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Smart Forecast of Algeria's Unemployment Rates During 1991 – 2020

تنبؤ ذكي لمعدلات البطالة في الجزائر خلال الفترة الزمنية من 1991 إلى 2020

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Abstract

The current study has aimed to apply a mathematical approach of artificial intelligence, which is represented by Non-Linear Autoregressive Artificial Neural Network Model (NNAR) to forecast Algeria's monthly unemployment rates during Dec 1991-Dec 2020, using various algorithms in the training process. By comparing the results of proposed neural networks, it has been shown that the neural network model: NAR-LM of (4-1-20-1), which based on the Back-Propagation Algorithm, has better performance than the Bayesian Regulation Neural Network model and Gradual Training Algorithm as well, where forecast error has reached a value of 3, 56*10^{-6} .Also, the generated series by neural networks: NAR-LM (4.1.20.1) and NAR-BR (4.1.20.1) emulate well the original series compared to NAR-SCG (2.1.10.1).

Key words: Algeria Unemployment Rate, (NNAR) Model; Back-Propagation Algorithm; Bayesian Regulation; Gradual Training Algorithm.

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ملخص

هدفت هذه الدراسة لتطبيق أسلوب رياضي من بين أساليب الذكاء الاصطناعي وتمثل في نموذج الشبكات العصبية الاصطناعية اللاخطية ذات الانحدار الذاتي (NNAR) للتنبؤ بمعدلات البطالة الشهرية في الجزائر خلال الفترة الممتدة من شهر ديسمبر عام 1991 إلى غاية شهر ديسمبر عام 2020، مع استخدام مختلف خوارزميات المطبقة في عملية التدريب، من خلال المقارنة بين نتائج الشبكات العصبية المقترحة تبين أن نموذج الشبكة العصبية ذو البنية NAR-LM(4-1-20-1)، والذي يعتمد على خوارزمية الانتشار الخلفي له أداء أفضل من نموذج الشبكة العصبية ذات تنظيم بايزي و خوارزمية التدريب المتدرج، حيث بلغ خطأ التنبؤ قيمة $3,56*10^{-6}$ و، تبين كذلك أن السلسلة الناتجة عن الشبكة العصبية NAR-LM(4-1-20-1) والشبكة العصبية-NAR BR(4-1-20-1) تحاكيان السلسلة الأصلية بشكل جيد مقارنة بالشبكة العصبية NAR-SCG(2-1-10-1)

الكلمات المفتاحية : معدل البطالة في الجزائر،نموذج (NNAR)خوارزمية الانتشار العكسي، التنظيم البايزي،خوارزمية التدريب المتدرج

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1. INTRODUCTION

Standard computer and statistical mathematical methods in analyzing and studying the economic phenomena have been numerous. Machine learning techniques have proven to be efficient and potential to accurately forecast macroeconomic variables. They tackle problems that linear statistical models have been unable to resolve, thus they are able to explain the non-linear data action without taking into account the distributions of these processed data.

Unemployment problem is a major development hindrance of social security that imperils social safety. It is one of the basic economic problems affecting the entire world; therefore, addressing this problem in developing countries, mainly, it is extremely difficult and complex. The reason behind its complexity is the underdevelopment profound root causes, namely: unsuccessful development efforts, as well as the poor niche of developing countries in the global economy (شيبي عبد الرحيم, 2008, p. 2)

Among these countries, Algeria has the same circumstances. According to the joint research study that carried out from the World Bank and the National Statistical Office as well, which had confirmed that poverty phenomenon prevalence, is based, essentially, on the worse supply to employment, before focusing on purchasing capacity decline, individuals having unemployed status, do not get neither social-protection nor any remuneration as in most other states. (بن حسين ناجي م. م., 2002, p. 115)

From this standpoint, this research aimed at carrying out a modelling and forecasting processes to model and to forecast Algeria's unemployment rates during 1991-2020 using Non-linear Auto-regression Artificial Neural Network Model, through responding the following research question: **How effective is the application of neural network models in forecasting Algeria's monthly unemployment rates during 1991-2020?**

The Study Importance and its Objectives:

✓ To clarify the variation in Algeria's unemployment rates manner as a problem that still affect significantly the national economy, rather, it has even been found that it increased in previous years.

✓ To clarify the main causes contributing in its inflation with suggesting significant solutions to reduce their severity and risk score.

To create a highly efficient mathematical method that can carry out the modelling and forecasting process, concerning Algeria's unemployment rates using Non-linear Auto-Regression Artificial Neural Networks.

2. Literature Review:

In 2017, (Nanthakumaran & Tilakaratne, 2017) had presented a research study entitled**: A Comparison of Accuracy of Forecasting Models: Studying Selected Foreign Exchange Rates**. This study aimed to compare Auto-regression neural network model performance using the Scaled Conjugate Gradient Algorithm and the SVR model, with Gaussian function to forecast Russian-Sri Lankan daily exchange rate with Euro and Yen during 2/7/2012-31/8/2016.

