

# Machine Learning Techniques And The Use Of Event Information For Stock Market Forecasting: A Review

Astelio Silvera Sarmiento<sup>1</sup>, Darwin Daniel Ordoñez-Iturralde<sup>2</sup>, Johanna Maribel Ochoa-Herrera<sup>3</sup>, Jorge Armando de la Hoz Hernandez<sup>4</sup>, Ana Maria Echeverria<sup>5</sup>

<sup>1</sup>Universidad de la Costa, Barranquilla, Colombia Fundación Para La Investigación, Desarrollo e Innovación, Colombia, [asilvera3@cuc.edu.co](mailto:asilvera3@cuc.edu.co), <https://orcid.org/0000-0001-9416-0264>

<sup>2</sup>Facultad de Administración, Universidad Laica VICENTE ROCAFUERTE de Guayaquil [dordonezy@ulvr.edu.ec](mailto:dordonezy@ulvr.edu.ec), <https://orcid.org/0000-0003-2175-4488>

<sup>3</sup>Facultad Jurídica, Social y Administrativa, Universidad de Loja, Ciudad Universitaria Guillermo Falconí, Loja, Ecuador, <https://orcid.org/0000-0003-2530-7108>, [johanna.ochoa@unl.edu.ec](mailto:johanna.ochoa@unl.edu.ec)

<sup>4</sup>Fundación Para La Investigación, Desarrollo e Innovación, Colombia, [jadelahoz@fundacionidi.org](mailto:jadelahoz@fundacionidi.org), <https://orcid.org/0000-0002-9454-6172>

<sup>5</sup>Universidad de la Costa, Barranquilla, Colombia, Fundación Para La Investigación, Desarrollo e Innovación, Colombia, [aecheverria@cuc.edu.co](mailto:aecheverria@cuc.edu.co), <https://orcid.org/0000-0002-0256-1130>

## Abstract

A documentary review was carried out on the production and publication of research papers related to the study of Machine Learning Techniques and the Stock Market. The purpose of the bibliometric analysis proposed in this document is to know the main characteristics of the volume of publications registered in the Scopus database during the period 2016-2021, identifying a total of 576 publications. The information provided by the said platform was organized through tables and figures, categorizing the information by Year of Publication, Country of Origin, Area of Knowledge and Type of Publication. Once these characteristics were described, the position of different authors regarding the proposed topic was referenced by employing a qualitative analysis. Among the main findings of this research, it is found that India, with 209 publications, was the country with the highest scientific production registered in the name of authors affiliated with institutions of that country. The Knowledge Area that made the greatest contribution to the construction of bibliographic material referring to the study of Machine Learning Techniques for Stock Market prediction was Computer Science with 459 published documents, and the type of publication that was most used during the aforementioned period was the Conference Article, representing 50% of the total scientific production.

**Keywords:** Machine Learning Techniques, Stock Market.

## 1. Introduction

The prediction of different study variables is currently possible thanks to the management of Machine Learning algorithms, which look for behavioral patterns in the data, identifying the relationships that may exist between them (Vázquez, 2016). Machine Learning is an area of Artificial Intelligence (AI) that consists of

programs capable of generating a specific behavior from data (Guardiola, 2020). It has been developing more in business environments, in the prediction of market behavior, increases and decreases in input prices, and production costs in certain seasons of the year, among others. The historical data of the movements in this sector feeds a whole source of data stored in these systems that,

thanks to AI, are processed yielding valuable information according to the behavior patterns projecting certain conditions in the future. This information is valuable for the company because of decision-making in terms of investment, launching new products, hiring personnel, purchases, etc. The behavior that could be expected in an eventual scenario is analyzed, which significantly reduces risk and increases productivity and competitiveness.

In the stock market, investors expect to make a profit by buying and selling stocks. These profits for them are usually the difference between the purchase price and the sale price of the shares. To this end, they have used certain techniques that allow them to predict the behavior of these shares in the market, playing with its dynamics, hoping to buy a group, and selling them when they have exceeded their initial value. One of these techniques is Machine Learning, which studies have hypothesized that in the data of historical quotes there is a certain amount of usable information to predict the future movement of the market (Manso et al., 2017); however, there is still some controversy within the scientific community, in which some support this assumption and others argue that the dynamism of the stock market, by its nature cannot be predictable. Therefore, it is necessary to know the impact of the research carried out on the subject to measure the scope of the knowledge generated around the variables proposed in this article. To this end,

this bibliometric analysis has been implemented to answer the question: How is the production and publication of research papers concerning the study of Machine Learning Techniques for the prediction of movements in the Stock Market during the period 2016-2021?

