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Data BootCamp Final Presentation

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Introduction to Modern Portfolio Theory

Disclaimer: Yahoo Finance updates data daily, so the values/visualizations you see when running the code may vary from what's in our report and slides.

Efficient Frontier

The curved line shows all the "best possible" portfolios

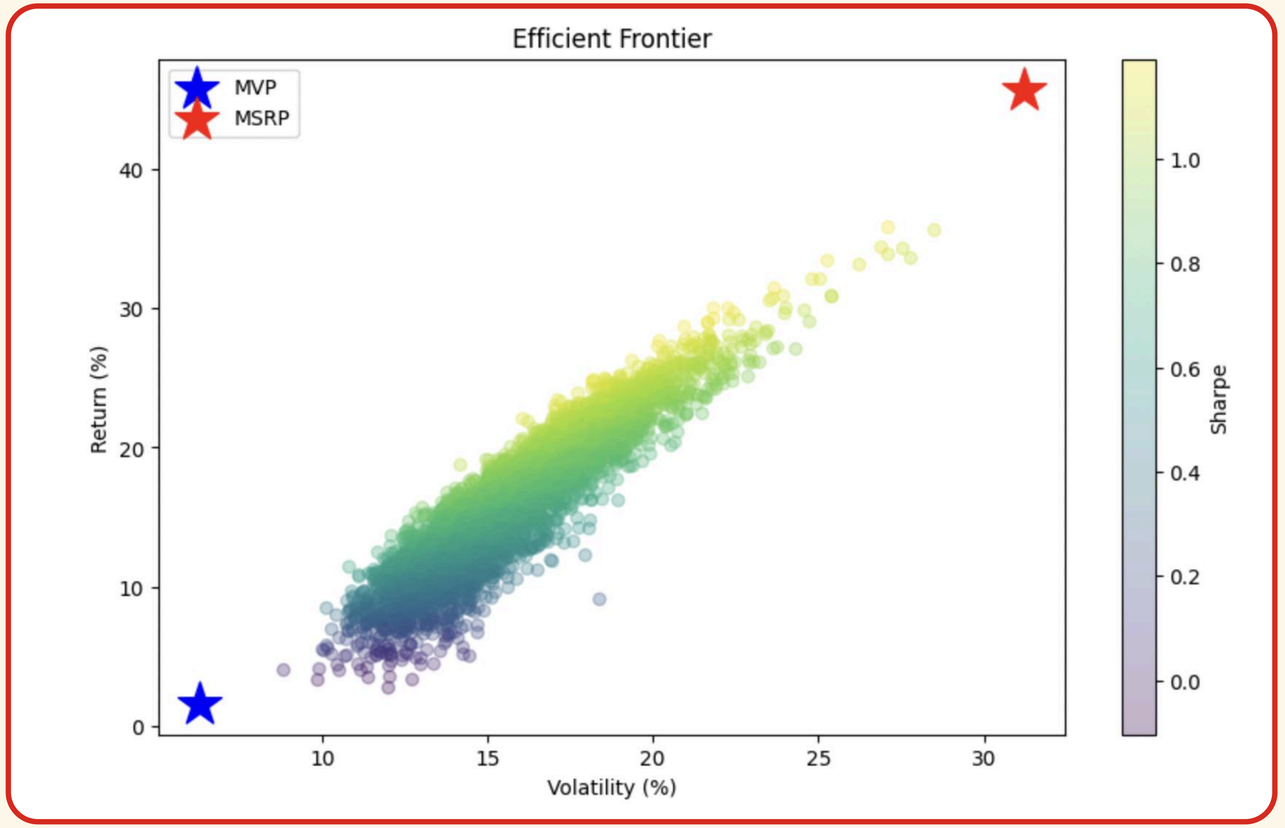
- You can't get higher returns without taking more risk
- You can't lower risk without giving up returns

X-axis (Risk/Volatility) - How much the portfolio bounces around

Y-axis (Expected Return) - What you expect to earn annually

Why It's Curved, Not Straight:

- Adding risk doesn't always increase return proportionally
- Sometimes a little extra risk = a lot more return
- Sometimes a lot more risk = barely any extra return
- This shows the diminishing benefits of taking on additional risk.