The obtained results indicated that both models have good performance, and based on the differentiation results, a model (SVR) was selected based on MSE findings. Also, (Mucaj & Sinaj, 2017)has discussed a research study entitled: **Exchange Rate Forecasting Using ARIMA, NAR and ARI-ANN Hybrid Model**. This latter aimed at applying three mathematical models (ARIMA model, NAR model and hybrid model) to forecast monthly exchange rate data (USD/ALL) during 2000-2015 in Albania. Based on the expected results, SARIMA (2.1.1) (2.1.1) model and NNAR (2.2.2) model were selected among suggested models. ARI-ANN hybrid model has been nominated according to the comparison results, in order to carry out and accurate modeling and forecasting process. In 2018, (SZILÁRD MADARAS, 2018) conducted a research study entitled: **Forecasting the Regional Unemployment Rate Based on the Box-Jenkins Methodology VS the Artificial Neural Network Approach: Case Study of Brasor and Harghita Countries.**

It aimed at predicting monthly regional unemployment rates in two Roman provinces using Auto-regression Neural Network Model (NAR) during 1/2000-11/2016. Its results are going to be compared with Auto-regression Moving Averages Model (ARMA). Through forecast performance criteria results, the Auto-regression Neural Network Model is a valid for a short term, while Auto-regression Moving Averages Model has better performance in the medium term, especially in Hargita County. Besides, (Jiarui Chang, 2018), had presented a study in 2018, entitled:

Nonlinear Autoregressive (NAR) Network with Bayesian Regularization for Accurate Prediction of Bitcoin Price.

It aimed to apply non-linear auto-regression network with a Bayesian algorithm, and the Levenberg-Marquard algorithm; to analyze Bitcoin fluctuations using historical data and setting up a machine learning model that could better forecast daily Bitcoin price trends; thus, a network structure consisting of 50 neurons in the hidden layer and 30 feedback backlogs was selected. After 126 training performance of the millennium, it achieved better results. Also, the RMSE error of the Bayesian algorithm was less according to the comparison findings between the implementation of (NAR) network and the implementation of different algorithms.

In 2018, (Mozafar Ansari, 2018), carried out a research study entitled: **Analysing the Accuracy of Machine Learning Techniques to Develop an Integrated Infulient Time Series Models: Case Study of a Water Treatment Plant in Malaysia**. It is aimed to model the flow rate of weekly sewage treatment plants (stp) during 2011-2013 using auto-regression moving averages (ARIMA) model, (NAR) model and regression support vector machine model (SVM). As a preliminary assessment, and to evaluate performance, RMSE and R2 criteria have been used. And as a final assessment, the peak flow criterion (PEC), Low flow criterion (LFC), and Relative Error (RE). Consequently, the initial assessment results were surpassing (NAR) model. According to the peak flow criterion in the final assessment, regression support vector machine model (SVM) was selected, while the low flow criterion findings supported the preliminary assessment results, in term of selecting (NAR) model.

Moreover, in 2018, (سهيلةعتروس, 2018) had discussed a research study, entitled: **Forecast Electricity Consumption at Sonalgaz Using Box-Jenkins Methodology and Artificial Neural Networks: BISKRA as a Case Study**. She shed light on applying Box-Jenkins Methodological and the Auto-regression Artificial Neural Network Model during 1/2014-112/2017. The performance comparison results outperformed the traditional statistical method (Box-Jenkins Methodology) compared to the Auto-regression Artificial Neural Network Model, i.e., the conventional model outputs better simulate the reality.

In 2019, (Bubaker M. B. Mohamed, 2019), carried out a research study, entitled: **Prediction of Road Traffic Accidents in Libya Using Artificial Neural Network and Principal Component Regression.** Its objective was to forecast traffic movements in Libya using artificial neural network model and basic elements regression technique. The study variables were the number of the road traffic deaths (Y), Gross National Product (GNP) per capita, Fuel Consumption, and Number of Registered Vehicles during 1970-2017.

The results had affirmed that the three independent variables effectively explain the negative impact on traffic-related deaths. The comparison results between the two models indicated that the performance of the synthetic neural network model was nominated for accurate forecasting. In 2020, (Valerii Matskul, 2020) carried out a research study, entitled: **Ukraine and EU Trade Balance: Prediction via Various Models of Time-series**. This study aimed at forecasting using trade balance dynamics between Ukraine and the European Union through mathematical models, namely: SARIMA model, Holt model of exponential homogeneity and artificial neural network model using monthly monitoring database. i.e., exports and imports gross variance between Ukraine and the European Union.

According to the expected findings, the artificial neural network model has poor performance compared to the other two models. All in all, Holt's model was nominated for modelling and forecasting process, basing upon the less forecasting error that had been scored. In 2021, (Suhail Sharadqah, 2021) had presented a research paper, entitled: **Nonlinear Rainfall Yearly Forecast Based on Autoregressive Artificial Neural Networks Model in Central Jordan Using Data Records during 1938-2018** .This research paper aimed to analyze climate change trends, concerning the rainfall parameters of five stations in Jordan during 1938-2018 using NAR model based on Levenberg-Marquard algorithm.

Its results were about obtaining a rough matching between actual and forecasted rainfall data, while future rainfall forecasts are not the same in all stations. It was found that there is a constant rainfall level at two stations and a high increase at one station (Toufaylia Station), with a significant expected reduction in the Southern station (Al Rachidia Station).

