Using Artificial Intelligence Models to Predict Bitcoin Prices – Artificial Neural Network Model-

استخدام نماذج الذكاء الاصطناعي للتنبؤ بأسعار عملة البيتكوين – نموذج الشبكات العصبية الاصطناعية–

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Abstract: This study aims to highlight the role of using modern artificial neural network models in predicting the prices of cryptocurrency, which have become of great and increasing importance in trading markets. We conducted a forecasting process on the Bitcoin currency, which is considered the most important and widely used cryptocurrency, by entering data represented in the daily prices of the Bitcoin currency,

The study concluded that the use of modern models represented by the artificial neural network model of the PNN type is considered one of the effective models in short-term forecasting, compared to the results obtained from the forecasting process, where the predicted prices were very close to the actual prices, and thus it is possible to rely on These models help in making short-term trading decisions.
Keywords: Cryptocurrency; Bitcoin; Artificial intelligence; Artificial neural networks; Forecasting

Résumé : Cette étude vise à mettre en lumière le rôle des modèles de réseaux de neurones artificiels modernes dans la prédiction des prix des cryptomonnaies, dont l'importance sur les marchés financiers ne cesse de croître. Nous avons réalisé une prévision du Bitcoin, la cryptomonnaie la plus importante et la plus utilisée, en utilisant les données de ses cours quotidiens sur le marché mondial. L'étude conclut que l'utilisation de modèles modernes, notamment le réseau de neurones artificiels de type PNN, s'avère particulièrement efficace pour les prévisions à court terme. Les résultats obtenus sont en effet très proches des prix réels, ce qui permet de s'appuyer sur ces modèles pour la prise de décisions de trading à court terme.
Mots-clés : Cryptomonnaie; Bitcoin ; Intelligence artificielle; Réseaux de neurones artificiels ; Prévision

ملخص: تهدف هذه الدراسة إلى إبراز دور استخدام نماذج الشبكات العصبية الاصطناعية الحديثة في التنبؤ بأسعار العملات الرقمية المشفرة التي أصبحت تمثل أهمية كبيرة و متزايدة في أسواق التداول. حيث قمنا بإجراء عملية التنبؤ على عملة البتكوين التي تعتبر أهم العملات الرقمية وأوسعها استخداما، من خلال إدخال بيانات تمثلت في الأسعار اليومية لعملة البتكوين.

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و توصلت الدراسة إلى أن استخدام النماذج الحديثة المتمثلة في نموذج الشبكات العصبية الاصطناعية من النوع PNN تعتبر من النماذج الفعالة في التنبؤ للمدى القصير، حيث اقتربت الأسعار المتنبأ بها من الأسعار الفعلية بشكل كبير، و بالتالي يمكن الاعتماد على هذه النماذج في اتخاذ قرار التداول للمدى القصير إلى جانب الأساليب الأخرى كالتحليل الفني والأساسي.

الكلمات المفتاح : العملة الرقمية؛ البتكوين؛ نماذج الذكاء الاصطناعي؛ التنبؤ

I- Introduction :

The world today is experiencing a comprehensive technological revolution that has extended to all aspects of life and has significantly influenced various economic, social, and cultural patterns. It has also contributed to the emergence of a set of new phenomena, including digital currencies, which are considered among the most recent and important innovations in the field of financial transactions, and which have gained wide acceptance and spread. Bitcoin is one of the most important and well-known digital currencies, as it is regarded as the first digital currency to ever exist. It was designed based on the idea of eliminating the need for a central authority and is considered the first system that is not subject to any control by a central power, as it is entirely used over the Internet.

Since its emergence, Bitcoin has been considered one of the best assets that can be acquired and invested in. The increasing demand for it has caused its prices to experience significant fluctuations, especially in the short term. Thus, predicting the direction of Bitcoin price movements along with other cryptocurrencies has become a difficult task for both investors and speculators, requiring…

Developing modern methods for predicting cryptocurrency prices has become necessary, alongside traditional methods such as technical and fundamental analysis. Among these modern models is the Probabilistic Neural Network (PNN), which is considered one of the most advanced approaches related to prediction.

