



ADVANCED STOCK MARKET DASHBOARD

An Interactive R Shiny Tool for
Quantitative Analysis

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MTH208 Data Science Lab I | Guidance of Dr. Aakash
Anand

PROJECT OBJECTIVE

1. Build a responsive R Shiny dashboard with interactive visualizations.
2. Implement standard indicators: SMA, EMA, RSI, MACD, Bollinger Bands
3. Integrate mean-variance portfolio optimization.
4. Provide benchmark comparisons and backtesting visuals.
5. Ensure reproducibility: provide instructions, code organization and package list.

OUR PROJECT

PRIMARY DATA SOURCES

The dashboard uses only publicly available data:

1. Yahoo Finance via `quantmod::getSymbols` and `tidyquant::tq_get`: OHLCV daily series per ticker.
2. Yfinance library fetching

INTERACTIVE CANDLESTICK CHARTS

1. Candlestick Chart as the Core

Displays daily price movements — open, high, low, and close values.
Helps users visually interpret market trends and price behavior.

2. Integration of Key Technical Indicators

Includes popular indicators for analyzing trend, momentum, and volatility.
Provides a comprehensive technical view to support data-driven trading insights.

3. Interactive Visualization with Volume Analysis

Volume bars alongside candlesticks highlight trading activity and market strength.
Enhances user interaction and understanding of price-volume relationships.

MODULE 1:TACTICAL STOCK ANALYSIS


MOVING AVERAGES (SMA AND EMA)

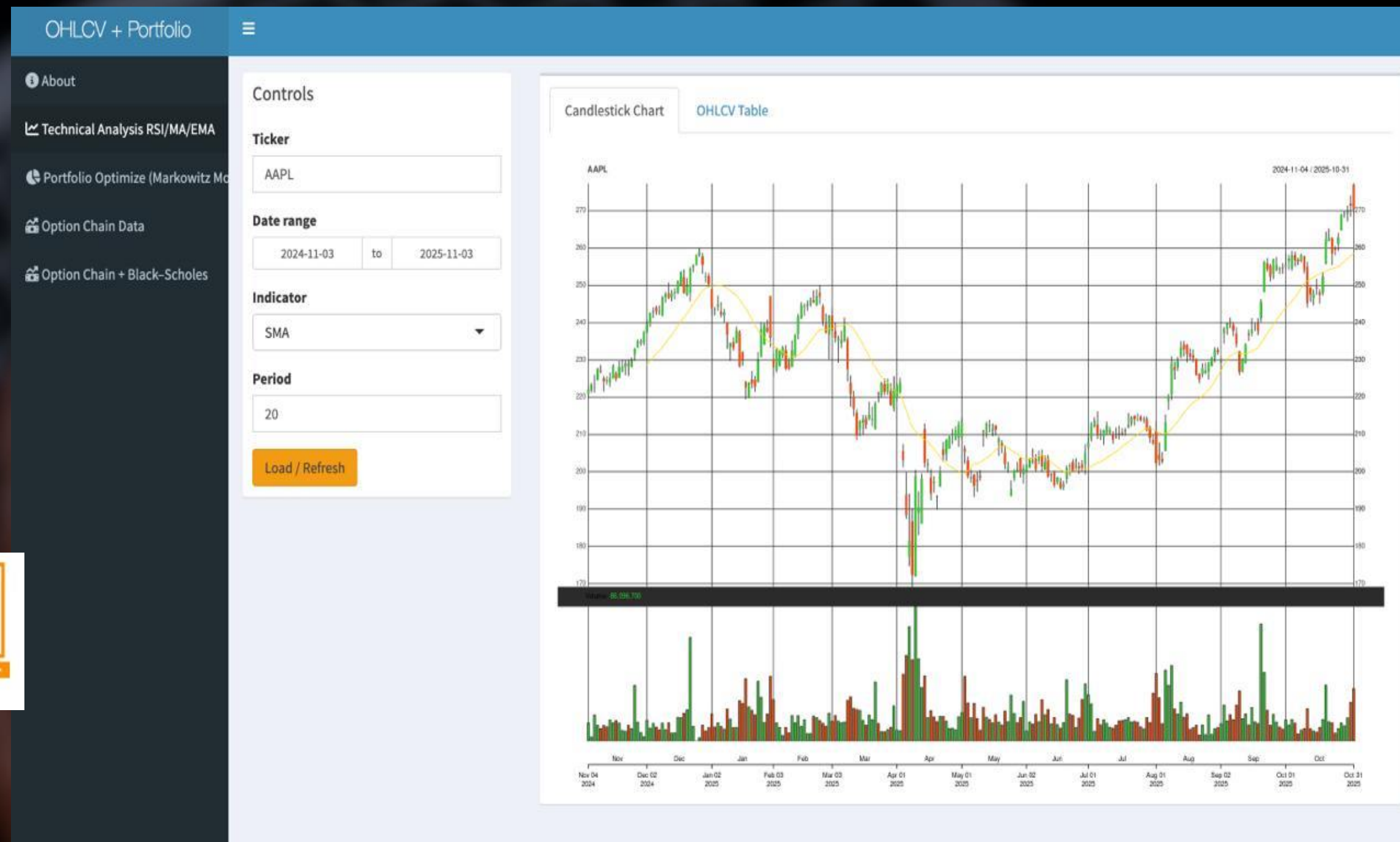
Added Simple and Exponential Moving Averages (SMA & EMA) for 20, 50, 100, and 200-day periods. Helps identify both short-term and long-term market trends..