Moreover, (Amani Moussa Mohamed, 2021) has carried out a research study, entitled: **A Comparison between Classification Statistical Models and Neural Networks with Application on Palestine Data**. This study aimed to get the best model describing of the relationship between the labour force using eight independent variables. This dependent variable has two categories: Employment and unemployment for people living in the West Bank and Gaza Strip, who have been between 15 and 65 years and other factors, through using artificial neural networks model, logistical regression, and discriminatory analysis. The comparison and estimation results had indicated that artificial neural networks model was nominated to modelling and forecasting, process with a determination coefficient of 82%.

In 2021, (Kauppinen, 2021) carried out a research study, entitled: **Economic Growth Forecasting in Nordic Countries: A Comparative Analysis between Generalized Autoregressive Conditional Heteroscedasticity Models and Nonlinear Autoregressive Neural Network Models.** The study aimed at comparing the results of the application of the Auto-regression and moving averages model with Generalized Autoregressive conditional heteroscedasticity models (ARMA-GARCH) and non-linear, Auto-regression artificial neural network (NAR) models; to forecast quarterly real growth using gross domestic product (GDP) rates for five countries in the North, namely: Denmark, Finland, Iceland, Norway, and Sweden. The obtained results indicated the detection of slight variations, in term of forecasting capacity on the whole, so that the NAR model did not always outperform the ARMA-GARCH model. So that the results in Norway and Sweden are not the same in Denmark, in which the linear model (ARMA-GARCH) has been outperformed. As a summary of this study, the NAR model has not performed well in forecasting real growth rates.

Add to this, (Harish Paruchuri, 2021) had presented a research study entitled**: Conceptualization of Machine Learning in Economic Forecasting.** The study aimed at testing the use of machine learning models in the Italian economic forecasting using non-linear auto regression model (NAR), non-linear auto-regression model with external variables (NARX), vector regression suppor (SVR), and (BR) model . The studied variable was the GDP rate during the first quarter of 1995 to the second quarter of 2015.

Drawing on various economic criteria that helped in forecasting GDP and identifying the economic situation, the findings of forecast capacity comparison criteria indicated the surpassing of auto-regression with external variables model (NARX) over other used models.

Similarly, (Hermansah Hermansah, 2021) had presented a research study, entitled: Automatic **Time Series Forecasting Using Non-linear Autoregressive Neural Network Model, with exogenous input**. This study aimed at demonstrating the use of the machine forecasting of univariate time-series, represented by inflation rates data (Y) Indonesian exchange rate (X) during 1/2007-12/2018, using non-linear artificial neural network model (NAR), non-linear artificial neural network model with external inputs (NARX), and comparing them with traditional statistical models (ARMA and ETS models). Based on the results of the MSE and MAP forecasting accuracy criteria, (NARX) default models were surpassed NAR, ARMA and ETS models.

Besides, (Sri Rajitha Tattikotal, 2021) had presented a research study, entitled: **Integration of Econometric Models and Machine Learning-Study on Us Inflation and Unemployment.** This study aimed at comparing the performance of the standard economic models (ARIMA) model, (GARCH) model, and machine learning models (logistic regression, vector machine support(SVM), (Gradient booting) model, (K-nearest) (neighbors) model, and (Random Forest); to forecast quarterly unemployment rates during 1997-2020, and inflation rates during 1960-2020. The obtained comparison results of unemployment indicated that EGARCH model, and machine learning (K-nearest) are the best econometric models. In addition to that, EGARCH model was also selected for inflation rates with two models in machine learning, which are: support vector machine (SVM), and (Random forest) model. In general, machine learning models have outperformed standard econometric models.

Furthermore, (Adriana AnaMaria Davidescu.al, 2021) had presented a research study entitled: **Comparative Analysis of Various Univariate Forecasting Methods of Modelling and Forecasting Romanian Unemployment Rate during 2021-2022**. This research study aimed at carrying out a comparative analysis of the expected performance of various univariate time series methods; in order to provide future forecasts of unemployment rates. The applied models, during 1/2000 -12/2017, were: SARIMA model, auto-regression threshold (SETAR), Hotl-Winters model, ETS model and the NNAR model. According to the forecast accuracy assessment, NNAR model had surpassed other models in accordance with RMSE and MAE criteria. For MAPE criterion, SARIMA model outperformed, while the Diebold-Mariano test results have chosen (NNAR) model to carry out the modelling and forecasting process to model and forecast unemployment rates.

Last but not least, (Cristina Ghinea.al, 2021) focused on carrying out a research study entitled: **Artificial Neural Network Applied in Forecasting the Composition of Municipal Solid Waste in Lasi, Romania**. The study aimed at applying artificial neural networks two models, namely: (NIO) model and (NARX) model to modeling and forecasting solid waste composition in Yash city, Romania. The independent variables used were number of inhabitants; inhabitants aged 15-59 years; life expectancy in urban areas; and gross solid waste. Then, (NIO) (6-11-4) model and (NARX) model with an architectural structure of (6-13-4) were chosen. Also, the performance assessment results with the forecasted performance comparison results have shown that the (NARX) model possesses better performance, than the (NIO) model; hence it can be easily applied.

