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Using Artificial Neural Networks as One of the Data Mining Algorithms to Predict the Iraqi Gross Domestic Product

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Abstract:- Several Artificial intelligence techniques can help predict future values of time and provide guidance on social and economic development plans. The goal of this study was to analyze the Iraqi economy using neural networks. It was able to predict the country's gross domestic product from 2003 to 2020. Thirty-six networks of different types (feed-forward backpropagation, NARX, Layer Recurrent Network (LRN)) were built. The recommended model was chosen according to the RMSE criterion. The Iraqi GDP prediction was made using an artificial neural network that utilized the TRAINBR training and transit functions. It performed well and earned the lowest error value.

Keywords:- *Gross Domestic Product, Time Series, Artificial Neural Networks.*

I. INTRODUCTION

The Gross Domestic Product is considered the most important axes of macroeconomics, as it is a measure of the size of the economy's production in a certain period, and its importance lies in defining many facts in this economy, as it gives a general idea of the general economy whether it is in a state of contraction or expansion and an indication of its efficiency [1-2]. Gross Domestic Product is the sum of the monetary values of final goods and services produced by a country during a year [3]. GDP forecasting helps in making important decisions and developing strategic economic and social plans. Future values of GDP can be predicted by studying the time series of GDP. Many methods are used in studying the time series and predicting future values, some of these methods are related to statistics and some are related to artificial intelligence. In this scientific paper, we will focus on forecasting GDP through artificial neural networks as one of the methods of artificial intelligence in forecasting [4-6].

II. STUDY PROBLEM

Gross domestic product is a monetary measure of the market value of all goods and services produced during a specific period, that is, it reflects the performance of the overall economy. Gross Domestic Product is used as an economic indicator that can be used for economic analyzes, development plans and policies, and knowledge of current economic trends. Modern economies increasingly rely on analyzing numerical data over a while to address economic problems and predict the future. There are several methods or standard and statistical models and models related to artificial intelligence through which prediction can be made, as artificial neural networks are considered one of the most important methods used in predicting the behavior of the future time series, so the study problem can be formulated with the following question: Is it possible to find a mathematical model to predict GDP using artificial neural networks.

- **Objectives and importance of the research:**The objective of the research is to use neural networks to predict the Iraqi economy's gross domestic product. This method is useful in helping planners make informed decisions regarding the country's economy.
- **Research methodology:**An analytical approach was used to study the changes in Iraq's gross domestic product annually from 2003 to 2020. The data was then analyzed using neural networks. The GDP prediction was made using the program known as MATLAB.
- **Research variables:** the variable of the Iraqi gross domestic product at current prices.
- **The concept of time series:** A time series is defined as a random process of historical data collected over time [7]. It is described as a statistical time series, which is a collection of observations X_t that occurred consecutively $X_1, X_2, ..., X_t$ with time, which can be expressed mathematically as meaning that the value of observation is in time. Views may be hourly, daily, weekly, monthly, yearly. Time series analysis aims to know the nature of the time series and the type of changes it contains (seasonal or cyclical, general trend) on the one hand, and use it to predict future values based on current and historical values on the other hand [8].
- **The concept of artificial neural networks:** simulates the way the human brain performs a specific task through mathematical models consisting of huge processing units distributed in parallel, and made up of simple processing units called neurons connected through communication forces called synaptic weights as shown in the figure (1). It is similar to the human brain in terms of the ability of neurons to store information and knowledge by adjusting the weights to make them available to the user [9].

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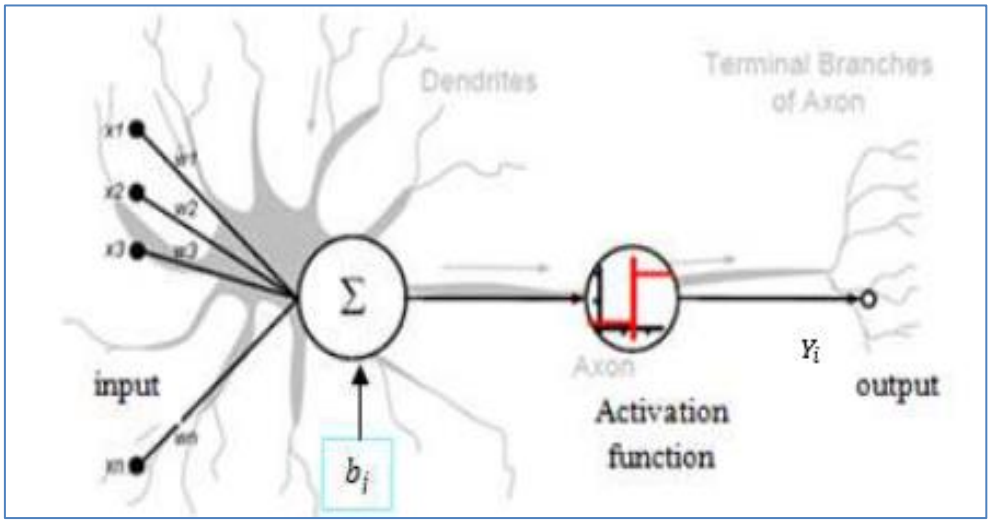