Problem Statement:

Based on the previous introduction, the following problem can be raised:

-To what extent can neural network models be effective and robust in predicting cryptocurrency prices?

To answer this problem, the following sub-questions were formulated:

-What is Bitcoin, and what are its main characteristics?

-Are Probabilistic Neural Network (PNN) models effective in predicting cryptocurrency prices?

-Can modern econometric models be relied upon in making trading decisions alongside traditional methods such as technical and fundamental analysis?

Research Hypotheses:

To answer the previously stated problem, the following hypotheses are proposed:

-Bitcoin is considered a cryptocurrency that is not issued by any central bank or legal authority. It is characterized by the absence of regulation in its issuance and the lack of supervision in its use.

- Using an artificial neural network model to predict cryptocurrency prices yields good results.

- Modern econometric models can be relied upon when making trading decisions, alongside technical and fundamental analysis.

Importance of the Study:

The importance of this study lies in attempting to demonstrate the effectiveness of modern econometric models in predicting cryptocurrency prices in the short term, and in obtaining results that can be relied upon when making trading decisions in cryptocurrencies, in addition to the commonly used methods such as technical and fundamental analysis.

Objectives of the Study: The study aims to:

-Provide theoretical concepts regarding Bitcoin;

- Identify the model used in the study;

-Demonstrate the effectiveness of the model used in predicting cryptocurrency prices.

Methodology Used:

To answer the proposed problem, the descriptive-analytical method was adopted in the theoretical part in order to present some concepts related to Bitcoin. As for the applied part of this study, the econometric method and its tools were used by selecting the artificial neural network model, which will be employed to predict Bitcoin prices in the short term.

Previous Studies:

-A study by Abdelhafidhi Issa, titled "An Attempt to Predict Cryptocurrency Prices Using Artificial Neural Network Models – A Case Study of Bitcoin, Ethereum, and Cardano." This study aimed to predict the prices of cryptocurrencies (Bitcoin, Ethereum, and Cardano), given their growing importance in the economic field. The study utilized modern models, specifically artificial neural networks (ANNs), to determine their effectiveness in predicting cryptocurrency prices. The study concluded that PNNs are powerful models for predicting short-term cryptocurrency prices, as the predicted values closely matched the actual values.

-A study by Darbal Amina and Souar Youssef, titled "Prediction and its Role in Investment Decision-Making (MLP) Using a Multi-Layer Neural Network Model – A Case Study of the Dubai Financial Market." This study aimed to predict the returns of the Dubai Financial Market index using a daily dataset from December 4, 2006, to February 3, 2015. The study concluded that the (1, 10, 1) layered artificial neural network model is efficient in prediction.

-Abbas Vahedi's 2012 study, titled "Predicting Stock Price Using Artificial Neural Network," aimed to predict stock prices on the Tehran Stock Exchange using artificial neural networks. This was achieved using annual data from 2000-2008, along with the following independent variables: securities sales revenue, earnings per share, and net assets (as inputs). After estimation, the artificial neural network method yielded suitable results and strong predictions.

2. Conceptual Framework for Bitcoin: Recently, coinciding with the digital revolution, numerous digital and cryptocurrencies have emerged. These currencies possess characteristics that distinguish them from traditional currencies and are traded online. Bitcoin is among the most important and sought-after of these currencies.

2.1Definition of Bitcoin:

Many definitions of Bitcoin have been provided, including the following:

Bitcoin is considered a digital encrypted currency that relies on cryptographic technology to settle its transactions. It is intangible, meaning it is a virtual currency traded and used electronically only. Moreover, Bitcoin is a decentralized currency, as it is not linked to any central authority, whether governmental or non-governmental. In other words, it is not controlled by a single entity, unlike traditional currencies controlled by governments through their central banks. Furthermore, Bitcoin is not pegged to a specific exchange rate or to a particular commodity such as gold; its value is determined entirely by supply and demand forces. (Abd Al-Rahman, 2018, pp. 9–10).

