



# Portfolio Engine

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Presented by  
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# Introduction

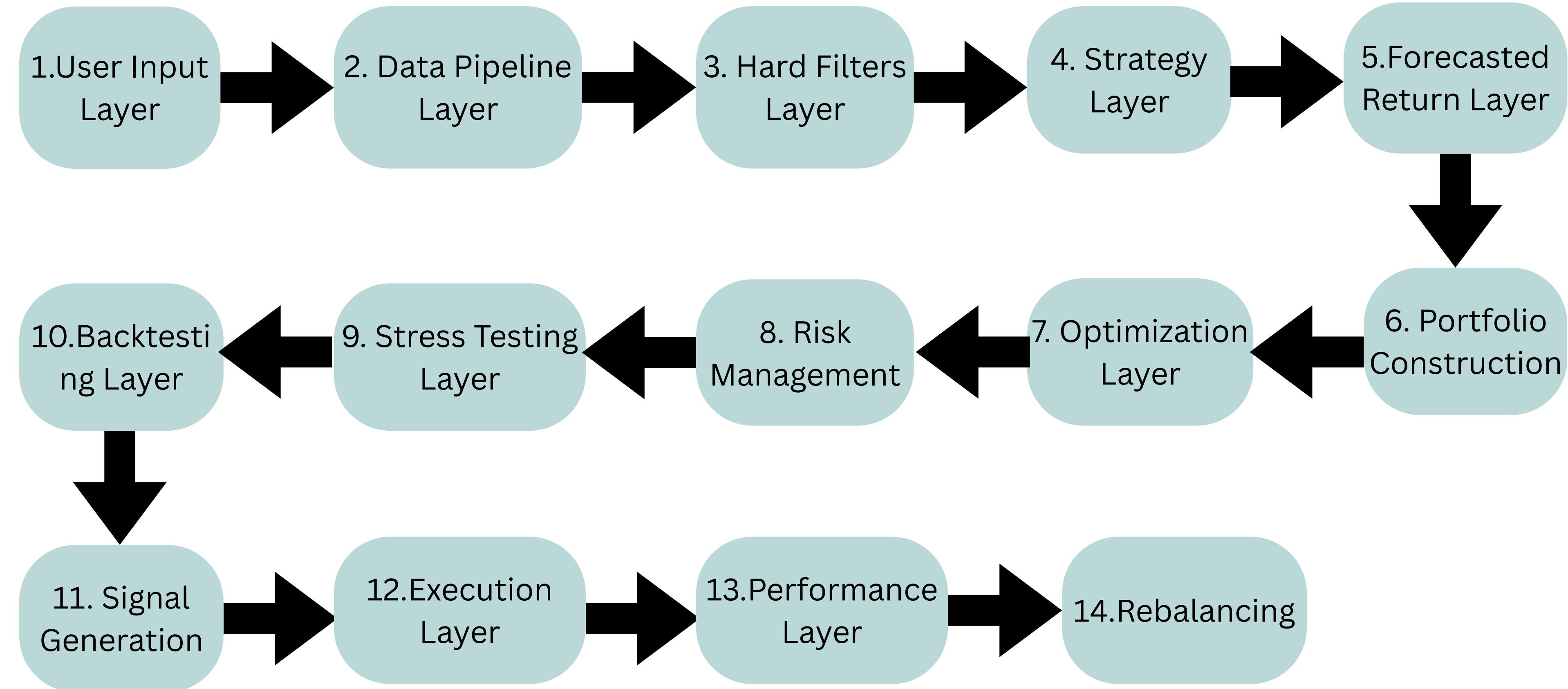
Portfolio Engine is a unified system that automates the entire quantitative investing workflow from selecting assets to evaluating risk and performance.

At its core, the system combines:

- Sector-based and technical strategies for stock selection
- Forecasting of expected returns using rolling historical patterns
- Mean-Variance-based portfolio optimization
- Real-time risk metrics such as volatility, VaR, Sharpe, and drawdown for every cycle
- Automated weekly/monthly rebalancing with buy/sell decisions
- Detailed P/L tracking including cash, realized and unrealized returns, and transaction costs

This makes Portfolio Engine a complete, end-to-end investment pipeline

# Project Flow



## 1 User Input Layer

The engine begins with a small set of required user selections:

- Strategy (Momentum, Value, etc.)
- Company size (Small / Medium / Large)
- Capital amount
- Reference date → the system automatically fetches the past 120 days of data from this date
- Sector(s) selection
- Rebalance frequency → the system checks for holidays and non-trading days and, if the selected date is not a trading day, it automatically shifts to the most recent trading day

These inputs drive all downstream computations.

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# 1 User Input Layer

The screenshot displays the 'User Input' layer of the Automated Portfolio Manager application. On the left, a sidebar contains several input fields:

- Select Strategy:** Momentum (selected)
- Market Cap:** Mid Cap
- Capital (\$):** 10000 (with increment/decrement buttons - and +)
- As of Date:** 2025/11/29
- Asset Class:** Equities
- Select Sectors:** Choose options
- Backtest Rebalance Frequency:** Monthly

The main content area features a logo with three bars (green, red, blue) followed by the text "Automated Portfolio Manager". Below the logo, a message states: "Selected date 2025-11-29 is not a trading day. Trades will execute on 2025-12-01 at the market open." A note below the message indicates: "Calculations use market data through 2025-11-28 (previous trading close)." In the top right corner, there are "Deploy" and more options buttons.

## 2 Data Pipeline Layer

### Reading company metadata

The file companies.csv contains details such as:

- Ticker
- Company name / Short name
- Industry
- Description
- Website / Logo
- CEO
- Exchange
- Market cap
- Sector
- Tags (1, 2, ,3)

### Cleaning and preprocessing

- Cleaned csv file - Ticker, Company name, Market cap, Sector
- OHLCV - Removes stocks with missing, incomplete, or insufficient price history

### Fetching price data (yfinance)

- Downloads OHLCV data for all filtered stocks

## 3 Hard Filters Layer

### Purpose:

This layer acts as a sieve to remove "uninvestable" or undesirable assets before deep analysis begins. It ensures the strategy only focuses on high-quality candidates that match the user's risk profile.

### Inputs:

- Cleaned Data: The historical data from Layer 2.
- User Constraints: Risk level (Market Cap) and Sector preferences from Layer 1.

### Process:

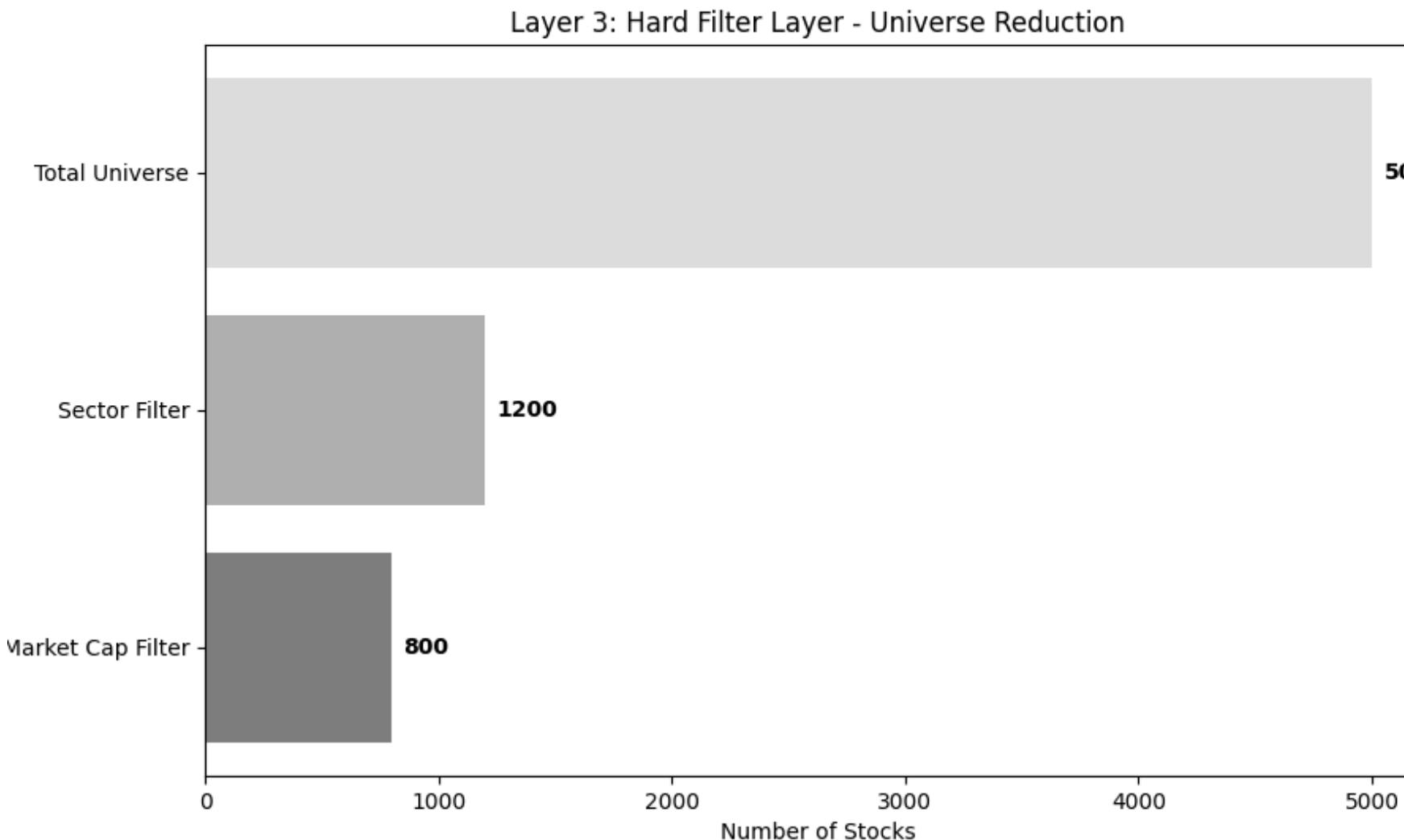
- Sector Filtering: Keeps only stocks in the user-selected sectors (e.g., Technology).
- Market Cap Filtering: Removes companies that are too small or too large based on the Risk Level (e.g., keeping only Large Caps for Low Risk).
- Selection - Picks the top 10 stocks to form the Candidate Pool.