3. Methodology:

3.1 Artificial Neural Networks:

The widespread use of artificial neural network models in many forecasting processes is due to their ability to design a non-linear model related for dependent and independent variables (inputs and outputs). It is a modern and efficient method, and it will be based on logic in their processes, rather than on constant relationship principle between symbols and reactions. (سهيلةعتروس, 2018, p. 172)

3.2 Non-linear Auto-Regression Neural Network (NAR):

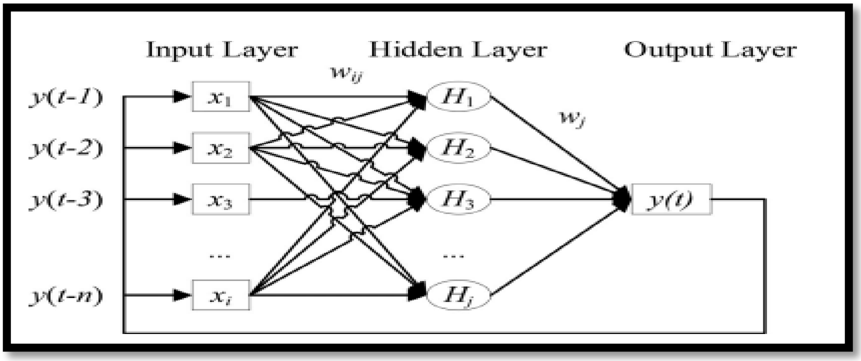
The Non-linear Auto-Regression Neural Network (NAR) belongs to dynamic neural networks group. It is a neural network with backlogs, i.e.

The output depends not only on current inputs, but on previous periods' inputs or outputs. NAR model is expressed through the following equation:

$$y_t = f(y_{t-1}, y_{t-2}, y_{t-3}, \dots \dots \dots .., y_{t-n})$$

n = number of backlogs included in the model. (xuecai xu, 2021, p. 5)

Fig.1. Nonlinear Auto-regression Neural Network Structure



Source: Xuecai Xu and al. , A hybrid Autoregressive Fractionally Integrated moving average and Nonlinear Autoregressive neural network model for short-term traffic flow prediction ,Journal of Intelligent Transportation systems ,2021,p9.

According to Markus Kauppinen, it is one of artificial neural network types. It is trained to forecast studied time series future values. It is based on training algorithms that adjust weights values to achieve desired output. Two basic adopted approaches in the current studies used to improve the network functioning, which are:

1) The Selection Approach: in which a complex network is built. This network consists of a large number of neurons. Then, the unnecessary cells are reduced and extra-connections are removed when needed.

2) Progressive Approach: in which the simplest possible neural network structure is built, after which neurons or layers are added until the ideal structure is reached. (Kauppinen, 2021, pp. 19-20)

3.3 Non-linear Auto-Regression Neural Network Model Algorithms (NAR):

Neural networks are generally classified into static and dynamic networks, where static networks do not contain feedback and backlogs elements. In other words, output is counted directly through inputs using feedforward connections, while for dynamic neural network extraction; it depends not only on current inputs but also on previous and current inputs and outputs. Non-linear Auto-Regression Neural Network Model uses, basically, a training algorithm, such as: Levenberg-Maquardt Algorithm, Bayesian Regulation, and Progressive Training Algorithm (Scaled Conjugate Gradient). All these algorithms have strengths and weaknesses, as follows:

Levenberg-Maquardt Algorithm: its application requires less time, but a large memory is consumed. This algorithm stops when the mainstream stops improving, i.e. with average quartet error increase).

Bayesian Regulation: requires time in the training process, but it provides good mainstream, and it shows good performance in micro databases and macro databases sets. The training stops when adaptive weight is reduced.

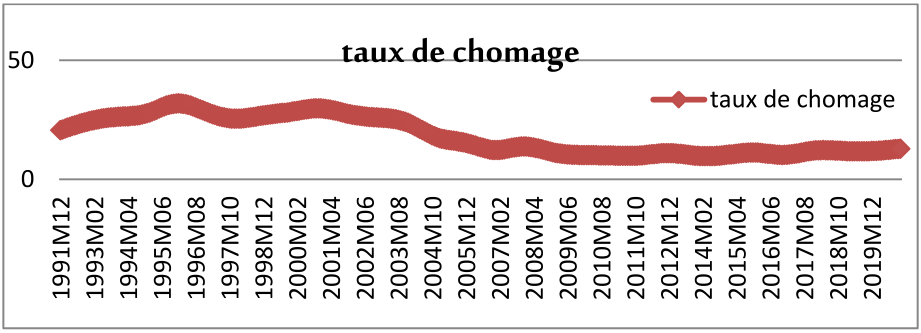
Scaled Conjugate Algorithm: it is highly efficient in micro databases, and its training stops when the mainstream stops improving, i.e. average quartet error increase of the verification sample) (Jiarui Chang, 2018, pp. 56-57)

4. Discussion and Results:

4.1 Algeria's Unemployment Data Analysis:

Figure (02) indicates monthly series of Algeria's unemployment rates during Dec 1991-Dec 2020. It is apparent that these rates were registered their highest levels in 1995, as a result of the structural stabilization programme, which negatively affected the unemployment index. After that, this index was undergoing a gradual decline in 2000. By the end of 2019, a new rise of unemployment rates was noted due to Covid-19 epidemic widespread that it is not yet determined how to adapt to it, considering it as an external variable that has not been eliminated definitively.