Fig. 1: Shows a neural network simulation of the shape and performance of an artificial neural network [10]

- **The structure of an artificial neural network:** Artificial neural networks generally consist of three layers and each layer contains a set of nodes as follows [11]:

✓ **Input Layer:** It feeds the network with quantitative or qualitative data for the independent variables, so the input layer contains several neurons equal to the number of independent variables.

✓ **Hidden Layer:** The hidden layer in which the data sent by the input layer is processed and is located between the input and output layers. The network may have more than one hidden layer and may not contain hidden layers.

✓ **Output Layer:** this is the output or solution to the problem under study (the output of the neural network).

The network also contains three layers of weights that connect the three layers with links that show the strength of the neural connection between the layers of the neural network [12].

- **The mechanism of action of the artificial neuron:** The neuron is considered the basic processing element in the neural network, as it receives the input elements X_i to be multiplied by the weight corresponding to it w_i, then the results are collected with the bias value b. Then the result of the collection is converted through the activation function to one of the values that are supposed to be within the network outputs (The output of the neuron) [13]. As shown in Figure (2).

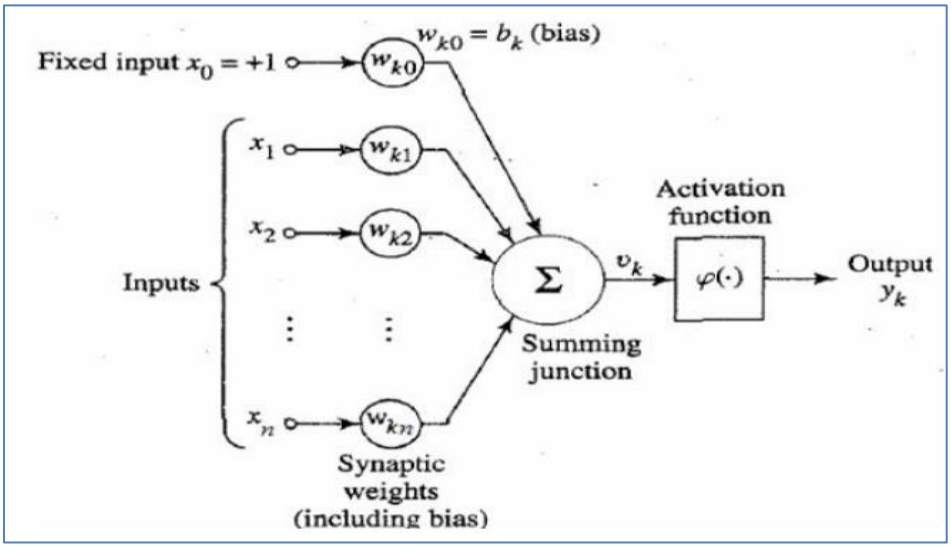

Fig. 2: The mathematical structure of the artificial neuron.

- **Classification of artificial neural networks:** There are many classifications of networks, including:

✓ **Feed Forward Neural Networks:** where the computational operations move in one direction forward from the input layer to the output layer, and thus are devoid of a closed loop.

✓ **Feed Back Neural Networks**: in which computational operations are transmitted in both directions (forward and backward), where the outputs of some neurons are linked to the results of the same neurons at a previous moment in time or to the outputs of other neurons, some examples of which are the NARX network.

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III. RESULTS AND DISCUSSION

This study aims to forecast Iraq's GDP using the data collected from 2003 to 2020, as shown in Table (1).

