This preprocessing step was done by measuring accuracy. Based on the performed study, the result selected 400 data as training data.

4.1.2. Prediction Result

Based on training and testing data, the algorithm generates a prediction of online learning based on students' data. The result of the prediction can be seen in Fig 5. The spread of online education has been predicted within one year of a month (1-12). The figure shows an increase in the spread of online education, as it is expected during 2021 that the prevalence of online learning will increase rapidly in Jordan.

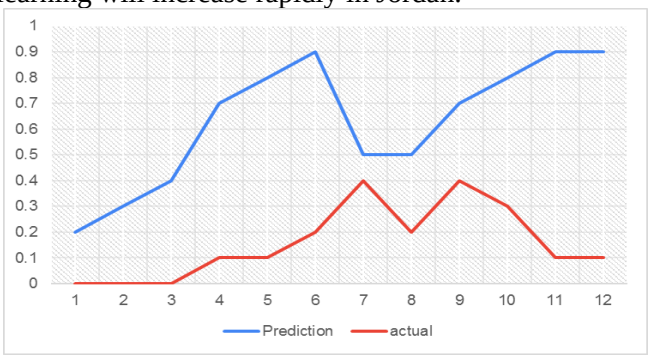

Fig. 5 The prediction result

4.1.3. Accuracy Result

The final Accuracy result has done by analyzing the best k value of the k-NN algorithm. In order to investigate the best K value for predicting online education, tests have been done with various nearest neighbors K (from 1 to 40) values, and the prediction accuracies were obtained. For different values of K, it is shown that the prediction accuracy is improved along with the K increase, up to the best when K equals nine, and the prediction accuracy has little reduction when the K continues to increase. The accuracy of the KNN-ID method proposed in this report was 95.02 %.

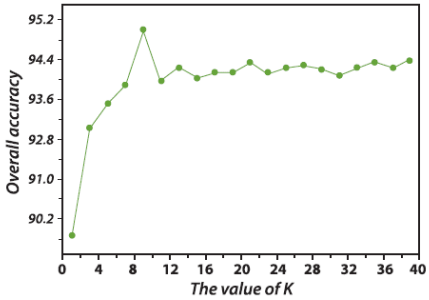

Fig. 6 The predictive trend of over accuracy at different values of K using the KNN-ID method

4.2. RNN Method for Faculty Member Data Prediction

RNN algorithms were used to predict the extent and speed of online education spread within one year in Jordan using faculty member data collected to predict the prevalence and efficacy of online education. The models were created in python on the Jupyter notebook using Keras (https://github.com/fchollet/keras) deep learning API with Tensorflow backend. All the experiments were run for 2,000 records, but only the best weight for each test run was saved using callbacks in Keras.

4.2.1. Training and Testing Data for the Prediction Model

Student training data in 2021 was collected through questionnaires distributed to students to find out their opinion on online education and its effectiveness. It was converted into numbers and entered into the system through an excel file. 1400faculty member data are used as master data.

Table 2 Sample of training data

FM	EU	P	TS	IN	SM	EV
1	3	1	1	1	1	1
2	3	1	1	0	1	1
3	3	0	1	1	0	1
4	3	0	1	1	0	1
5	2	1	1	0	0	0
6	3	0	1	0	1	1
7	3	1	0	1	1	1
8	3	1	0	1	1	0

Many columns were used as sources of training data. Therefore not all columns are used. The research must determine the selected columns as attributes to predict the spread of online education. Based on research methodology their are6 columns were selected; EU (Easy to use), P (Platform), TS (Technical support), IN (Interactive), SM (supportive methods), and EV (Evaluation).

It can be seen in Table 2. The columns were divided into two groups and named as attributes or predictor variables and label/class. This research defines MT, EC, TE, SM, EV, and IN as predictor variables.

In order to gain the best accuracy, donated data must be preprocessed. This preprocessing step was done by measuring accuracy. Based on the performed study, the result selected 1400 data as training data.

4.2.2. Prediction Result

Based on training and testing data, the algorithm generates a prediction of spread online learning based on students' data. The plots between predicted and the actual values for 12 months from January 2021 to December 2021 are shown in fig. 7.