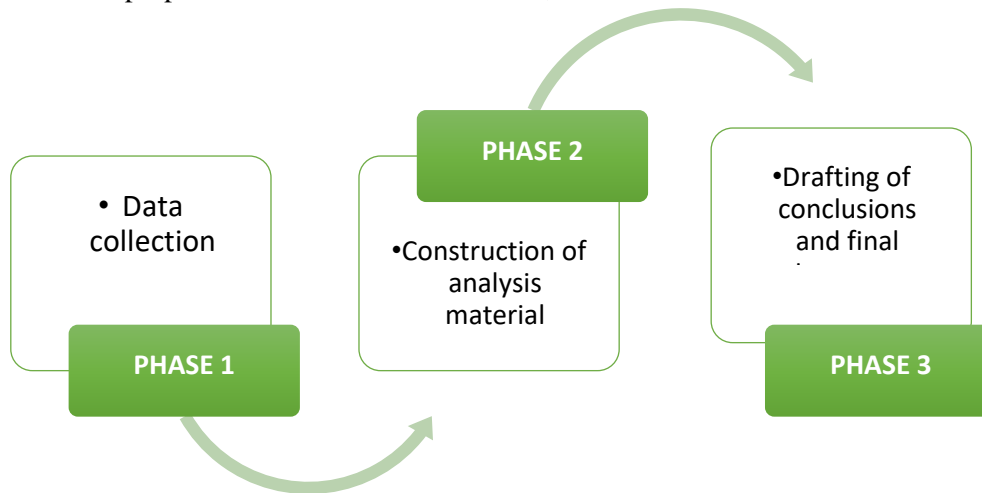
## 2. Objetivo general

To analyze, from a bibliometric and bibliographic perspective, the production of research papers on the variable Machine Learning Techniques regarding the prediction of movements in the Stock Market during the period 2016-2021.

## 3. Methodology

Quantitative analysis of the information provided by Scopus is performed under a bibliometric approach to the scientific production regarding the study of Machine Learning Techniques for the prediction of movements in the Stock Market. Likewise, from a qualitative perspective, examples of some research papers published in the area of the study mentioned above are analyzed from a bibliographic approach to describe the position of different authors on the proposed topic.

The search is carried out through the tool provided by Scopus and the parameters referenced in Figure 1 are established.



**Figure 1.** Methodological design



**Source:** Own elaboration (2022); based on data provided by Scopus.

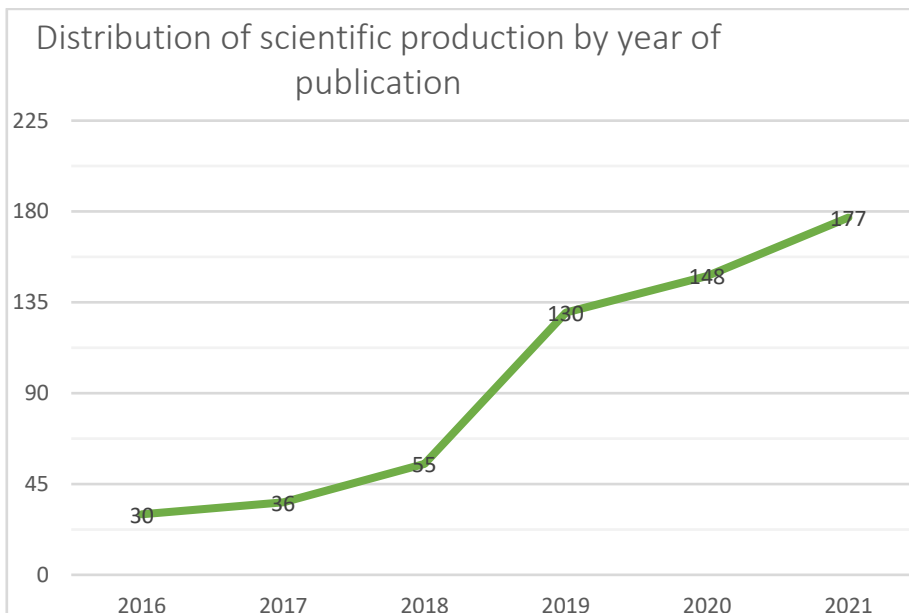
Financial Markets was the keyword used most frequently in the research identified through the execution of Phase 1 of the Methodological Design proposed for the development of this article, directly associated with the word Investments, which allows inferring what concerns the feasibility study of investors regarding the purchase of securities is closely linked to the use of programs designed to predict the fluctuation in the stock market. Similarly, the use of variables such as Stock Market Prediction, Deep Learning, Risk Assessment, Data Analysis and Artificial Intelligence are also among the most frequently used variables in the group of publications analyzed in this document.