It is also defined as a digital form stored on the Internet that takes shapes and forms resembling physical assets, whether movable or immovable. It has both tangible and virtual value in the virtual world and is characterized by the ability to transfer its ownership through digital wallets such as BitOasis, exchange it for physical items, convert it into real currencies, or even sell it through an encrypted virtual contract, whose most prominent feature is the principle of freedom of will, without any intermediary controlling the contract as in real currencies, based on the idea that the will is absolute and unrestricted. (Mohamed & Abdel-Basset, 2021, p. 145).

2.2 Bitcoin Characteristics:

Bitcoin has multiple characteristics, including the following: (Ahmed, 2019, pp. 41–50)**.**

- digital currency: This means it has no physical existence; it is a virtual payment tool used through smart electronic devices and recognized within a specific scope that is rapidly expanding. Digital wealth is no longer limited to information only. By analogy, thousands indeed millions of pieces of information stored on the Internet constitute wealth worth billions, and similarly, virtual currencies have become digital assets that are traded and stored using a technology called Blockchain, which is now used by many banks and financial institutions.

- **high degree of security**: Bitcoin is distinguished by a very high level of security through its implemented system. However, achieving absolute protection against all cyberattacks (100%) remains uncertain. All types of currencies whether paper, electronic, or virtual regardless of their

characteristics, are vulnerable to manipulation, theft, or fraud. Every currency has weaknesses that can be exploited or electronic vulnerabilities that can be accessed. Nonetheless, Bitcoin stands out through its system for providing a very high level of security, designed to ensure the safety of its users according to the following characteristics:

- **-Accuracy:** ensuring that financial transfers reach the intended destination without errors, as the system executes its commands with a very high level of precision that does not allow mistakes, based on the information provided by both the sender and the receiver.
- **-Fairness:** accepting the completion of transactions that are under verification and execution according to specific protocols.
- **-Anonymity:** the complete confidentiality enjoyed in trading operations, where no one can identify personal information since it does not exist in the first place; sending and receiving are carried out based on public keys that contain no personal data, only numbers.
- **-Resistance to spoofing attacks:** each user possesses a unique pseudonym and a sequence of codes that represent their identity.

-Decentralization: The issuance of virtual currencies in a decentralized manner, without being subject to any authority, is considered the most prominent feature of virtual currencies. This makes them less vulnerable to a single point of failure or a single target for attacks. Decentralization has been used to achieve the principle of encryption and to strengthen the financial transactions carried out through the systems used in virtual currencies. This feature makes private trading platforms protected from software destruction, as they constitute a widely distributed system used by all participants, and are not subject to the control of any of them or any authority overseeing exchange operations.

-Peer-to-peer system: Under this system, a Bitcoin user does not bear any costs related to transfer or transmission operations, unlike traditional procedures, which involved fees paid to banks, credit card companies, and exchange offices.

-Reliance on Blockchain technology: The blockchain system in Bitcoin was the first to achieve a decentralized accounting structure. This technology is considered the backbone of encrypted virtual currencies. It acts as a public, tamper-proof ledger through which all transactions and operations are recorded, or, in other words, it represents the public accounting record in the financial sector.

-Mineable / Self-mining (Mining): Mining represents the process of issuing Bitcoin and verifying transactions; it is essentially the production rate of Bitcoin. Mining has two functions: verifying transfers and generating new Bitcoin on the network. It also prevents any specific group from having full control over the network.

Mining is a complex process that requires significant computational power. Bitcoin can be used through open-source software platforms that allow self-mining of the currency, and miners are rewarded for their contribution in verifying that transactions proceed securely along the blockchain. However, Bitcoin mining will not continue indefinitely. When Bitcoin was first created, the reward for a single block was 50 Bitcoins, but this reward is halved every 210,000 blocks, or approximately