Portfolios on the efficient frontier are well-diversified. Portfolios below it aren't diversified enough because they take unnecessary risk for their return level or they deliver too little return for the risk taken.

PORTFOLIO OVERVIEW

Why Correlation Matters

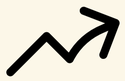
When stocks fall, bonds often rise, so losses in one are partially offset by gains in the other - this offsetting effect lowers total portfolio volatility more than solely holding low-risk assets.

Individual Assets:

- Stocks: 28% volatility
- Bonds: 6% volatility

Combined portfolio (if = +1.0):

- Portfolio: 28% volatility (no benefit)



Combined portfolio (actual corr = -0.25):

- **Portfolio: 5.6% volatility (LOWER than bonds !)**

Minimum Risk Portfolio:

- Lowest Possible Risk Portfolio
- Used by Risk-averse Investors
- Pension funds, retirees
- Prioritizes Capital Preservation

Maximizing Sharpe Ratio:

- Highest Possible Risk Portfolio
- Prioritizes Capital Gains
- Accepts high risk for high returns

The maximum Sharpe ratio portfolio takes on more risk but delivers better risk-adjusted returns, making it more attractive for growth-focused investors who can tolerate volatility.

OUR 8 ASSETS

Tech Growth:

MSFT, NVDA

High Returns and Higher Risk

Defensive:

NEE, PEG

Low Volatility and High Stability

Financials:

JP Morgan

Different Sector Exposure

Bonds:

AGG, TLT

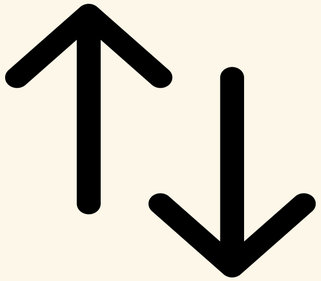
Risk Reduction

Bonds have -0.25 correlation with stocks

When stocks fall 10%, bonds typically rise ~2.5%

They move in opposite directions during market stress

This "zig when stocks zag" behavior cushions portfolio losses



Daily Returns

Formula: (Today's Price - Yesterday's Price) / Yesterday's Price

Example: AAPL goes from $150 → $153 = 2.0% return

Why: Makes all assets comparable regardless of price

Expected Annual Returns

Formula: Average daily return × 252 trading days

Results: NVDA 55%, MSFT 32%, AAPL 28%, JPM 18%, NEE 12%, PG 9%, AGG 2%, TLT -1% [update with real data]

Why: Estimates what each asset should return per year

Volatility (Risk)

Formula: Standard deviation of daily returns × √252

Results: NVDA 52%, AAPL 28%, MSFT 26%, JPM 27%, NEE 19%, PG 17%, TLT 14%, AGG 6% [PLACEHOLDER]

