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Advancement in Inflation Projection with AI Insights: A Case Study on India's Inflation Data

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***Abstract*—The study critically reviews the existing literature on inflation forecasting in India, emphasizing the limitations of traditional econometric models in capturing intricate relationships among macroeconomic variables influencing inflation. In response, Machine Learning (ML) and Deep Learning (DL) models are proposed for inflation forecasting, leveraging a dataset comprising Indian macroeconomic variables. The devised model undergoes training and testing through various ML and DL techniques, encompassing LR, K-NN, DT, SVM (Linear Kernel), SVM (RBF Kernel), NN, RF, GB, AdaBoost, and XGBoost. Comparative analysis against traditional econometric models demonstrates the superior predictive performance of the ML and DL model. Notably, the convolutional neural network model stands out as the most accurate forecasting techniques. This study also identifies key variables influencing inflation rates in India, including interest rates, exchange rates, and fuel prices. The results underscore the potential of ML and DL methods in enhancing inflation forecasting in India, utilizing the latest dataset collected through survey methods across diverse Indian cities. Furthermore, XGBoost emerges as the optimal classifier for predicting inflation in India. These findings hold significant implications for policymakers and central banks, offering valuable insights for informed decision-making and the formulation of effective monetary policies in the context of developing countries.**

***Index Terms*— Developing Countries, Development Policy, Machine Learning, Deep Learning, Macro Economic Variables.**

I. INTRODUCTION

The economic crises, pandemics, inflation, exchange rates, and other factors require fiscal policy in order to achieve economic growth and well-being (David Valle-Cruz, et al. 2022). One of the important goals of monetary policy is to stabilize prices (Yang et al. 2021). The research aims to provide valuable insights for policymakers, businesses, and economists seeking to leverage AI-driven methods for more reliable inflation predictions and better economic decision-making. This research explores the application of AI, particularly in predicting inflation. High- lighting the significance of accurate inflation forecasts for economic decision-making, it aims to leverage AI advancements to overcome traditional forecasting limitations. Focused on India's unique economic conditions, the study holds practical implications for policymakers and businesses, potentially optimizing resource allocation and risk management. If successful, AI-based forecasting could positively impact economic stability and decision-making across various sectors.

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A. Research Objectives

a. Evaluate AI Techniques: Assess the effectiveness of AI techniques in forecasting inflation using historical Indian data.
b. Optimize Model Parameters: Finetune AI models to enhance predictive capabilities for inflation.
c. Investigate Feature Importance: Identify key economic indicators influencing in- flation forecasts in India.
d. Contribute to Literature: Publish research findings to enhance knowledge on AI applications in economics and inflation forecasting.

B. Contribution

The main objective of this research are to contribute to the existing body of knowledge on AI-ML applications in inflation forecasting, specifically focusing on the case of India, assess the scalability and practical applicability of AI-ML models for inflation forecasting in India by considering factors such as computational requirements, data processing speed, and implementation challenges in real-world scenarios, develop and optimize AI-ML models: Build and fine-tune AI-ML models specifically tailored for inflation forecasting in India by experimenting with different algorithms, model architectures, feature selection techniques, and hyperparameter tuning to enhance the accuracy and robustness of the models and evaluate the effectiveness of AI-ML techniques in fore- casting inflation:
The paper has been organized as covering the Literature Review, Dataset Prepara- tion, Data pre-processing, Exploratory Data Analysis, Research Methodology, Result and Discussion, Conclusion, and Future Scope.