Marked important crossover events like the Golden Cross and Death Cross. These indicate potential bullish or bearish momentum shifts in the market.

$$\text{Simple Moving Average} = \frac{(A_1 + A_2 + \dots + A_n)}{n}$$

$(A_1, A_2, \dots, A_n) = \text{Prices}$
 $n = \text{The number of total periods}$

$$\text{Exponential Moving Average} = C - P \times \frac{2}{(n + 1)} + P$$




RELATIVE STRENGTH INDEX (RSI)

- Integrated the Relative Strength Index (RSI) to analyze market momentum. Measures the speed and magnitude of recent price changes..

- $RSI > 70$: Indicates potential overbought conditions.
 $RSI < 30$: Indicates potential oversold conditions.

- This allows users to identify periods of market exhaustion and potential entry or exit points.



- About
- Technical Analysis RSI/MA/EMA
- Portfolio Optimize (Markowitz Mo
- Option Chain Data
- Option Chain + Black-Scholes

Controls

Ticker

AAPL

Date range

2024-11-03

to

2025-11-03

Indicator

RSI

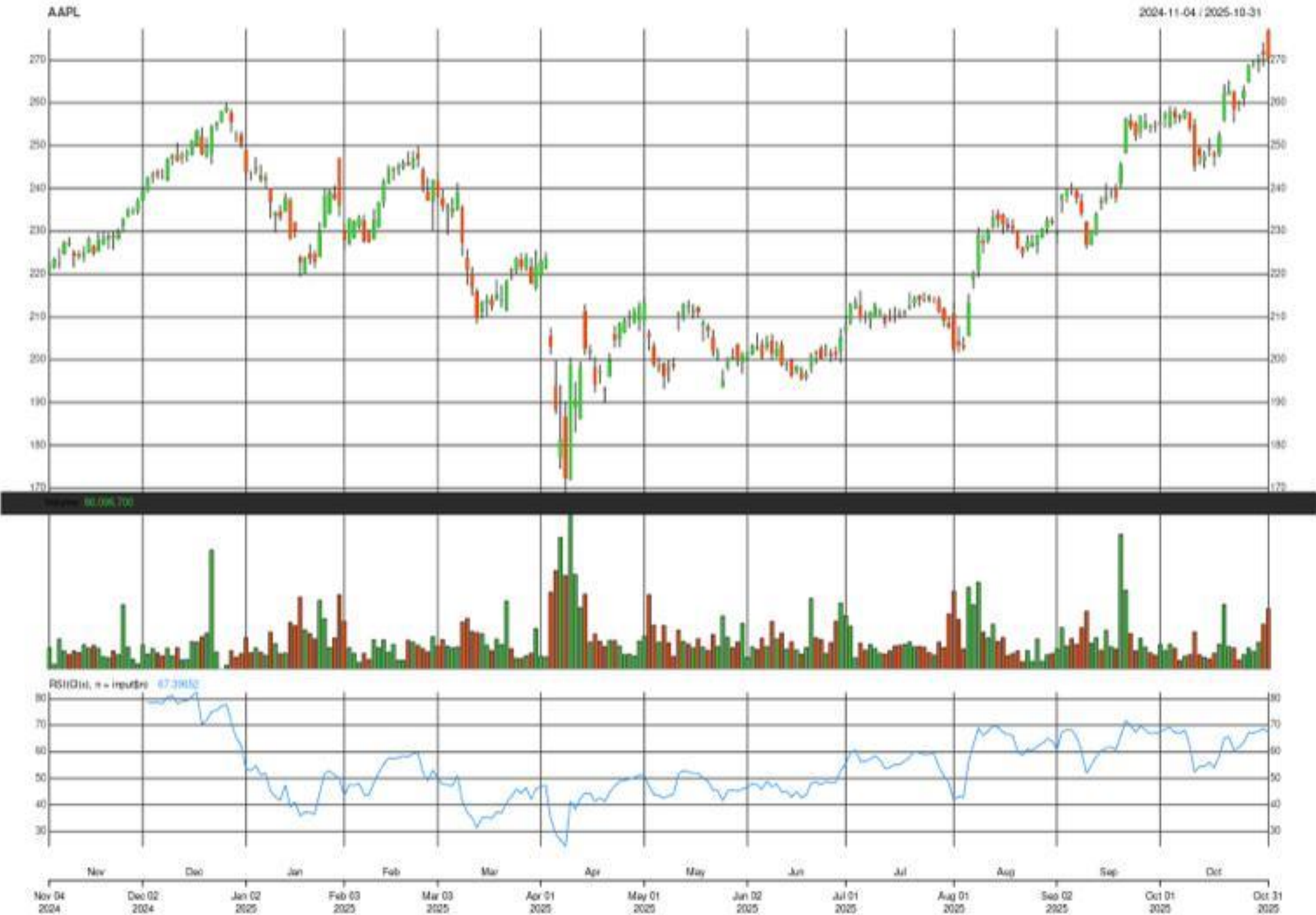
Period

20

Load / Refresh

Candlestick Chart

OHLCV Table



BOLLINGER BANDS

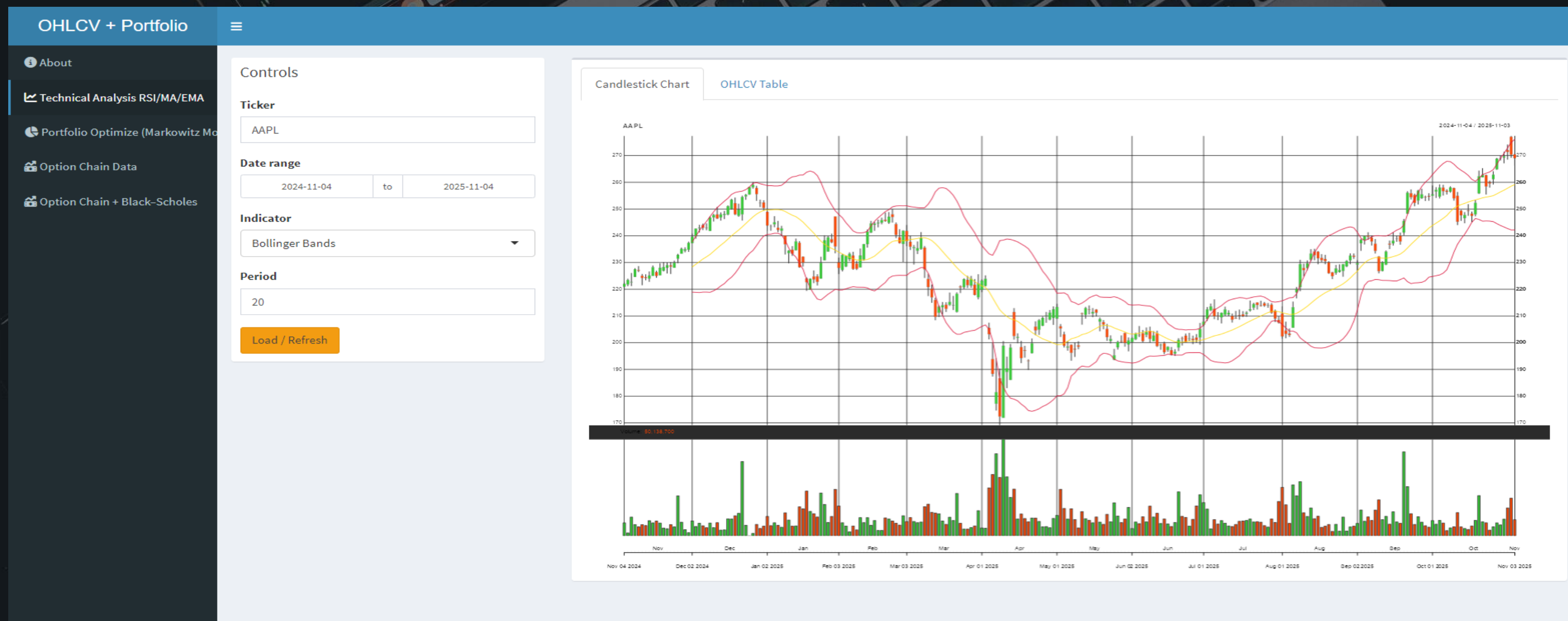
Implemented Bollinger Bands to visualize market volatility, using a moving average with upper and lower bands.

Wider bands indicate high volatility, while narrower bands suggest a potential breakout or trend reversal..

Middle Band = SMA (N periods)

