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Research Article

Forecasting Iraq Stock Exchange index based on hybrid Genetic and partial swarm optimization

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Abstract

An overall state of the economy of a country is reflected through the stock price market. Where high levels of index indicate an improved and growing economic state while low levels mean crisis and downturn. The prediction of stock price index through particle swarm optimization (PSO), artificial neural network and genetic algorithm (GA) can provide a great help. This paper attempts to identify the factors that affect the stock exchange index through the prediction and modeling Iraqi Stock Exchange Index on GAs with PSO approach. The paper aims of predicting the Iraq Stock Exchange Index and presents a general view of items that influence it, through implementing hybrid GA_PSO and compare with other regression model as GA,PSO, ANN. The simulation results the MSE of ANN, GA,PSO, hybrid GA-PSO 0.29332, 0.087423, 0.092345, 0.0077798 in order, that mean the GAPSO achieve the best result

Keywords: Forecasting, neural network, GA, PSO hybrid GA-PSO, Iraq stock exchange index

1. Introduction

Economic sectors offer economic protection to people and material resources, as well as acting as a financial crisis shield for the national economy [1]. According to the financial weight that this sector inhabiting driven by the prominent role, and that the insurance companies play in compiling the national savings, which requires high financial skills from these companies to accomplish the objectives and goals of the economic development plans, insurance plays a significant role in the stability and growth of numerous economic sectors and efficiently contributes to achieving the objectives of the economic development plans. It is not questionable that the current state of the insurance industry, as well as anticipated changes in the future, require the use of modern and advanced analytical techniques to monitor the financial activity of insurance firms, particularly finance and investment. [2]. As a result, financial analysis has become more important in many areas of economic activity, especially in the banking and insurance sectors, as a result of the nature of the banks' and insurance firms' business, which is linked to money collections from depositors and policyholders [3]. The importance of financial analysis not only due to its being a tool for assessing performance and management efficiency, but also because it is needed in the process of financial planning [4]. The financial analysis methods are intended to determine the extent of the result that came out from implementing legal policies and making decisions in the companies, as well as the companies' capability to achieve their obligations to policyholders, as well as assisting and enabling financial regulators to oversee the execution of insurance firms' policies [5].

An Artificial Neural Network (ANN) model has been used in many different types of corporate decision making to better anticipate issues in management. Companies, for example, utilize ANN to predict bankruptcy, customer attrition, stock price predictions, and a variety of other things. To predict the insurance company's premium income, we utilized the GA PSO produced regression hybrid technique.

2 **Related Work and Background Theoretic**

Arash BAKHSHA1 [6] 2015, this work tried the identifying of factors that affect stock exchange index (SEI) through the modeling and predicting the Iran SEI based using the approach of NN, the monthly pattern of developments from 2015 to 2019 was examined. **G. W. R. I** [7] 2020, ARIMA has shown its ability to anticipate future delays with precision and accuracy. There is relatively few research in the literature that have focused on novel methods to forecasting high volatility stock price indices for the Colombo Stock Exchange (CSE). Only numbers of studies that have focused on modern methods for forecasting the high volatility stock price indexes. In recent years, lots of economic data techniques and statistical methods have been implemented widely for the purpose of classifying CSE's patterns, stock prices and trade volume. This paper views the best organization and sector to invest in, as well addresses if the deep-learning algorithms for time series data projection, such as the Back Propagation NN are more efficient than traditional algorithms and how they are better. The results revealed that traditionally based algorithms like the model ARIMA accuracy was less than Deep learning algorithms like BPNN. The MAPE values were 0.1783333 and 0.472206 for ANN and ARIMA respectively, while the value of MAE achieved 4.708423 for ANN and 29.6975 for ARIMA. The MAE and MAPE values relative to ARIMA and BPNN, which suggests BPNN `s superiority to ARIMA. **Wijesinghe.,[8],** investigated the Colombo Stock Exchange (CSE) to reveal innovated predictive approaches that predicts the high instability of stock price indexes. Over the last decade, lots of economic data strategies and statistical approaches were used on a wide range to describe the trade volume levels and movements of market prices in CSE. This work explains how the newly advanced deep learning algorithms for the projection of time series data, such as the Back Propagation NN, perform better than traditional algorithms. It is noted from the outcomes that traditionally based algorithms like the model ARIMA are of less performance than Deep learning algorithms like BPNN. The MAE and MSE values relative to ARIMA and BPNN, which suggests BPNN 's superiority to ARIMA. **Dutta, Abhijt[9] 2020,** showed that an accuracy of 99% was provided by that algorithm. The research is being utilized as an alternative to the liner models that are often used to forecast returns. OSS-TANSIG presented the best prediction by validity of 0.9407. Most of the models are of equal value in terms of usefulness as determined by weighted totals. As a result, in real life, particularly for extremely long period data, the choice of model is unimportant and of low order. **Saroei, Somayeh [10] 2020,** able to design a valid statistical model by using findings of artificial neural network (ANN) system to predict the bankruptcy of Iranian companies? The statistical population in this study is all of listed companies in Tehran Stock Exchange. By considering the criteria and method of systematic deletion, 172 companies from this statistical society have been selected as the sample in this research from 2007 to 2016. The results of the analysis of the research data show that the ANN system can identify of the factors affecting on bankruptcy of Iranian companies in the year before bankruptcy by Precision equal 98%