II. Literature Review

"Forecasting Inflation in India: A ML Approach" by Rakesh Kumar and Amit Kumar published in the Journal of Quantitative Economics (2018), the paper proposes an ML approach to forecasting inflation in India. The study uses data from 2000 to 2015 and finds that all three techniques can produce accurate inflation forecasts, with SVR outperform- ing the other two methods. The study concludes that ML techniques can provide an effective tool for inflation forecasting in India (R. Kumar et al. 2018). Manish Kumar and Abhinav Sachdeva pub- lished in the Journal of Computational and Theoretical Nanoscience (2017), the paper explores the application of ML techniques for inflation forecasting in India. The study uses data from 2004 to 2014 and finds that all three techniques can produce accurate inflation forecasts, with ANN and SVR performing slightly better than RFR. The study concludes that ML techniques can provide a promising approach for inflation forecasting in India (M. Kumar, et al. 2017). Sandhya Samarasinghe and Madhu Fernando published in the Journal of Forecasting (2014), the paper investigates the use of ANN and SVR for inflation forecasting in India. They use monthly data from 1991 to 2011 to train and test the models. The study concludes that ML techniques, particularly SVR, can provide a useful tool for inflation forecasting in India (S. Samarasinghe et al. 2014). The paper investigates the use of ANN for inflation forecasting in India. They use monthly data from 1996 to 2009 to train and test the models. (S. K. Bose and Kousik Gupta,2011). They use monthly data from 2003 to 2016 to train and test the models, and they compare the performance of various ML techniques, including ANN, SVR, and RF. (Rakesh Kumar and Amit Kumar, 2018). The study concludes that ML techniques can be an effective tool for inflation prediction in India, particularly in the presence of non-linear relationships between macroeconomic variables (D. Dheeraj and N. Bhuvaneswari, 2018). The study concludes that ML techniques can be an effective tool for inflation forecasting in India, and that XGB is the most accurate technique for this purpose (Rahul Gupta and Ruchi Sharma, 2021). The study provides valuable insights for policymakers and financial practitioners on the potential use of DNNs for inflation forecasting (Spyridon Bozinis and Georgios Sermpinis, 2021). They argue that ML methods can help central banks and policymakers make more informed decisions by providing more accurate and timely inflation forecasts (Vincenzo et al. 2020). They found that ARIMA models with seasonal differencing improved the accuracy of inflation forecasts (Sharma and Bhati 2018). Authours used a VAR model to forecast inflation in India and examined the impact of various factors such as money supply, exchange rates, and interest rates on inflation Bhanumurthy and Ranjan (2014). Authors estimated the Phillips Curve for India and used it to forecast inflation based on projected changes in unemployment rates [Sahoo and Dash, 2013). Authors developed a structural econometric model to analyze the impact of fiscal policy, monetary policy, and external factors on inflation in India (Keshari and Sinha, 2018). Authors used a time series decomposition approach to forecast CPI inflation in India (Mishra and Mishra, 2016).
Overall, Inflation Forecasting using AI provides a valuable contribution to the field of macroeconomic forecasting and highlights the potential of ML techniques in this area.

III. Dataset Preparation

We have taken a Dataset from Data Bases on Indian Economy (RBI's Data Ware- house). The data were collected from the official website of RBI from year 2015 to 2022 [10,11]. The links are as follows:
https://rbi.org.in/scripts/PublicationsView.aspx?Id=21755
https://dbie.rbi.org.in/DBIE/dbie.rbi?site=unitLevelData

a. View on 3 Months ahead Inflation Rate and View on 3 Months ahead Inflation Rate -actual rate above 16%
b. View on 1 year a heads Inflation Rate and View on 1 year ahead inflation Rate -actual rate above 16%. We have converted the categorical data to quantitative by using a label encoder.

A. Exploratory data analysis (EDA)

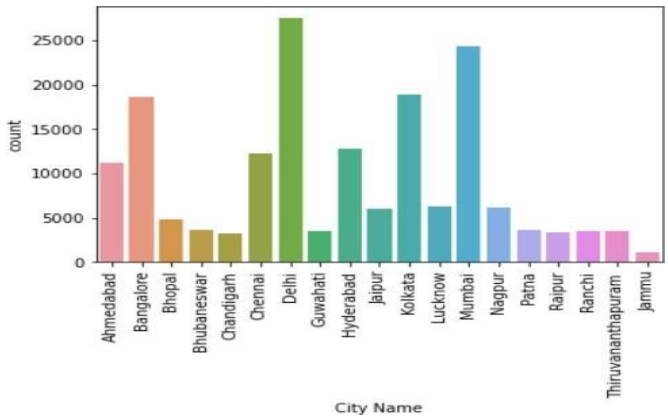

Fig. 1 Citywide respondent

Fig. 1 shows the majority of respondents are from the category Homemaker who are female. Fig. shows the period is uniformly distributed. The survey of inflation is collected from year 2018 to 2022. Inflation rate are positively skewed. Maximum respondent have given the inflation rate (for current, 3 year ,1 year) between 0 – 10. We have split our dataset into two – next 3 months inflation and 1 year ahead. In both dataset we have dropped unnecessary columns which are not needed for the model training, mainly Block 1.