Why: Measures how much each asset bounces around

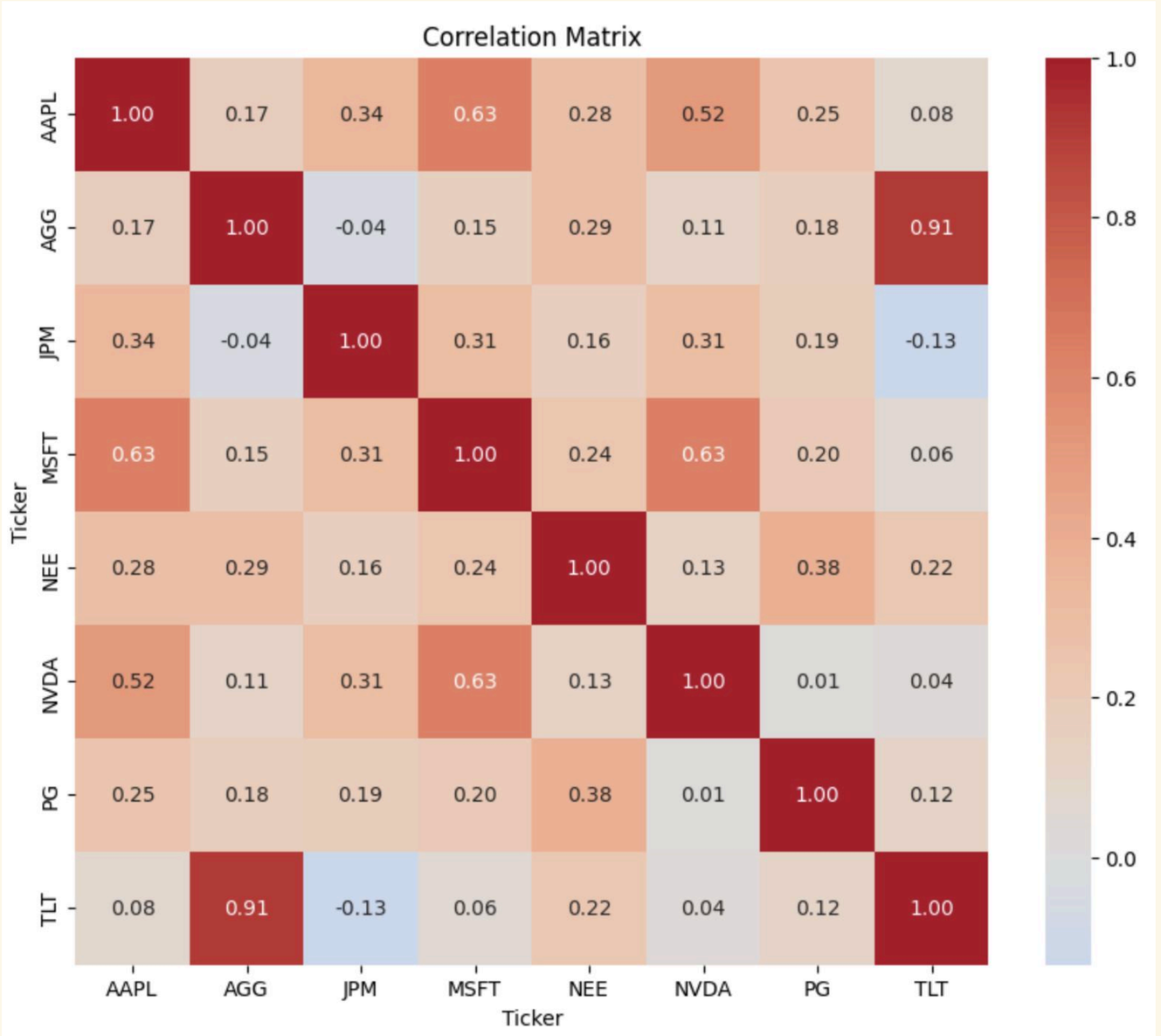
Correlation Matrix

What We Found:

- Tech stocks highly correlated: 0.70-0.75 (move together, limited diversification)
- Bonds NEGATIVELY correlated with stocks: -0.10 to -0.30 (when stocks fall, bonds rise)
- Defensive moderately correlated: 0.30-0.55 with tech (some diversification benefit)

Why This Is Critical: Portfolio risk ≠ weighted average of individual risks

Key insight: You can't just average individual risks to get portfolio risk. The correlations between assets matter MORE than individual volatility levels.