### Outputs:

Filtered Universe: A reduced list of "eligible" tickers ready for strategy scoring.

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# 3 Hard Filters Layer



ticker	company name	market cap	sector	market_cap_percentile
CLF	Cleveland-Cliffs Inc.	3164955843	Basic Materials	0.6586
BTG	B2Gold Corp (Canada)	3103220381	Basic Materials	0.6538
CBT	Cabot Corporation	2862321994	Basic Materials	0.649
BCPC	Balchem Corporation	2751714587	Basic Materials	0.6442
KWR	Quaker Chemical Corporation	2714876510	Basic Materials	0.6394
SXT	Sensient Technologies Corporation	2662482523	Basic Materials	0.6346
ARLP	Alliance Resource Partners L.P.	2552943534	Basic Materials	0.6298
WDFC	WD-40 Company	2527365656	Basic Materials	0.625
FUL	H. B. Fuller Company	2493676072	Basic Materials	0.6201
PAAS	Pan American Silver Corp.	2266432218	Basic Materials	0.6153
LBTYB	Liberty Global plc Class B Ordinary Shares	16712405037	Communication Services	0.6428
SKM	SK Telecom Co. Ltd.	16381140953	Communication Services	0.625
LBRDK	Liberty Broadband Corporation	15805836664	Communication Services	0.6071
LBRDA	Liberty Broadband Corporation Class A Common Stock	15764306785	Communication Services	0.5891
ATUS	Altice USA Inc. Class A	14173290146	Communication Services	0.5714
TEO	Telecom Argentina SA	7145936817	Communication Services	0.5535
KT	KT Corporation	6724320986	Communication Services	0.5356
TIGO	Millicom International Cellular S.A.	6277874590	Communication Services	0.5178
TKC	Turkcell Iletisim Hizmetleri AS	6054400000	Communication Services	0.5
GLIBA	GCI Liberty Inc. Class A Common Stock	5668996088	Communication Services	0.4821



## 4 Strategy Layer

### Purpose:

This layer is the brain of the stock-selection process.

It applies a specific investment logic (the chosen strategy) to evaluate, score, and rank the eligible stocks.

Its main job is to identify which stocks show the strongest potential to perform well.

### Inputs:

- Filtered Universe: Valid stocks passed from Layer 3

### Process:

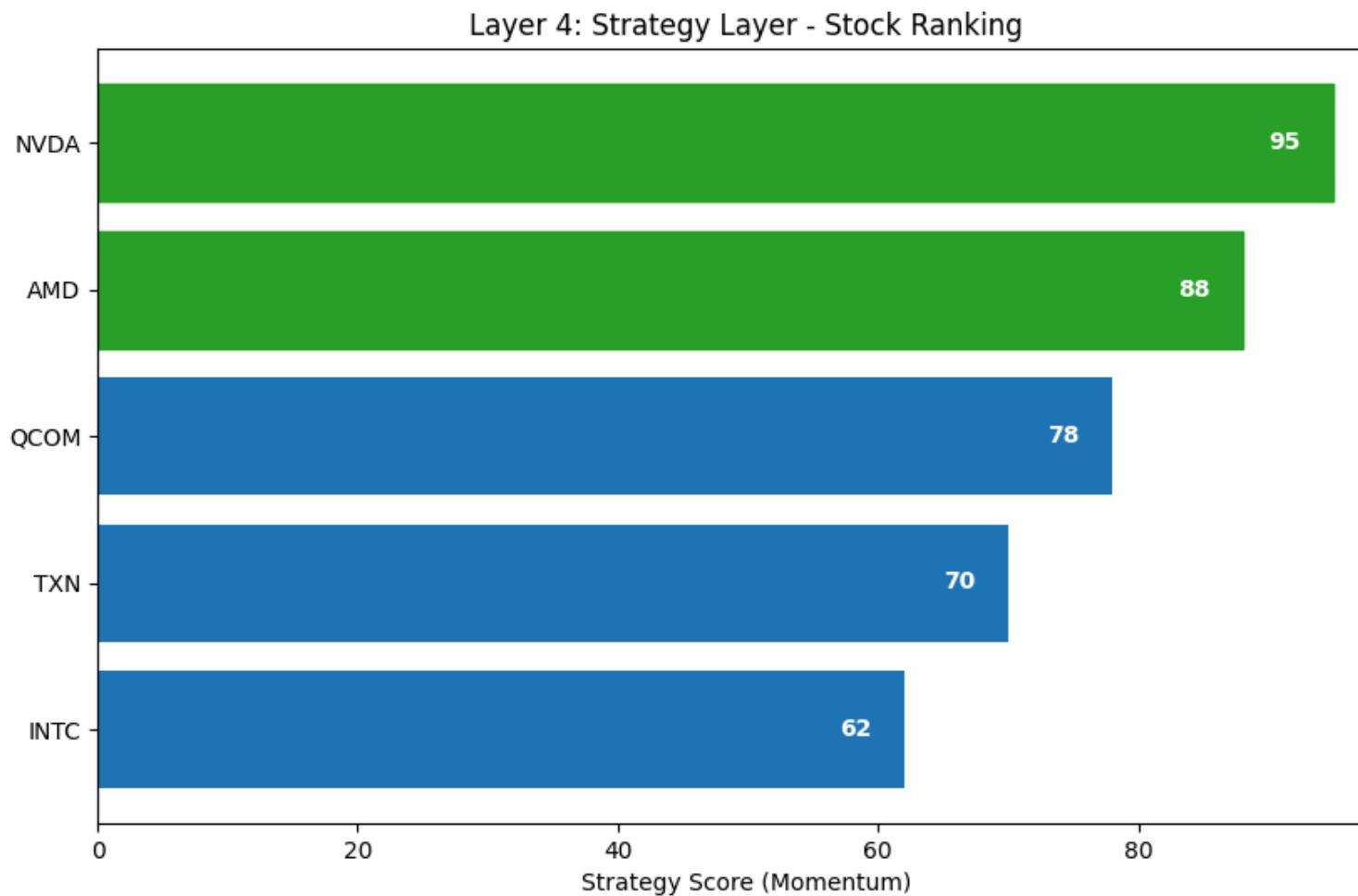
- Indicator Calculation - Computes technical or fundamental indicators for each stock (e.g., RSI, SMA, EMA, MACD, 20-day return, etc.)
- Scoring - Assigns a numerical score to each stock based on the strategy logic.
- Ranking - Sorts all stocks from highest score (best) to lowest score.

### Outputs:

- Ranked Candidate List: A DataFrame of the top-3 highest-ranked stocks in each category, with their Strategy Score and Rank.

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# 4 Strategy Layer



**Selection Summary**

<b>Strategy</b>	<b>Market Cap</b>	<b>Start</b>
Momentum	Mid Cap	2025-06-22
<b>As of</b>	<b>Data Through</b>	<b>Total Days</b>
2025-10-21	2025-10-20	120 days
<b>Strategy Window</b>		
60d		
<b>Rebalance cadence:</b> Weekly		
<b>Backtest window:</b> 2025-10-10 → 2025-10-21		
<b>Data through:</b> 2025-10-20		
<b>Selected sectors:</b> Basic Materials, Communication Services		

**Strategy Winners (Top 3 per Sector)**

Ticker	Sector	Strategy_Score	Rank
CLF	Basic Materials	0.7286	1
ARLP	Basic Materials	0.5286	2
BTG	Basic Materials	0.4696	3
TEO	Communication Services	0.3817	1
TIGO	Communication Services	0.2341	2
TKC	Communication Services	0.016	3

These top-ranked tickers will flow into the forecasting layer for further analysis.

# Momentum Strategy

## Definition:

The Momentum strategy selects stocks that have shown strong recent performance, based on the idea that assets trending upward are likely to continue performing well in the near term.

## Momentum Metrics Used:

To measure momentum, the system calculates four technical signals:

- 20-Day Price Return: Captures medium-term price strength.
- Trend Position (vs SMA-20 & EMA-20): Evaluates whether the stock is trading above or below key moving averages.
- RSI Deviation (RSI-14): Measures how far the stock's momentum is from a neutral level.
- MACD Histogram: Assesses the strength of short-term trend acceleration.

Each metric is normalized to ensure fair contribution to the overall score.

## Final Momentum Score:

The four normalized metrics are averaged to create a single Momentum Score ranging from -1 to +1. Stocks are then ranked by this score,

## 5 Forecasted Return Layer

### Purpose:

- Convert historical price data into expected returns ( $\mu$ ) that drive portfolio optimization.

