



SmartStock Inventory Optimization for Retail Stores



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Title & Overview

SmartStock Inventory Optimization for Retail Stores

Objective:

Develop an ML-based demand forecasting system to reduce inventory losses by minimizing overstock and stockout issues.

Tech Stack:

Python, LightGBM, Pandas, Matplotlib, Seaborn, Scikit-learn, Hugging Face Datasets.





Problem Statement & Goals

Problem Statement:

- Retail businesses face losses due to:
- Overstock → Increased storage & wastage
- Stockout → Lost sales & poor customer experience

Goal:

- Build a predictive model that:
- Forecasts sales per store & product
- Classifies stock as Understock ●, Overstock ●, Balanced ●
- Helps retailers maintain optimal inventory levels





Methodology / Workflow

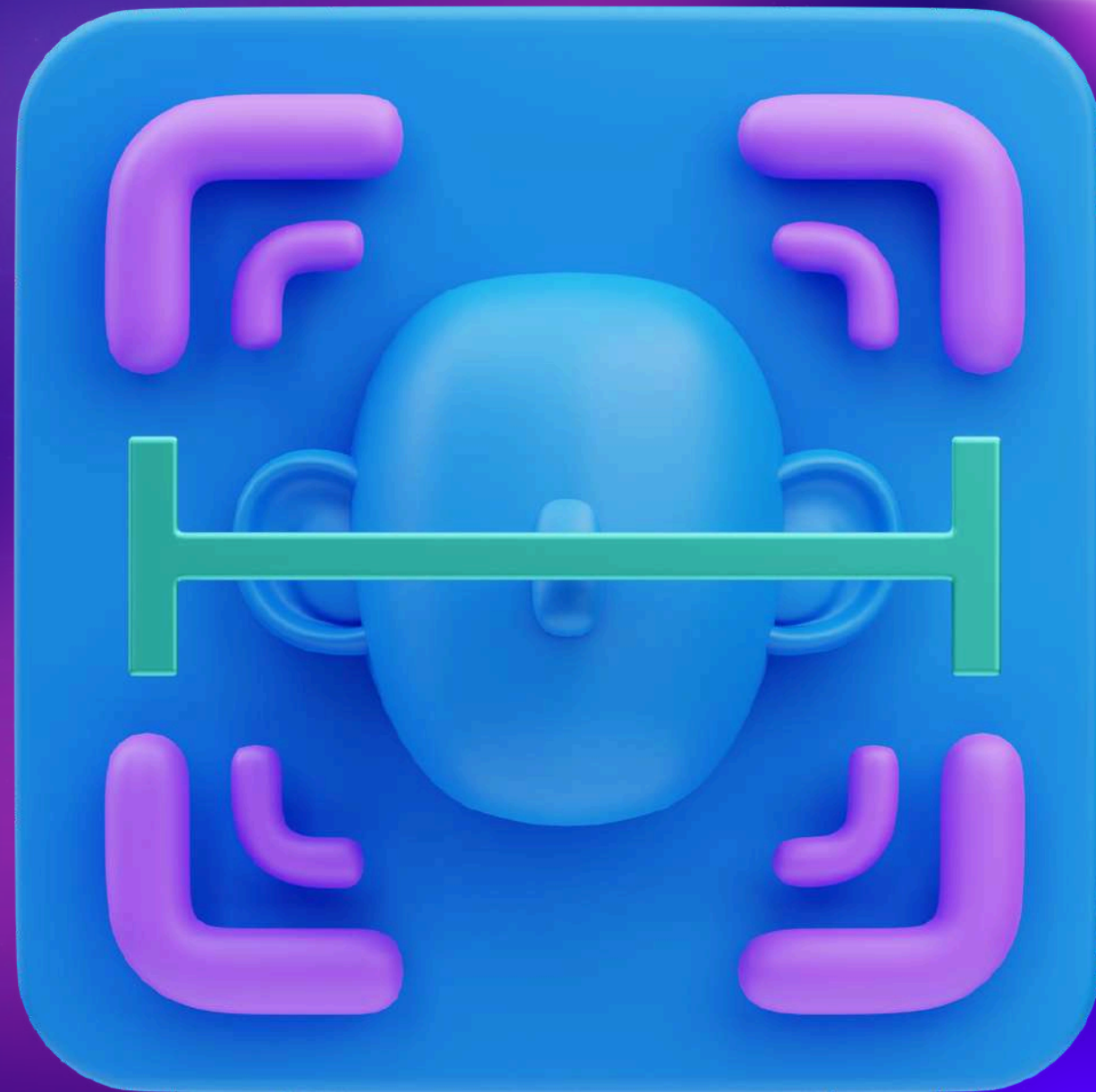
Data Pipeline Steps

- 1. Data Loading:** Hugging Face dataset(store-sales-time-series-forecasting)
- 2. Preprocessing:** Categorical encoding, date conversion
- 3. Feature Engineering:**
 - Time features: day, month, weekday
 - Lag features: 7, 14, 28 days
 - Rolling features: moving averages & stds
- 4. Model Training:** LightGBM regression
- 5. Evaluation:** RMSE
- 6. Reporting & Visualization**

Workflow Diagram

Data → Preprocess → Feature Engineering → Model Training → Forecast → Stock Classification → Report





Machine Learning Model (LightGBM)

Why LightGBM?

