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# Enhancing Mutual Fund Investment Decision-making Using Machine Learning: A Survey

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***Abstract***

*In India, a significant portion of individuals save a part of their income for a secure future. Government and various public sector financial companies also provide some saving schemes through banks, post offices, and Life Insurance Corporation (LICs) such as Recurring Deposit (RD), Public Provident Fund (PPF), Sukanya Samridhhi Account (SSA) fixed deposits, etc. Over the past decade, many individuals have shifted their saving schemes to vigorously searching for investment plan in mutual fund (MF) that gives optimal returns. The knowledge and interest in MF investments are increasing rapidly day by day. Indian investors who invested in MF 60 out of 100 in the previous year, many individuals failed to select the most appropriate MF schemes for their investment goals. This paper aims to provide insights to the individuals by conducting a brief literature review on various papers published in the domain of mutual funds as well as stock market investments. This survey will focus on understanding the criteria for selecting appropriate MF schemes, effective portfolio management strategies, and investigating the use of machine learning (ML) algorithms to predict the returns.*

**Keywords:** Mutual funds, machine learning algorithms, deep learning algorithms

## INTRODUCTION

In India different investors investing in different mutual fund (MF) scheme depends on their financial needs. Finding the right investment method, either a lump sum or a systematic investment plan (SIP) is crucial to get the expected returns. A lump sum involves investing a significant amount at once, while SIP allows you to invest smaller, regular amounts. We present five subtasks of Mutual funds investment and propose a taxonomy based on machine learning (ML) algorithms. Investors needs to analysis more information to select a mutual fund to invest. Data is must for analysis an appropriate mutual fund and get the prediction. By processing data, a machine learning (ML) algorithm can generate more accurate and effective predictions. ML acts as the catalyst that facilitates the discovery of predictive algorithms capable of continuous enhancement. Its scope extends beyond data scientists, with automation becoming the norm for various essential tasks. Mutual funds leverage the power of ML for forecasting and predictive analysis, leading to more informed decision-making. With a range of algorithms available, machine learning predictive modelling offers immense potential for businesses across industries.

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The most common algorithms that are often applied to predict and analyze mutual fund performance as shown in Table 1.

## RELATED WORKS

In existing articles, authors were explaining the mutual fund selections, portfolio optimization, net asset value (NAV) prediction, stock market

 

prediction, time series data analysis with the ML algorithm such as Long Short-Term Memory (LSTM), BPNN, K-means, Support Vector Machine (SVM), Concurrent Neural Network (CNN). But they have failed to propose the demographic based recommendation to buy a mutual fund and to manage portfolio.

Aayush Shah et al. (2022) proposed a model based on knowledge graph combined with deep learning embedding to provide personalized recommendation for mutual fund selection with explanation. They considered 8 types of entities such as user, Income range, occupation and 10 types of relations such as purchase, redeem, Income. The developed model will comprise of two processes, (1) using the deep neural embedding of the knowledge graph and generate the explanation, (2) other application of related recommendations. It recommends most appropriate funds as per the needs of the investors with explanation [1].

D. Mohan Srisai et al. (2021) proposed using neural network algorithms to enhance burstiness and perplexity while maintaining a lower level of predictability. By leveraging the capabilities of artificial intelligence, they aim to bridge the gap between AI-produced content and content written by humans. this article sheds light on the importance of incorporating burstiness and perplexity in content creation [2].

Tao Tao et al. (2019) taken K-nearest neighbor algorithm, neural network model, XGBoost, random forest algorithm to classify the mutual fund category. After the data preprocessing, they have taken 33 predictor variables for analysis. Tao tao used cross validation to build a valid model for prediction. Here the graphical software tool 'Plotly' has been used for the data visualization and understanding. They proved that XGBoost algorithm as well as random forest tree algorithm gives high accuracy than k-nearest neighbors (KNN) and neural network model [3].

