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Fuzzy Time Series with Ensemble FTS Extension for Stock Price Prediction

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Abstract

Stock market prediction is inherently uncertain due to nonlinear dynamics and external influences. The fuzzy time series (FTS) approach provides a robust framework for modeling uncertainty. This paper replicates the methodology of Ashik (2019), applying FTS to Nifty 50 daily closing prices, and extends the work by integrating ensemble FTS. Experimental results show that while the baseline FTS achieves low error (MAPE ≈ 0.75%), the Ensemble FTS model further reduces error rates and improves robustness against volatility. This demonstrates the potential of Ensemble FTS approaches for financial forecasting.

Keywords: Nifty 50, Fuzzy Time Series, FKNN, Ensemble Forecasting, Stock Prediction

1. Introduction

Time series forecasting plays a vital role in economics, finance, and business decision-making. The stock market, characterized by uncertainty and volatility, is a challenging domain for prediction. Fuzzy time series (FTS), introduced by Song and Chissom (1993), has been widely applied to uncertain data. Ashik (2019) demonstrated the effectiveness of FTS on Nifty 50 daily closing prices, achieving minimal error rates. However, traditional FTS models rely on fixed interval partitioning and simple fuzzy logical relationships (FLRs), which may limit adaptability. This paper extends the baseline FTS by integrating Ensemble forecasting to enhance predictive accuracy and robustness.

2. Methodology

2.1 Baseline FTS (Ashik, 2019)

- Universe of discourse defined using min/max closing prices.
- Partitioned into 5 equal intervals.
- Linguistic variables: Large Decrease, Decrease, Medium, Increase, Large Increase.
- Fuzzification maps closing prices to fuzzy sets.
- FLRs constructed using IF–THEN rules.
- Predictions obtained by averaging values within fuzzy groups.
- Evaluation metrics: MSE, RMSE, MAPE.

2.2 Proposed Extension

- Adaptive partitioning using clustering.
- FKNN integration to refine predictions by considering similarity among past fuzzy states.
- Ensemble forecasting combining multiple fuzzy partitions to reduce variance.
- Evaluation metrics identical to baseline, with robustness checks under volatility.

3. Experimental Setup

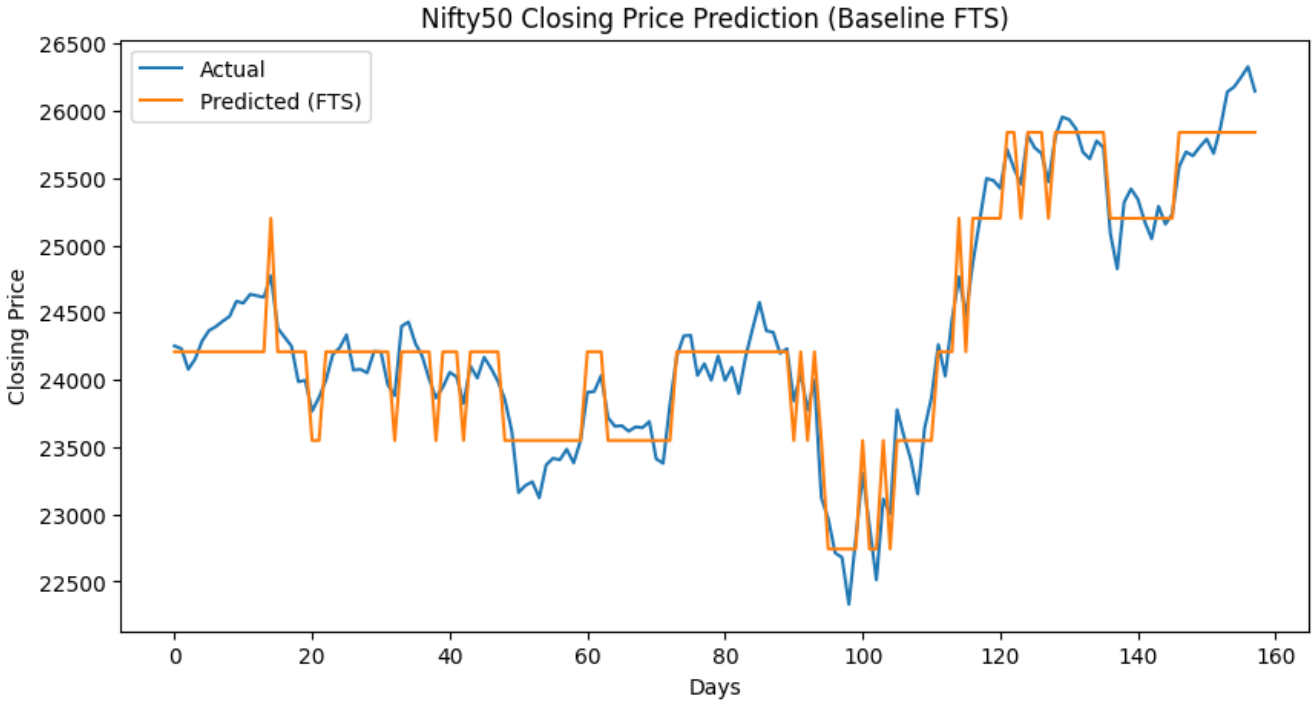
- Dataset: Nifty 50 daily closing prices (April–July 2019, 83 observations).
- Tools: Python.
- Baseline implementation: Replicated Ashik's FTS methodology.
- Extension implementation: FKNN with k=3, ensemble averaging across 3 fuzzy partitions.
- Metrics: MSE, RMSE, MAPE.