Upper Band = $SMA + k \times s.d(N \text{ periods})$

Lower Band = $SMA - k \times s.d(N \text{ periods})$

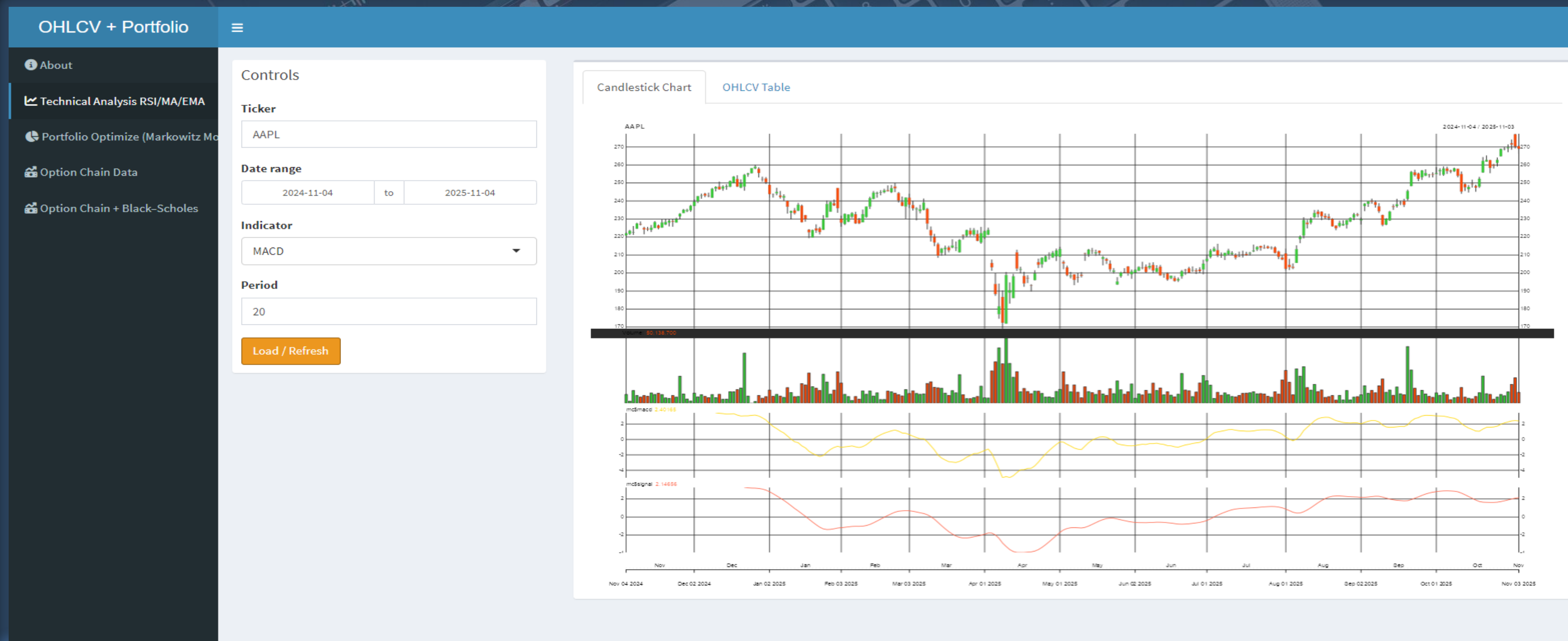


MODULE 1: TACTICAL STOCK ANALYSIS

MACD

Integrated the Moving Average Convergence Divergence (MACD) indicator to help identify trend reversals. Visualized using a histogram and signal line for clearer pattern recognition

MACD line crossing above the signal line
→ indicates bullish momentum.
MACD line crossing below the signal line
→ signals bearish movement.



Markowitz mean-variance optimization

■ Let μ be the vector of expected returns (sample mean of log returns) and Σ the sample covariance matrix

Formulation 1 (Minimize Risk for Target Return):

$$\min_w w^T \Sigma w \quad \text{s.t.} \quad w^T \mu = \mu_p, w^T \mathbf{1} = 1, w \geq 0$$

Formulation 2 (Maximize Return for Target Risk)

$$\max_w w^T \mu - \frac{\lambda}{2} w^T \Sigma w \quad \text{s.t.} \quad w^T \mathbf{1} = 1, w \geq 0$$

Markowitz mean-variance optimization

where μ_p is the target portfolio return and λ is the risk aversion parameter. The efficient frontier is traced by solving either formulation for a range of μ_p values (first formulation) or λ values (second formulation).

The point with maximum Sharpe ratio $(\mu_p - r_f) / \sigma_p$ represents the tangency portfolio, where r_f is the risk-free rate.

In the next slide we will see Markowitz Efficient Frontier plot
For various companies stock like Apple, Microsoft, Google, Amazon and Tesla
Using Tickers AAPL, MSFT, GOOG, AMZN, TSLA
Let's say for a particular year

- About
- Technical Analysis RSI/MA/EMA
- Portfolio Optimize (Markowitz Model)
- Option Chain Data
- Option Chain + Black-Scholes

Portfolio Inputs

Enter stock tickers (comma separated)