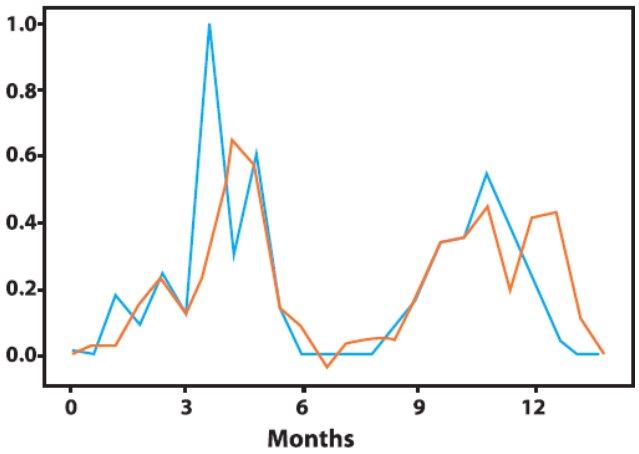

Fig. 7 The plots between predicted and the actual values for 12 months

4.2.3. Accuracy Result

This method's purpose was to predict the spread of online education in Jordan. In this test, a dataset with 2000 rows of faculty member data was used. The epochs were set on 50 to train the model. The fig. 8 shows the performance of the model. The accuracy measured the model prediction performance, and the model loss presents the uncertainty of the model prediction. The distance between the training and validation line is small in figure's part A and the accuracy plot. The training and validation line starts to divert from each other at around 0.92 and stops approximately 0.97. The accuracy of the RNN method proposed in this report was 97.9 %.

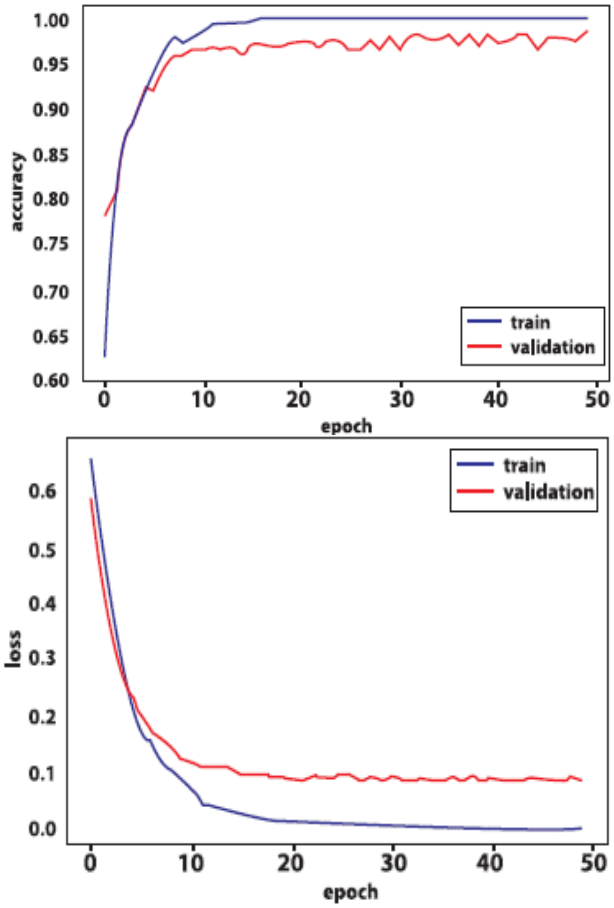

Fig. 8 Performance of the model

4.3. Narx for Administrator's Data Prediction

Narx algorithms were used to predict the extent and speed of online education spread within one year in Jordan using administrator's data collected to predict the prevalence and efficacy of online education. Python Code was used to build a prediction module.

4.3.1. Training and Testing data for the Prediction Model

Student training data in 2021 was collected through questionnaires distributed to administrators to determine their opinion on online education and its effectiveness. It was converted into numbers and entered into the system through an excel file. There are 1100 administrator's data that is used as master data.

Table 3 Sample of training data

AD	CM	RW	WL	PE	EV
1	1	0	0	1	1
2	0	1	1	0	0
3	0	0	1	0	1
4	1	1	0	1	0
5	1	1	1	0	0
6	0	1	0	0	0
7	1	1	1	1	1
8	1	1	0	1	1

Many columns were used as sources of training data. Therefore not all columns are used. The research must determine the selected columns as attributes to predict the spread of online education. Based on research methodology their are5 columns were selected; CM (Communication), RW (Remote work), PE (Productivity Enhancement), WL (workload), and EV (Evaluation).

It can be seen in Table 3. The columns were divided into two groups and named as attributes or predictor variables and label/class. This research defines CM, RM, PE, EV, and WL as predictor variables.

In order to gain the best accuracy, donated data must be preprocessed. This preprocessing step was done by measuring accuracy. Based on the performed study, the result selected 1100 data as training data.