2.2 Iraq Stock Exchange:

It is a non-profit organization that is administratively and financially independent, established under Law 74 in 2004 and was officially inaugurated on June 24, 2004, before 2003 it was called the Baghdad Stock Exchange and managed by the Iraqi Ministry of Finance, and now it has become a self-regulating body subject to the Securities Supervision Commission. Iraq and includes under it more than a hundred companies belonging to seven sectors (banks, industry, services, agriculture, tourism, communications, insurance).The Iraq Stock Exchange aims to achieve the following: first Organizing the transactions of its members with all that is related to buying and selling operations. Second Determining the rights and obligations of the parties and the means of protecting their legitimate interests. third Collecting, analyzing and publishing the statistics for the information necessary to achieve the stated goals. Fourth, Educating investors to trade in the capital markets while ensuring work in free, honest and transparent

markets. The ISX60 index consists of (60) joint stock companies, which were approved after the development of the trading system from Horizon to X-stream in 2014, when it was launched in the first session of 2/9/2015. The index is a measure of market performance, because it shows the general trend of stock price movements. At the end of each session, the value of the achieved indices is compared with their value in the previous session, to determine whether the market trend is high, low, or unchanged [11,12].

2.3 Artificial Neural Networks

ANNs provide a computational method that is distinct from traditional digital computing. Digital computers work in a sequential fashion and can do very rapid arithmetic calculations [13]. In ANNs, each processing unit takes input from other sources or output signals from other units before producing an output. The input signals (x_i) are multiplied with weights (W_{ji}) of connection strength between the sending unit "i" and receiving unit "j". An activation function is applied to the sum of the weighted inputs. The output may be utilized as a source of information for adjacent units or units in the next tier. Assume that the input signal by a vector ($x_1,x_2,..x_n$)and the corresponding weights to unit "j" by ($w_1,w_2,..w_n$), the net input to the unit "j" is given by Equation (1). The weight (W_{j0} = b) is a special weight called bias whose input signal is always +1 [14,15].

$$Net_j = \sum W_{nj} X_n + W_{j0} = W_{jx} + b \quad \text{eq.1}$$

If the networks output shows with and actual value with Y, the aim of network training is to discover the weight of networks to reduce the network error. If the forecasting error is calculated using the Sum of Squared Errors (SSE), the goal is to reduce the Equation. (2) [16].

$$\mathrm{SSE} = \sum \left(Y_i - \overline{Y_i} \right)^2 \quad \text{eq.2}$$

2.4 Genetic algorithm GA

The present population is also the starting population in the first generation. Selection may be done in a variety of ways. The creation of the intermediate population is complete after selection, and recombination is possible. This may be thought of as the intermediate population being used to create the following population. With a probability of Pc, crossover is applied to randomly matched strings [17]. For recombination, a pair of strings is chosen with probability Pc. These strings are combined to create two new strings, which are then put into the following population. The mutation operator is used after recombination. All bits in the population are mutated with some probability Pm [18]. The probability of the mutation rate is typically less than 1%. In certain instances, mutation is understood as randomly producing a new bit, in which case the mutation will only alter the bit value 50% of the time. The next population will be evaluated after the selection, recombination, and mutation processes. Those processes all form one generation in the execution of a GA [19].

