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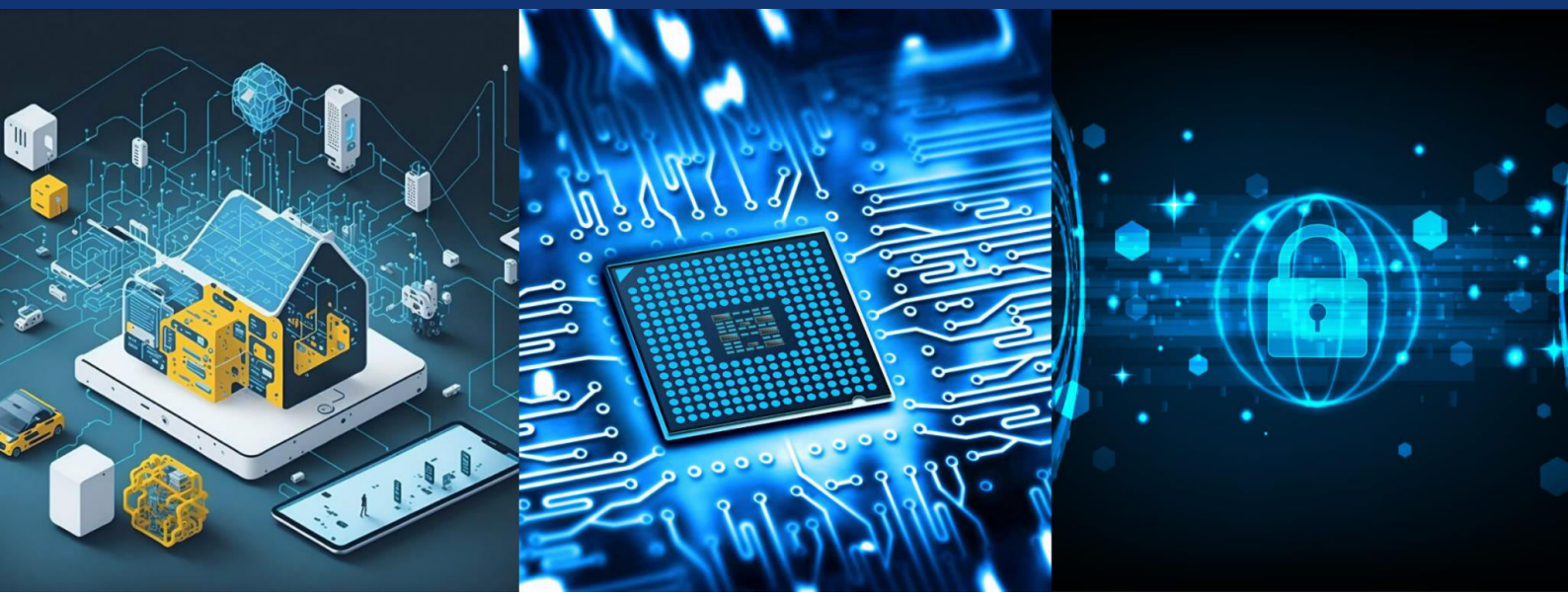