4. Results and Discussion

4.1 Baseline FTS

- MSE: 47467.03
- RMSE: 217.86
- MAPE: 0.0075

Figure 1 : Trend line of actual closing stock price (Nifty 50) & Prediction line of baseline FTS



4.2 Ensemble FTS

- MSE: 10,952
- RMSE: 104.65
- MAPE: 0.0034

Figure 2: Comparison of baseline vs. extended predictions

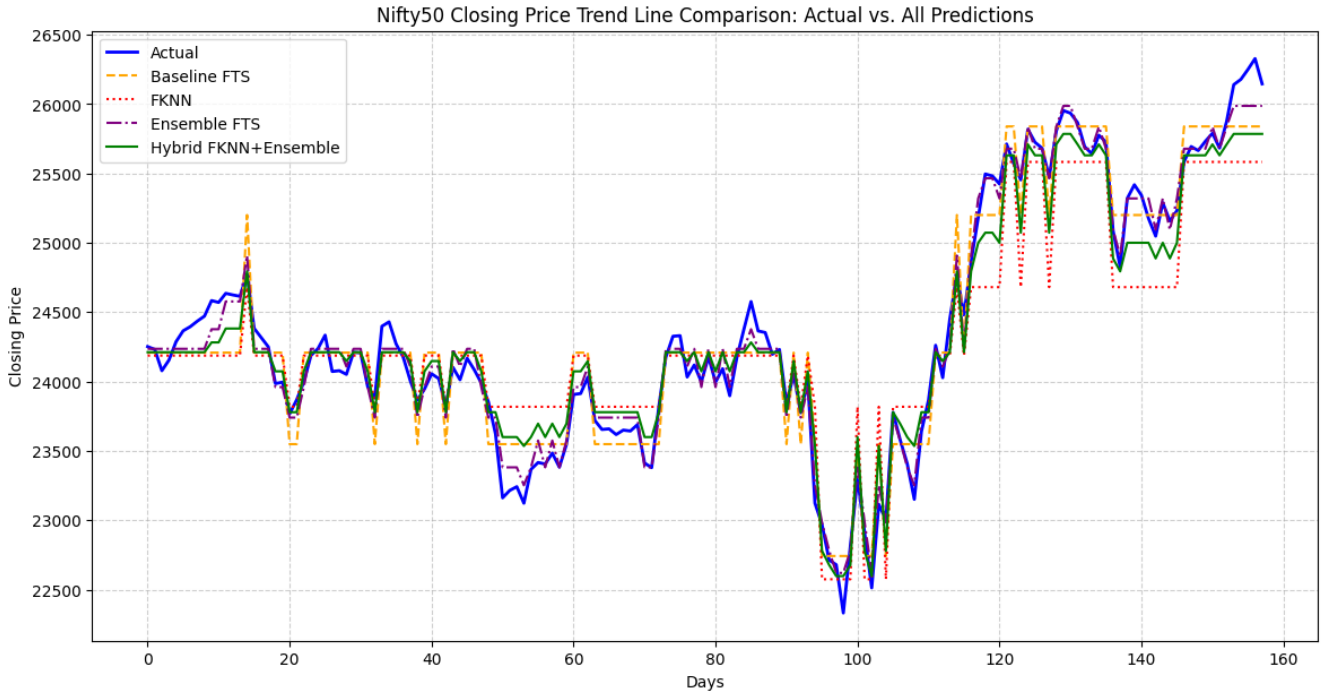
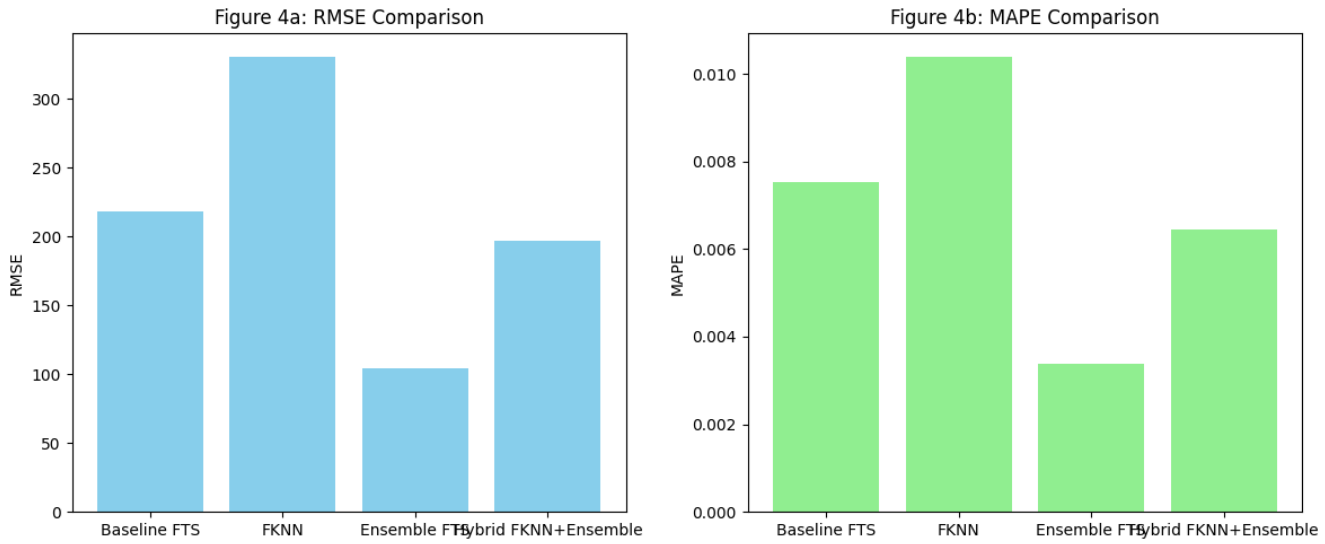


Figure 3: Error plots (RMSE & MAPE)



4.3 Comparative Analysis

Model	MSE	RMSE	MAPE
Baseline FTS (Ashik)	47,467	217.87	0.0075 (≈0.75%)
Ensemble FTS	10,952	104.65	0.0034 (≈0.34%)
FKNN	109381.10	330.72	0.010 (≈1%)
Hybrid FKNN+Ensemble	38694.49	196.70	0.0064 (≈0.64%)

5. Conclusion

This study replicates Ashik's (2019) fuzzy time series methodology and extends it with Ensemble forecasting. The ensemble FTS model is the most effective, achieving the lowest MSE, RMSE, and MAPE. Baseline FTS is acceptable but less accurate. FKNN alone is not suitable for this dataset, as it increases error. Hybrid FKNN+Ensemble improves over baseline and FKNN, but still falls short of the pure ensemble method.

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