**Table 1.** Mutual fund performance.

| Algorithms | Functions | Scenario |
|---|---|---|
| Regression Analysis | Predicting the upcoming performance of MF based on historical data | Forecasting the returns or Net Asset Value |
| Time Series Analysis (ARIMA, GARCH) (generalized autoregressive conditionally heteroscedastic) | Analyzing with forecasting trends in time ordered MF data | Predicting the future MF values based on time-stamped data |
| Machine Learning Regression (Linear and Random Forest Regression) | Building the predictive models of MF returns | Developing the models to guesstimate future MF performance based on various factors |
| Neural Networks (deep learning) | Netting complex relationships within financial data of MF prediction | Retaining the deep learning of predicting and understanding non-linear patterns |
| Decision Trees and Random Forests | categorizing and collaborating the learning of ML | Assessing factors influencing mutual fund performance and building robust predictive models |
| Support Vector Machines | Classifying MF based on historical data and other features | Identifying the trends and patterns in MF for predictive analysis |
| K-Nearest Neighbors | Grouping the similar characteristics based on historical data for MF | Gathering funds with comparable performance metrics |
| Clustering Algorithms (K-means) | Grouping the MFs with similar risk-return data | Creating Portfolio and diversified investment strategies |
| Ensemble Learning (XGBoost, AdaBoost) | Combining the predictions to enhance overall accuracy | Enhancing the robustness of predictive models |

 

C.M. Anish et al. (2016) proposed a feedback functional link artificial neural network (FFLANN) for the prediction of NAV of Indian Mutual funds. They took the historical NAV data of Birla SunLife Equity Funds, ICICI Prop-Top 100, SBI Bluechip fund, UTI Eqity Fund. They generate 789 patterns for each MF. From the total number of patterns, 80% is used for training and 20% used for testing. They used FFLANN, Functional Link Artificial Neural Network (FLANN), and Multilayer Artificial Neural Network (MLANN). FFLANN shows better results in terms of convergence, MAPE and RMSE [4].

Achyut Ghosh et al. [5] proposed the LSTM for the prediction on mutual fund. They have considered 3 sectors namely Index Tracking (IT), banking and pharmaceutical. And suggested 3 stocks to portfolio management using LSTM-based model with historical data.

In their study, Nghia Chu et al. [6] examined whether deep learning models could offer more precise predictions of Mutual fund performance compared to traditional statistical models. Their findings indicated that LSTM and gated recurrent units (GRU) deep learning techniques outperformed traditional statistical models such as ARIMA, ETS, and Theta in forecasting funds' Sharpe ratios.

In their work, Kasun Bandara et al. (2020) [7] introduced a prediction model compatible with various types of RNN models tailored for subgroups of similar time series, identified through time series clustering techniques. We evaluate our proposed methodology employing LSTM networks, a widely adopted RNN variant, and demonstrate its competitive performance on benchmark datasets following established evaluation protocols.

Yongxin Yang et al. (2023) [9] utilized semi-supervised learning (SSL) to extract features from financial time series data. These features were then employed to assess the similarities among assets within the market. Given the pivotal role of similarity measurement in portfolio diversification, the researchers addressed two portfolio optimization challenges: IT and Minimum Variance Portfolio (MVP). They introduced additional diversification terms associated with various similarity measurements derived from distinct SSL algorithms.

Soumya Banerjee et al. (2022) [10] chosen genetic algorithm to obtain an optimal portfolio select of India equity mutual funds to get minimum risk and maximum return.

We considered funds with a positive average return and a negative skewness of return. They have taken 26 large cap funds, 20 mid cap fund, 22 small cap funds from Indian mutual funds with 5-year operations. From their research, they guide to the investor to choose the mutual funds for the portfolio [10].

Chae-eun Par et al. (2021) focused on using a time series model named Prophet model. The fund information also contains the risk level that can be matched with the investment propensity of the user. For determining the fund risk level, they suggested K-means algorithm along with an elbow method with 4 classes (high risk, high return, high risk low return and so on). The Prophet model further accurately predicts the future price of the fund. The training time for this model is significantly less than traditional ML models [11].

Aayush Shah et al. (2023) proposed a clustering model for recommending mutual funds, which analyzes theories related to mutual fund investments and returns. Scaled dataset was used to implement these four types of clustering algorithms. These algorithms were evaluated and checked against two metrics, which were inertia and silhouette. By this article authors provided valuable insights for future research and investment decision-making [14].

In their 2023 paper, Chen et al. [15] aimed to enhance the accuracy and timeliness of fund classification using a Gaussian hybrid clustering algorithm from ML. Additionally, they implement a deep learning-based prediction model to forecast the price movement of fund classes based on these

 

classifications. The classification of 3,625 Chinese mutual funds demonstrates both accuracy and efficiency. The primary contribution of this paper is the introduction of a novel approach to fund classification and price movement prediction, which aims to enhance decision-making for next-generation AI-assisted robo-advisors.