Table 1: Gross Domestic Product during the period (2003-2020)

GDP	Year	GDP	Year
254225490.7	2012	29585788.6	2003
273587529.2	2013	54436920.23	2004
266332655.1	2014	74872119.6	2005
194680971.8	2015	97540378.9	2006
196924141.7	2016	113779143.6	2007
221665709.5	2017	161087757.4	2008
268918874	2018	135043501.9	2009
277884869.4	2019	163104739	2010
198774325.4	2020	217327107.4	2011

Source: Iraq's statistical group provided data for the period 2020 to 2021.https://cosit.gov.iq/ar/

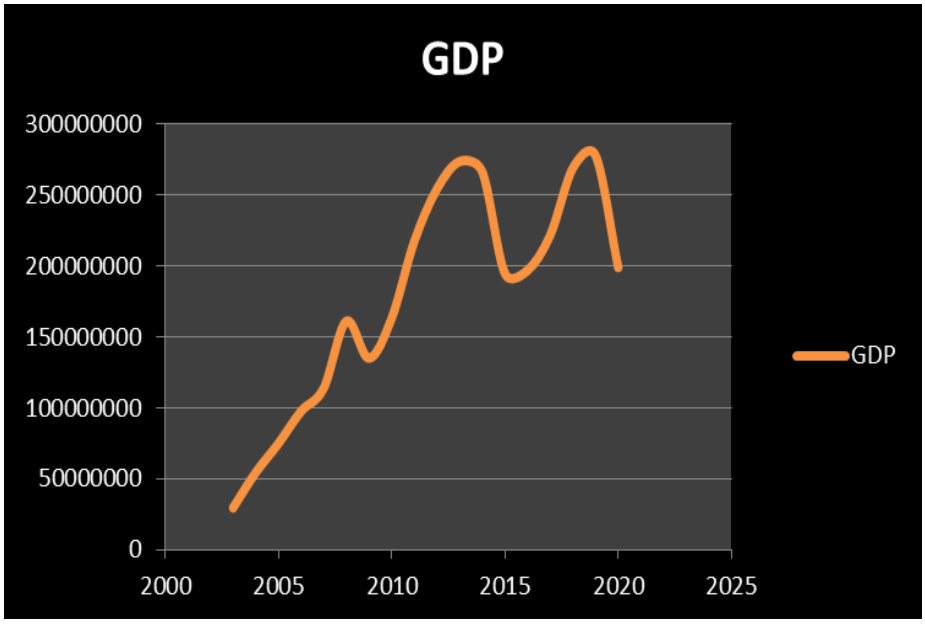

Fig. 3: Shows the changes in the Iraqi gross domestic product during the period studied

From Figure (3), it is clear that there is a general increasing trend for the period from 2003 to 2013, to return and decline until 2015, then rise again until 2019, and then return and decline (the figure shows that the series takes the shape of a sinusoid).

IV. FORECASTING THE IRAQI GDP USING ARTIFICIAL NEURAL NETWORKS

he data collected during this period were then entered into the model using the nntool in MATLAB. The target of the study was Iraq's gross domestic product. The sample sizes for the training set and the test set were then split into 70% and 15% respectively.The model's selection for the type of neural network that will be used for forecasting is based on the menu labeled "Networks". Different types of networks, such as the LRN, the feedback propagation network, and the NarX, were then tested with varying number of hidden layers.Different types of transfer functions, such as linear, angular, and logarithmic, were then utilized in the outer and hidden layers. The program used TRAINLM and TRAINBR for training. The white noise and weights were also selected automatically.The 36 networks that were created were chosen according to the various requirements for the design and construction of a neural network. A comparison of the resulting networks was then performed using the error metrics MAE, MSE, and MAPE.The results of the analysis are presented in Table (2). The series with the lowest error value was selected.