Fig.2. Monthly Algeria's unemployment rates from 1991 to 2020



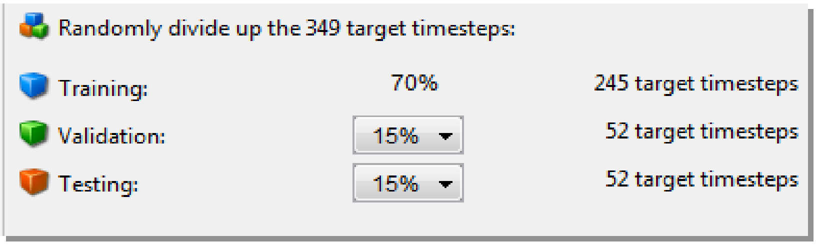
Source : by Researchers Using Excel

4.2 Study -data Assessment:

The study variants were the series of monthly Algeria's unemployment rates from 1991 to 2020, i.e. total of 349 views. Data were divided into three groups:

- ✓ Training group with 70% of the study data.
- ✓ Ascertainment group comprising 15% of the study data
- ✓ Examination group comprising 15% of the study data.

Fig.3. Incomes ray ratios



Source : by the researchers using Matlab R2014a Programme

4.3 Artificial Neural Network Type:

This study is based on a non-linear auto-regression neural network (NNAR), which is highly applied in the modelling and forecasting process of univariable study, which is expressed by monthly Algeria's unemployment rate in this study.

4.4 Artificial Neural Network Structure:

The adopted neural network consists of three layers (inputs, hidden layer, outputs). The Levenberg-Marquard Back-propagation Algorithm, Bayesian Regulation, and Scaled Conjugate Gradient Algorithm have been applied. Also, carrying out a change in neurons number present in the hidden layer and the backlogs degree, and selecting the logistical function as an activation function in the hidden layer, with the linear assembly function in the output layer. Its aim is to achieve an original artificial neural network that emulates well the original series of low error average, which can be used to forecast future unemployment rates.

4.4.1 Appropriate Artificial Neural Network Model Identification Using Backpropagation Algorithm:

After several attempts and changing the neurons number in the hidden layer (increase and decrease), 10 neurons; 20 neurons; and eight neurons were tested, as well as changing backlogs degree (From 2.3.4). Comparing correlation coefficient values with quartet error average in the training and testing phase, a neural network structure of four backlogs with one hidden layer of 20 neurons was selected. In both phases, the correlation coefficient possesses a value of 0.999, with very small quartet error average of 3, $53*10^{-6}$ in training phase, and 2, $87*10^{-6}$ in testing phase, as shown in table (1).

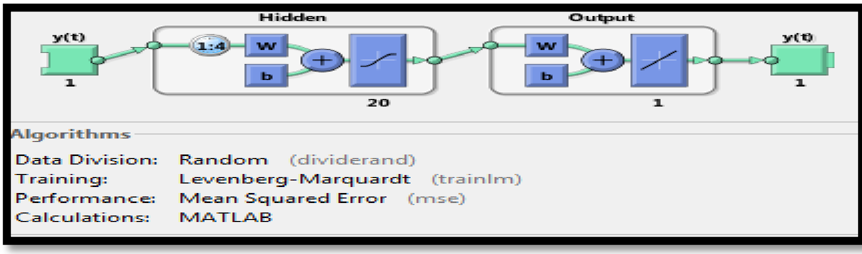
Table1. Applied Neural Network Models Using Backpropagation Algorithm

Model	Train		test	
	MSE	R	MSE	R
NAR-LM(2-1-10-1)	$2,32*10^{-4}$	$9,999998*10^{-1}$	$3,04*10^{-4}$	$9,99997*10^{-1}$
NAR-LM(3-1-10-1)	$7,50*10^{-6}$	$9,99999*10^{-1}$	$1,001*10^{-5}$	$9,99999*10^{-1}$

NAR-LM(4-1-10-1)	$2,05*10^{-6}$	$9,99999*10^{-1}$	$5,009*10^{-6}$	$9,99999*10^{-1}$
NAR-LM(4-1-20-1)	**$3,53*10^{-6}$**	**$9,99999*10^{-1}$**	**$2,87*10^{-6}$**	**$9,99999*10^{-1}$**
NAR-LM(4-1-8-1)	$5,45*10^{-5}$	$9,99999*10^{-1}$	$4,93*10^{-5}$	$9,99999*10^{-1}$