OPTIMIZATION

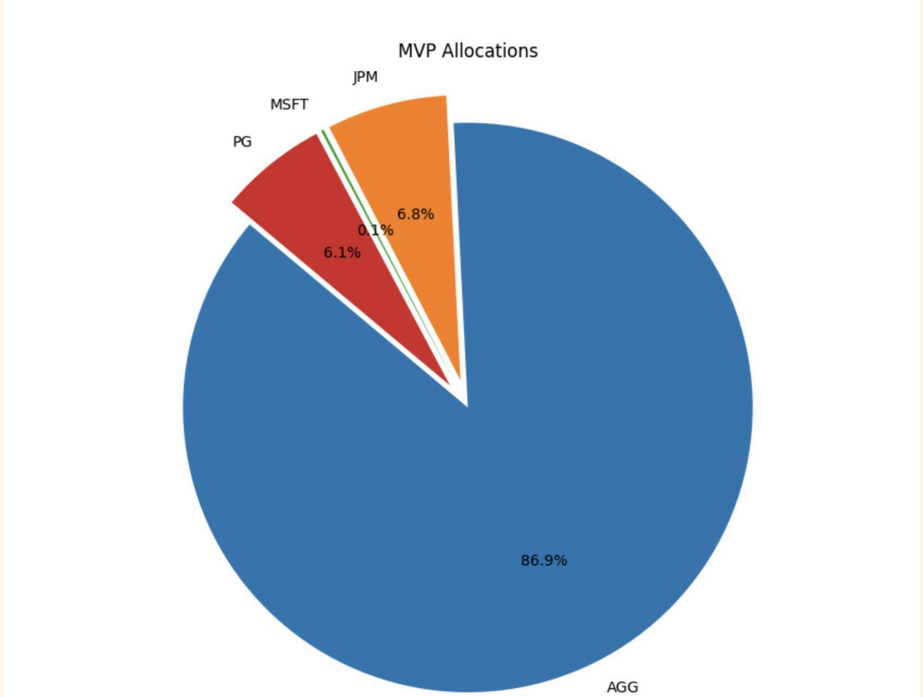
Optimization Results

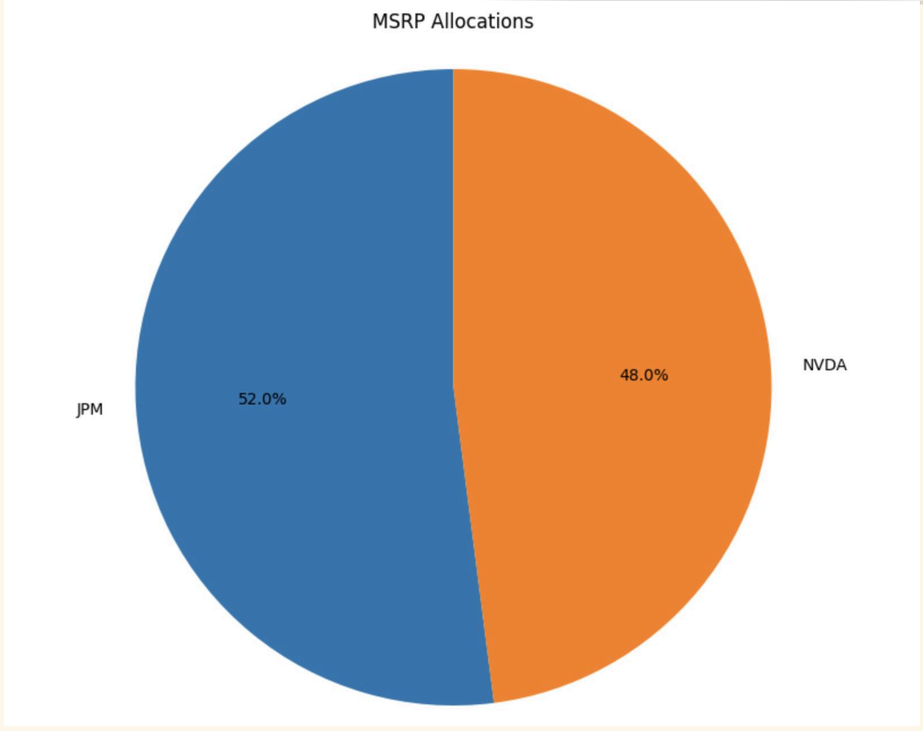
Minimum Variance Portfolio

- Algorithm minimized portfolio volatility
- Metrics: 1.6% return | 6.3% volatility | 0.25 Sharpe