### Inputs:

- Clean OHLCV price history (filtered universe)
- Config parameters of strategy (e.g., 60-day rolling window)

### Process:

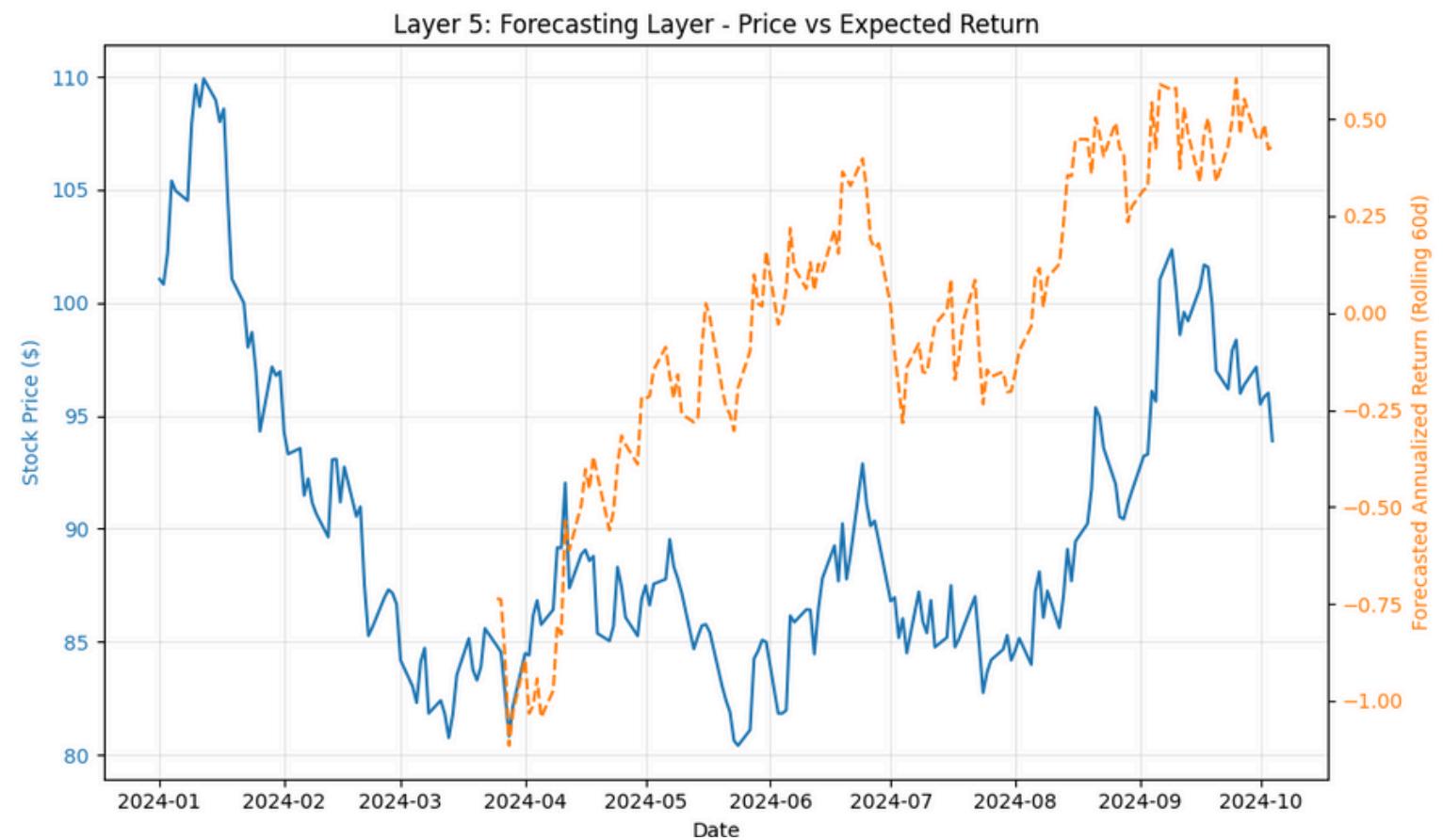
- Compute daily log returns
- Apply rolling mean to smooth noise
- Annualize returns
- Assemble expected-return vector ( $\mu$ ) for each asset

### Outputs:

- Expected Returns Vector ( $\mu$ ) — key input for optimizer

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# 5 Forecasted Return Layer



**Forecasted Returns ( $\mu$ )**

Ticker	Expected_Return
BTG	0.0066
CLF	0.0056
TIGO	0.0039
TKC	0.0005
ARLP	-0.0008
TEO	-0.0029

Expected returns rely on the strategy-defined lookback window (~60 days) when sufficient price history exists.

# 6 Portfolio Construction Layer

## Purpose:

Build the mathematical foundation for optimization by combining selected equities, expected returns ( $\mu$ ), and risk models ( $\Sigma$ ) into a structured optimization problem.

## Inputs:

- Ranked stock list (from Strategy Layer)
- Expected Returns Vector ( $\mu$ )

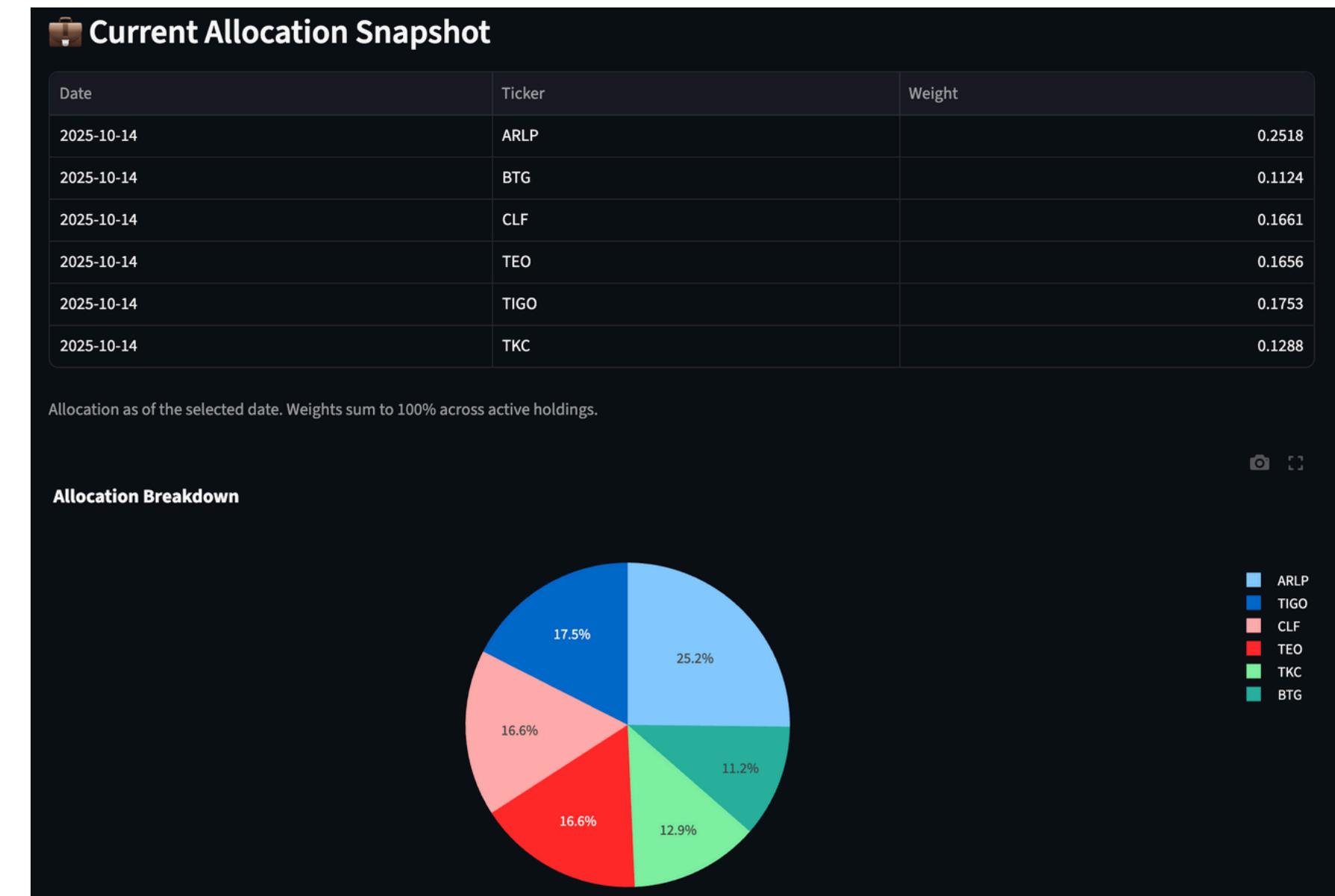
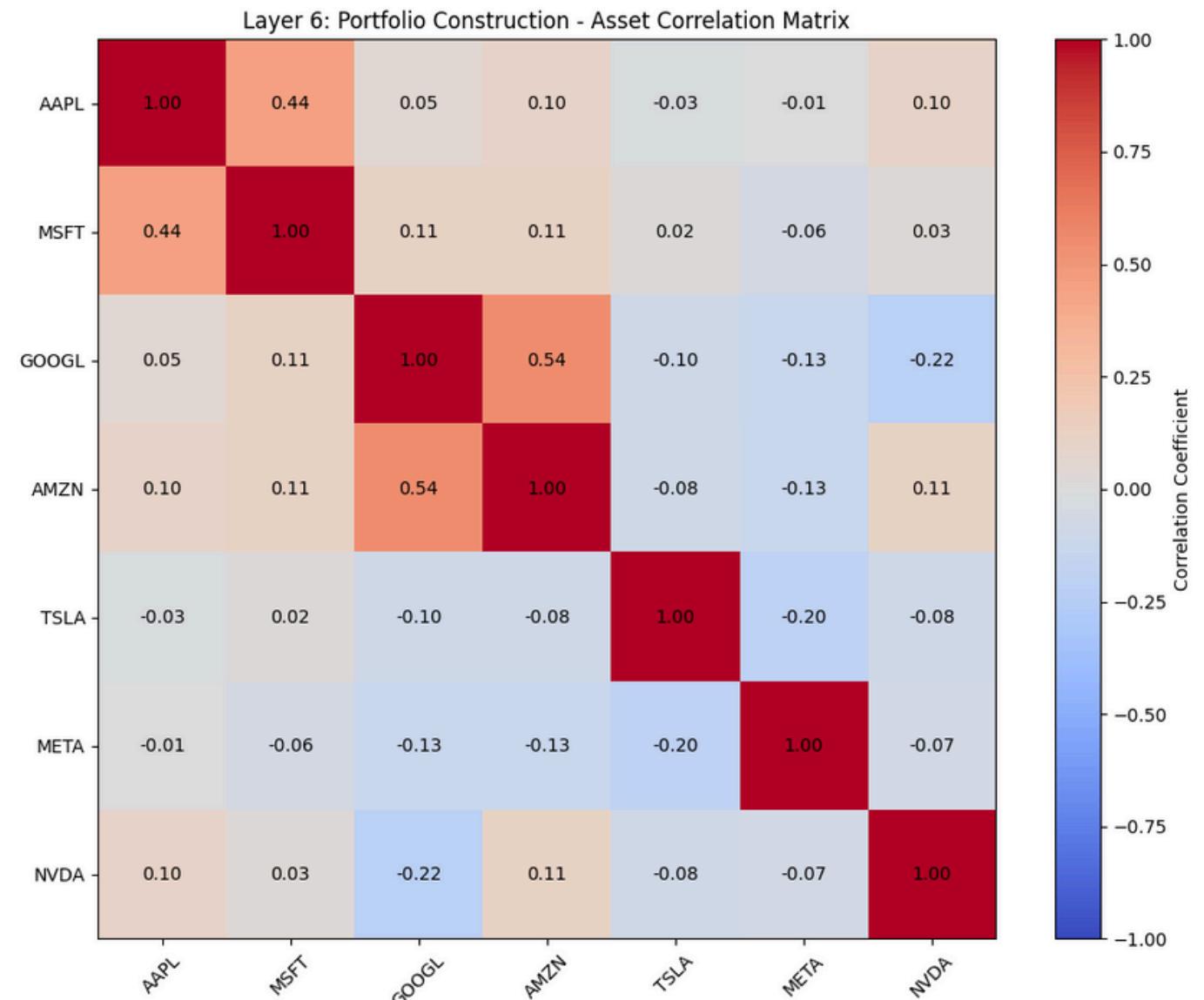
## Process:

- Align  $\mu$  and  $\Sigma$  for the same tickers
- Compute/validate covariance Matrix ( $\Sigma$ ) for risk modeling
- building a base for Mean-Variance Optimization (MVO) objective
- Apply diversification and allocation constraints

## Outputs:

- Optimization Problem Instance (ready for solver)
- Aligned  $\mu$  and  $\Sigma$  matrices for the optimizer

# 6 Portfolio Construction Layer



## 7 Optimization Layer

### Purpose:

Solve the mathematical optimization problem to find the optimal portfolio weights that balance return ( $\mu$ ) and risk ( $\Sigma$ ) based on the investor's risk tolerance.

### Inputs:

- Optimization problem from Layer 6 ( $\mu, \Sigma$ , constraints)
- Risk aversion parameter ( $\lambda$ ) from user's risk level (according to small/mid/large cap)
- Strategy ranks for hybrid allocation

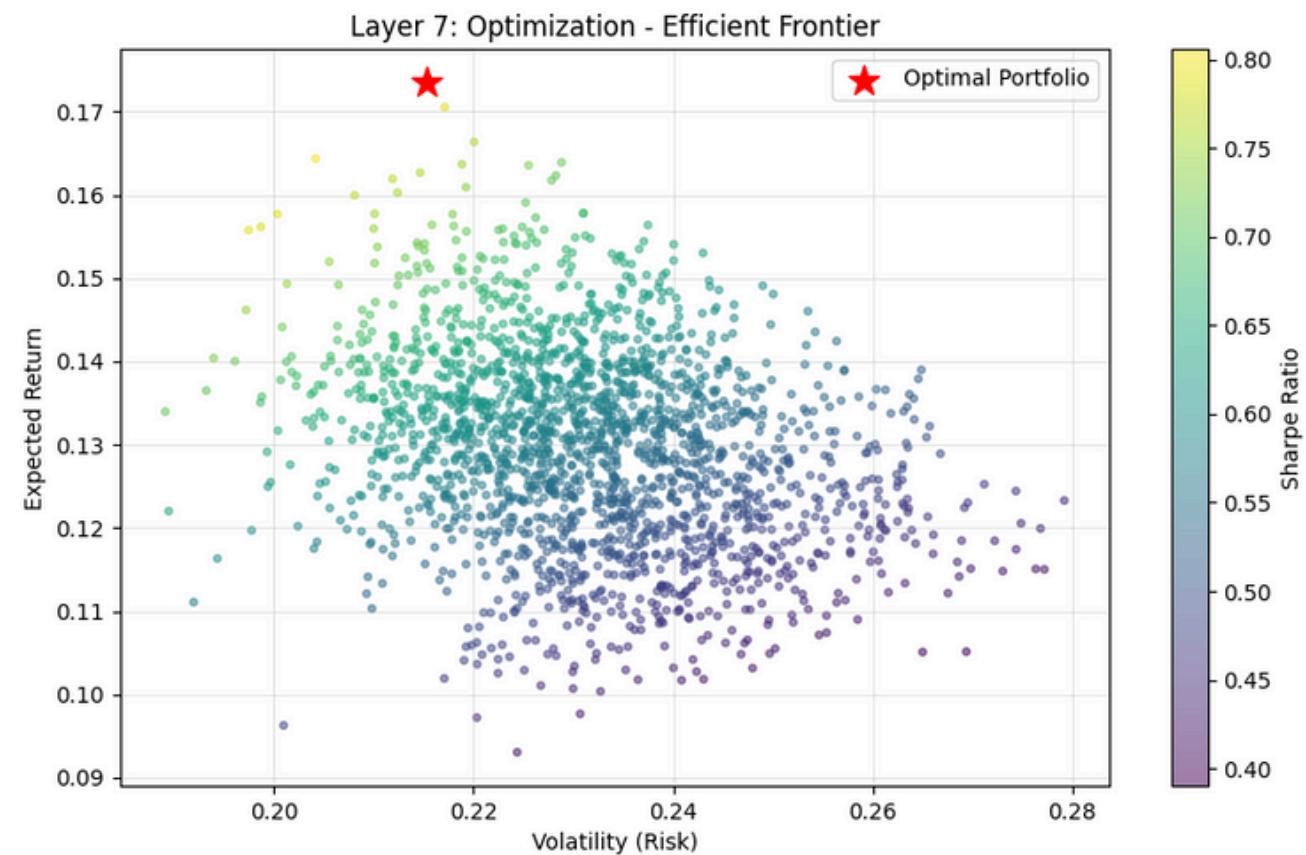
### Process:

- Run Mean-Variance Optimization (MVO):  
$$\min_w -\mu^T w + \lambda(w^T \Sigma w)$$
- Enforce constraints (weights sum to 1, max weight limits)
- Blend MVO weights with Strategy Layer weights for a hybrid portfolio

### Outputs:

- Final Target Weights for each stocks

# 7 Optimization Layer



**Optimization & Allocation**

**Mean-Variance Optimized Weights**

Ticker	Opt_Weight
CLF	0.0405
ARLP	0.3791
BTG	0.1561
TEO	0.0388
TIGO	0.1882
TKC	0.1969

**Blended Allocation (Rank vs. Optimizer)**

Ticker	Final_Weight	Rank_Weight	Opt_Weight
CLF	0.1661	0.25	0.0405
ARLP	0.2517	0.1666	0.3791
BTG	0.1124	0.0833	0.1561
TEO	0.1656	0.25	0.0388
TIGO	0.1753	0.1666	0.1882
TKC	0.1288	0.0833	0.1969

Final weights blend rank-based intuition with mean-variance optimization.

## 8 Risk Management Layer

### Purpose:

Assess the risk of the optimized portfolio by quantifying potential losses in normal and extreme market conditions.