2.5 Particle Swarm Optimization (PSO)

Swarming behaviors seen in swarms of bees, schools of fish, or flocks of birds as well as human social behavior, are all included into Particle Swarm Optimization (PSO). Each particle is defined by the original PSO equations as a possible solution to a problem in D-dimensional space. Particle i's position is indicated by [20].

"X = (x_{i1}, x_{i2},....., x_{id})

Each particle also maintains a memory of its previous best position, represented as:

$P = (P_{i1}, P_{i2},....., P_{id})$

A particle in a swarm is moving; hence, it has a velocity, which can be represented as:

$v = (v_{i1}, v_{i2},....., v_{id})$"

To this point, all particles recognize their best values (pbest) and their positions. In addition, these particles also know the best value in the group (gbest) among the (pbest)s. This data is analogous to knowing how the other particles in their environment have done. Using the information below, each particle attempts to change its location:

• the distance between the current position and pbest.

• the distance between the current position and gbest.

The notion of velocity may be used to describe this change. In the inertia weight method, the following equation (1) can be used to change the velocity of each agent. (IWA)[21,22]

$Vid= w*vid +c1(gbest – xi)+ c2(pbest – xi)$

$Pnew =Pid + vid$

3. Proposed Method

The required data was collected from the Central Bank of Iraq, Exchange trading system under the collapse of stock exchange organization from 2017 to 2021, on a monthly basis, to model and forecast the Iraq Stock Exchange and identify the economic factors influencing it. Various sectors, such as the banking industry, have an impact on the Iraq Stock Exchange Index, they also may include basic metals industry, petrochemical industry and chemical products, gas, oil, construction industry, automotive industry, price of dollars on the open market, and cement industry, follow in algorithm (1),

Algorithm (1) the General algorithm
Input the Iraq Stock Exchange index Output : the model
First step: Data collection : In this work, the daily, weekly and monthly data of the Iraqi Stock Exchange were used from 1/1/2017 until 1/1/2021, where these data represent the general indicator of the Iraqi stock market, and the approved variable indicator was described. In representing the explanatory variables for the number of shares traded x1,..X6 Second step:calculate the statistical description for each sector (telecommunications, tourism, service agriculture, industry, banks) based on the following criteria: Mean, Median, Maximum, Minimun, Std.Dev, Skewness, Jarque-Bera, Probability. Step third : **graphical analysis** The time series data of the six models are drawn as a first step to analyze the data and to give an idea of the stability of the time series or not, and to clarify the extent to which the series needs appropriate transformations for its stability or the stability of its variance before conducting any analysis of it step fourth : fill missing value this achieve by fill of an array or database with the next value, and normalization the database step five : split the data to training data and test data based kfold cross validation where the train represent the 80% and test represent 20 % step sixth: training model apply algorithm (2) forecasting ANN apply algorithm (3) forecasting GA apply algorithm (4) forecasting PSO

apply algorithm (5) forecasting HybridGA-PSO
step seven : test the each model and compute MSE of each model

Algorithm (2) forecasting ANN

Input the Iraq Stock Exchange index
Output : the model

- The consistent from 20 hidden layer layer and one output.
- The NN Fitting Tool assists with data selection, network creation and training, and performance evaluation utilizing regression analysis and mean square error.
- A twenty-layer feed-forward network with sigmoid hidden neurons and linear output neurons.
- Given consistent data and enough neurons in its hidden layer, NN Fitting can fit multi-dimensional mapping problems arbitrarily well.
- The Levenberg-Marquardt backpropagation algorithm is going to be used for network training.