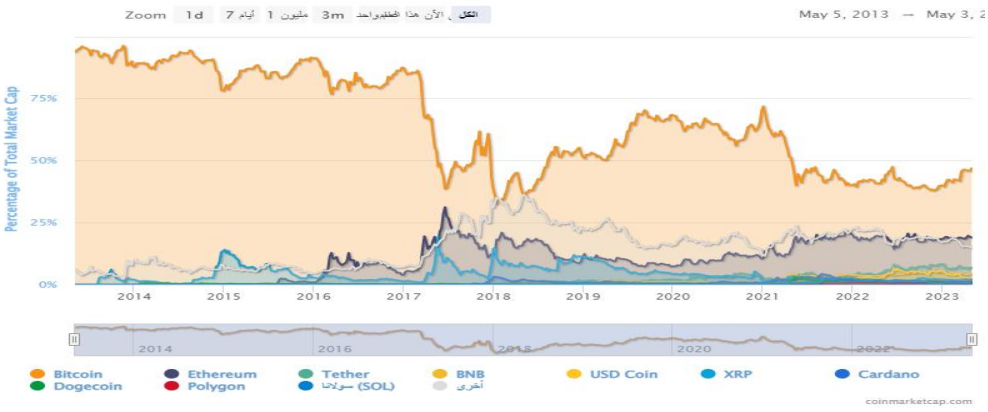
every four years, in order to regulate the rate at which new Bitcoins are issued, as defined in the protocol.

-Limited supply and divisibility (Fixed Supply and possibilities of fragmentation): Bitcoin is characterized by having a limited supply and being divisible. Its monetary supply has been set at 21 million Bitcoins, which can be divided into smaller units called Satoshis.

2.3 Bitcoin's Share in the Virtual Currency Market:

To identify Bitcoin's market share, the following graph can be presented for the period 2013–2023:

Figure (1): Bitcoin's Share in the Virtual Currency Market



Source: https://coinmarketcap.com, accessed on 12/02/2024

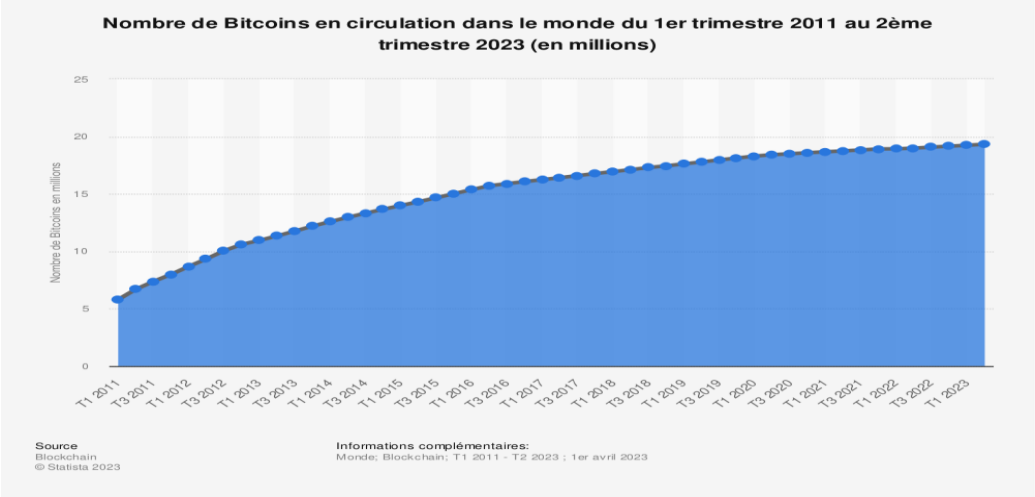
The graph above illustrates the individual shares of the ten largest groups of cryptocurrencies in terms of the total market capitalization of all assets. It is observed that Bitcoin has maintained the largest share of trading volume in the virtual currency market so far, reaching a dominance rate of 96.33% on 17/11/2013, compared to 3.91% for other digital currencies. On 12/03/2017, the dominance rate exceeded 80% of the total market capitalization, representing its highest level. However, this percentage began to decline and fluctuated between 40% and 80% throughout this period.

On 21/01/2018, Bitcoin's dominance dropped to 34.37%, compared to an increase in the share of other cryptocurrencies to 65.63%. Its most recent dominance rate on 30/04/2023 was above 40% of the total market capitalization of all assets. Since Bitcoin was the first cryptocurrency, it has continued to hold the highest market share.