### Inputs:

- Portfolio weights (from Layer 7)
- Historical returns of selected equities
- Confidence level (e.g., 95%)

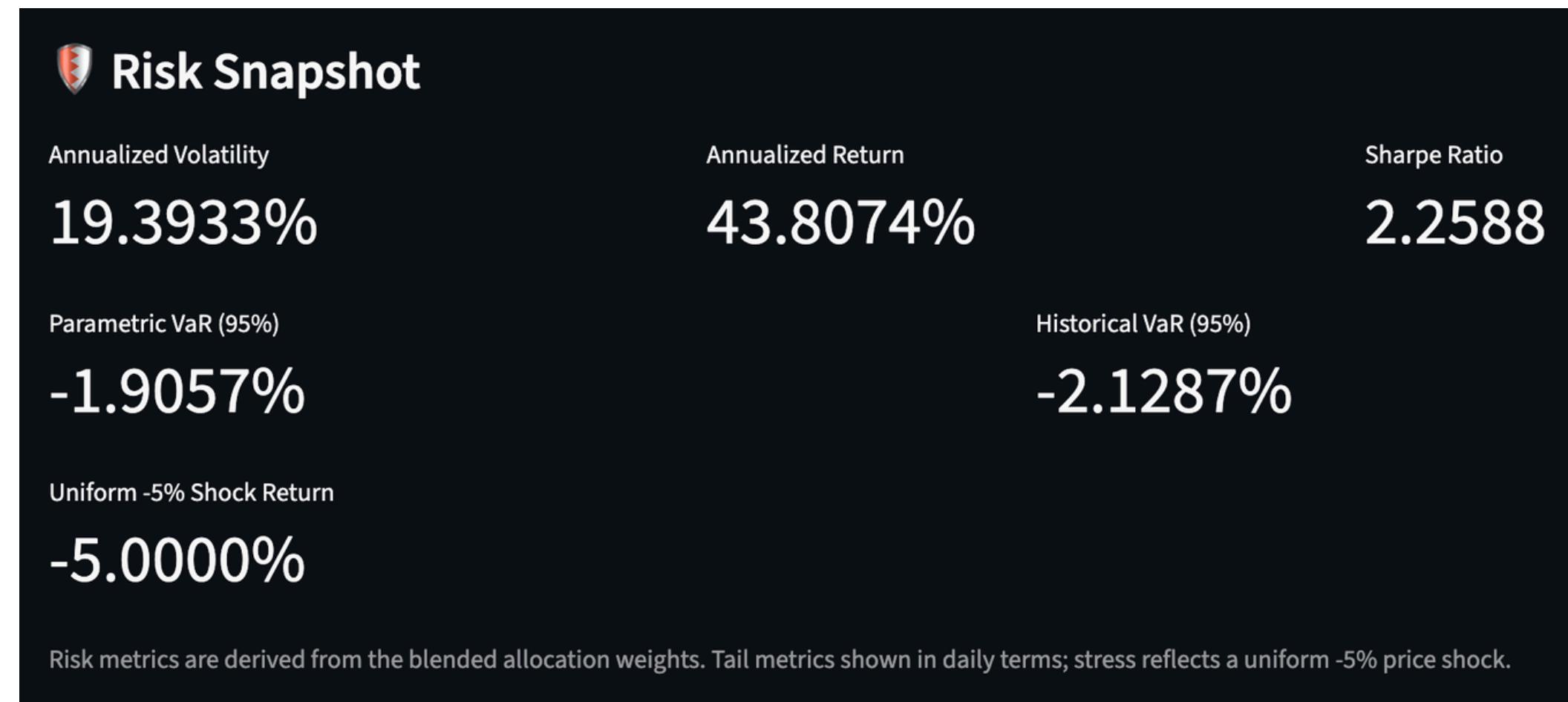
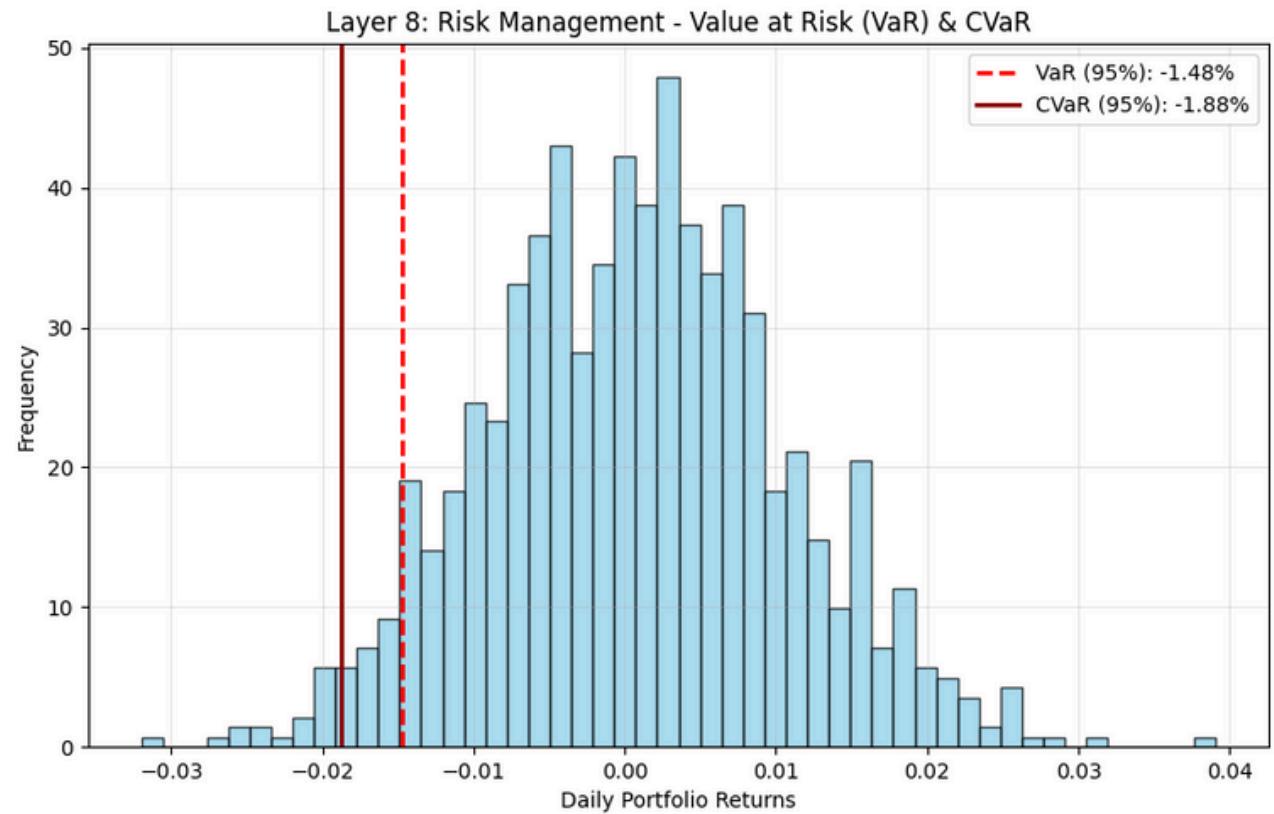
### Process:

- Compute annualized portfolio volatility
- Estimate Value-at-Risk (VaR):
  - Parametric VaR (normal distribution)
  - Historical VaR (worst historical days)
- Calculate Conditional VaR (CVaR) to measure average loss beyond VaR

### Outputs:

- Risk Report including Volatility, Sharpe Ratio, VaR (95%), and CVaR (95%)

# 8 Risk Management Layer



## 9 Stress Testing Layer

### Purpose:

Evaluate how the portfolio performs under extreme market conditions by simulating shocks and historical crises.

### Inputs:

- Current portfolio weights (from Layer 7)
- Shock scenarios (e.g., -20% market drop, rate hikes)

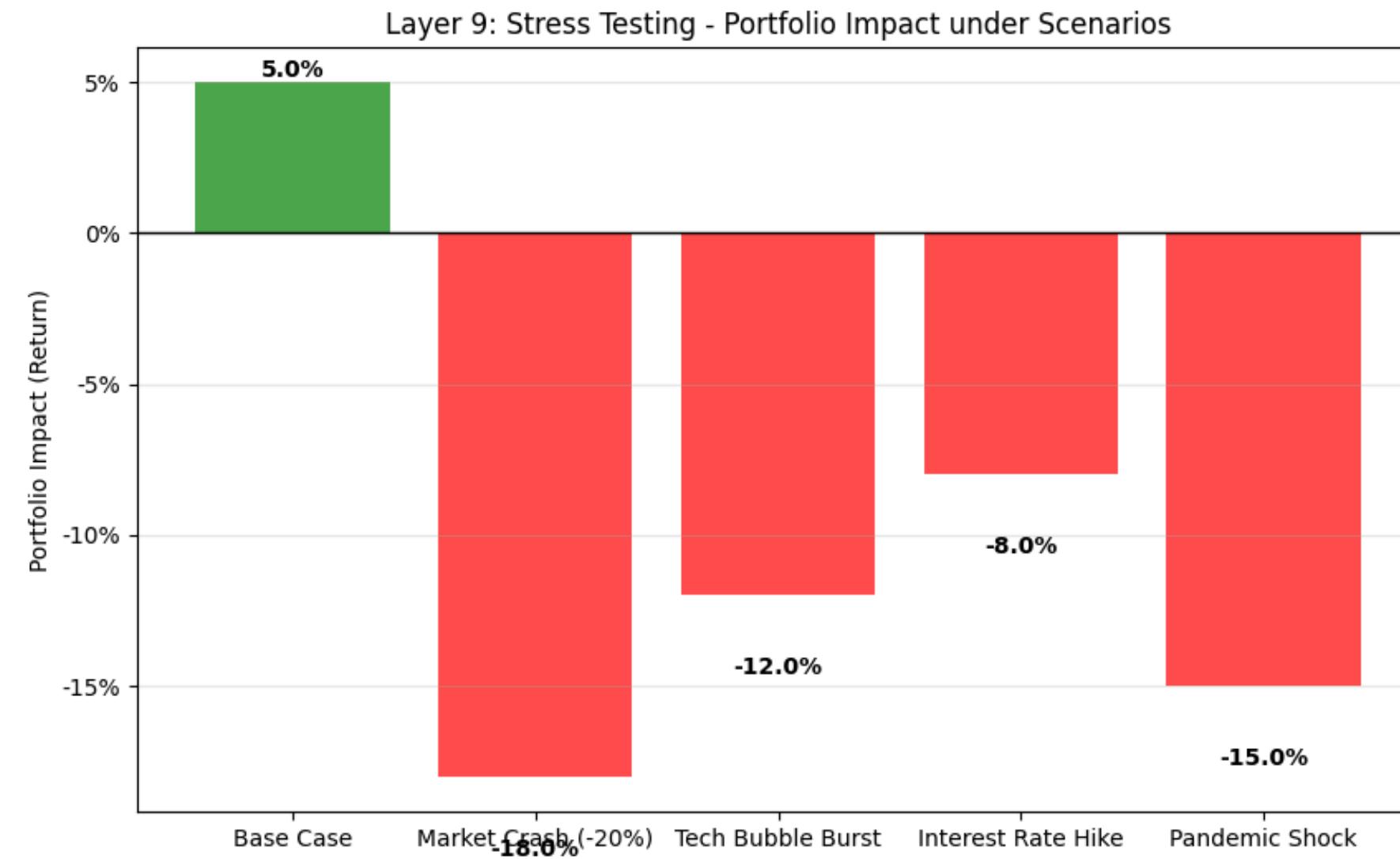
### Process:

- Apply parametric shocks (uniform percentage drops)
- Run sector-specific shocks for targeted drawdowns
- Replay historical crisis periods (e.g., 2008, 2020) to measure impact

### Outputs:

- Stress Report showing estimated losses, percentage drawdowns and scenario-by-scenario P&L impact

# 9 Stress Testing Layer



# 10 Backtesting Layer

## Purpose:

Simulate the strategy over historical data to validate performance before deploying it in real markets.

## Inputs:

- Full historical price data (from Layer 2)
- Strategy rules (from Layer 4)
- Rebalancing schedule (e.g., weekly/monthly)

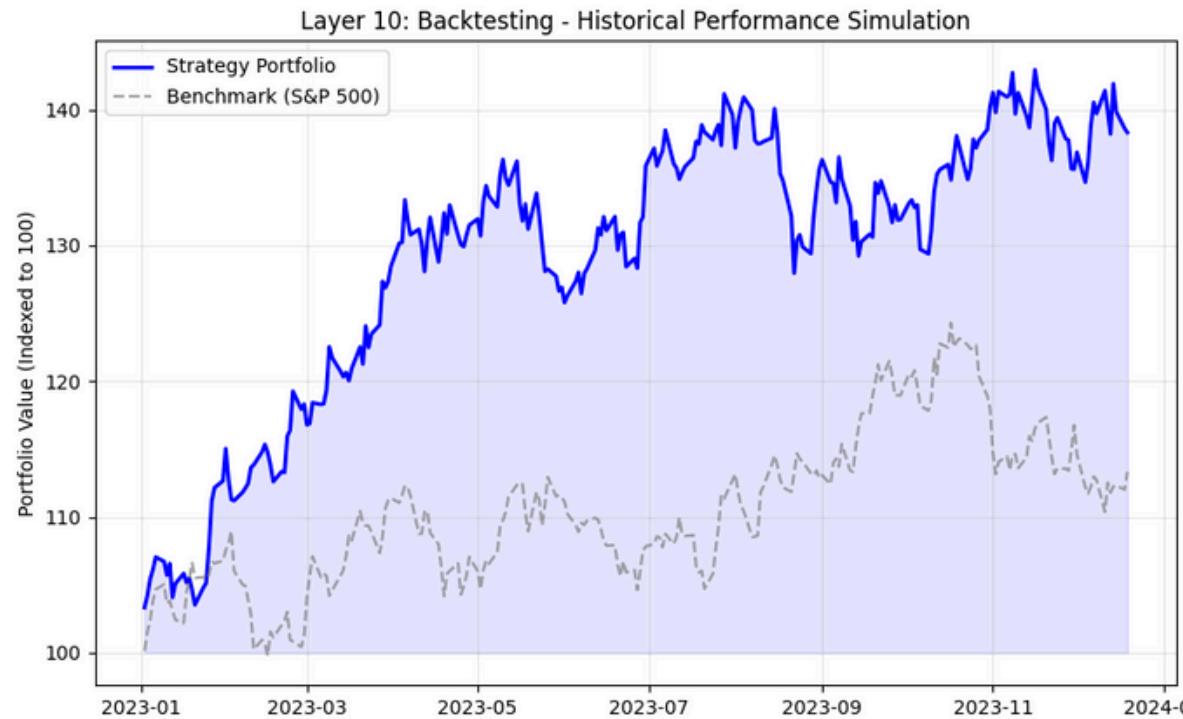
## Process:

- Run a time-based simulation loop
- Recalculate signals and weights at each rebalance date (no lookahead)
- Execute trades with transaction cost accounting
- Track daily portfolio value to form the equity curve

## Outputs:

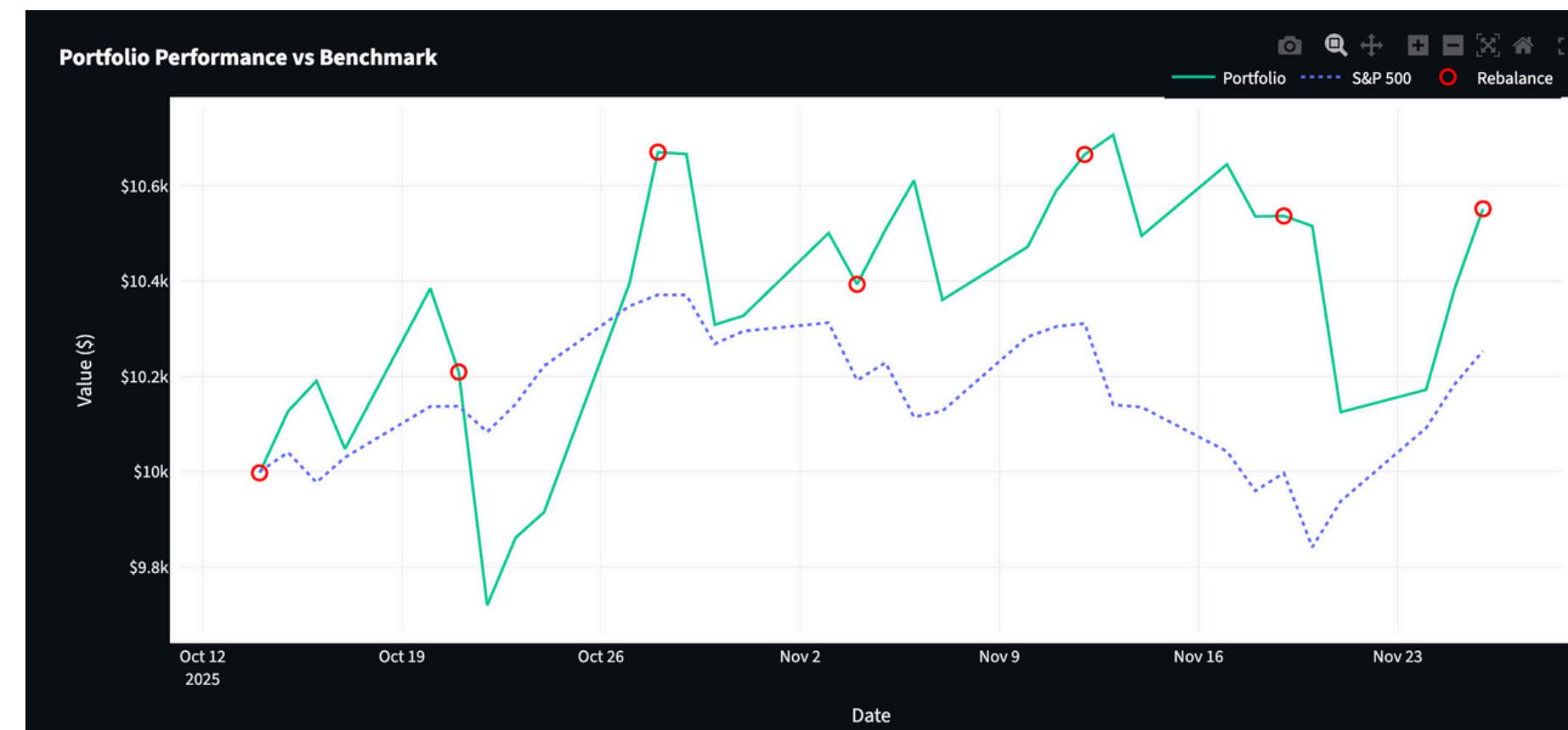
- Equity Curve comparing strategy vs. benchmark
- Performance Metrics such as Total Return, CAGR, and Max Drawdown

# 10 Backtesting Layer



Live Holdings Snapshot

Ticker	Shares	Price	MarketValue
TEO	215.0649	\$7.6999	\$1,655.9782
BTG	216.1538	\$5.1999	\$1,123.9781
ARLP	102.1345	\$24.6537	\$2,517.9933
CLF	124.0477	\$13.3900	\$1,660.9987
TKC	236.7647	\$5.4400	\$1,287.9999
TIGO	36.8488	\$47.4099	\$1,746.9979
CASH			\$0.0008



# 11 Signal Generation Layer

## Purpose:

Convert target portfolio weights into clear buy/sell instructions, bridging optimized allocations and actual trade execution.