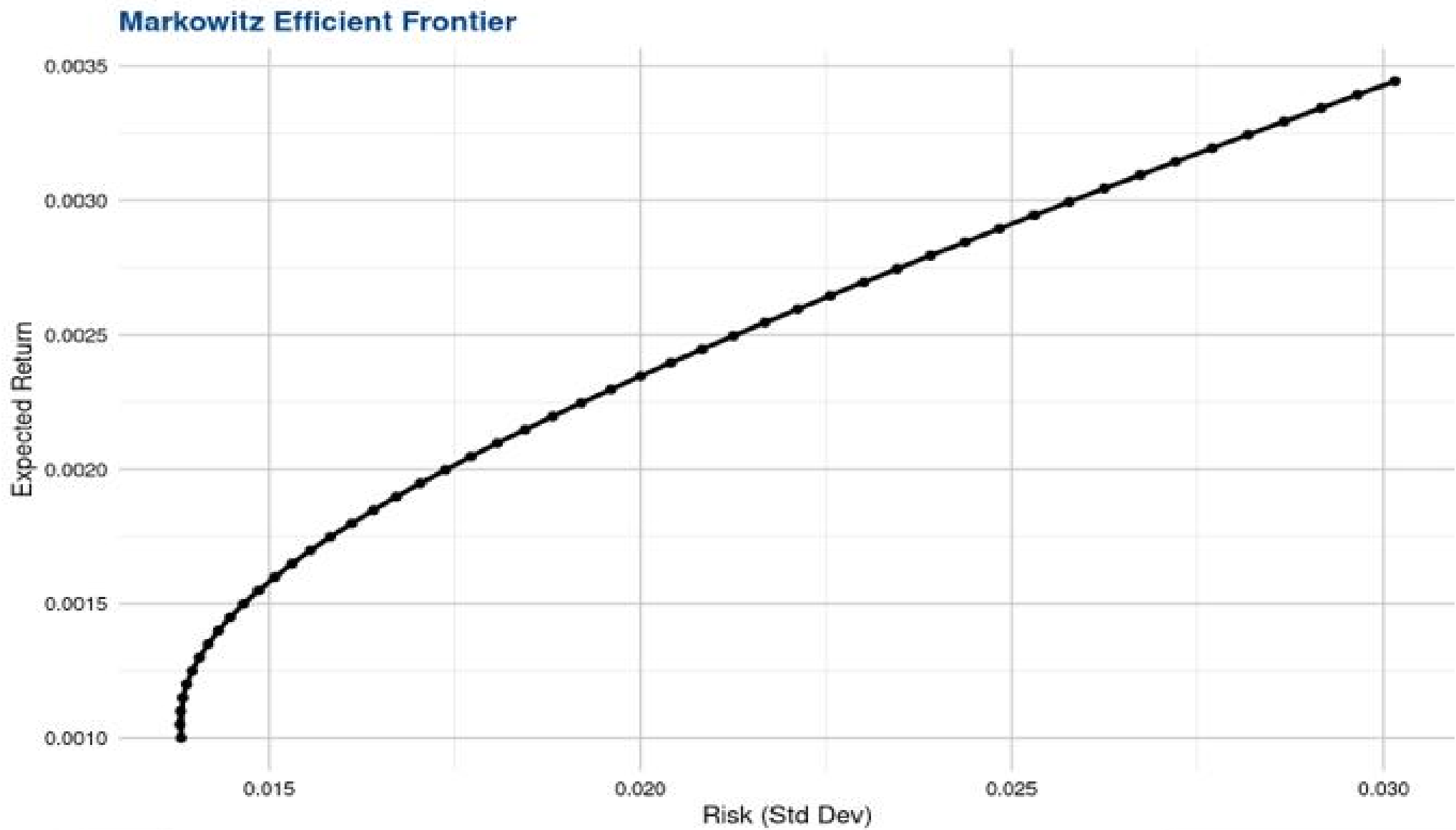
AAPL,MSFT,GOOG,AMZN

Date range

2024-11-03 to 2025-11-03

Load & Optimize

Efficient Frontier



Show 10 entries Search:

	Ticker	Weight
1	AAPL	0.197
2	MSFT	0.699
3	GOOG	0.248
4	AMZN	-0.025
5	TSLA	-0.118

Markowitz mean-variance optimization

Numerical Implementation

- The app returns Optimal weights for selected points on the frontier
- Expected portfolio return and volatility
- Sharpe ratio relative to a user-specified risk-free rate

OPTION CHAIN VISUALIZATION

- Displays a structured Option Chain showing strike prices, bid–ask premiums, implied volatilities, and expiry dates for selected underlying assets
- Highlights in-the-money (ITM), at-the-money (ATM), and out-of-the-money (OTM) options, helping users quickly interpret moneyness and relative pricing users to compare options across strikes and maturities interactively, supporting strategy evaluation and market sentiment analysis in real time.

Module 3: Options & Derivatives

OPTION CHAIN VISUALIZATION

Options are financial contracts that give the buyer the **right (but not the obligation)** to buy or sell a stock at a **pre-decided price** in the future.

Call
Options

Put
Options

Strike Price

OI (Open
Interest)

IV

ITM

Bid Ask



OPTION CHAIN VISUALIZATION

OHLCV + Portfolio												
☰												
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Option Chain Data												
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Option Chain Controls												
Ticker												
AAPL												
Fetch Option Chain												
Option Chain Data												
Calls Puts												
Show 10 entries Search:												
⬆	Expiration ⬆	Strike ⬆	Last ⬆	Chg ⬆	ChgPct ⬆	Bid ⬆	Ask ⬆	Vol ⬆	OI ⬆	LastTradeTime ⬆	IV ⬆	ITM ⬆
	2025-11-07T00:00:00Z	110	0.02	0	0	0	0	2	0	2025-10-16T18:43:47Z	0.500005	false
	2025-11-07T00:00:00Z	125	0.01	0	0	0	0	100	0	2025-10-23T14:44:51Z	0.500005	false
	2025-11-07T00:00:00Z	130	0.01	0	0	0	0		0	2025-10-20T17:40:07Z	0.500005	false
	2025-11-07T00:00:00Z	135	0.01	0	0	0	0	128	0	2025-10-24T17:49:14Z	0.500005	false
	2025-11-07T00:00:00Z	140	0.01	0	0	0	0	30	0	2025-10-24T19:52:48Z	0.500005	false
	2025-11-07T00:00:00Z	145	0.02	0	0	0	0	1	0	2025-10-22T16:14:58Z	0.500005	false
	2025-11-07T00:00:00Z	150	0.01	0	0	0	0	25	0	2025-10-28T16:11:28Z	0.500005	false
	2025-11-07T00:00:00Z	155	0.01	0	0	0	0	100	0	2025-10-28T19:58:34Z	0.500005	false
	2025-11-07T00:00:00Z	160	0.01	0	0	0	0	46	0	2025-10-29T14:39:35Z	0.500005	false
	2025-11-07T00:00:00Z	165	0.02	0	0	0	0	11	0	2025-10-31T13:30:02Z	0.500005	false

OPTION CHAIN VISUALIZATION

OHLCV + Portfolio

About

Technical Analysis RSI/MA/EMA

Portfolio Optimize (Markowitz Mo

Option Chain Data

Option Chain + Black-Scholes

Option Chain Controls

Ticker

AAPL

Fetch Option Chain

Option Chain Data

Calls

Puts

Show 10 entries

Search:

ContractID	ContractSize	Currency	Expiration	Strike	Last	Chg	ChgPct	Bid	Ask	Vol	OI	LastTradeTime	IV	ITM
AAPL251107P00270000	REGULAR	USD	2025-11-07T00:00:00Z	270	3.2	0	0	0	0	15982	0	2025-10-31T19:59:59Z	0.0039162109375	false
AAPL251107P00272500	REGULAR	USD	2025-11-07T00:00:00Z	272.5	4.35	0	0	0	0	6273	0	2025-10-31T19:59:58Z	0.00001	true
AAPL251107P00275000	REGULAR	USD	2025-11-07T00:00:00Z	275	5.96	0	0	0	0	2092	0	2025-10-31T19:59:41Z	0.00001	true
AAPL251107P00277500	REGULAR	USD	2025-11-07T00:00:00Z	277.5	7.88	0	0	0	0	866	0	2025-10-31T19:59:30Z	0.00001	true
AAPL251107P00280000	REGULAR	USD	2025-11-07T00:00:00Z	280	10.2	0	0	0	0	2450	0	2025-10-31T19:59:09Z	0.00001	true
AAPL251107P00282500	REGULAR	USD	2025-11-07T00:00:00Z	282.5	12.31	0	0	0	0	158	0	2025-10-31T19:59:35Z	0.00001	true
AAPL251107P00285000	REGULAR	USD	2025-11-07T00:00:00Z	285	14.68	0	0	0	0	4660	0	2025-10-31T19:54:57Z	0.00001	true
AAPL251107P00287500	REGULAR	USD	2025-11-07T00:00:00Z	287.5	16.06	0	0	0	0	4	0	2025-10-31T18:26:05Z	0.00001	true
AAPL251107P00290000	REGULAR	USD	2025-11-07T00:00:00Z	290	17.96	0	0	0	0	36	0	2025-10-31T19:30:33Z	0.00001	true
AAPL251107P00292500	REGULAR	USD	2025-11-07T00:00:00Z	292.5	22.96	0	0	0	0	21	0	2025-10-31T14:11:42Z	0.00001	true

Showing 41 to 50 of 65 entries

Previous

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BLACK–SCHOLES–MERTON (BSM) MODEL

- It calculate European call and put option prices using key inputs such as spot price, strike price, volatility, risk-free rate, and time to expiry.
- Enables users to understand option behavior and risk exposure through quantitative outputs and interactive visualization, enhancing practical understanding of derivative pricing.

BLACK–SCHOLES–MERTON (BSM) MODEL

■ The formulas for the theoretical price of a European Call Option (C) and a European Put Option (P) (for a non-dividend-paying stock) are:

$$C = SN(d1) - Ke(-rt) N(d2)$$

$$P = Ke(-rt) N(-d2) - SN(-d1)$$

The value of d1 and d2 are

$$d1 = (\ln(S/K) + (r + \sigma^2 / 2) T) / \sigma \sqrt{T}$$

$$d2 = d1 - \sigma \sqrt{T}$$

σ : Volatility of the underlying asset's returns
(annualized standard deviation)

Module 3: Options & Derivatives

BLACK-SCHOLES-MERTON (BSM) MODEL

Symbol	Description
C	Theoretical Call Option Price
P	Theoretical Put Option Price
S	Current price of the Underlying Asset (e.g., stock price)
K	Strike Price (Exercise Price) of the option
r	Risk-free Interest Rate (annualized, continuously compounded)
T	Time to Expiration (in years)
e	The base of the natural logarithm (approx. 2.71828)
N(.)	The Cumulative Distribution Function (CDF) of the standard normal distribution. This represents the probability that a value from a standard normal distribution will be less than or equal to the input value.
d1	A probability-related factor
d2	A probability-related factor

Module 3: Options & Derivatives

BLACK–SCHOLES–MERTON (BSM) MODEL

In the next slide we will see this Model for Apple Stock

For Apple Inc we will use AAPL as ticker

And Put Risk free rate = 5%

Days to expire = 30 days

Fallback volatility (% , used if IV missing) = 20

Where we can see table giving IV (stands for Implied Volatility, which is a measure of the market's expectation of future price fluctuations for an asset), BSM theoretical value (fair or theoretical price of an options contract), Strike (predetermined price at which an option contract holder can buy or sell an underlying asset.)

BLACK–SCHOLES–MERTON (BSM) MODEL

OHLCV + Portfolio

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Option Chain Inputs

Ticker

AAPL

Risk-free rate (annual, %)

5

Days to expiry

30

Fallback volatility (%
used if IV missing)

20

Fetch & Compute

Option Chain + BSM Comparison

Calls

Puts

IV vs Strike

Show 10 entries

Search:

	Strike	Last	Bid	Ask	IV	IV_num	BSM_Theoretical
1	110	160.5	159.4	161.05	4.164067294921875	4.164067294921875	184.5662314338001
2	120	151.1	149.4	151.05	3.785156787109376	3.785156787109376	173.9829207138821
3	125	145.8	144.35	146.1	3.6093759765625	3.6093759765625	168.666114407708
4	140	130.55	129.4	130.85	2.843752890625	2.843752890625	148.3779207267824
5	145	131.95	124.4	126.1	3.011721220703125	3.011721220703125	147.7782529710503
6	150	117.38	119.4	120.85	2.56250359375	2.56250359375	137.524347720903
7	155	116.82	114.4	115.85	2.42969142578125	2.42969142578125	132.0881899446684
8	160	111.77	109.45	111.05	2.576175434570312	2.576175434570312	131.2534257467834
9	165	106.76	104.35	106.1	2.39844150390625	2.39844150390625	124.9794246465557
10	170	101.85	99.45	100.85	2.121098447265624	2.121098447265624	116.8364174386847

