README

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7/1/2026

Overview

This project develops a **short-term demand forecasting solution** for industrial products operating under **high volatility and limited historical data** (40 monthly observations per product, no exogenous variables).

Classical time series models (ARIMA, ETS) are used as benchmarks and compared against a **feature-based LightGBM model** with shock-aware features.

Business Problem

Forecasts support **monthly production planning and inventory decisions**.

- Over-forecasting → higher holding costs
- Under-forecasting → stockouts and lost sales

Because demand is irregular and shock-driven, the solution provides **probabilistic forecasts (P10–P50–P90)** to quantify uncertainty and support scenario-based planning.

Data & Constraints

- Monthly data (2021–2024)
- 40 observations per product
- No exogenous variables
- High volatility, non-Gaussian changes

These constraints require **robust and parsimonious models** with realistic validation.

Modeling Approach

Benchmarks - ARIMA - ETS (discarded due to poor performance under volatility)

Final Model - LightGBM regression with engineered features: - Lagged demand (1, 2, 3, 6, 12) - Rolling averages (3, 6, 12) - Cyclical seasonality (sin/cos) - Shock features capturing abrupt changes

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Validation

Models are evaluated using **walk-forward (expanding window) cross-validation**, retraining at each step and forecasting one month ahead.
This setup mimics real deployment and avoids look-ahead bias.

Key Results (PR2 example)

Model	MAPE
ARIMA	29%
ETS	30%
LightGBM (basic)	26%
LightGBM + shock features	**15%**

→ **Forecast error reduced by 50%** relative to the ARIMA baseline.

Outputs

- Point forecasts
- Quantile forecasts: **P10 / P50 / P90**
- 6-month horizon forecasts for each product

Notes

- Small sample size (40 obs)
- No exogenous drivers
- Short-term forecasting only (1–6 months)

Deep learning models were intentionally excluded due to overfitting risk under these constraints.

Project Structure

src/

- features.R
- walk_forward.R
- models_lgbm.R
- forecast_quantiles.R

report/

- time_series_forecasting.pdf

README.md

Contact

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