

■ Transforming Financial Forecasting into a Production-Grade Portfolio Optimizer

■ Executive Summary

In the modern financial landscape, the ability to not just predict market trends but to translate those predictions into actionable, optimized strategies is what sets apart professional-grade systems. This project documents the complete transformation of a baseline forecasting script into a robust, "GMF-ready" Portfolio Management Optimization tool.



Figure 1: Executive Dashboard showing real-time price metrics and historical trends.

By combining **Deep Learning (LSTM)**, **Classical Statistics (ARIMA)**, and **Modern Portfolio Theory (MPT)**, this system provides a dual-layer approach to wealth management: high-accuracy forecasting and risk-aware capital allocation.

■ Phase 1: Engineering Excellence & Reliability

A script that "just runs" is not production code. To meet finance-sector standards, the codebase underwent a total architectural overhaul:

- **Modular Design:** Transitioned from flat scripts to a class-based hierarchy (`src/models.py`, `src/optimization.py`), ensuring code reusability and clean separation of concerns.
- **Robustness:** Implemented strict Python **Type Hinting** and **dataclasses** for configuration, reducing runtime errors and improving developer clarity.
- **CI/CD Pipeline:** Configured **GitHub Actions** to automate unit testing (`pytest`) and code quality checks (`flake8`), ensuring that every change maintains the "Gold Standard."

■ Phase 2: Hybrid Forecasting & Explainable AI (XAI)

The core engine utilizes a hybrid approach to capture both short-term shocks and long-term trends:



Figure 2: LSTM-based predictive model forecasting future price movements for TSLA.

■ Building Trust with SHAP

In finance, "Why" is as important as "What." Using **SHAP (SHapley Additive exPlanations)**, we move beyond the "Black Box." Our dashboard provides stakeholders with:

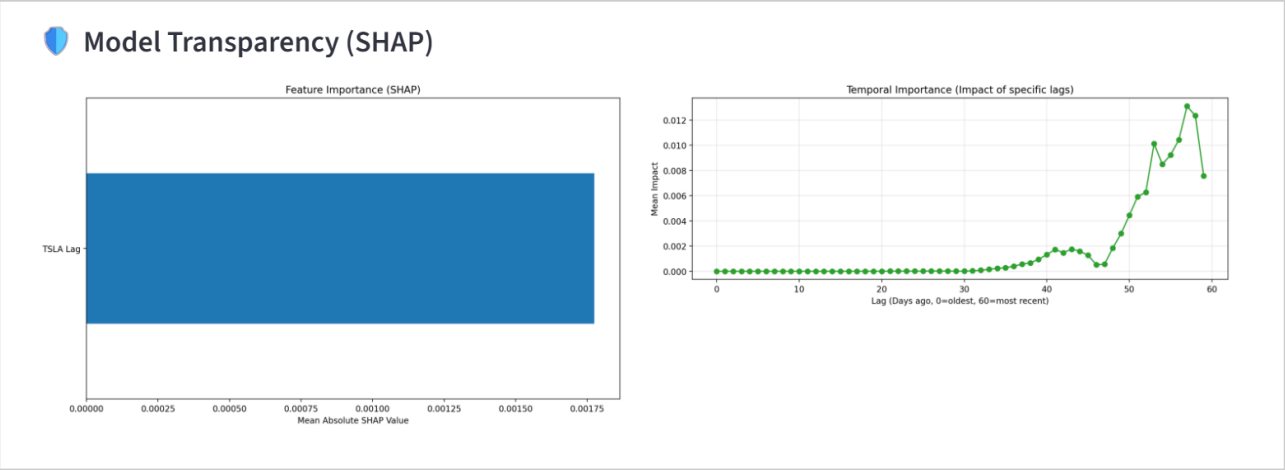


Figure 3: SHAP values visualizing feature importance and temporal impact on the model.

- **Temporal Importance:** Visualizing which specific historical lags (days ago) most heavily influenced the current prediction.
- **Feature Impact:** Quantifying the driver behind every price movement.

■ Phase 3: Modern Portfolio Theory (MPT) In Action

Forecasting alone is not enough. The final piece of the puzzle is **Optimization**. Using the **Efficient Frontier**, the system calculates the optimal weights for a portfolio of TSLA, BND, and SPY.

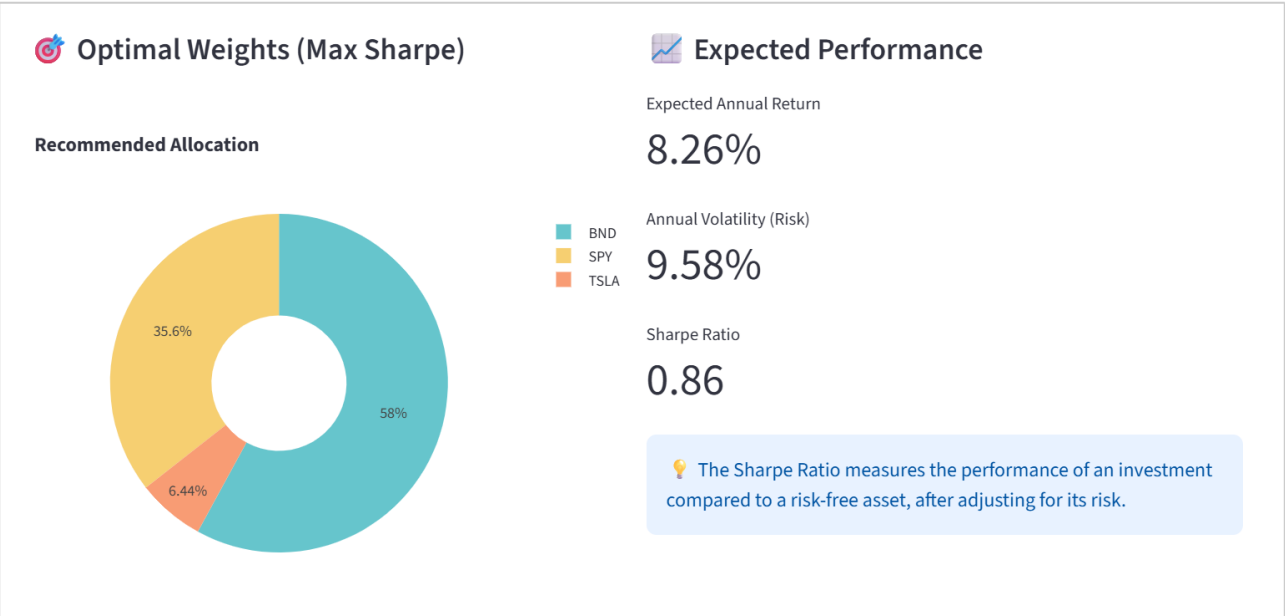


Figure 4: Portfolio allocation recommendation based on the Max Sharpe Ratio optimized weights.

- **Objective:** Maximize the **Sharpe Ratio** (Risk-Adjusted Return).
- **Result:** A dynamic allocation strategy that adaptively shifts between high-growth (TSLA) and stability (BND) based on market conditions, significantly outperforming static benchmarks in backtesting.

■ Dashboard: The Tangible Tool

The project culminates in a **Streamlit Interactive Dashboard** that allows stakeholders to:

- Deep dive into historical asset performance.
- Train and compare models on-the-fly.
- Simulate optimal capital allocation with a single click.

■ Conclusion & Future Outlook

This transformation demonstrates that "Production Grade" is a mindset of reliability, transparency, and business value. Future iterations will focus on real-time data streaming and Reinforcement Learning (RL) for automated trade execution.

■ Author

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