- Extremely fast
- Handles large tabular time-series
- Supports categorical features
- Excellent accuracy for demand forecasting

Key Parameters:

- num_leaves = 128
- learning_rate = 0.05
- objective = regression
- metric = RMSE
- early_stopping = 100 rounds

Evaluation:

Validation RMSE \approx 216.0788047916286

Test RMSE \approx 209.62396426002664



Results & Stock Visualizations

Generated Visuals:

- Train vs Validation error curve
- Prediction vs True values (test data)
- Category-wise stock status
- Store-wise stock summary (grouped bar chart)

Example Stock Classification:

Store	Product	Forecast	Est. Stock	Status
1	Snacks	220	150	UNDERSTOCK ●
2	Dairy	100	160	OVERSTOCK ●
3	Beverages	120	130	BALANCED ●

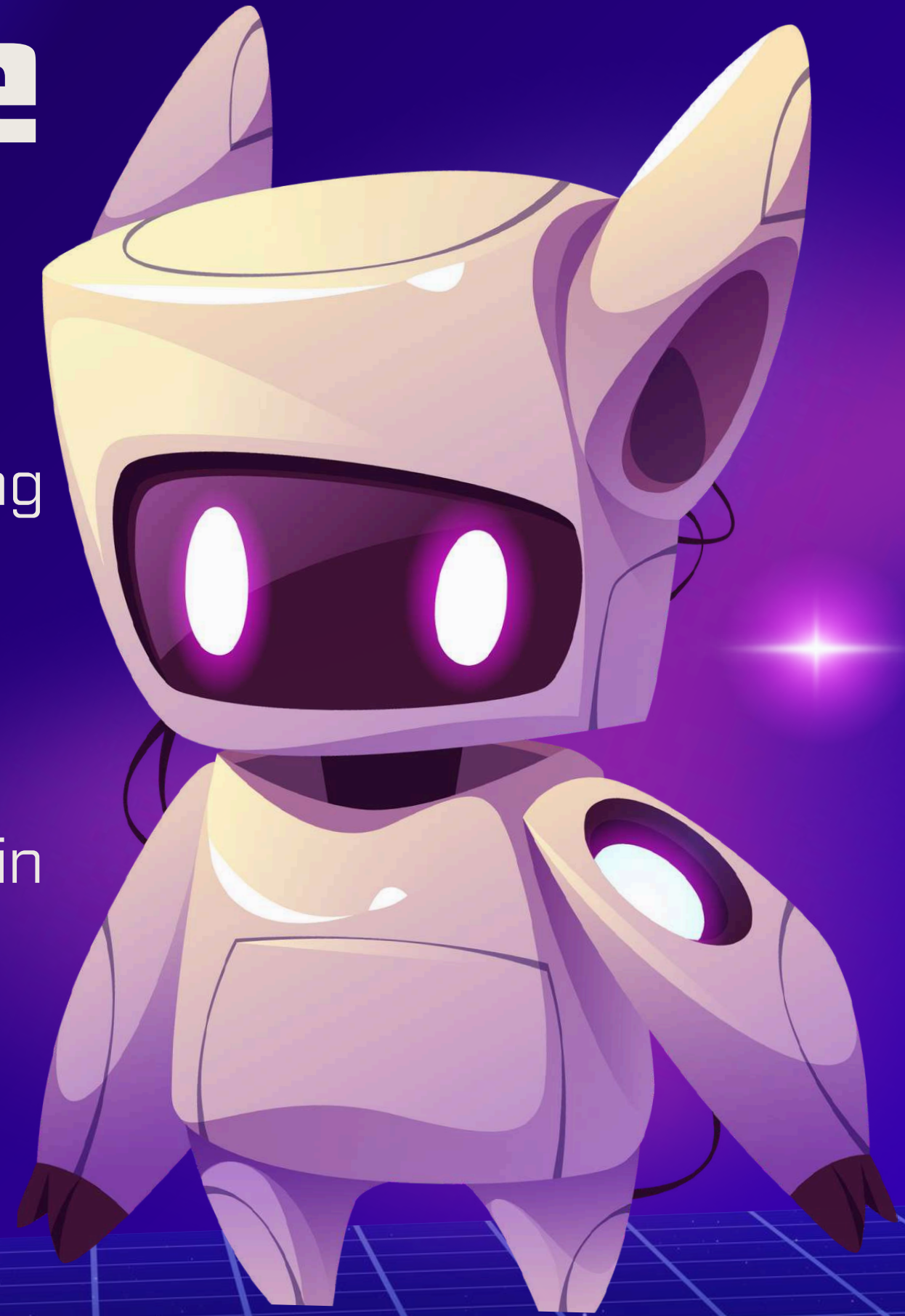
Conclusion & Future Enhancements

Conclusion

- Built an automated LightGBM-based forecasting pipeline
- Identifies overstock/understock conditions
- Provides decision-ready stock recommendations
- Helps reduce waste, improve sales, and maintain balanced inventory

Future Enhancements

- Real-time predictions (POS integration)
- AutoML & Neural Networks
- Deployment using FastAPI + React Dashboard



THANK YOU