In their 2022 study, Khalid Alkhatib et al. proposed six deep learning models—MLP, GRU, LSTM, Bi-LSTM, CNN, and CNN-LSTM—to predict the adjusted closing price of stocks. To improve accuracy and reduce losses, they introduced a new set of features. Instead of the traditional four features (high, low, volume, open), they created six feature sets, including high, low, volume, open, HiLo, and OpSe. The study also examines the impact of data size by utilizing datasets of varying sizes from Apple, ExxonMobil, Tesla, and Snapchat to enhance open innovation dynamics. The results indicated that LSTM-based models improved with the new approach, with no single model consistently outperforming the others [18].

Akhila Vangara et al. (2018) predicted NAV by expanding the various parameter as input. They have conducted the experiments on Indian market especially HDFC (Housing Development Finance Corporation) mid cap opportunity MF scheme. They used SVM model from ML to predict NAV of HDFC mid cap opportunity growth [21].

## REVIEW METHODOLOGY

In this article, we focus on literature pertaining to mutual fund selection and prediction. we implemented the following strategy as: (1) We limited the timeframe to the last 8 years. (2) We identified the ML algorithms, data mining, deep learning and artificial intelligence conferences. (3) We utilized the search engine of science direct, N-List, Google Scholar with specific keywords such as mutual fund selection, portfolio management, NAV prediction, time series with ML, deep learning. We were download near 100 papers and have selected 45 papers for our survey from top conferences, such as IEEE, IRJET, Elsevier, IRJET, SSRN, ICANN, Hindawi, arXiv, ESWA, Springer, IJCCE, ICSMDI, MSEA and so on. Figure 1 shows the number of papers by publication year. The largest number of papers in this survey were published in 2022 and smallest number in 2019. This survey covers XGBoost, LSTM, Feedforward back propagation neural network, knowledge graph with deep learning, SVM, CNN, back propagation neural network (BPNN), K-means, self-supervised learning, random forest, deep learning, and artificial intelligence (AI) algorithms [8].

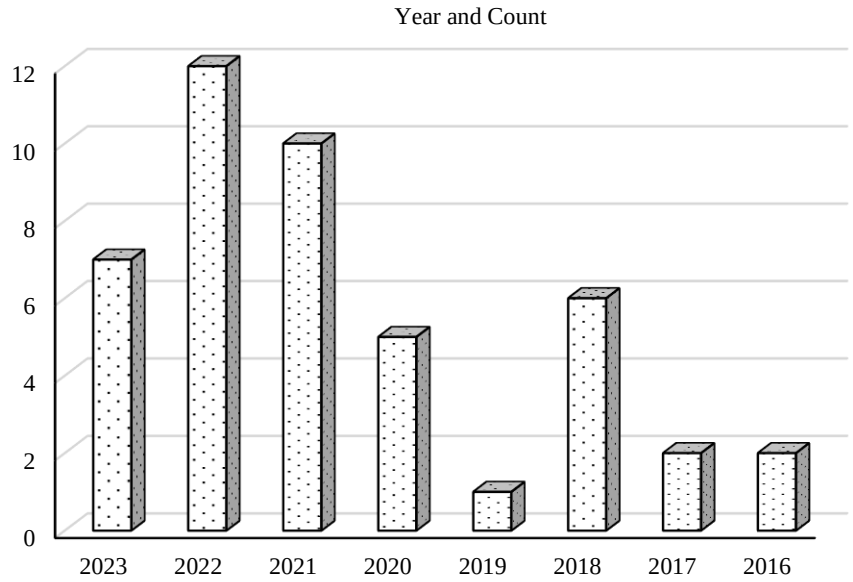


**Figure 1.** Number of papers by publication year.

 

## MUTUAL FUND SELECTION AND PREDICTION IN MACHINE LEARNING

The following task are provided from the concept of existing articles which has been mentioned in the literature survey.

1. Mutual fund selection/recommendation.
2. Mutual fund NAV/returns prediction.
3. Portfolio management on mutual fund/stock market.
4. Mutual fund classification.
5. Time series data.

### Mutual Fund Selection/Recommendation

Mutual fund selection is based on various parameters [16, 17]. These include the expected returns, risk tolerance, and investment prospect. There are the different parameters to reflect for fund selection including ratio of expensive, previous performance, fund manager's experience, and assets under the management.

### Mutual Fund NAV/Returns Prediction

NAV of a mutual fund schemes are calculated at the end of each day the markets are open, so NAV will be changed only once in a day. The price of equity shares changes in real times as shares are traded during the market hours [19, 20].