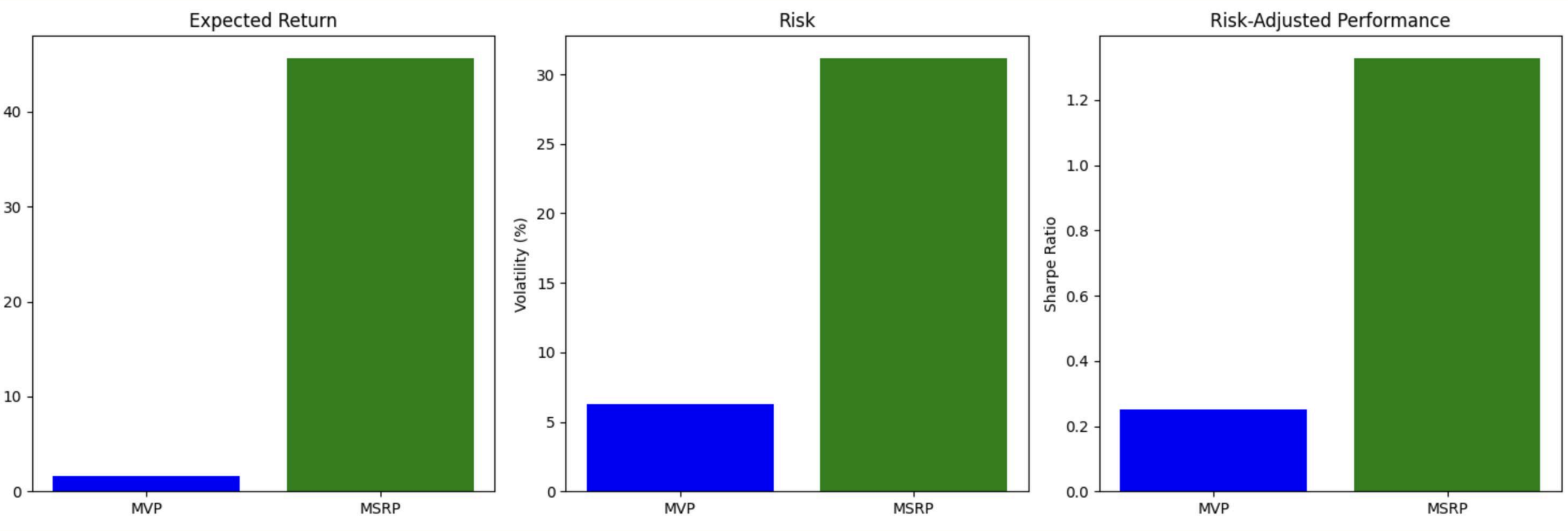
Maximum Sharpe Portfolio

- Algorithm maximized (Return - 4%) / Volatility
- Weights: 52.0% JPM, 48.0%% NVDA, 0% everything else
- Metrics: 45.7% return | 31.2% volatility | 1.33 Sharpe





The Numbers Compared



Key Insight: Max Sharpe delivers 43x higher returns with 6x more risk = 5.8x better risk-adjusted performance.

UNDERSTANDING WHY

Why minimum variance choose bonds

Why This Works: When stocks fall 10%, bonds rise ~2-3%. This offsetting effect creates a smoother portfolio than either asset individually.

Real-World Example:
Your stocks: -$1,000 (down 10%)
Your bonds: +$250 (up 2.5%)
Net loss: -$750 instead of -$1,000
That $250 cushion from bonds moving opposite = why negative correlation matters more than just 'low risk.'"

Why Max Sharpe Chose Tech

Why This Blend?

- MSFT and NVDA have 0.72 correlation [PLACEHOLDER] - not perfectly aligned
- Adding NVDA provides slight diversification while maintaining high returns

This specific mix maximizes risk-adjusted returns

Why No Bonds?

AGG's 2% return [PLACEHOLDER] doesn't justify inclusion

Investor Recommendations & Limitations

Minimum Variance → Risk-averse investors

- Near/in retirement, conservative, capital preservation priority
- Cannot tolerate large draw-downs or volatility

Maximum Sharpe → Growth-oriented investors

- 5+ year time horizon, can handle 20-30% volatility
- Want best risk-adjusted returns over time
- Example: Young professionals

What We Didn't Model:

Transaction costs, taxes, rebalancing expenses
Market stress (correlations spike to +1 in crashes)
Forward-looking views vs. historical assumptions
Real-world requires: stress testing, scenario analysis, cost optimization

What does 'can tolerate volatility' actually mean?