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BLACK–SCHOLES–MERTON (BSM) MODEL

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Option Chain + Black-Scholes

Option Chain Inputs

Ticker

AAPL

Risk-free rate (annual, %)

5

Days to expiry

7

Fallback volatility (% , used if IV missing)

20

Fetch & Compute

Option Chain + BSM Comparison

Calls

Puts

IV vs Strike

Show 10 entries

Search:

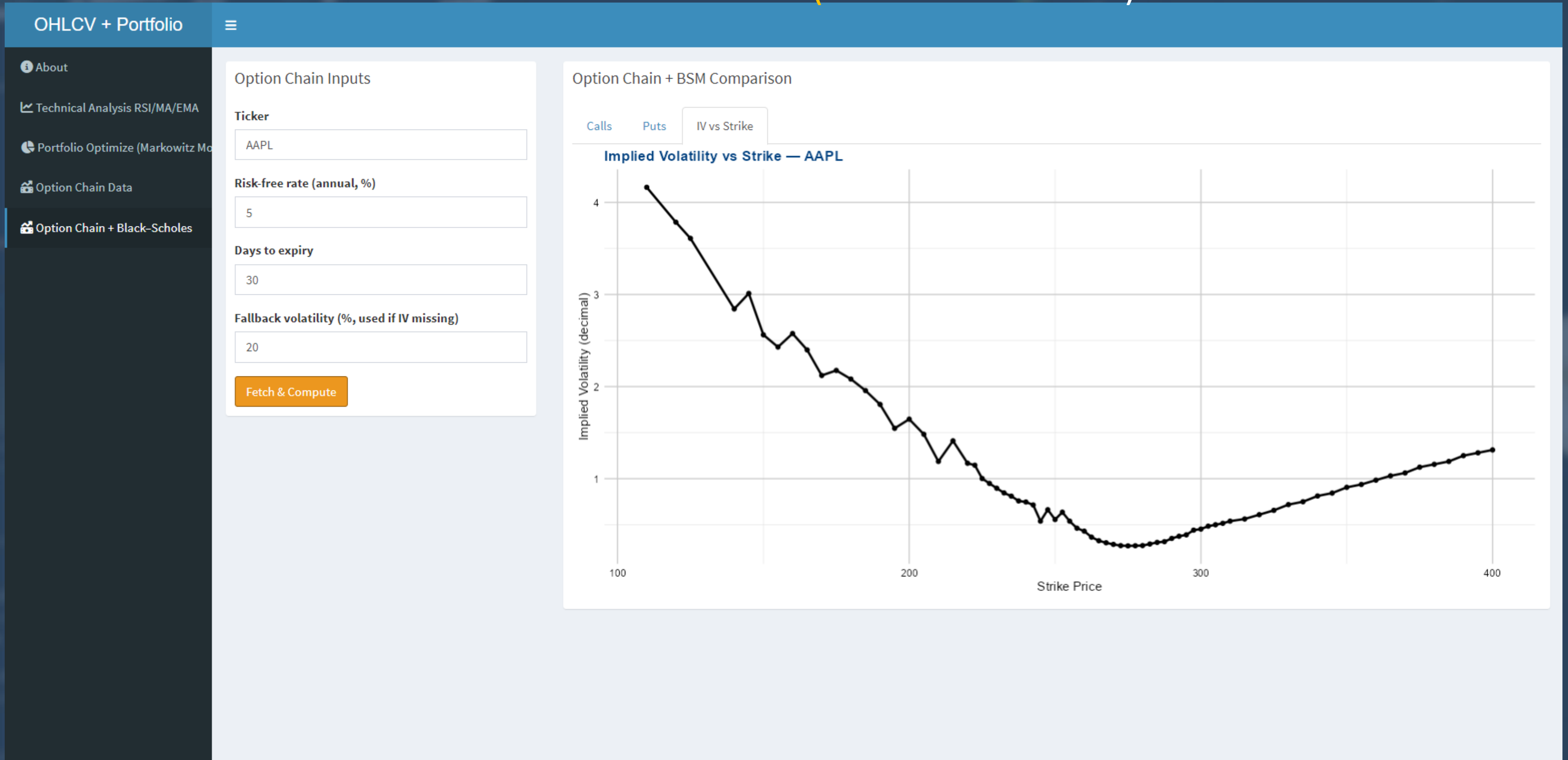
	Strike	Last	Bid	Ask	IV	IV_num	BSM_Theoretical
1	110	0.02	0	0	0.500005	0.500005	5.435025698436306e-39
2	125	0.01	0	0	0.500005	0.500005	3.780596884393618e-29
3	130	0.01	0	0	0.500005	0.500005	2.017160424911666e-26
4	135	0.01	0	0	0.500005	0.500005	6.303949150744775e-24
5	140	0.01	0	0	0.500005	0.500005	1.213126133980124e-21
6	145	0.02	0	0	0.500005	0.500005	1.50227496770609e-19
7	150	0.01	0	0	0.500005	0.500005	1.244684678613315e-17
8	155	0.01	0	0	0.500005	0.500005	7.142629779556671e-16
9	160	0.01	0	0	0.500005	0.500005	2.927789458405034e-14
10	165	0.02	0	0	0.500005	0.500005	8.812356818976308e-13