The above allows confirming the relevance of the publications with the initially stated objective, as well as demonstrates how investors resort to tools derived from Artificial Intelligence to define or make a decision to buy and/or sell shares. This is thanks to the

generation of historical data that are collected in high-capacity memories and then processed and converted into predictions based on a pattern of behavior that occurred in several previous periods. The analysis of the keywords used in the research allows knowing which has been the orientation of the researchers about a specific topic. Figure 2 shows a whole universe of variables related to the term Financial Market and Artificial Intelligence, among which stand out those related to the automatic learning techniques and the decision-making regarding the movements in the stock market.

#### 4.2 Distribution of scientific production by year of publication

Figure 3 shows how the scientific production is distributed according to the year of publication, taking into account the period from 2016 to 2021.



**Figure 3.** Distribution of scientific production by year of publication.

**Source:** Own elaboration (2022); based on data provided by Scopus.

One of the main characteristics of the volume of publications registered in Scopus is the year

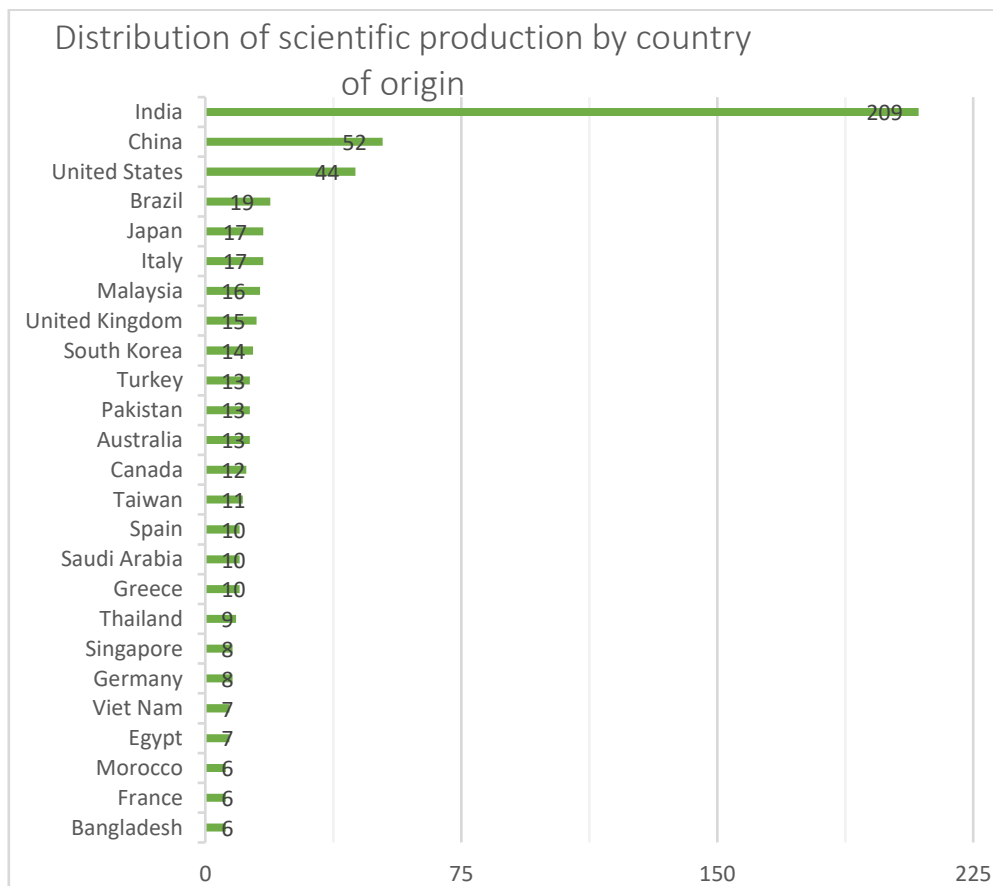
of publication. Through this classification, it was possible to determine the behavior