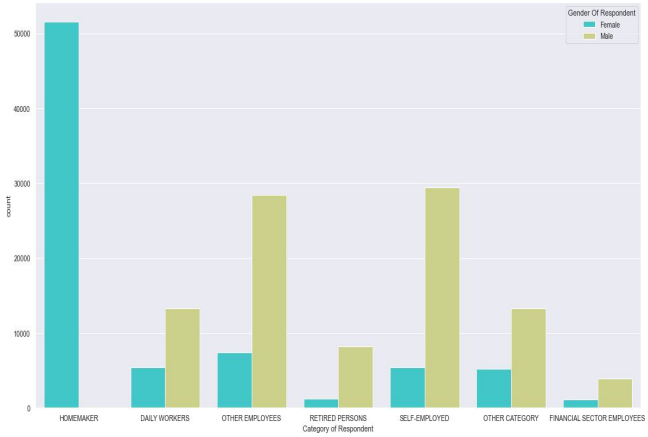

Fig. 2. Male-Female Ratio

IV. Methodology

After going through various research paperes, we experimented various outperformed ML and DL algorithms (LR, K-NN, DT, SVM (Linear Kernel), SVM (RBF Kernel), NN,RF,GB, AdaBoost and Xgboost) for the our case study.
To analyse the dataset and predict inflation on prepared dataset, we used the approach shown in Figure 4.