Algorithm (3) forecasting GA

Input the Iraq Stock Exchange index
Output : the model

- Initial population, where the chromes content the β of generation randomly between 0 and 1, the length of population represent by 20 chromosome and each chromosome length equal the number of input the dataset
- Compute the fitness of each chromosome and the fitness function : MES =Y - $\sum \beta_i * X_i$
- Selection : the operation of selection use the Rolette wheel
- Crossover over : apply by single point crossover and the probability of crossover (0.0001)
- Mutation : in this step select random position value and replace new where the probability of mutation (0.0001)
- Compute the fitness of new child chromosome and add to population
- The maximum number of iteration is 1000

Algorithm (4) forecasting PSO

Input the Iraq Stock Exchange index
Output : the model

- Initial population, where the chromes content the β of generation randomly between 0 and 1, the length of population represent by 20 practical and each practical length equal the number of input the dataset
- Compute the objective function of each practical and the objective function: MES =Y - $\sum \beta_i * X_i$
- Determine the best global practical and best local practical
- Update the all practical in in the population based on the equation of PSO
  Velocity new = velocity current + c_1*(gbest - X_i) + c_2*(pbest - X_i)
  X_i new = $X_i$current + Velocity
- update the objective function of each practical update the best global practical and best local practical
- loop the steps until reach the maximum itration

Algorithm (5) forecasting hybrid GA-PSO

Input the Iraq Stock Exchange index
Output : the model

- Initial population, where the chromes content the β of generation randomly between 0 and 1, the length of population represent by 20 practical and each practical length equal the number of input the dataset
- Compute the objective function of each practical and the objective function: MES =Y - $\sum \beta_i * X_i$
- Determine the best global practical and best local practical

- Update the all practical in in the population based on the equation of PSO
  Velocity new = velocity current + c_1*(gbest - X_i) + c_2*(pbest - X_i)
  X_i new = $X_i$current + Velocity
- Compute the fitness of each chromosome and the fitness function : MES =Y - $\sum \beta_i * X_i$
- Selection : the operation of selection use the Rolutte wheel
- Crossover over : apply by single point crossover and the probability of crossover (0.0001)
- Mutation : in this step select random position value and replace new wher the probability of mutation (0.0001)
- update the objective function of each practical update the best global practical and best local practical
- loop the steps until reach the maximum iteration

4. Rustle and Discussion

The findings suggest that it is possible to calculate Iraqi stock exchange index by using the MATLAB 2020a based on ANN, GA, PSO and hybrid GA-PSO. In this work, collection the daily, weekly and monthly data of the Iraqi Stock Exchange were used from 1/1/2017 until 1/1/2021, where these data represent the general indicator of the Iraqi stock market, and the approved variable indicator was described. In representing the explanatory variables for the number of shares traded, pointer, current rate, previews rate, current close, previews close as shown in the figure()