regarding the documents published in high-impact journals indexed in this database. The period to be analyzed was 2016-2021, the period during which a total of 576 documents were published. Figure 3 allows contemplating how the number of publications has been growing year after year; however, the most significant variation is shown between 2018 and 2019 when it went from 55 publications to 130. From this year on, the growth is maintained until reaching 2021, with a total of 177 research papers indexed in Scopus, a figure that represents the highest record of the entire period analyzed. Among these papers, there is the article entitled "Importance of machine learning in investment decision making in the stock market" (Prasad & Seetharaman, 2021), whose purpose was to analyze more than 50 research papers focused on various machine

learning algorithms with varying levels of input variables and reaching to the conclusion that, although the performance of the models measured by root mean square error (RMSE) for regression and accuracy score for classification models varied greatly, the short term memory (LSTM) model showed higher accuracy among the machine and deep learning models reviewed. The main contribution of the authors related to the proposed topic of the study lies in the confirmation of the effectiveness that investors manifest when analyzing market behavior by employing machine learning techniques versus the technical analysis traditionally practiced.

#### 4.3 Distribution of scientific production by country of origin

Figure 4 shows the distribution of scientific production according to the nationality of the authors.



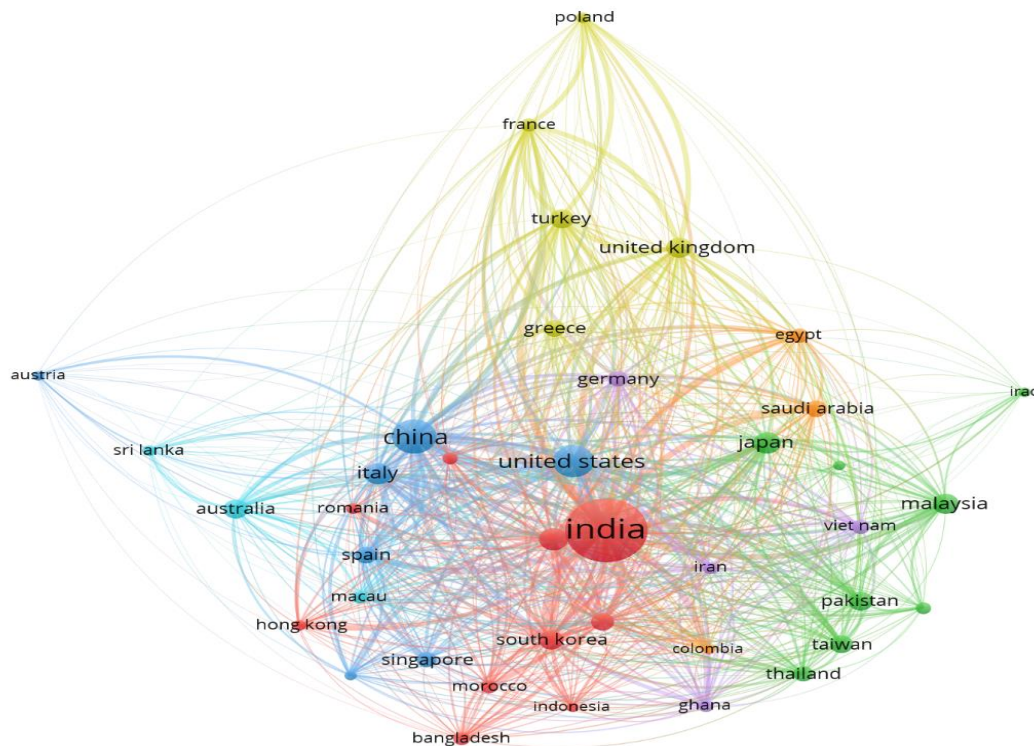
**Figure 4.** Distribution of scientific production by country of origin.