## Inputs:

- Old portfolio holdings
- New target weights (from Layer 7)
- Tolerance threshold to avoid minor, unnecessary trades

## Process:

- Compute weight deltas between old and new portfolios
- Generate signals:
  - BUY if new > old
  - SELL if new < old
  - EXIT(SELL) if new = 0 and old > 0 and BUY(new stock from optimization Cycle)
  - HOLD if No change in Weight
- Log each signal with timestamp and reason

## Outputs:

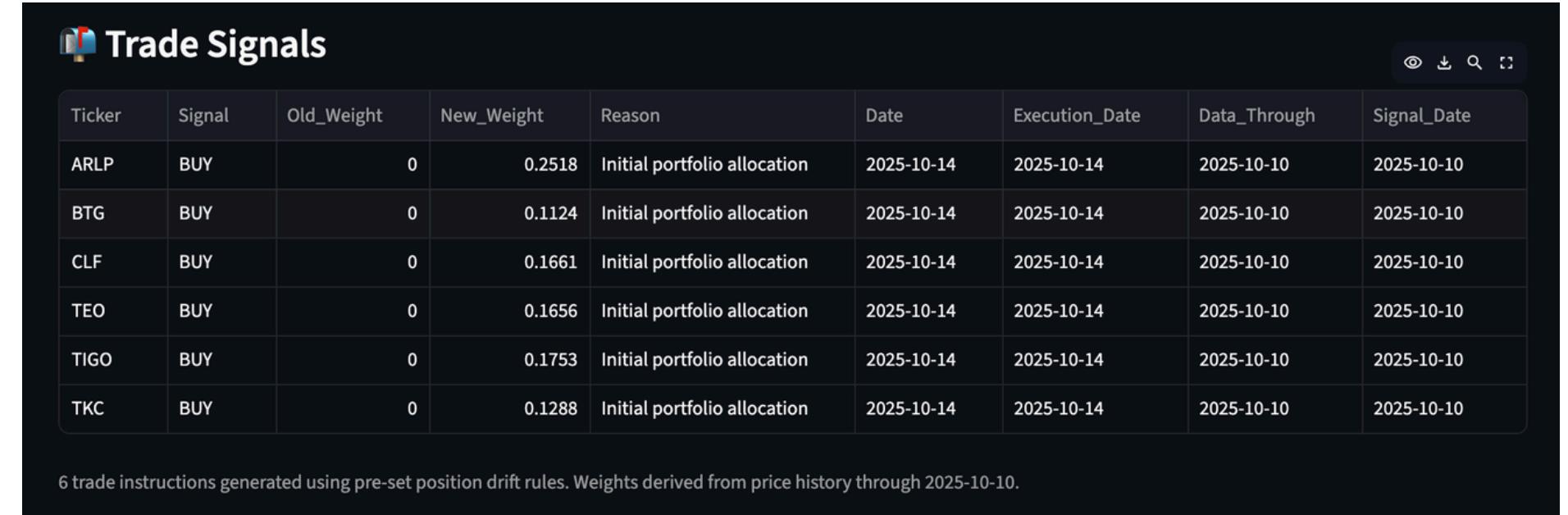
- Trade Instructions (ticker, action, quantity) ready for execution or simulation

# 11 Signal Generation Layer

**Layer 11: Signal Generation - Trade Instructions**

Ticker	Signal	Old Weight	New Weight	Action
AAPL	REBALANCE	12.5%	14.0%	Buy +1.5%
MSFT	BUY	0.0%	5.0%	Buy +5.0%
GOOGL	SELL	8.2%	0.0%	Sell All
AMZN	HOLD	5.0%	5.0%	No Change
TSLA	REBALANCE	10.0%	8.5%	Sell -1.5%

**Trade Signals**



Ticker	Signal	Old_Weight	New_Weight	Reason	Date	Execution_Date	Data_Through	Signal_Date
ARLP	BUY	0	0.2518	Initial portfolio allocation	2025-10-14	2025-10-14	2025-10-10	2025-10-10
BTG	BUY	0	0.1124	Initial portfolio allocation	2025-10-14	2025-10-14	2025-10-10	2025-10-10
CLF	BUY	0	0.1661	Initial portfolio allocation	2025-10-14	2025-10-14	2025-10-10	2025-10-10
TEO	BUY	0	0.1656	Initial portfolio allocation	2025-10-14	2025-10-14	2025-10-10	2025-10-10
TIGO	BUY	0	0.1753	Initial portfolio allocation	2025-10-14	2025-10-14	2025-10-10	2025-10-10
TKC	BUY	0	0.1288	Initial portfolio allocation	2025-10-14	2025-10-14	2025-10-10	2025-10-10

6 trade instructions generated using pre-set position drift rules. Weights derived from price history through 2025-10-10.

Data_Through	Execution_Date	Ticker	Signal	Old_Weight	New_Weight	Reason	Timestamp
2025-10-10	2025-10-14	ARLP	BUY	0	0.2518	Initial portfolio allocation	None
2025-10-10	2025-10-14	BTG	BUY	0	0.1124	Initial portfolio allocation	None
2025-10-10	2025-10-14	CLF	BUY	0	0.1661	Initial portfolio allocation	None
2025-10-10	2025-10-14	TEO	BUY	0	0.1656	Initial portfolio allocation	None
2025-10-10	2025-10-14	TIGO	BUY	0	0.1753	Initial portfolio allocation	None
2025-10-10	2025-10-14	TKC	BUY	0	0.1288	Initial portfolio allocation	None

## 12 Execution Layer

### Purpose:

Turn trade signals into executed transactions either simulated (backtesting)

### Inputs:

- Trade instructions (from Layer 11)
- Market prices (historical) open Price
- Cash balance

### Process:

- Convert target weights into share quantities
- Validate sufficient cash and enforce constraints
- Simulate or send execution:
  - Use next-period open price as fill
  - Deduct commissions and update cash
- Update holdings after each fill

### Outputs:

- Transaction Log (date, ticker, price, shares, cost)
- Updated Portfolio State reflecting new positions and cash

# 12 Execution Layer

## Layer 12: Execution - Transaction Log (Fixed Commission)

Date	Ticker	Side	Shares	Price	Comm.
2024-01-02	AAPL	BUY	142	\$150.00	-\$1.00
2024-01-02	MSFT	BUY	55	\$300.00	-\$1.00
2024-01-02	GOOGL	SELL	20	\$2800.00	-\$1.00
2024-02-01	TSLA	SELL	10	\$900.00	-\$1.00
2024-02-01	AMZN	BUY	45	\$3300.00	-\$1.00

Date	Ticker	Signal	Action	Net weight	Reason	Shares	Price	TradeValue	Transaction Cost	CashFlow	RemainingCash
2025-10-14	ARLP	BUY	BUY	0.2517	New allocation	102.1345	24.6537	2517.9994	-1	-2517.9994	7481.0005
2025-10-14	BTG	BUY	BUY	0.1123	New allocation	216.1538	5.1999	1123.9997	-1	-1123.9997	6356.0008
2025-10-14	CLF	BUY	BUY	0.166	New allocation	124.0477	13.39	1660.9987	-1	-1660.9987	4694.0021
2025-10-14	TEO	BUY	BUY	0.1655	New allocation	215.0649	7.6999	1655.9996	-1	-1655.9996	3037.0024
2025-10-14	TIGO	BUY	BUY	0.1752	New allocation	36.9753	47.4099	1752.9989	-1	-1752.9989	1283.0034
2025-10-14	TKC	BUY	BUY	0.1278	New allocation	235	5.44	1278.4	-1	-1278.4	3.6034
2025-10-21	ARLP	SELL	SELL	-0.2518	Removed from new opt	102.1345	23.7558	2426.2908	-1	2426.2908	2428.8943
2025-10-21	BTG	BUY	BUY	0.0538	Weight increase	104.8526	5.25	550.4761	-1	-550.4761	3375.3403
2025-10-21	CLF	REBALANCE	SELL	0.0085	Weight updated in latest	8.8451	15.4799	136.9221	-1	136.9221	2564.8164
2025-10-21	KT	BUY	BUY	0.1526	New allocation	81.9576	19.03	1559.6531	-1	-1559.6531	1814.6871
2025-10-21	SXT	BUY	BUY	0.1481	New allocation	15.8043	95.7766	1513.6831	-1	-1513.6831	300.004
2025-10-21	TEO	BUY	BUY	0.0125	Weight increase	16.8715	7.57	127.7172	-1	-127.7172	171.2867

## 13 Performance Layer

### Purpose:

Provide a continuous scoreboard of portfolio health by calculating returns, risk-adjusted metrics and benchmark comparisons.