Source :by the researchers using Matlab R2014a Programme

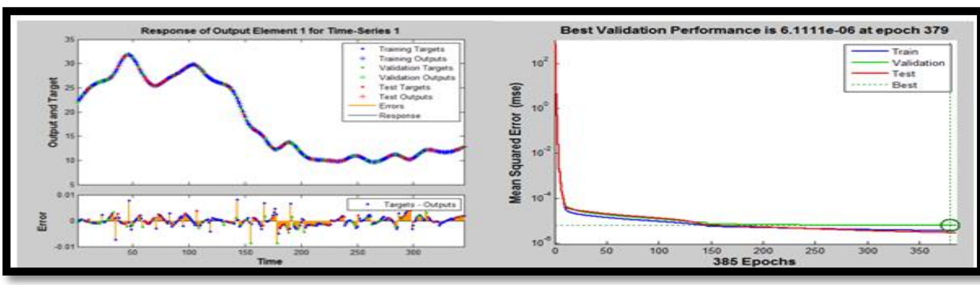
Fig.4. Neural Network Box Diagram NAR-LM (4-1-20-1)



Source : by the researchers using Matlab R2014a Programme

After selecting of the NAR-LM (4-1-20-1) model, its efficiency has been proved (look Fig (5) results). According to the first diagram (on the right), the good performance of the network had been indicated after 379 attempts, giving the smallest error average in the test phase, followed by the training and verification phase. According to the second diagram, the residue autocorrelation function trapped within (-0.01, 0.01).

Fig.5. NAR-LM (4-1-20-1) Training and Testing Processes Results



Source : by the researchers using Matlab R2014a Programme

4.4.2 Appropriate Artificial Neural Network Model Identification Using Bayesian Regulation:

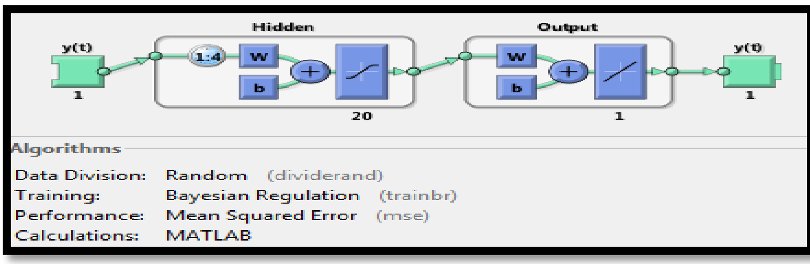
Based on Table (02) results, a neural network structure of four backlogs has been selected. This latter contains 20 neurons in the hidden layer and one output, which corresponds to the used neural network structure using the back propagation algorithm where the quartet error average the training process possesses a value of 4, $28*10^{-6,}$ while a value of 3, $56*10^{-6}$ in the test process. In addition to that, the correlation factor in both phases is equal with a ratio of 0.999, which indicates a strong correlation between the input and output model.

Table 2. Applied Neural Network Models Using Bayesian Regualation

Model	train		test	
	MSE	**R**	**MSE**	**R**
NAR-BR(2-1-10-1)	$4{,}13*10^{-5}$	$9{,}99996*10^{-1}$	$5{,}22*10^{-4}$	$9{,}99995*10^{-1}$
NAR-BR(3-1-10-1)	$1{,}71*10^{-5}$	$9{,}99999*10^{-1}$	$2{,}52*10^{-5}$	$9{,}99999*10^{-1}$
NAR-BR(4-1-10-1)	$4{,}83*10^{-6}$	$9{,}99999*10^{-1}$	$6{,}35*10^{-6}$	$9{,}99999*10^{-1}$
NAR-BR(4-1-20-1)	$\mathbf{4{,}28*10^{-6}}$	$\mathbf{9{,}99999*10^{-1}}$	$\mathbf{3{,}56*10^{-6}}$	$\mathbf{9{,}99999*10^{-1}}$
NAR-BR(4-1-8-1)	$5{,}23*10^{-6}$	$9{,}99999*10^{-1}$	$5{,}99*10^{-6}$	$9{,}99999*10^{-1}$

Source : by the Researchers Using Matlab R2014a Programme

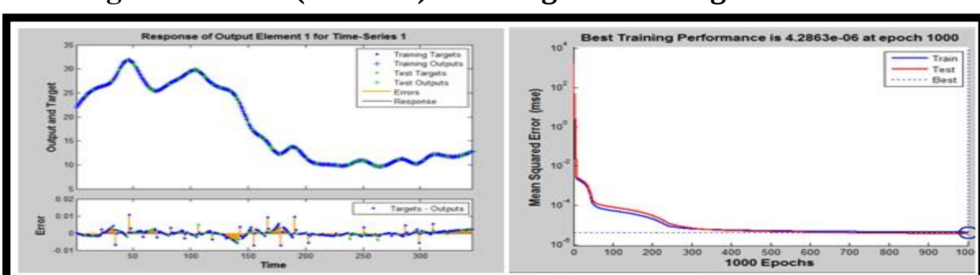
Fig.6. Neural Network Box Diagram NAR-BR(4-1-20-1)



Source : by the Researchers Using Matlab R2014a Programme

According to the figure below results, which is showing network output performance, this latter perform good after the 1000th attempt for both test and training sample. Therefore, the trend of residue autocorrelation function change was not exceeded (-0.01 ;0.01). (According to the diagram)

Fig.7. NAR-BR (4-1-20-1) Training and Testing Process Results



Source : by the Researchers Using Matlab R2014a Programme

4.4.3 Appropriate Artificial Neural Network Model Identification Using Gradual Training Algorithm (Scaled Conjugate Gradient)