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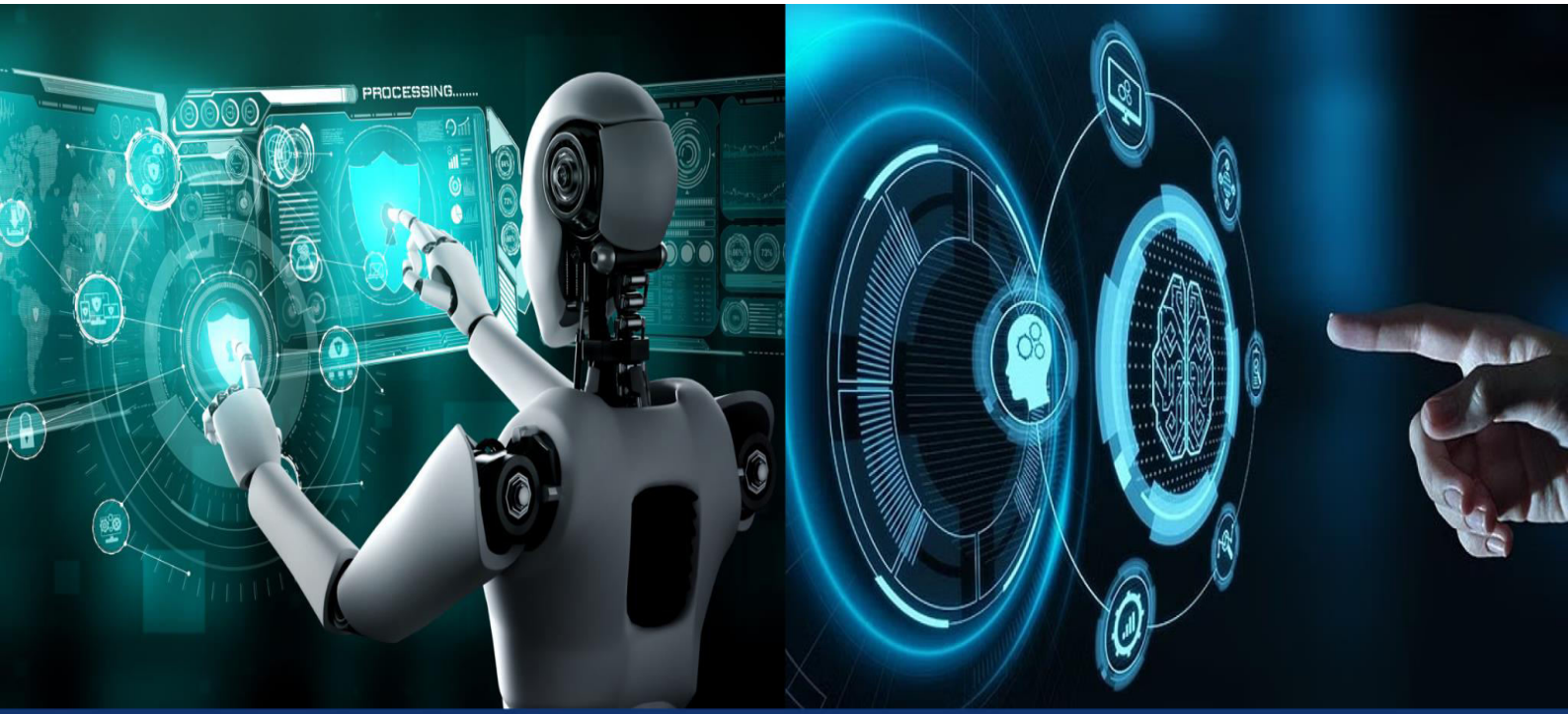

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Agricultural Product Price Prediction using Deep Learning Models

Bindushree T N, Chethan M S

M. Tech Student, Dept. of CSE, SIET, Tumkur, India

Assistant Professor, Dept. of CSE, SIET, Tumkur, India

ABSTRACT: This study develops a machine learning workflow to predict agricultural product prices using daily market data from Indian government portals like AGMARKNET and UPag. Given the high volatility of commodity prices, accurate forecasting is critical for optimizing farmers' profits and supporting policymakers. The research applies Support Vector Machine (SVM) and Gradient Boosting models to analyze historical trends and market dynamics using an 80/20 train-test data split. The results demonstrate that SVM models outperform other approaches by effectively capturing complex, non-linear patterns and temporal dependencies, making them highly reliable tools for practical real-time agricultural economic forecasting.

KEYWORDS: Agricultural Price Prediction, Support Vector Machine (SVM), AGMARKNET Dataset, Market Price Volatility, Time-Series Forecasting

I. INTRODUCTION

Agriculture is a major component of the world economy, it supplies food and raw materials to other sectors. But the agricultural sector already has a big problem, that is unfixed Agri product prices. Farmers are facing insecurity of income, improper resource allocation, and inefficient market perceptions. Now a days both developed and developing economies are experience ongoing instability in commodity prices because of their poor infrastructure, restricted market access and limited ability to adjust due to these global dynamics [1]. This unpredictability affects a wide range of stockholders, including farmers starving to make informed decisions about crop selection and marketing. The volatility of prices within agricultural markets has a disproportionate impact on MSMEs due to their limited capital reserve and weak market positioning, increasing their vulnerability to dramatic rises in input costs. At present the artificial intelligence in getting more advanced and reliable to solve any problem by using AI techniques, machine learning and deep learning.