2.4 Number of Bitcoins in Circulation Worldwide:

The following figure shows the evolution of the number of Bitcoins in circulation worldwide during the period 2011–2023:

Figure (2) : Number of Bitcoins in Circulation Worldwide for the Period 2011–2023



Source: https://www.statista.com, accessed on 14/02/2024

From the previous graph, we observe the total number of Bitcoins in circulation worldwide between the first quarter of 2011 and the second quarter of 2023. It is clear that the total number of Bitcoins increased significantly during the indicated period, rising from 6 million Bitcoins at the beginning of the first quarter of 2011 to approximately 19.33 million Bitcoins during the first quarter of 2023, an increase of more than 216%.

2.5 Changes in Bitcoin Price:

The following figure illustrates the changes in the price of Bitcoin during the period 2011–2023, through a line graph showing the evolution of the currency's price levels.

Figure (3) : Bitcoin Price Evolution During the Period 2011–2023



Source: https://coinmarketcap.com, accessed on 25/02/2024

From the curve, we observe that the development of Bitcoin's price over the indicated period can be divided into three stages:

-First stage (13/07/2010 to 02/04/2017): During this period, Bitcoin's price did not experience significant growth, increasing only from 0.06183 USD to 1,080.61 USD.

-Second stage (02/04/2017 to 10/07/2020): Bitcoin's price experienced fluctuations between increases and decreases. The price did not exceed 19,1064 USD during this stage, with this value recorded on 12/08/2017. Despite these fluctuations, the price of Bitcoin generally showed a significant upward trend during this phase.

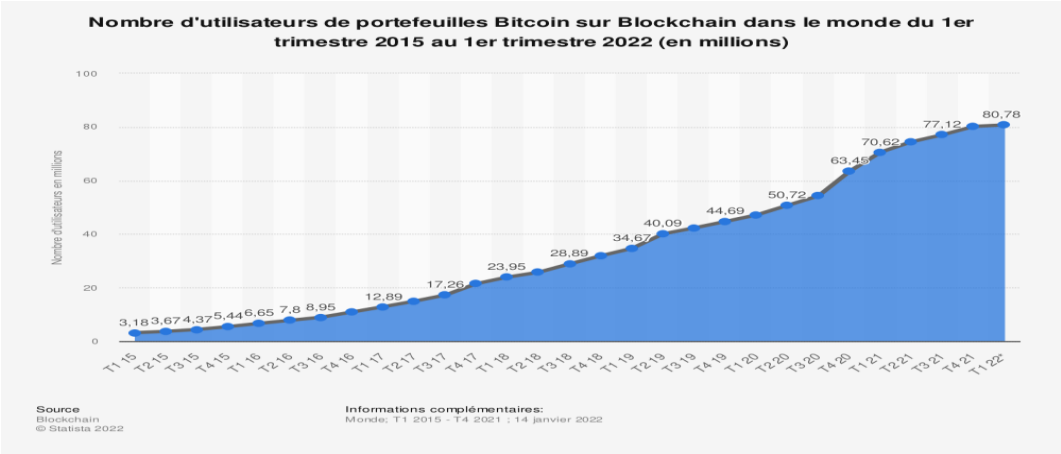
Third stage (10/07/2020 to 01/05/2023): During this period, as shown in the graph, Bitcoin's price witnessed a sharp increase compared to the previous two stages, despite continued fluctuations. Two major price surges were recorded in the same year, representing Bitcoin's highest historical levels. The first was on 12/04/2021, reaching 60,17594 USD, and the second on 11/12/2021, reaching 64,86398 USD.

Bitcoin also experienced sharp declines during this period, the lowest of which was recorded on 28/11/2022, with a value of 16,44022 USD. Starting from this date, the price began to trend upward gradually, with the most recent recorded value being 29,2271 USD on 01/05/2023.

2.6 Evolution of the Number of Bitcoin Wallet Users on the Blockchain:

The following chart presents the evolution of the number of Bitcoin wallet users on the blockchain worldwide during the period from the first quarter of 2015 to the first quarter of 2022.

Figure (4) : Evolution of the Number of Bitcoin Wallet Users on the Blockchain During the Period 2015–2022.