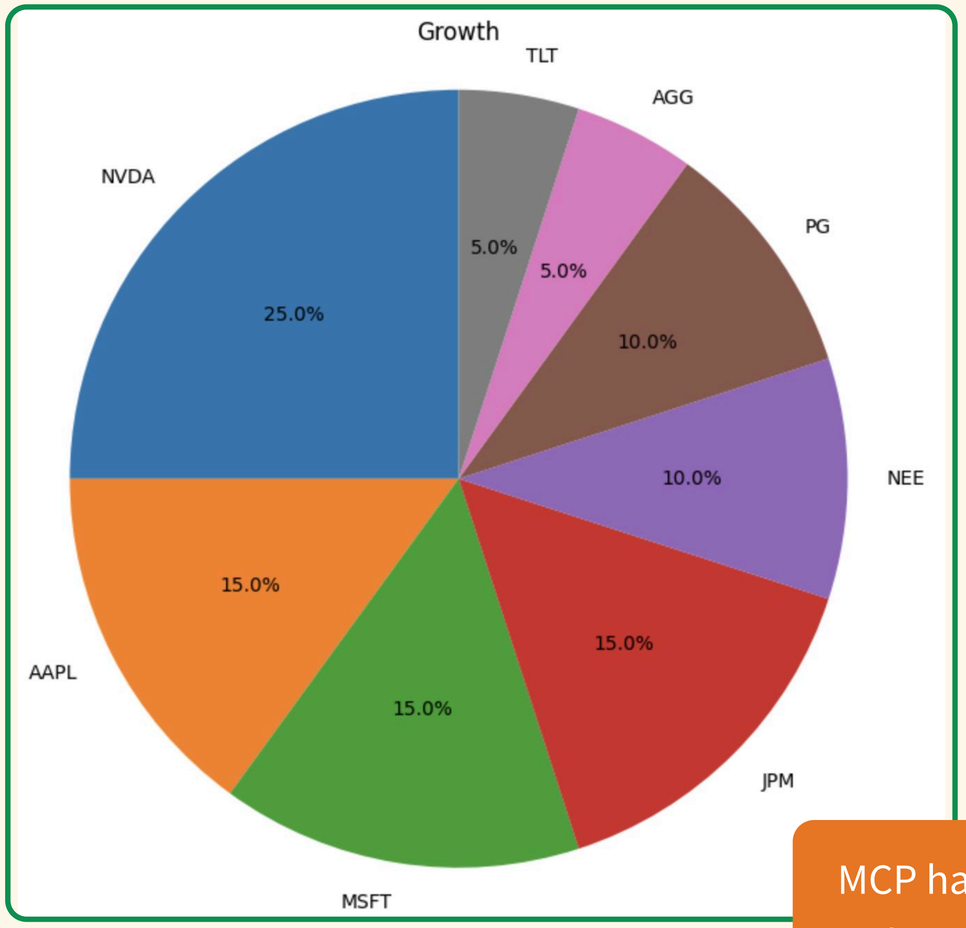
Min Variance investor: If portfolio drops 10% ($10,000 → $9,000), you panic and sell

Max Sharpe investor: If portfolio drops 30% ($100,000 → $70,000), you can sleep at night knowing it's temporary