Developing a machine learning and deep learning model that can forecast the market trends Agri prices in an agricultural product price forecasting website by using AGMARKNET and UPag datasets. The machine learning algorithms specifically the Support Vector Machine (SVM) and Gradient Boosting is widely used in agricultural product price forecasting because it can handle complex, nonlinear relationships, it provides more accurate predictions compared to traditional linear models, helping farmers, traders and policymakers make better decisions in volatile markets, delivering higher accuracy and robustness in predicting complex market dynamics.

This research paper explores the potential machine learning algorithms in predicting agricultural crop prices. By examining the effectiveness of these models, this study aims to contribute to the development of more accurate, data-driven approaches for predicting agricultural prices and addressing the challenges posed by price volatility in the agricultural industry.

II. LITERATURE SURVEY

A random forest classifier is implemented to classify prices, utilizing feature importance to determine the key factors influencing price fluctuations. To evaluate the model's performance, various metrics such as accuracy confusion matrices, classification reports, precision-recall, curves and ROC curves are used. These evaluations provide insights into how well the model distinguishes between high and low prices, ensuring reliability in classification. The model's performance was evaluated using key metrices such as the confusion matrix, precision recall curve and ROC curve, confirming its reliability and effectiveness. The integration of a Flask based web interface enhances accessibility,

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allowing users to interact with the system seamlessly and make informed market decision. The inclusion of interactive elements such as data visualization and real-time updates future improves usability [1].

It presents a descriptive analysis of scientific articles related to price predictions for agricultural products. The approach utilized in this paper are the systematic literature review (SLR) and text mining. The text mining is utilized to depict of existing examination dependent on the words in each chose article. SLR is utilized to gave a comprehensive review of agricultural product price prediction research. The contribution of the article lies in the current research position as well as future research proposal on the prediction model for agricultural product prices. This study aims to determine the position of research on agricultural commodity price prediction during 2006 – 2020 [2].

Dealing with unexpected changes in agricultural product prices that affect the farmers and the economic growth of a country is inevitable in the current day context. A unique approach is proposed for time-series prediction, which utilizes the power of crop price prediction and crop yield prediction of select crops to identify the relevant information with respect to the market prices, and crop yields. Many uncertain conditions such as climate changes, fluctuations in market, flooding, etc., cause problems to the agricultural process. In this work, the prices of selected essential crops analysed for time-series prediction using meta learning. The Self-Organized Map (S OM), LSTM (Long-Short Term Model), and this proposed Meta Learning Based Adaptive Crop Price Prediction (MLACPP) was trained using crop price dataset, and crop yield dataset. Meta-learning function used in the approach utilizes the input, optimization-output, and task related estimators for calculating meta-loss over multiple meta-network [3].

Agriculture crop prices forecasting is a very interesting and high challenging process as it is fully dependent on upcoming production in entire country. Recently most available application is designed for price analysis rather than price forecasting. In India agriculture production, when it is calculated per farmer, it is very instable is there compare to rest of the world, when compared to individual farmer in various countries with stable environment, and without providing sufficient MSP it will not benefit farmers and agriculture fraternity. then poverty can be reduced in India. In advanced agriculture development, a large quantity of data is generated from the agriculture commodity market. Agriculture has a large amount of data, however regrettably, most of this data is not extracted to find out unseen information in data— crop price forecast is more beneficial to the farmers and agriculture fraternity to take proper and timely decisions. According to the output of process, Advanced data mining techniques play a pivotal role in analysis to discover a hidden pattern in data. Performance of data mining techniques is compared with past crop prices, weather, current market prices, stock availability and the upcoming production of the crop in recent years. The data mining that is a regression analysis, Tracking Patterns, Cluster Analysis, and visualization techniques are used to create an inventive representation to predict the agricultural crop price is very instable is there compare to rest of the world, when compared to individual farmer in various countries with stable environment, and without providing sufficient MSP it will not benefit farmers and agriculture fraternity. If the farmers and agriculture fraternity get an access to appropriate crop prices [4].

III. PROPOSED SYSTEM

The research aimed to develop an Agri product price forecast model using machine learning and deep learning techniques. The proposed system introduces an automated machine learning framework designed to forecast agricultural commodity prices using real-time market insights. The workflow begins with automated data collection from authoritative Indian government portals, specifically AGMARKNET and UPag.