Source: https://fr.statista.com, accessed on 28/11/2023

From the curve above, we observe that the total number of Bitcoin wallet users on the blockchain worldwide has been continuously increasing during the indicated period. The number rose from 3.18 million users to 80.78 million users, especially in the later period, where the growth rate accelerated significantly between the third quarter of 2020 and the second quarter of 2022. During this interval, the number increased from 50.72 million to 80.78 million users, representing an increase of 30.06 million users in a period of just seven quarters.

3. Applied Study: Predicting Bitcoin Prices:

3.1 Definition of the Model Used:

-According to (Qussi & Ahmed, 2011), artificial neural networks are computational techniques designed to simulate the way the human brain performs a specific task. This is done through massively parallel distributed processing composed of simple processing units. These units are merely computational elements called neurons or nodes, which possess neural properties in the sense that they store scientific knowledge and experimental information and make it available to the user through weight adjustments.

3.2 Components of the Neural Network: (Farid & Mohamed Al-Arabi, 2019, pp. 72–74)

Neural networks contain inputs that represent the processing units in which the computational operations occur, whereby the weights are adjusted and responses are obtained for each input to the network. The input units form a layer known as the input layer, and the processing units form the processing layer, which generates the network outputs known as the output layer. Between each of these layers is an interconnection layer that links each layer to the next and in which the weights of each interconnection are adjusted. The network contains only one input layer, but it may include more than one processing layer.

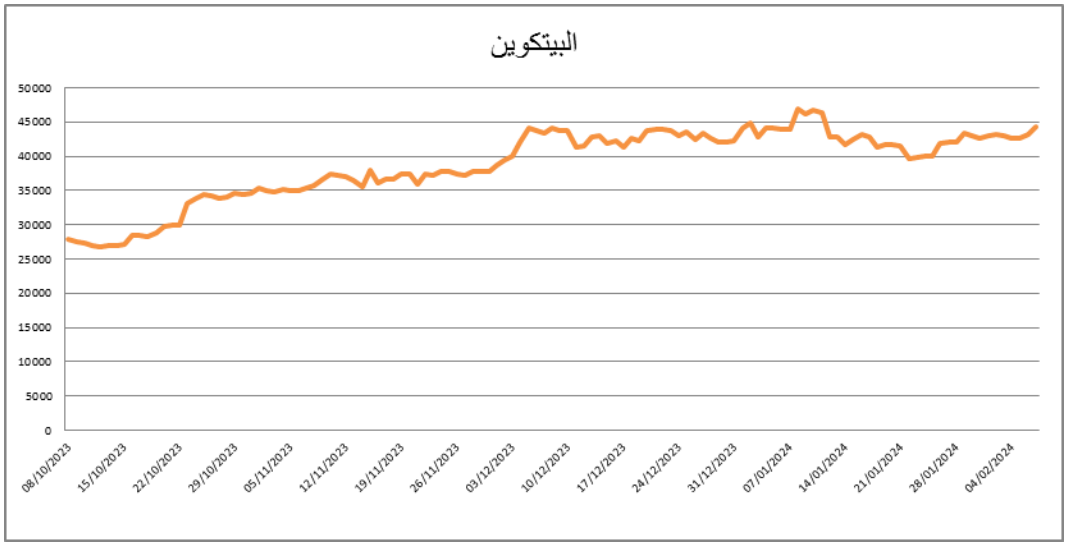
3.3 Results of the Applied Study: To apply the artificial neural network model as a widely used model particularly in forecasting we structured the database as follows:

- The period from 08/10/2023 to 07/02/2024: testing period.
- The period from 08/02/2024 to 16/02/2024: forecasting period.

The study relied on the EViews 12 software, which constructs the neural network and tests its accuracy through essential stages.

First Step: Identifying the Variables: The study variables consist of the time series of the closing price (last price) of the cryptocurrency Bitcoin, which serves as the input for the artificial neural network. This covers the time period from 08/10/2023 to 07/02/2024 (124 observations), as shown in the following figure:

Figure (6) : Actual Values of Bitcoin



Source: Prepared by the researchers based on data from https://www.investing.com

From the previous graph, which shows the evolution of Bitcoin prices, we observe that prices are trending upward, following an increasing trajectory. The price rose from 26,297.56 USD to 44,001.09 USD, nearly doubling, during the period from 08/10/2023 to 07/02/2024, which represents the study period. This rise is attributed to the strong demand and high interest of traders engaging in transactions involving this currency.