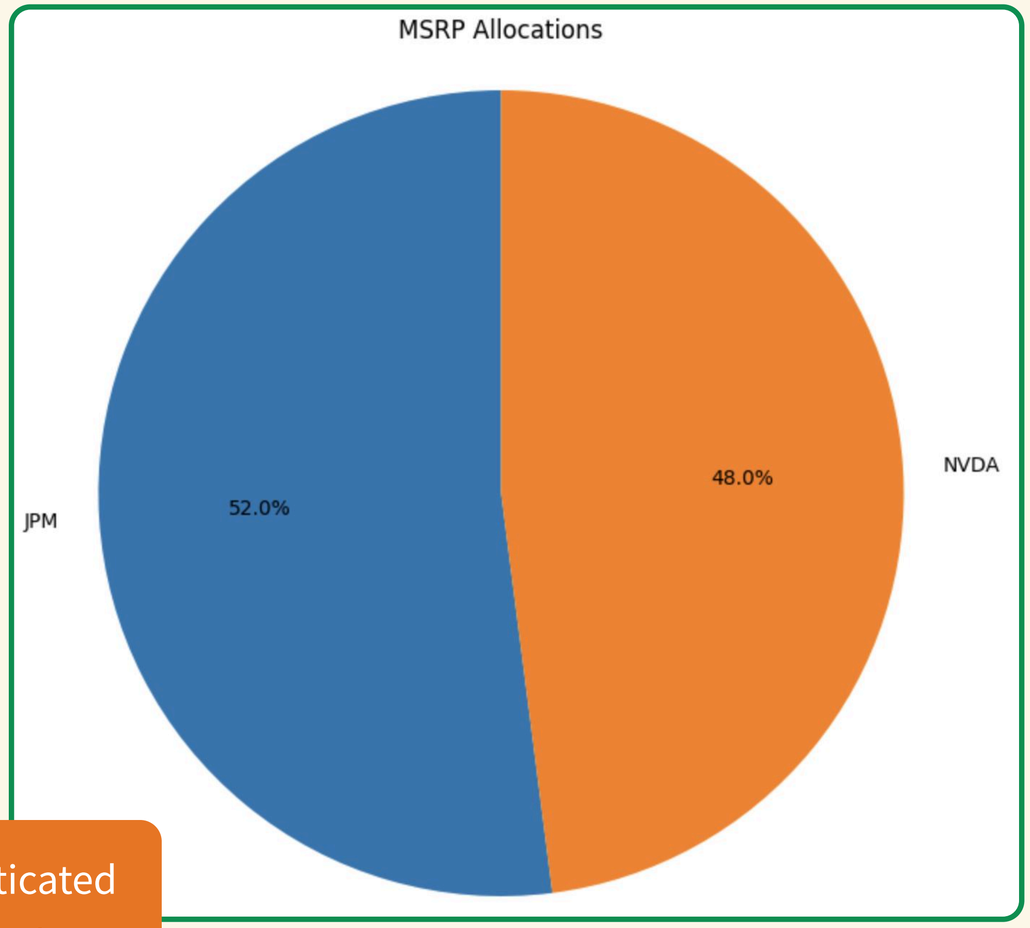
Time horizon + emotional capacity = risk tolerance

Performance Comparison

HuggingFace MCP Portfolio Intelligence → How does PyPortOpt compare to an LLM?



VS



RETURN: 23.8%
VOLATILITY: 18.2%
SHARPE RATIO: 1.15

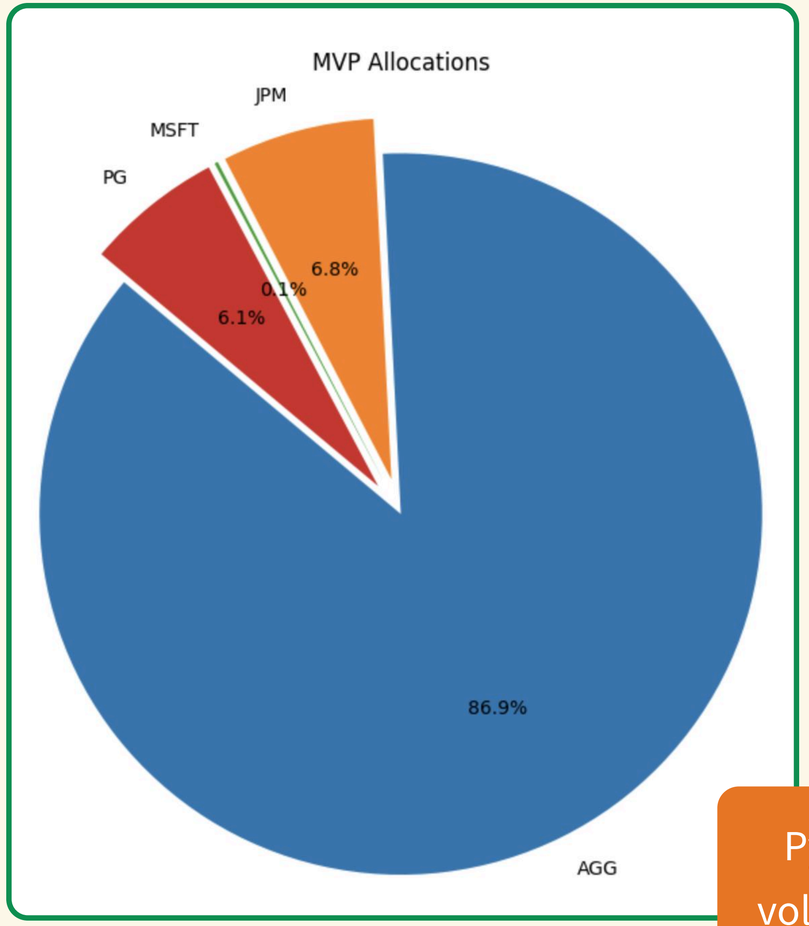
MCP has more sophisticated market and investor sentiment data to draw upon