**Source:** Own elaboration (2022); based on data provided by Scopus.

As shown in Figure 4, India was the country with the highest number of records in Scopus, with a total of 209 publications during the period 2016-2021 followed by China with 52, the United States with 44 and Brazil with 19. Within the research papers published by authors affiliated with Brazilian institutions, the article entitled "The use of artificial intelligence to forecast oil prices" (Ignácio et al., 2017) whose purpose was to build a Multilayer Perceptron Neural Network (MLP), with the help of the Levenberg-Marquardt training algorithm, expecting to obtain a very close prediction of the data results for the observed time series, used to train the network, which demonstrates the efficiency of the developed model. Within the tests performed, it was determined that the percentage of error in the application of this model (MAPE - Mean Absolute Percentage Error) was 4.9512[%] demonstrating the accuracy of ANNs to predict one step ahead of Brent oil yields, which turns out to be a very

significant contribution since this is one of the most active commodities traded in stock exchanges around the world, allowing to create a benchmark to replicate these high accuracy models in forecasting fluctuations in the stock market worldwide.

At this point, it should be noted that the production of scientific publications, when classified by country of origin, presents a special characteristic and that is the collaboration between authors with different affiliations to both public and private institutions, and these institutions can be from the same country or different nationalities so that the production of an article co-authored by different authors from different countries of origin allows each of the countries to add up as a unit in the overall publications. This is best explained in Figure 4, which shows the flow of collaborative work from different countries.



**Figure 4.** Co-citations between countries.

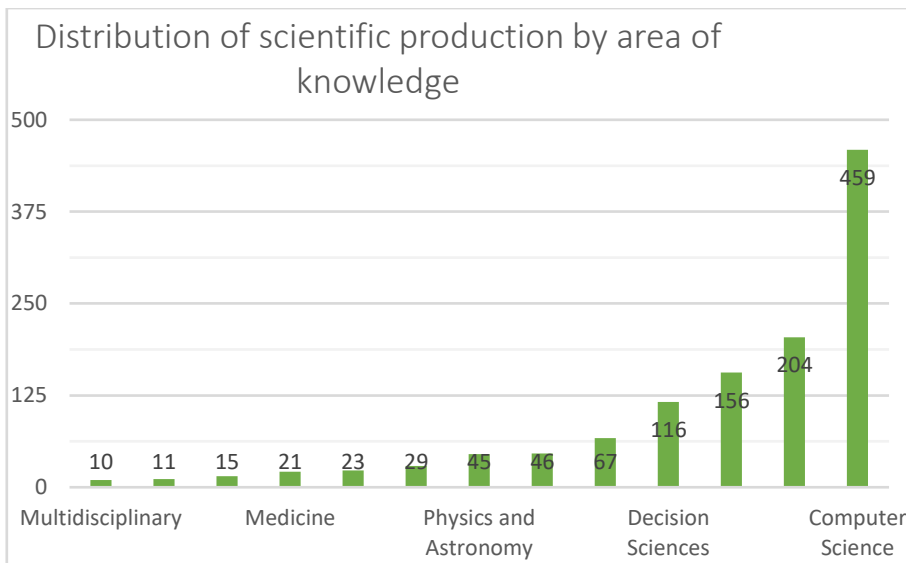
**Source:** Own elaboration (2022); based on data provided by Scopus.

India is not only the country with the highest number of papers published through its institutions but also the one with the highest international participation in its projects. Leading a major group where publications are co-authored with researchers from South Korea, Morocco, Indonesia and Bangladesh. China, the United States, Italy, Spain and

Singapore also have a high level of collaboration between researchers affiliated with institutions in that country.

#### 4.4 Distribution of scientific production by area of knowledge

Figure 5 shows how the production of scientific publications is distributed according to the area of knowledge through which the different research methodologies are executed.