Second Step: Predicting the Price of the Cryptocurrency Bitcoin

This study included daily observations of Bitcoin prices during the period from 08/10/2023 to 07/02/2024. Based on the appropriate model obtained, we performed a short-term prediction of future Bitcoin price levels for 10 days, from 08/02/2024 to 16/02/2024, by inputting the closing prices for this period. The study relied on the previously tested models (Appendix No. 01), which proved effective for forecasting. After obtaining the prediction outputs, we compared them with the actual prices for the same period, as shown in the following table:

Table (1): Predicted Bitcoin Prices for the Period 08/02/2024 to 16/02/2024

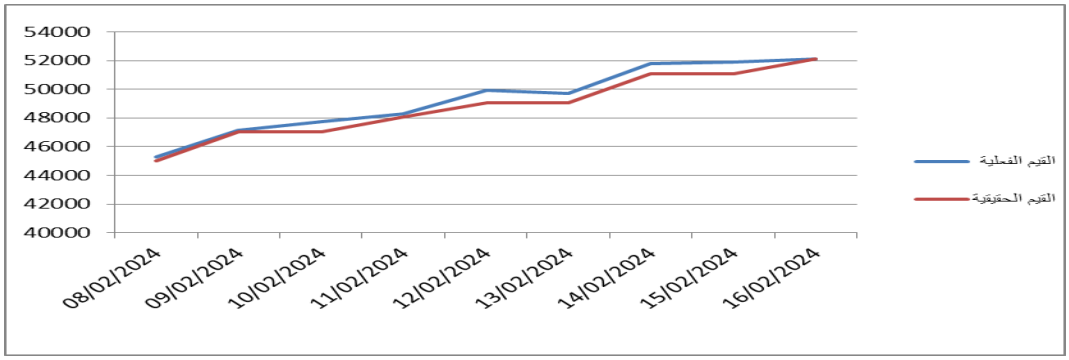
Period	Actual Bitcoin Values	Predicted Bitcoin Values
2024/02/08	45293.3	45023.41
2024/02/09	47127.5	47034.14
2024/02/10	47758.2	47044.58
2024/02/11	48277.3	48054.76

2024/02/12	49941.3	49064.69
2024/02/13	49716.0	49074.37
2024/02/14	51782.4	51083.81
2024/02/15	51901.3	51093.02
2024/02/16	52134.2	52102.02

Source: Prepared by the researchers using EViews 12

From the table, we observe that the predicted Bitcoin results for the study period from 08/02/2024 to 18/02/2024 are very close to the actual results. The predicted values also indicate a continued upward trend of the currency in the short term, which indeed occurred when compared to the actual values. Therefore, it can be said that the designed artificial neural network models produced good results and can be relied upon when making short-term trading decisions in cryptocurrencies, in addition to technical and fundamental analysis. This can be illustrated through the following figure:

Figure (7) : Predicted and Actual Bitcoin Prices for the Period 08/02/2024 to 16/02/2024



Source: Prepared by the researchers using EViews 12

From the figure above, it is clear that the output values (actual values and predicted values) match closely, as shown by the alignment of the curves for both the actual and predicted Bitcoin prices. Therefore, the constructed neural networks can be relied upon to predict the price of Bitcoin.

IV- Conclusion:

The attempt to accurately predict cryptocurrency prices and market trends represents an important aspect, especially for investors and speculators. It has become necessary to develop modern methods to study the behavior and predict the prices of these currencies. This study was conducted to address this important aspect by using one of the advanced forecasting methods, namely artificial neural network models, to predict cryptocurrency prices. Bitcoin was selected, and its historical data for the period from 08/10/2023 to 18/02/2024 was used, with a sample size of 90

observations. Bitcoin was chosen because it is the first issued cryptocurrency and currently holds more than 40% of the total cryptocurrency market. The study led to the following results:

-The results of these networks were good and useful in predicting the price of Bitcoin under study.