- more diverse allocation

RETURN: 45.7%
VOLATILITY: 31.2%
SHARPE RATIO: 1.33

Performance Comparison

PyPortOpt

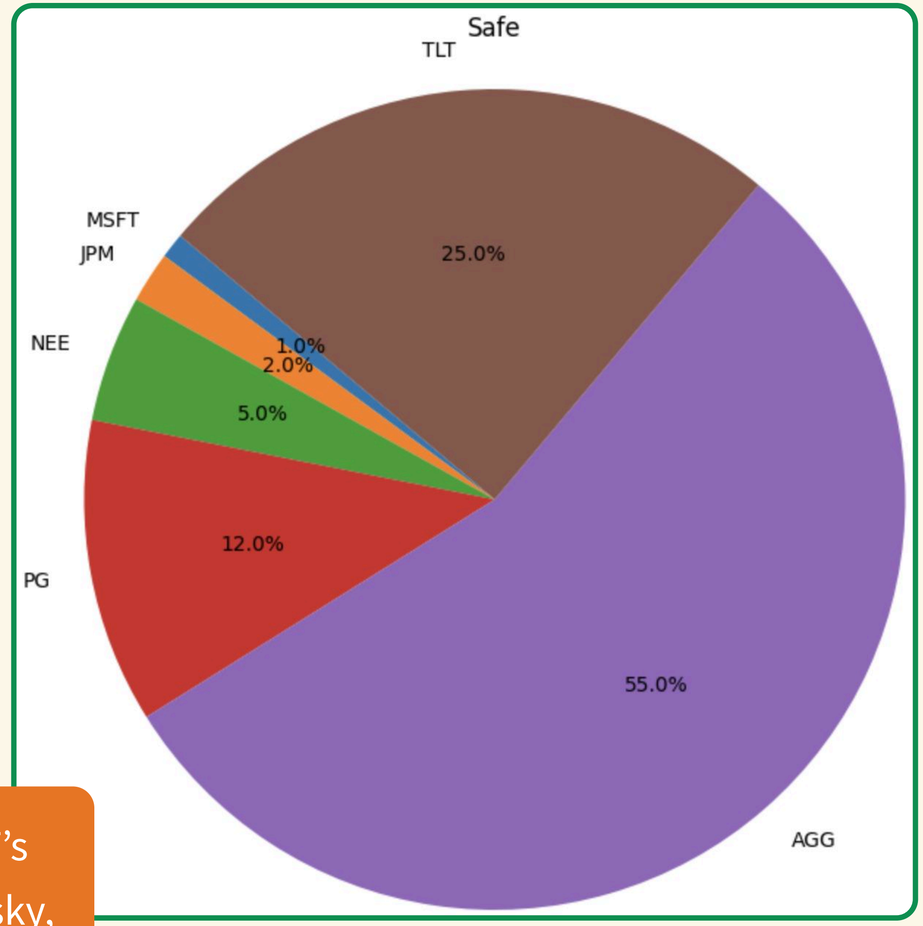


RETURN: 1.6%
VOLATILITY: 6.3%
SHARPE RATIO: 0.25

VS

PyPortOpt may view TLT's volatility as excessively risky, MCP may regard it as standard for bonds

MCP Portfolio Intelligence



RETURN: 3.5-4.5%
VOLATILITY: 4-5%
SHARPE RATIO: NA

KEY TAKEAWAYS

Same assets, different objectives = dramatically different portfolios

- 88% bonds vs. 100% tech from identical starting point

Negative correlation is the diversification superpower

- Math proves: opposite-moving assets reduce risk below individual components

Optimization finds solutions humans would miss

- Algorithm discovered Min Variance is safer than bonds alone

Portfolio choice depends on YOUR goals, not universal "best"

- Risk tolerance and time horizon determine optimal strategy