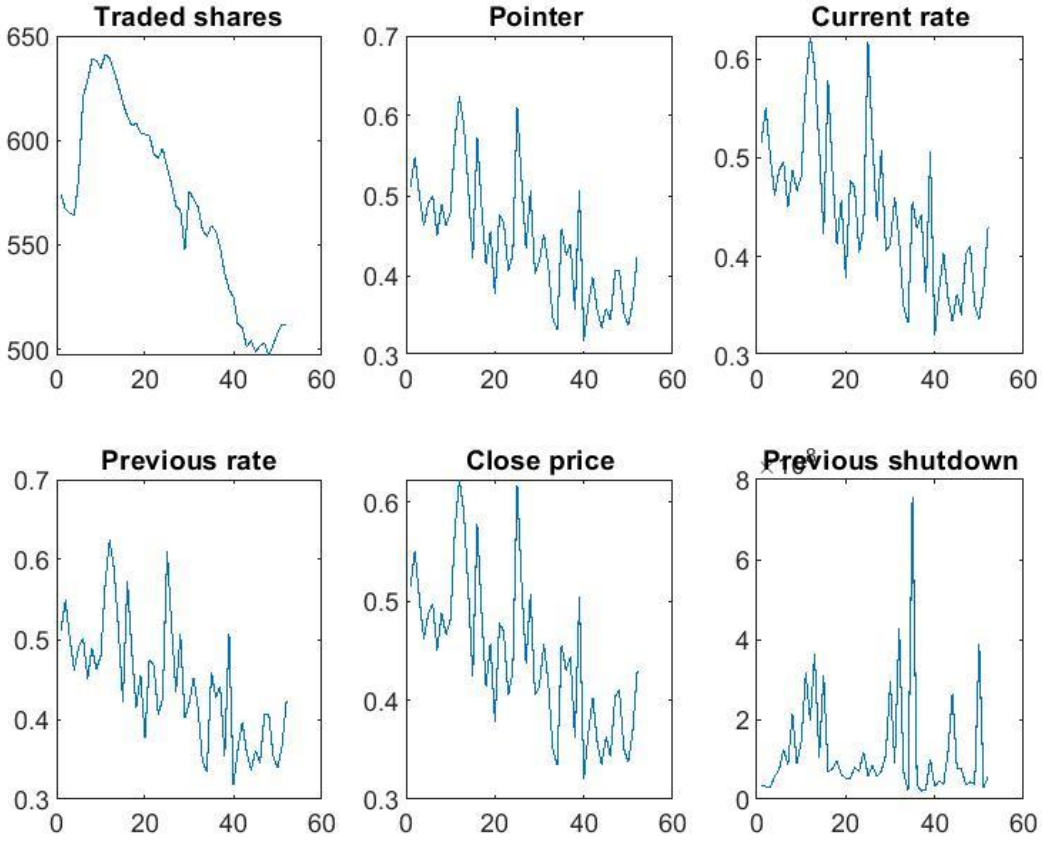

figure 1: time series data of the six variable

The figure 1 represent time series data of the six variable are drawn as a first step to analyze the data and to give an idea of the stability of the time series or not, and to clarify the extent to which the series needs appropriate transformations for its stability or the stability of its variance before conducting any analysis of it.Then calculate the statistical description for each sector (telecommunications, tourism, service agriculture, industry, banks) based on the following criteria: Mean, Median, Maximum, Minimun, Std.Dev, Skewness, Jarque-Bera, Probabilityas shown in table 1.

Tabel (1) statistical description for each sector

	Bank	**industy**	**Services**	**Agriculture**	**tourism**	**Communication**
Mean	0.4602	2.9019	5.7706	5.0503	18.3564	6.7105
Median	0.4594	2.8148	5.1031	5.1306	15.2895	7.2160
Maximum	0.7156	5.2506	15.155	14.847	60.3850	9.1720
Minimun	0.2479	1.0000	1.9840	0.1755	6.9233	0.7150
Std.Dev	0.1085	0.7750	2.5156	1.4368	8.7793	1.6312
Skewness	0.2166	0.3713	0.7969	1.6367	1.7862	-0.456
Jarque-Bera	6.8152	3.6545	17.036	1137.7	187.115	2.4449
Probability	0.0331	0.1608	0.0002	0.0000	0.0000	0.0245

The fill missing value based the next value, and normalization the Iraqi Socket index database as shown in figure 2 bellow

