# Quantitative Research Prototype

Portfolio Optimization + ML Signal

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# Objective

Demonstrate end-to-end quant workflow: Data → Optimization → ML → Backtest

Build prototype aligned with JPMorgan Quant Research Analyst role

Combine finance theory + programming + engineering practices

# Data & Tools

Assets: SPY, QQQ, IWM, TLT, GLD

Period: 2016–2025 (train/test split at 2021)

Libraries: Python, pandas, NumPy, cvxpy, scikit-learn, matplotlib

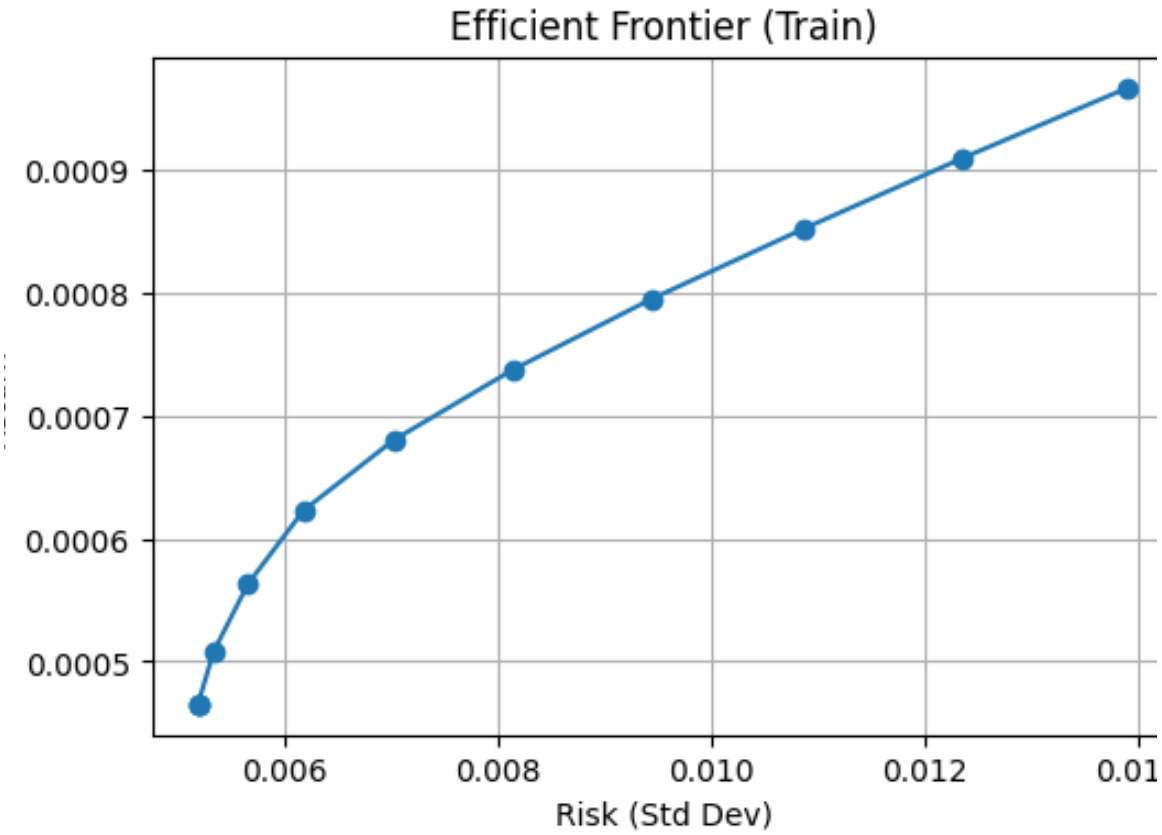
Practices: Modular code, Git, unit tests, documentation