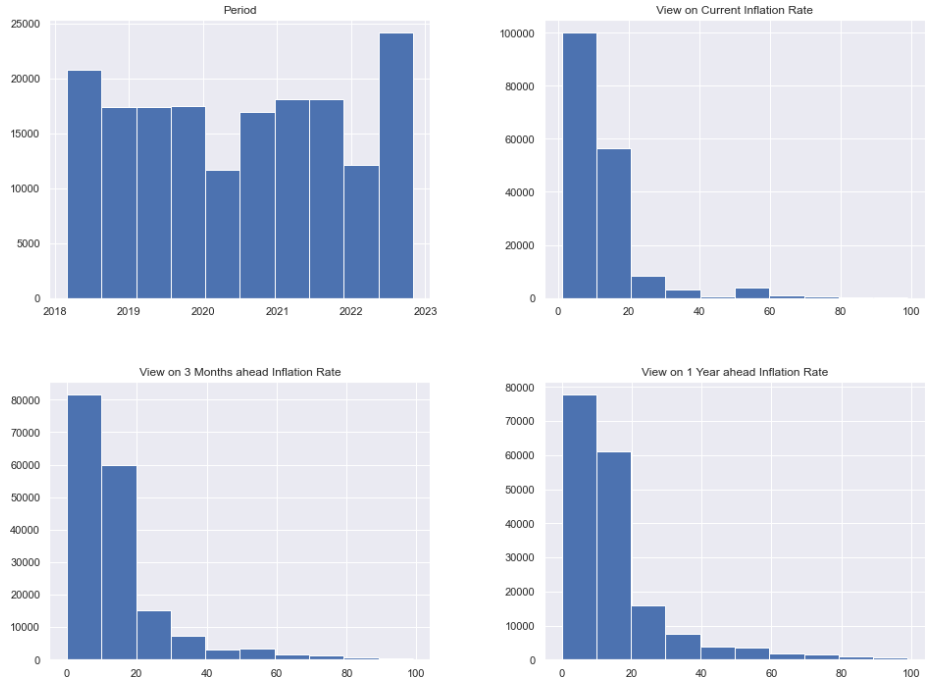

Fig. 3. Period wise past inflation rate

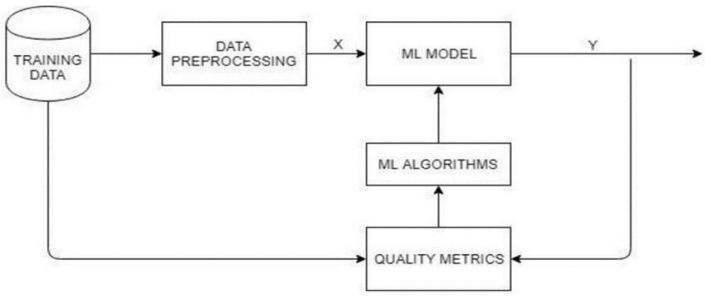

Fig. 4. Workflow plan

V. Results and Discussion

In this study we have experimented following AI techniques.

LR: It is a supervised technique used for regression tasks. It assumes a linear, rela- tionship between the input variables and the target variable. Regression analysis is one of the most used and most powerful multivariate statistical techniques for it infers the existence and form of a functional relationship in a population (Mohammad Mahbobi 2012).

(K-NN):K-NN is a supervised technique used for both cataloguing and reversion tasks. It categorizes or predicts the target variable based on the kNN in the feature space. The predicted value is determined by the average or majority voting of the k neighbours.

DT: This supervised technique used for both cataloguing and reversion tasks.

SVM with Linear Kernel: SVM is a dominant supervised technique used for both cataloguing and reversion tasks. The linear kernel SVM finds a linear decision boundary that maximizes the margin between classes or fits a linear function to the regression data.

SVM with RBF Kernel: SVM with RBF Kernel is a variant of SVM that uses a nonlinear kernel. It was initially designed for binary classification but can be extended to solve n-class problems (Belousov et al. 2002).

NN: It is a class of DL models stimulated by the assembly of the humanoid brain. They consist of interconnected nodes (neurons) organized in layers. They are widely used for various tasks, including cataloguing and reversion.

RF: RF (Liang 2022, Zhang 2023) is a basic ensemble ML model used in the gen- eration of LSM and is considered a conventional technique because of its popularity in landslide susceptibility mapping.
GB: Boosting is another collaborative technique that combines weak prediction models (typically decision trees) sequentially. Each subsequent model is trained to correct the errors made by the previous models, leading to improved predictions.
AdaBoost: It is a collaborative technique that sequentially combines weak models to improve prediction accuracy. Optimization for parameter tuning to accelerate the model training process using the ensemble approach (Pham et al. 2020).
XGBoost: It is an enhanced application of gradient boosting. It includes additional regularization methods and similar dispensation, making it faster and more accurate. XGBoost is widely used in various ML competitions and is known for its exceptional presentation (Pham et al. 2020).

TABLE I. DIFFERENT MODEL ACCURACY

Model Name	**Accuracy of Model**
Logistic Regression	0.85269
K-Nearest Neighbors	0.85001
Decision Tree	0.84983
Support Vector Machine (Linear Kernel)	0.85269
Support Vector Machine (RBF Kernel)	0.85269
Neural Network	0.85269
Random Forest	0.84982
Gradient Boosting	0.85269
AdaBoost Classifier	0.85268
XGBoost	0.85268

VI. CONCLUSION

The utilization of machine learning (ML) models, particularly XGBoost, in the analysis of the Inflation Expectations Survey of Households (IESH) has proven to be a highly effective approach for gaining valuable insights into consumer behavior and expectations. By leveraging historical data and incorporating economic indicators and demographic information as variables, ML models enhance the precision of predicting future inflation expectations. This study delved into the efficacy of various ML models for inflation forecasting in India, ultimately highlighting XGBoost as the preeminent model. Its consistent out- performance across LR, K-NN, DT, SVM (Linear Kernel), SVM (RBF Kernel), NN, RF, GB, and AdaBoost is evident in lower Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) values. The practical implications of XGBoost's proficiency make it an invaluable asset for policymakers and researchers aiming to navigate and anticipate inflation trends in the dynamic landscape of the Indian economy.

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