4.3.2. Prediction Result

Based on training and testing data, the algorithm generates a prediction of online learning based on students' data. The result of the prediction can be seen in fig. 9; the spread of online education has been predicted within one year of a month (1-12). The figure shows an increase in the spread of online education, as it is expected during 2021 that the prevalence of online learning will increase rapidly in Jordan (Fig. 9).

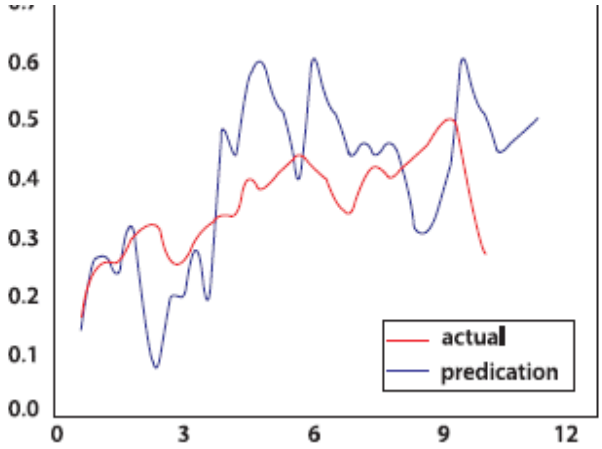

Fig. 9 The result of the prediction

4.3.3. Accuracy Result

This method's purpose was to predict the spread of online education in Jordan. The results obtained show that satisfactory prediction accuracy has been achieved through NARX use, which is an approach for online education spread in Jordan. a NARX model consisting of 10 neurons on the input and the hidden layers, an input and hidden layer which contain the sigmoid function, an output layer which contains the tansig function, and a random initialization of weights. The distance between the training and validation line is small in figure a and the accuracy plot. The accuracy of the NARX method proposed in this report was 92 % (fig. 10).

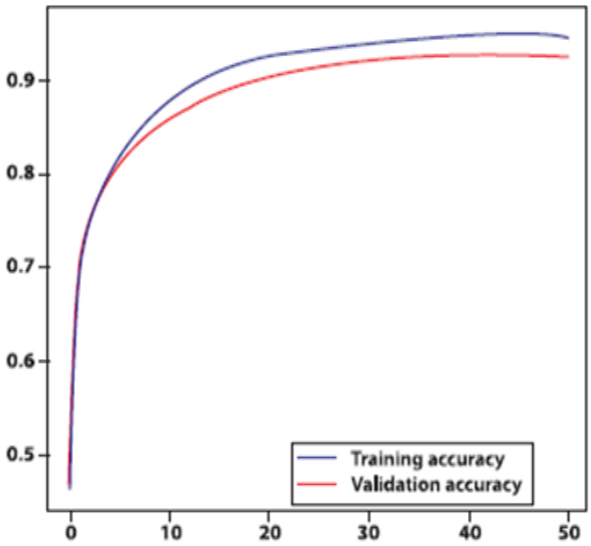

Fig. 10 Predictive trend of over accuracy at different values of using the NARX method

5. Conclusion

This study project aims primarily to study the degree and extent of the spread of online education, its effectiveness, its success in Jordan, and its assistance to higher education in Jordan to improve the quality of online education and to expect its spread within a year in Jordan. Moreover, the paper provided the reader with a strong knowledge base regarding online learning and digital development in education in a theoretical-practical framework.

The research was approved based on the main research question findings to suggest potential strategic responses that higher education could apply to improve online learning and develop a based knowledge for the online education environment. These suggestions were based on the analysis that could be made regarding this main research study, where we analyzed stakeholder data (students, faculty, and administrators).

The determinants of the study were the numbers included in it, where only 6500 questionnaires were included from the faculty, administrators, and students, but this number that we were able to include in the study.

The result from the three models was in the evaluation section 4. These sections provided the complete accuracy of the student model 97.9%, the accuracy of the faculty model is 95%, and the accuracy of the administrator's model is 92%. Predictions indicated that the prevalence of online learning would increase rapidly within a year in Jordan.

In this first study in Jordan, three algorithms were used to predict and determine the extent of online education in Jordan.

For future experiments, more complexity and more useful data are expected. In this way, we can take full advantage of the ability of a neural network classifier and measure how to do so; various data attributes can affect model performance. Additional machine learning algorithms can also have improved performance computation capabilities, such as Random Forest, Nave Bayes, and Support Vector Machines.

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