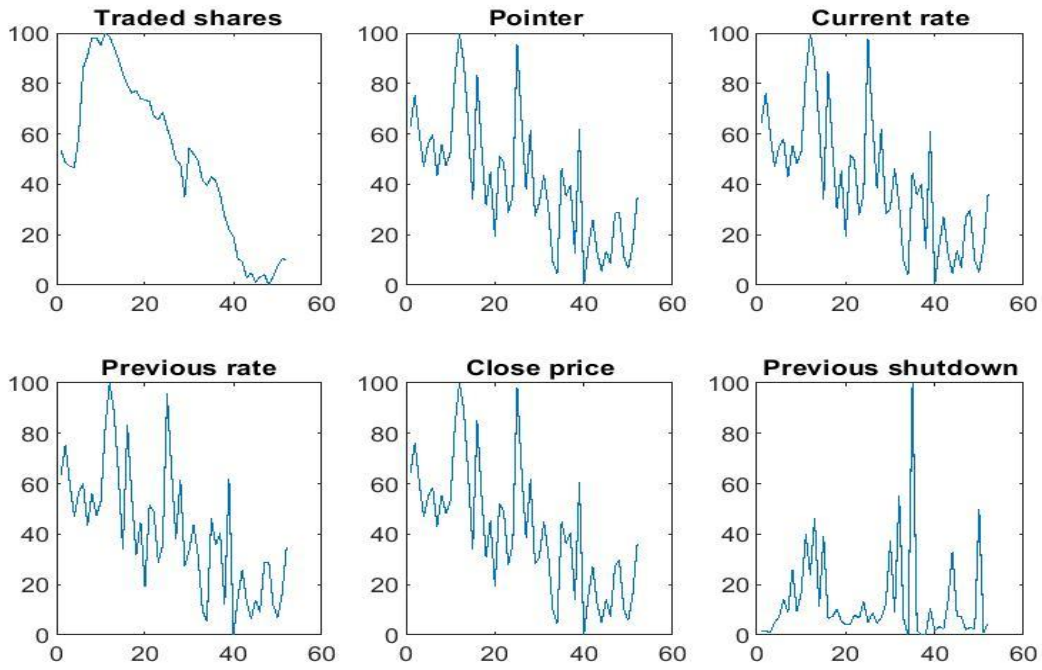

figure 1: show the normailiztion and fill missing value of the six variable

After that splitting the Iraqi Stock Exchange dataset to 80% traiging and 20% testing and the apply the ANN as showing in algorithm 1 where the number of input is 6 and regression one output and the structure of ANN is 20 Layer when training the Iraqi Stock Exchange dataset.

As illustrated in Figure 3, supervised networks, such as Fit Neural Networks trained using backpropagation, have a collection of input vectors and a set of target vectors that correspond to the intended output vectors.

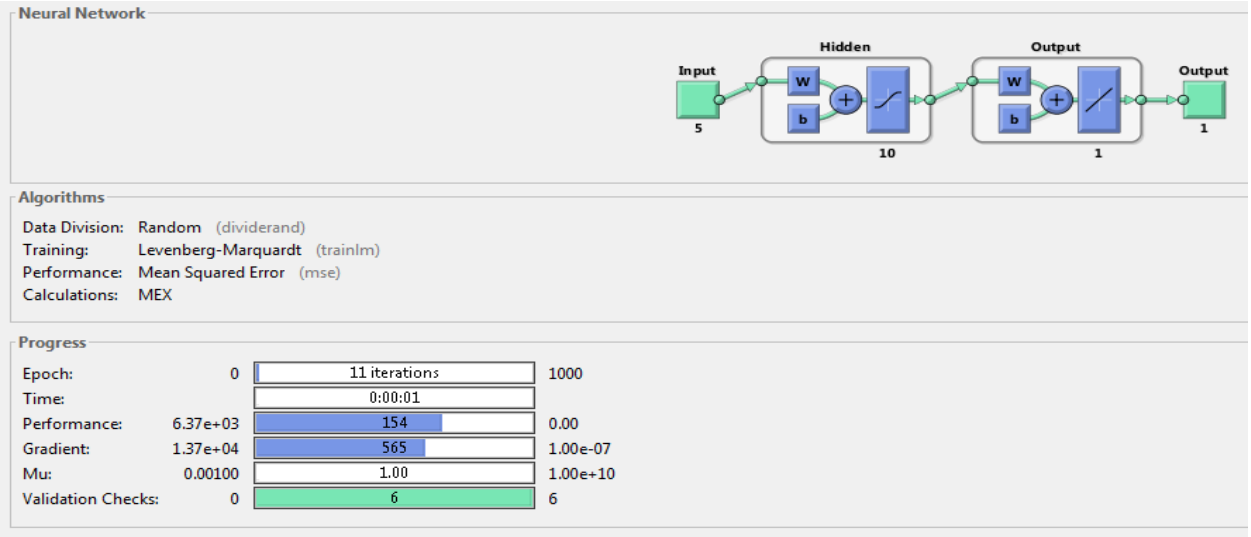

Figure 3 : The training of frocssting of proposed work

The results indicate that the network stopped at 11 iterations, time was ~ 0.001, the mean squared error was 6.37 e3, and the gradient (slope) was at 1.67e4 when it stopped.