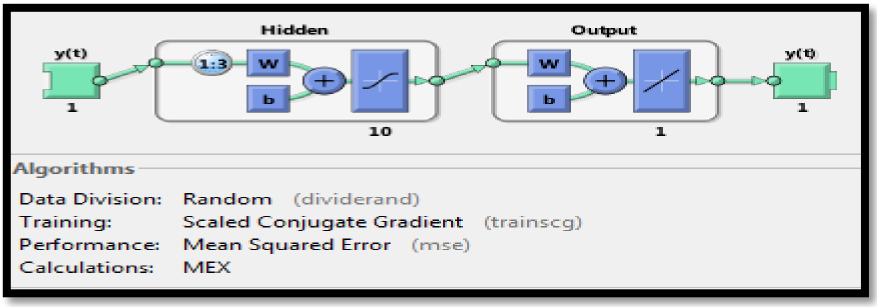
Based on table (03) results, the approved model for the lowest quartet error average of 3, 16*10^{-2} in the training process, and 4, 36*10^{-2} in the test process, with a large correlation factor of 0.97, proved that it is a model that consists of three backlogs and 10 neurons in the hidden layer, which did not correspond to the obtained network structure through the first two algorithms.

Table 3. Applied Neural Network Model Using Gradual Training Algorithm

Model	train		Test	
	MSE	R	MSE	R
NAR-SCG(2-1-10-1)	3,09*10^{-1}	9,97477*10^{-1}	3,61*10^{-1}	9,973*10^{-1}
NAR-SCG(3-1-10-1)	**3,16*10^{-2}**	**9,9974*10^{-1}**	**4,36*10^{-2}**	**9,996*10^{-1}**
NAR-SCG(4-1-10-1)	3,58*10^{-1}	9,972*10^{-1}	4,29*10^{-1}	9,9607*10^{-1}
NAR-SCG(4-1-20-1)	4,52*10^{-2}	9,996*10^{-1}	9,52*10^{-2}	9,9918*10^{-1}
NAR-SCG(4-1-8-1)	9,58*10^{-2}	9,992*10^{-1}	1,55*10^{-1}	9,985*10^{-1}

Source : by the Researchers Using Matlab R2014a Programme

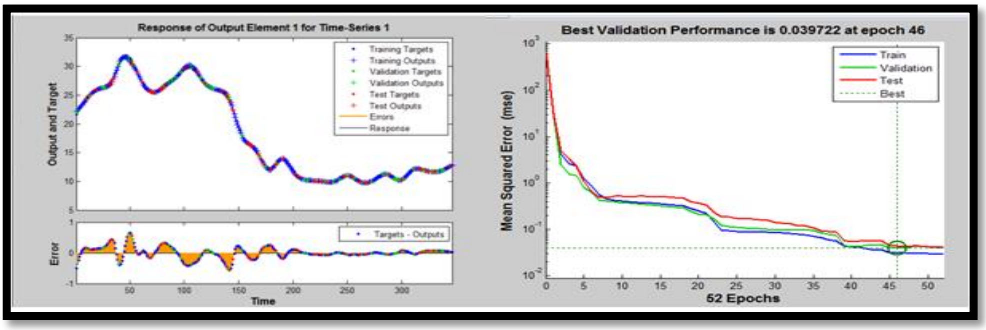
Fig.8. NAR-SCG (3-1-10-1): Neural Network Model Box Diagram



Source : by the Researchers Using Matlab R2014a Programme

The figure below indicates that the selected neural network performed well in the 46th attempt, which corresponds to a lower quartet error average of the selection process, followed by the verification and training processes. For the model residue autocorrelation function, it had been shown that it is trapped within (1- ; 1). The network results are not good compared to other applied neural networks results using various algorithms.

Fig.9. NAR-SCG (2-1-10-1) Training and Testing Process Results



Source : by the Researchers Using Matlab R2014a Programme

4.5 Using Various Algorithms to Choose Among Artificial Neural Network Models Performance

Based on Table (04) results, it had been shown that NAR (4.1.20.1) neural network performance using the Backpropagation algorithm is better than its performance using the two models of gradual training algorithm and Bayesian organization. The error average was of 3, $56*10^{-6}$ and a correlation factor was of 99.99%, what demonstrates artificial neural network efficient performance using Backpropagation algorithm.

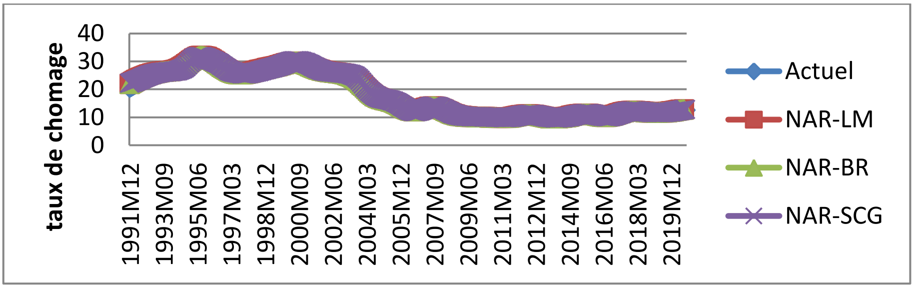
Table 4. Comparison Results of Neural Network Models Using Various Algorithms