### Portfolio Management

Portfolio management includes the strategic selection and mistake of a collection of investments with the aim of realizing the financial objectives. The aim of portfolio management is to allocate resources that maximizes returns and minimizing risks [22–28].

### Mutual Fund Classification

MF can be categorized based on the asset class, objective of investment, structure, specialty, and risk. Categorization based on the class of asset, objective of investment and structure are more common [29–35].

### Time Series Analysis

Time series analysis involves examining a dataset gathered over a time interval. Analysts gather data points at regular intervals throughout a specified period rather than sporadically or randomly.

Figure 2 shows the number of papers by publication year. The maximum number of papers in this survey were predict the mutual fund return and stock market values. Next the portfolio optimization has maximum in this survey. The least count has time series [36–45].

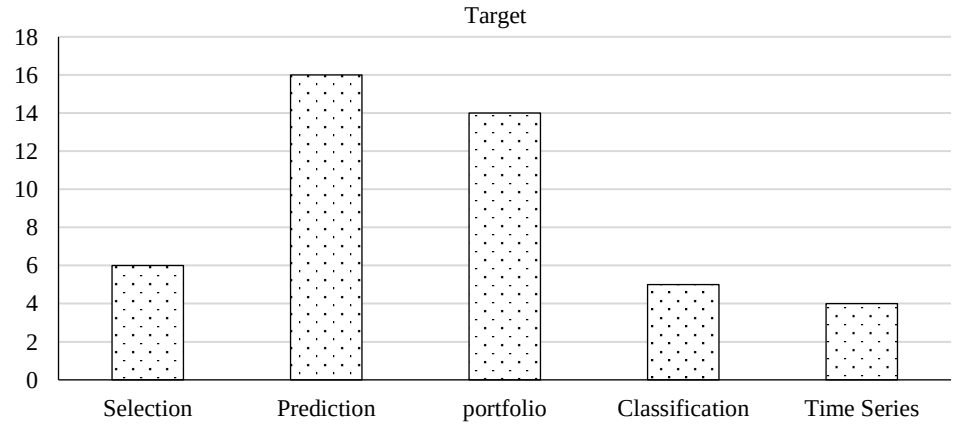


**Figure 2.** Mutual fund return and stock market values.

 

**Table 2.** Abbreviation of algorithms which has been used in reviewed papers.

| Abbreviation | Algorithm |
|---|---|
| KGDL | Knowledge graph with deep learning |
| FFBPNN | Feed forward back propagation neural network |
| XGBoost | Extreme gradient boosting |
| RF | Random forest |
| FFLANN | feedback functional link artificial neural network |
| LSTM | Long short-term memory |
| RNN | Recurrent neural network |
| SSL | Self-supervised learning |
| Gen. Alg. | Genetic algorithm |
| GDCF | Graph distributed coordination function |
| CNN | Convolutional neural network |
| SVM | Support vector machines |
| DL | Deep learning |
| BPNN | Back propagation neural network |
| DM | Decision Making |
| OT | optimization techniques |
| DNN | Deep neural networks |
| SVR | Support vector regression |
| SWT | Stationary wavelet transform |
| DRL | Deep reinforcement learning |
| ML Alg. | Machine learning algorithm |
| KNN | K-nearest neighbors |
| DLN | Deep learning networks |
| RB Apro. | Rule-based approach |
| ANN | Artificial neural network |
| DSS | Decision support system |

## SUMMARIES OF THE MACHINE LEARNING ALGORITHM USED IN MUTUAL FUND SELECTION

Table 2 represents the abbreviation of algorithms which has been used in reviewed papers.

## CONCLUSION

Now a day, there are several system apps and mobile apps are available to start investing directly in mutual funds schemes. We can select the mutual fund based on expense ratio, 3Y CAGR, exit load, dividend payouts. Then we can start SIP, manage portfolio, avail instar redemption anytime and from anywhere through the system app or mobile app. Investing in mutual fund portfolio helps in diversifying our investment and reduces the risk. In this paper, existing research on mutual fund as well as stock selection, prediction, portfolio management are analyzed. Data mining, deep learning, ML algorithms are used for the mutual fund's classifications, selections, NAV prediction, portfolio management, time series forecasting. These helps to know how the algorithms are used in mutual funds selection and portfolio management. In the future, the new algorithm will be developed for demographic based mutual funds selection and portfolio management using ML.

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