**Figure 5.** Distribution of scientific production by area of knowledge

**Source:** Own elaboration (2022); based on data provided by Scopus.

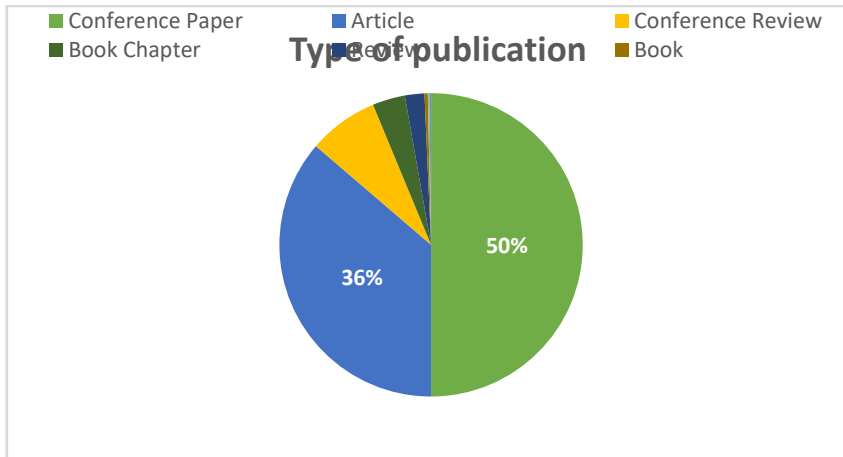
Computer Science was the area of knowledge with the highest number of contributions through the theories that are framed within it, in the search for new knowledge related to machine learning techniques applied to decision-making in the stock market, thanks to the same technological nature that involves the use of AI for the design of programs capable of learning through feedback from past periods, projecting possible future behavior according to behavior patterns in the market dynamics.

Decision Sciences ranks fourth with a total of 116 publications, among which it was possible to identify the one entitled "Stock price prediction using machine learning techniques" (Karthikeyan et al., 2021) whose objective

was to propose a robust technique to anticipate the bid rate using a model based on the moving average and compare how it varies and the actual cost. In this way, the researchers managed to design a strategy from the documentary review, applicable to the prediction of stock prices in the stock market, which undoubtedly constitutes an important aid to investors around the world, minimizing the risk and increasing the possibility of obtaining profits in their management.

#### 4.5 Type of publication

Figure 6 shows how the bibliographic production is distributed according to the type of publication chosen by the authors.



**Figure 6.** Type of publication

**Source:** Own elaboration (2022); based on data provided by Scopus.

50% of the publications analyzed in this review article correspond to Conference Papers, as this is the main type of publication chosen by authors from around the world to present their methodologies and findings concerning the study of machine learning techniques and their applicability in the prediction of stock market behavior. In the second place, Journal Articles represented 36% of the total production registered in Scopus during the period 2016-2021. Reviews 8% and Book Chapters 4%. It is important to mention that each publication was carried out through a publisher that has been indexed by the Scopus database, due to its high impact and reaches within the scientific community.

## 5. Conclusions

The bibliometric analysis proposed for the development of this article allows concluding that of all the countries participating in the execution of research projects related to the study of machine learning techniques and their applicability in the prediction of the stock market. India was the one that, with a great advantage over the second, occupied the first place with a total of 209 publications indexed in Scopus during the period 2016-2021. The above allows inferring that the main interest of researchers in this line of research, is to know technological programs capable of predicting the movements that are carried out within the dynamics of the stock market, using background data and its processing as an

evaluation of behavior patterns in terms of prices and stability of shares in the stock market.

Within the total number of publications identified through the application of certain search profiles and filters within Scopus, the present study determined that Computer Science was the area of knowledge with the greatest influence in the execution of 459 research projects that resulted in the same number of scientific publications. It should be noted that thanks to the interdisciplinarity that characterizes all research on topics associated with technological advances and their applicability, it was possible to identify areas such as Engineering, Mathematics, Decision Sciences, Business, Management and Accounting, and their influence on the application of theories associated with this line of research.

Finally, this article concludes by highlighting the importance of the study of machine learning techniques in the execution of strategies for predicting the behavior of stocks in the stock market, since, for investors, this information reduces uncertainty, high costs, and risk, and increases their competitiveness and profit margins in the exercise of their functions. The support of this type of technology inspired by the principles of AI allows to increasingly reduce the percentage of error and increase the effectiveness of decision making. Therefore, it is necessary to



know what has been written and published on the topic mentioned above, hoping that through the execution of documentary reviews such as the one presented in this document, it will represent for researchers an important input in the generation of new knowledge regarding new and better machine learning techniques and their applicability in decision making according to the prediction of the stock market.

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