Model	MSE	R
NAR-LM(4-1-20-1)	**$3,56*10^{-6}$**	**$9,99999*10^{-1}$**
NAR-BR(4-1-20-1)	$4,2863*10^{-6}$	$9,99999*10^{-1}$
NAR-SCG(3-1-10-1)	$3,46*10^{-3}$	$9,997*10^{-1}$

Source : by the Researchers Using Matlab R2014a Programme

Figure (10) illustrates the applied neural network models simulation results through various algorithms. The model emulates the original series by using Back-propagation Algorithm, followed by the neural network model using Bayesian regulation, and then the neural network model using Gradual training Algorithms.

Fig.10. Comparison of Actual and Predicted Unemployment Rates



Source : by the Researchers Using Excel Programme

According to Fig (10) results, and to demonstrate the outperformance of the training Backpropagation Algorithm, forecast errors were counted between actual monthly unemployment rates from Dec 2019 to August 2020, with forecasted unemployment rates using three neural network models, where actual unemployment rates correspond to those from the neural network model using the Backpropagation algorithm, which registered little forecast errors.

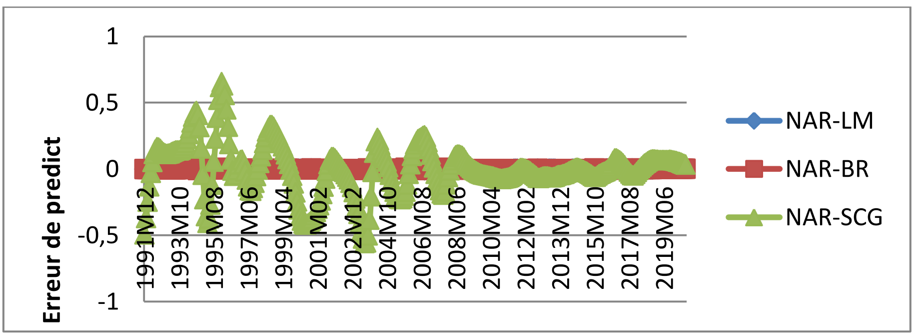
Table 5. In-sample Prediction Results of Unemployment Rate Values Using Three Artificial Neural Network Models during Dec 2019 – Sep2020

Year	Actual	NAR-LM		NAR-BR		NAR-SCG	
		Forecast	Prediction Error	Forecast	Prediction Error	Forecast	Prediction Error
2019M12	11,8100004	12,0606173	0,0010215	12,0597223	0,00191655	11,9210048	0,0657128
2020M01	11,86007	12,1419965	0,00119066	12,1412255	0,00196163	11,9988125	0,06282633
2020M02	11,9192519	12,2291968	0,00133747	12,2285302	0,00200409	12,0834794	0,05970783
2020M03	11,9867176	12,3213895	0,00146212	12,3208085	0,00204313	12,1742506	0,05628365
2020M04	12,0616388	12,4177452	0,00156576	12,4172327	0,00207824	12,2703608	0,05249079
2020M05	12,1431872	12,5174338	0,00165002	12,5169752	0,00210866	12,3710338	0,04827716
2020M06	12,2305342	12,6196245	0,00171737	12,6192079	0,00213397	12,4754817	0,04360212
2020M07	12,3228516	12,7234861	0,0017706	12,723103	0,00215366	12,5829047	0,03843716
2020M08	12,419311	12,8281873	0,00181266	12,8278326	0,00216731	12,6924895	0,03276723

Source : by the Researchers Using Matlab R2014a Programme

Based upon the forecast error value curves compared to the applied models represented in Fig (11), NAR-SCG (2-1-10-1) is ranked last, so that the corresponding forecast error curve is in constant high and low status trapped within (0.7, -0.6), followed by the NAR-BR (4-1-20-1) model in the second-ranking.

Fig.11. Comparing NAR-LM model; NAR-BR Model; and NAR-SCG model, in terms of Prediction Error values



Source : by the Researchers Using Excel Programme

Conclusion:

According to what has been presented in previous studies that were aimed at modeling and forecasting an economic phenomenon, we had found that the used methods have been artificial intelligence methods. This shows the efficiency and accuracy of these methods in emulating reality as required. What we have attempted to carry out in this study, is to apply Non-linear Artificial Auto-regression Neural Networks Model; to forecast Algeria's unemployment rates, focusing on identifying neural network performance, in terms of backlog degrees change and training algorithms various use. Also, mentioning to which extent the original series of unemployment rates matches the forecasted ones. Among the main findings of the study, we mention the following results:

- The Artificial Neural Networks Model "NAR-LM (4-1-20-1)" using Backpropagation Algorithm has been outperformed the Neural Network Model, using Bayesian Regulation and the Gradual Training Algorithm.
- According to Neural Network Forecast Error Ratios, we figure out that their values are trapped within plausible extent. This proves that neural network techniques perform effectively and accurately in modelling and forecasting, regardless of the applied algorithms.
- The Neural Network Model emulates well the original series with a forecast error of $-3,56*10^{-6}$

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