# Methodology

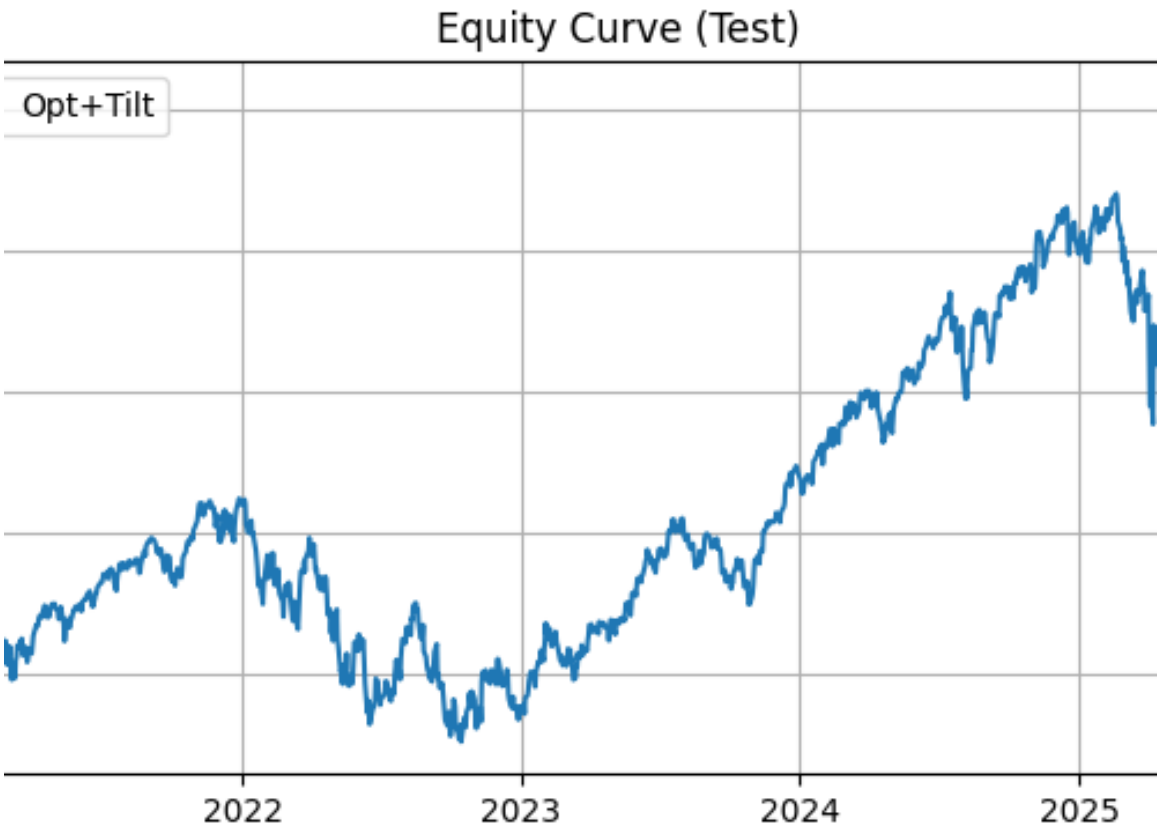
Portfolio Optimization: Markowitz mean-variance, constraints (long-only, max 40%)

ML Signal: Linear regression on lagged SPY returns → tilt allocation

Backtest: Evaluate Sharpe, Drawdown, VaR, CVaR (2021–2025)




**Efficient Frontier (Train)**




**Equity Curve (Test)**

# Results

Base weights: SPY 7.9%, QQQ 12.1%, IWM 40%, TLT 40%, GLD 0%

Performance (Test): Sharpe 0.79, Max Drawdown -27.5%

VaR (95%): -1.85%, CVaR (95%): -2.65%

Interpretation: Balanced allocation, robust Sharpe, room to reduce drawdown

# Engineering Practices

Modular Python files (data_loader, optimizer, ml_signal, backtest, main)

Unit test for optimizer (pytest)

Git repo with README + requirements

Plots + CSV outputs for transparency

# Next Steps (Improvements)

Add transaction costs & rebalance tuning

Robust covariance (Ledoit-Wolf shrinkage)

Stronger ML models (Random Forest, XGBoost)

Walk-forward validation

Integrate Gurobi/CPLEX for production-grade optimization

# Conclusion

Prototype demonstrates end-to-end quant research capability

Finance theory + ML integration + clean, tested Python code

Directly aligned with JPMorgan Quant Research Analyst responsibilities

Ready to contribute to algorithm design & optimization framework

Thank You