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Table 2: Results of RMSE error measures for predictive time series

			feed-forward backpropagation	Layer Recurrent Network	NARX
Training function	**Adaption learning function**	**transfer function**	**RMSE**	**RMSE**	**RMSE**
LM	GD	login	108868632	89100935.53	96030631.47
		purlin	58759272.75	173829195.4	169130947.7
		tansig	65455457.71	120135668.6	66134248.23
	GDM	login	14140248.88	84581855.42	19798324.78
		purlin	22815986.99	117538538.4	126231476.7
		tansig	66528218.58	97181754.62	69909506.51
BR	GD	login	9303593.818	106638518.5	55476664.02
		purlin	8990350.114	166936892.9	44540806.7
		tansig	1222771.16	144095418.3	47542496.76
	GDM	login	4958382.117	76032480.22	69162483.63
		purlin	175710919.5	70297145.74	8793258.395
		tansig	4951666.683	34935804.82	5778624.511

The table was created by the researcher using the output of the MATLAB program.The table (2) shows that the feed forward propagation network that utilized the transit and training functions has the lowest error rate. This means that it will be utilized in the future generation of forecasting tools. The table (3) displays the predicted values using the best network.The table (4) shows the estimated Iraqi GDP until 2025, utilizing an artificial neural network.

Table 3: Prediction results using neural networks

GDP	Year	GDP	Year
256295881.9	2012	31228853.67	2003
271996957.5	2013	54334552.51	2004
267520148.7	2014	74872566.03	2005
195370502.1	2015	97542013.98	2006
197550166.5	2016	113643110.6	2007
220931653.3	2017	160977317.1	2008
269324836.5	2018	135202664.9	2009
273831660.6	2019	163045607.8	2010
199331433.9	2020	216773459.3	2011

Table 4: Predictive values of the Iraqi GDP using artificial neural networks

GDP	**Year**	**GDP**	**Year**
333328213.5	2024	295993087.4	2021
345773255.5	2025	308438129.4	2022
		320883171.4	2023

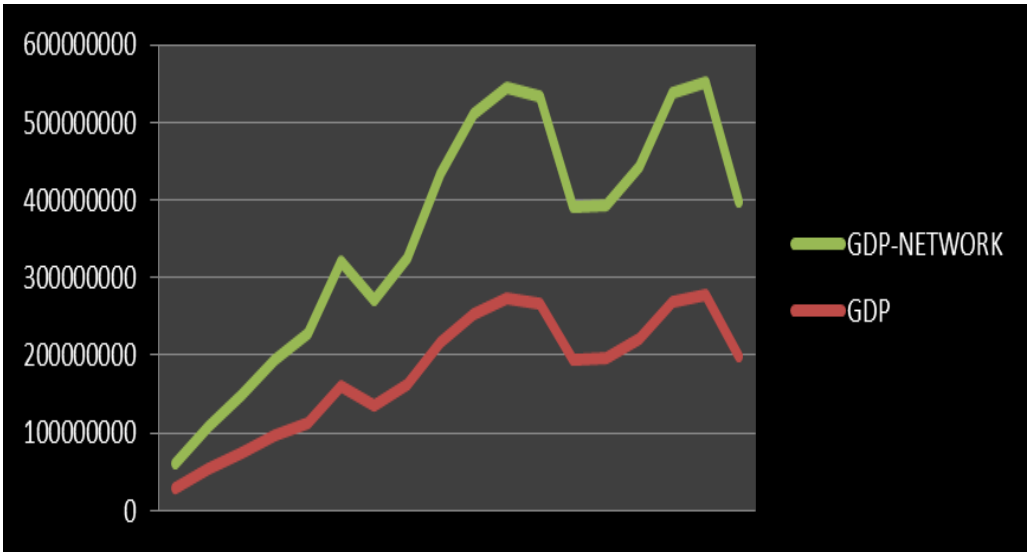

Fig. 2: The original and estimated series of Iraqi GDP according to neural networks for the period 2003-2020

Figure (3) shows the general trend that started in 2003 and continued until 2015, It then increased until 2019 before declining once more. The series appears to have a sinusoid shape.

V. DISCUSSION

The study utilized various artificial neural networks and time series analysis to forecast the Iraqi economy. The results of the analysis were highly significant.

- The GDP of Iraq has been modeled using the neural networks model, which includes the feed-forward backpropagation framework, the Layer Recurrent Network, and the NAREX framework.
- The prediction model that was selected for the project was based on the criteria set by RMSE.
- The Iraqi GDP was predicted using the neural network model that was developed using the TRAINBR training and transit functions. It performed well and had the lowest error value according to the RMSE standard.

VI. RECOMMENDATIONS

- We recommend that government agencies utilize the models that have been made to forecast the Iraqi GDP.
- In the future, we would like to conduct further studies on the Iraqi economy and use neural networks for forecasting its GDP.
- We recommend using statistical methods and neural networks to forecast the Iraqi economy, such as the ARIMA model.

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