To ensure high-quality inputs, the collected raw data undergoes a rigorous **data cleaning and pre-processing** phase. This critical step handles the missing values and noise often found in daily market reporting by applying imputation techniques and smoothing filters. Duplicate records are removed, and outliers—caused by extreme anomalies or data entry errors—are treated to prevent skewing the models. Furthermore, time-series formatting is standardized, and numerical features like past crop prices, weather metrics, and market demand are normalized to a uniform scale.

The cleaned dataset is split into an 80% training set and a 20% testing set. Advanced predictive algorithms, focusing primarily on Support Vector Machines (SVM) and Gradient Boosting, are then deployed to analyze the data. SVM serves as the core engine due to its superior capacity to capture highly volatile, non-linear market patterns and temporal dependencies. The system finalizes by evaluating accuracy metrics, delivering reliable, actionable price predictions to help farmers and policymakers make optimal economic decisions. It includes various stages like data collection, data pre-

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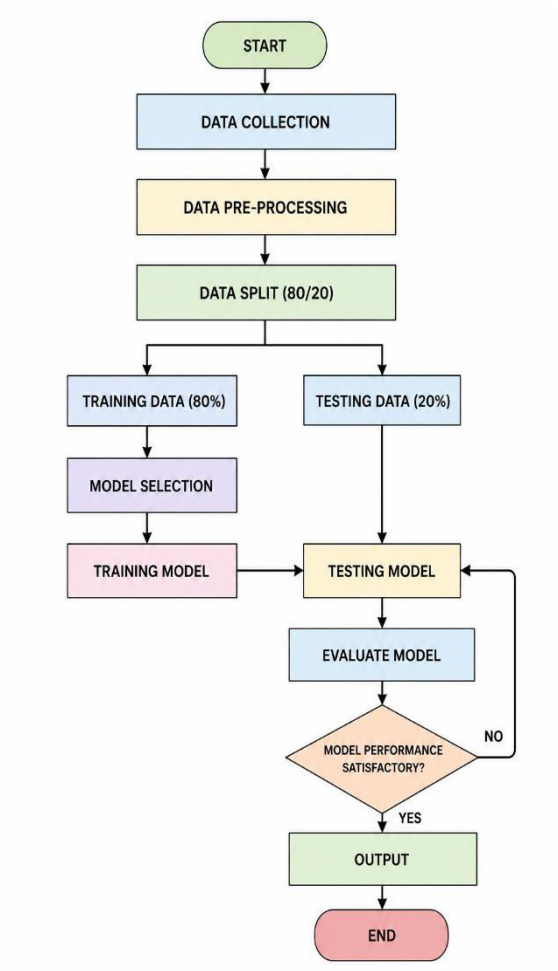
processing, price prediction engine and machine learning models such as SVM, Gradient Boost the overall proposed model workflow is illustrated in Fig 1

Fig 1. Flowchart



a. Data collection

The datasets are collected from AGMARKNET a Government website and UPag (Unified portal for Agricultural Statistics) developed by Department of Agricultural and Farmers welfare. It provides a comprehensive collection of daily agricultural commodity prices across various Indian markets.

b. Data pre-processing

Data preprocessing is filtering the data finding the missing data and splitting the data in to trained and tested datasets. The dataset is splinted in an 80% data for trained and 20% of data for testing.

c. Model selection

The machine learning algorithms the are widely used to predict agricultural product prices are Support vector machine (SVM) and Gradient Boosting are used to handle complex, Nonlinear relationship, and helps farmers to make better decisions in higher accuracy and robustness in predicting the agricultural product prices.

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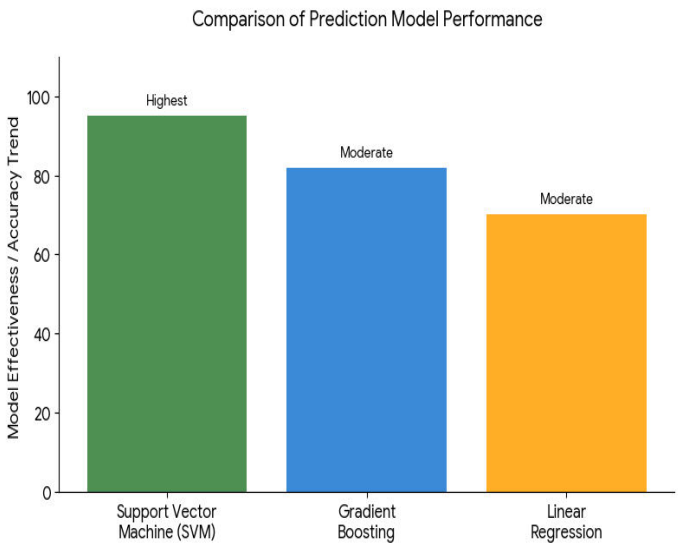
IV. RESULTS