At the five epoch the best validation performance is 294.292 in 11 iteration and training state in one epoch are shown in Figures 3. At epoch one, the network will be trained using the Levenberg-Marquardt back propagation method. NN is used to map between a data collection of numeric inputs and a set of numeric targets in a fitting issue. The Neural Network Fitting Tool assists in data selection, network creation and training, and performance evaluation utilizing mean square error and regression analysis. And then save the best model using the Genetic, Pos, and Hybrid Genetic–pso algorithms. After that, test each model ANN, GA,PSO, hybrid GA-PSO, for predicate Iraqi Stock Exchange dataset and compare with treget as shown in figure (4) bellow and compute the MSE

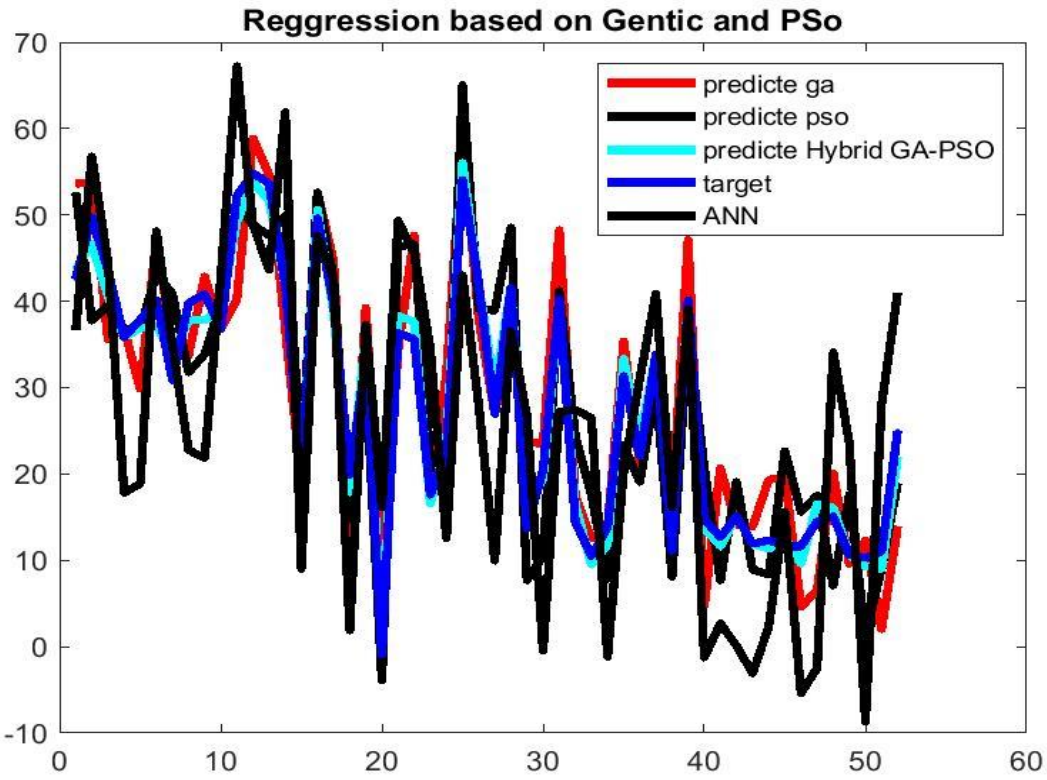

figure 4 : the prediction of each model ANN, GA,PSO,and hybrid GA-PSO

table 2: the calculate the MES of each model

Method	MSE
ANN	0.29332
GA	0.087423
PSO	0.092345
GA_PSO	0.0077798

From table (2) and figure ()4 above show the hybrid is provide better result than other technique GA,PSO,ANN

5. Conclusion

Artificial Neural Network, GA, PSO are a widely used method for estimating and predicting a variety of economic and accounting variables. The goal of this study is to predict the National Insurance Company of Iraq's insurance premium income using a hybrid GA-PSO model and compare it to ANN, GA, and PSO for the years 2017 to 2020. The National Insurance Company's investment income is used as an independent (Input) variable in this method. The findings shown that predicting insurance premium income using a hybrid GA-PSO is feasible and yields good forecasting results.

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