### Inputs:

- Daily portfolio value
- Benchmark index data (e.g., S&P 500)
- Risk-free rate

### Process:

- Compute daily returns
- Calculate performance metrics:
  - Sharpe Ratio
  - Sortino Ratio
  - Max Drawdown
  - CAGR
- Compare portfolio metrics vs. benchmark performance

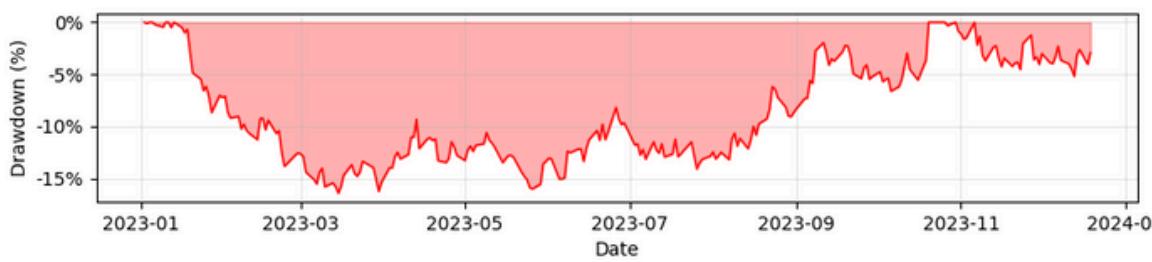
### Outputs:

- Performance Report with equity curve visualizations
- Metrics Table showing Sharpe, Drawdown, CAGR and benchmark comparisons

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# 13 Performance Layer

Layer 13: Performance Layer - Growth & Drawdown Analysis



Metric	Portfolio	S&P 500
Annualized Return	47.5780%	20.5868%
Annualized Volatility	32.1490%	13.4737%
Sharpe Ratio	1.3555	1.2310
Sortino Ratio	1.8425	1.9564
Max Drawdown	6.4117%	5.1100%
CAGR	52.9836%	21.7730%

Current Holdings + Cash – Initial = Realized + Unrealized – Fees.

Execution Date	Rebalance Cadence	Current Position	P/L	Return %	Rebalances	Realized P/L	Cumulative Realized P/L	Unrealized P/L	Latest Unrealized P/L	Transaction Costs	Cash
2025-10-14	Weekly Rebalance	\$9,993.9991	\$0.0000	0.0000%	1	\$0.0000	\$0.0000	\$0.0000	\$0.0000	\$6.0000	\$0.0008
2025-10-21	Weekly Rebalance	\$10,206.5197	\$220.5277	2.1999%	2	\$11.9969	\$11.9969	\$208.5308	\$208.5308	\$14.0000	\$0.0079
2025-10-28	Weekly Rebalance	\$10,670.1876	\$693.1890	6.9300%	3	\$102.9670	\$114.9639	\$369.6943	\$578.2252	\$23.0000	\$0.0016
2025-11-04	Weekly Rebalance	\$10,389.9485	\$422.9491	4.2200%	4	\$-271.7037	\$-156.7398	\$1.4637	\$579.6889	\$33.0000	\$0.0005
2025-11-12	Weekly Rebalance	\$10,667.8608	\$708.8611	7.0800%	5	\$44.9637	\$-111.7761	\$240.9483	\$820.6372	\$41.0000	\$0.0002
2025-11-19	Weekly Rebalance	\$10,538.6664	\$588.6704	5.8800%	6	\$102.1591	\$-9.6170	\$-222.3497	\$598.2875	\$50.0000	\$0.0040
2025-11-26	Weekly Rebalance	\$10,551.6774	\$610.6781	6.1000%	7	\$376.1857	\$366.5688	\$-354.1780	\$244.1094	\$59.0000	\$0.0007

## 14 Rebalancing Layer

### Purpose:

Keep the portfolio aligned with target allocations by correcting drift caused by market movements acting as the system's autopilot.

### Inputs:

- Current portfolio weights
- Target weights (from Layer 7)
- Rebalance frequency (e.g., monthly/quarterly)
- Drift threshold (e.g.,  $\pm 5\%$ )

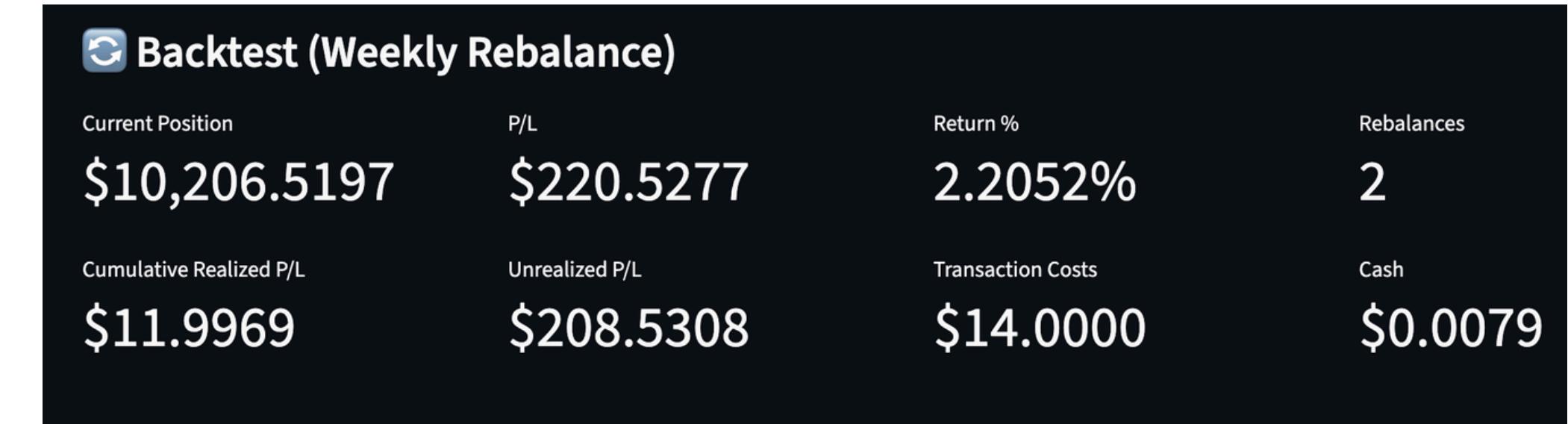
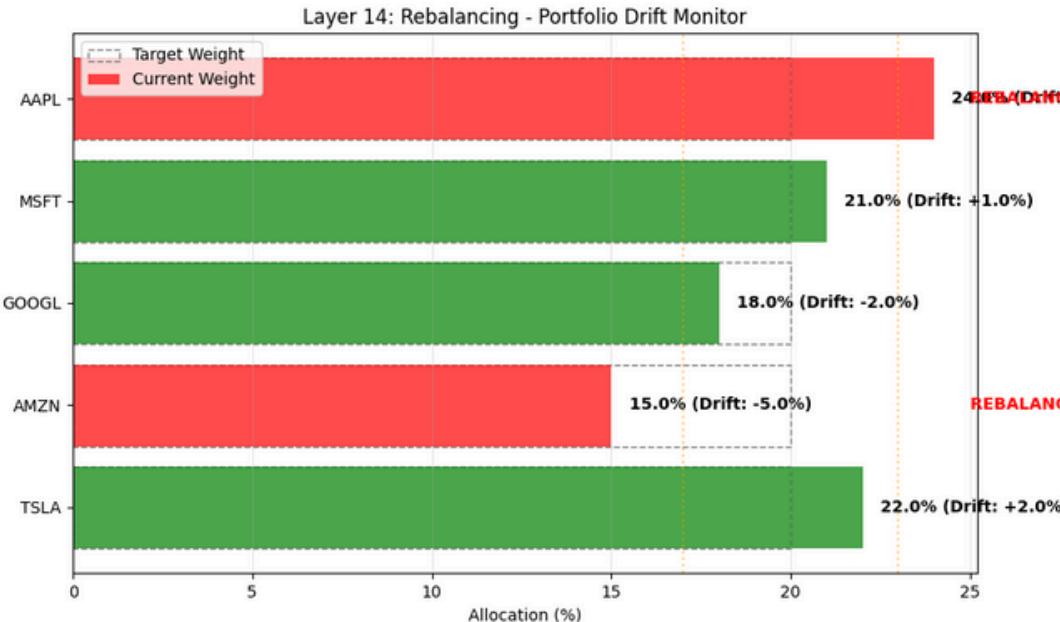
### Process:

- Monitor deviations between current vs. target weights
- Trigger rebalance when:
  - Time-based: scheduled rebalance date
  - Threshold-based: weight drift exceeds allowed range
- If triggered, rerun the full pipeline to compute updated target weights

### Outputs:

- Rebalance Trigger (True/False) indicating whether a new optimization cycle should run

# 14 Rebalancing Layer



Data_Through	Execution_Date	Ticker	Signal	Old_Weight	New_Weight	Reason	Timestamp
2025-10-20	2025-10-21	ARLP	SELL	0.2518	0	Removed from new optimized portfolio	2025-11-30 17:54:12
2025-10-20	2025-10-21	BTG	REBALANCE	0.1124	0.165	Weight updated in latest optimization	2025-11-30 17:54:12
2025-10-20	2025-10-21	CLF	REBALANCE	0.1661	0.1746	Weight updated in latest optimization	2025-11-30 17:54:12
2025-10-20	2025-10-21	KT	BUY	0	0.1527	Newly added to optimized portfolio	2025-11-30 17:54:12
2025-10-20	2025-10-21	SXT	BUY	0	0.1482	Newly added to optimized portfolio	2025-11-30 17:54:12
2025-10-20	2025-10-21	TEO	REBALANCE	0.1656	0.1719	Weight updated in latest optimization	2025-11-30 17:54:12
2025-10-20	2025-10-21	TIGO	REBALANCE	0.1753	0.1876	Weight updated in latest optimization	2025-11-30 17:54:12
2025-10-20	2025-10-21	TKC	SELL	0.1288	0	Removed from new optimized portfolio	2025-11-30 17:54:12
2025-10-27	2025-10-28	BCPC	BUY	0	0.2587	Newly added to optimized portfolio	2025-11-30 18:58:41
2025-10-27	2025-10-28	BTG	SELL	0.165	0	Removed from new optimized portfolio	2025-11-30 18:58:41

# Thank You!

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**For your listening...**

Elaborate on what you want to discuss.