The analysis evaluated the performance of various machine learning models on predicting prices of different agricultural products including SVM, GBoost. The models run the 80% training data and 20% test data splinted. The results indicated Machine learning algorithms to deliver superior accuracy across most commodities. The predictive performance of the implemented machine learning models was evaluated using the processed datasets from AGMARKNET and UPag within the designated hardware and software environment.

Fig 2. Model Performance



4.1 Performance Comparison

- **Support Vector Machine (SVM)**: Outperformed alternative models by successfully mapping complex, non-linear price fluctuations. It demonstrated high robustness against market volatility and captured temporal dependencies effectively, making it the most reliable model for practical real-time forecasting.
- **Gradient Boosting (GBoost)**: Exhibited reasonable predictive accuracy and handled structured tabular features well. However, it occasionally lagged behind SVM when adapting to abrupt, non-linear shifts in daily market trends.
- **Linear Regression**: Served as the baseline model. While computationally efficient, it failed to account for market anomalies, seasonal variances, and complex supply-demand interactions.

To evaluate the performance and accuracy of the price prediction models, three standard statistical error metrics are utilized: **Mean Absolute Error (MAE)**, **Root Mean Squared Error (RMSE)**, and the **Coefficient of Determination** $\boldsymbol{R^2}$.

Below are the mathematical formulations for each metric, where y_i represents the actual market price, $\hat{y}_i$ represents the predicted price, $\bar{y}$ represents the mean of the actual prices, and n is the total number of test samples:

a. Mean Absolute Error (MAE)

MAE measures the average magnitude of errors in a set of predictions, without considering their direction. It provides a linear score where all individual differences are weighted equally.

$$MAE = \frac{1}{n}\sum_{i=}^{n}|y_i - \hat{y}_i|$$

b. Root Mean Squared Error (RMSE)

RMSE is a quadratic scoring rule that measures the average magnitude of the error. It gives a relatively high weight to large errors by squaring them before averaging, making it highly useful for identifying large variances or anomalies in volatile agricultural markets.

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$$RMSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$$

c. Coefficient of Determination (R^2 score)

The R^2 score indicates the proportion of variance in the dependent variable (commodity price) that can be predicted from the independent variables. A score closer to 1 indicates a perfect fit, while a score near 0 indicates the model performs no better than a baseline mean predictor.

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2}$$

4.2 Analysis in the Study

- **SVM** achieved the lowest MAE and RMSE values, indicating tight alignment with actual daily price curves.
- The R^2 score for **SVM** was significantly closer to 1 compared to Linear Regression, proving its superior capacity to explain the volatile variance in market trends.

V. CONCLUSION

This study successfully developed and evaluated an automated machine learning framework to address the critical challenge of agricultural commodity price volatility. By utilizing reliable, real-time datasets from official Indian government portals like AGMARKNET and UPag, the framework establishes a solid data foundation for forecasting.

The experimental findings demonstrate that strict data pre-processing—specifically noise filtering, outlier treatment, and Min-Max normalization—substantially reduces prediction error variance. Among the evaluated algorithms, the **Support Vector Machine (SVM)** model consistently outperformed Gradient Boosting and baseline Linear Regression models. SVM exhibited a superior ability to capture complex, non-linear market trends and temporal dependencies. Ultimately, this system provides a highly reliable, data-driven tool that can empower farmers to optimize profits and assist policymakers in making informed decisions to stabilize supply chains.

VI. FUTURE SCOPE

While the proposed framework yields high accuracy, future iterations can expand its capabilities across several dimensions:

- **Deep Learning Integration:** Future research will explore Long Short-Term Memory (LSTM) networks and Gated Recurrent Units (GRU) to better capture long-term temporal dependencies in multi-year datasets.
- **External Data Modalities:** The model can be enhanced by integrating real-time external variables such as satellite-derived crop health indices, regional transportation cost fluctuations, and localized meteorological weather patterns.
- **Deployment and Accessibility:** Scaling the system into a cloud-based web interface or a lightweight mobile application will allow real-time price predictions to reach smallholder farmers directly in local languages.

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