-Neural network models can be relied upon for short-term trading decisions, alongside other methods such as technical and fundamental analysis.

Testing the Hypotheses:

-Bitcoin is considered a virtual, encrypted digital currency that is not issued by a central bank or financial institution. It is neither regulated in issuance nor supervised in use. Its concept is based on encryption and the peer-to-peer system, and it relies on the blockchain for trust. This confirms the validity of the first hypothesis.

-The prediction results obtained using the PNN artificial neural network model represented in the predicted Bitcoin prices were very close to the actual prices. Therefore, the second hypothesis is confirmed, and it can be stated that the artificial neural network model is highly effective in predicting cryptocurrency prices.

-Through the applied study, it became evident that modern econometric models can be relied upon in making cryptocurrency trading decisions, alongside modern methods such as technical and fundamental analysis. Thus, the third hypothesis has been confirmed.

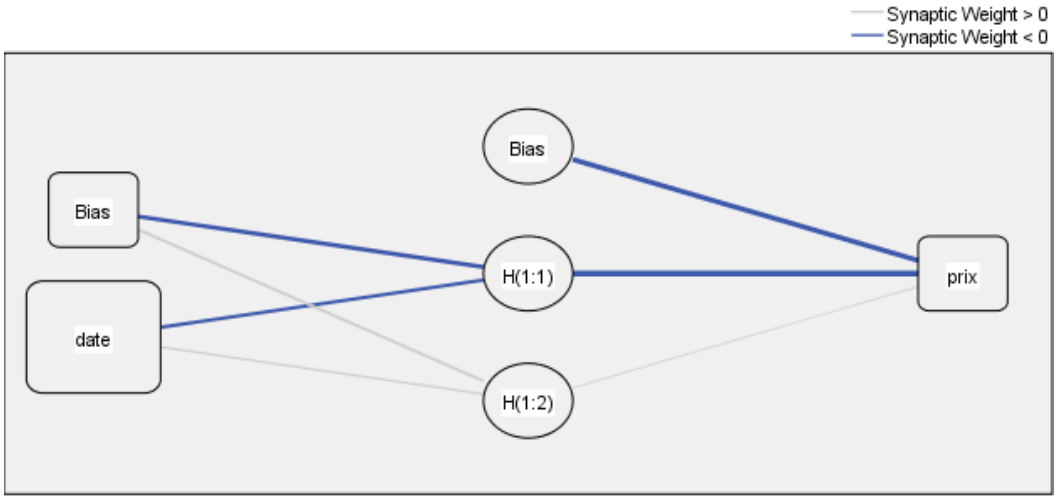
Recommendations: The main recommendations proposed by this study are:

-Exploring how to incorporate additional quantitative variables that may influence the behavior of cryptocurrency prices as inputs to the model, alongside historical prices.

-Investigating ways to develop methods based on econometric models and employing them in automated trading systems to support successful algorithmic trading decisions.

V- Appendices:

- Appendix 1: Graphical Representation of the Artificial Neural Network.



Hidden layer activation function: Hyperbolic tangent

Output layer activation function: Identity

Appendix 2: Summary of the Artificial Neural Network Analysis, Model Summary, and Test Table

Case Processing Summary

		N	Percent
Sample	Training	82	66,1%
	Testing	42	33,9%
	Valid	124	100,0%
	Excluded	10	
	Total	134	

Model Summary

Training	Sum of Squares Error	3,656
	Relative Error	,090
	Stopping Rule Used	1 consecutive step(s) with no decrease in error[a]
	Training Time	0:00:00,00
Testing	Sum of Squares Error	2,438
	Relative Error	,110

- Dependent Variable: prix de bitcouin
- a. Error computations are based on the testing sample.

Parameter Estimates

		Predicted		
		Hidden Layer 1		Output Layer
	Predictor	H(1:1)	H(1:2)	prix
Input Layer	(Bias)	-1,292	,299	
	date	-,938	,279	
Hidden Layer 1	(Bias)			-1,600
	H(1:1)			-2,402
	H(1:2)			,272

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