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Module 3: Options & Derivatives

IV vs Strike Plot (Curvature Skewed)



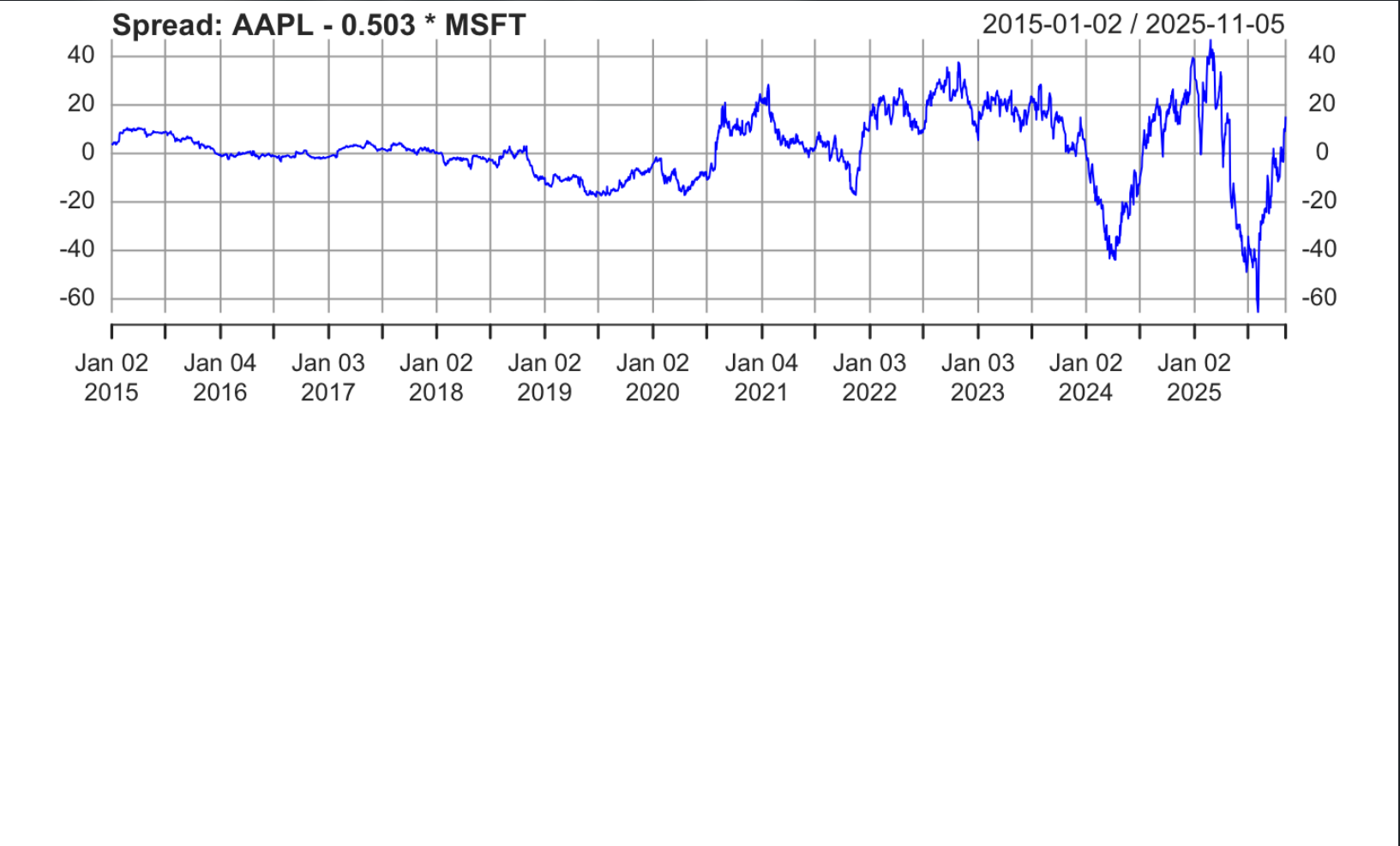
Analysis of Assets (statistics)

EDA analysis and Returns Distribution



AAPL and MSFT are cointegrated.

Pairs Trading between AAPL and MSFT



	Ticker	Mean_Daily_Return	Vol_Annualized	Min	Max	Median	SD
1	AAPL	0.001050767	0.290000	-0.1286471	0.1532885	0.0009883914	0.01826828
2	MSFT	0.001076590	0.269757	-0.1473903	0.1421692	0.0009544620	0.01699310

Correlation: 0.6662675

Hedge Ratio: 0.5026351

Spread Mean: 2.232905

Spread Std Dev: 14.68697

LIMITATIONS

Historical Bias: Past performance does not guarantee future results.

No Costs: Backtests ignore trading commissions, taxes, and slippage

Survivorship Bias: Analysis may not include delisted (failed) companies.

Future Extensions

ML Models: Integrate LSTM or XG Boost for price regime prediction.

User Authentication: Allow users to create and save persistent portfolios.

Real-Time Data: Connect to a websocket for live, streaming quotes.



THANK YOU

HERE THE LINK FOR OUR RSHINY APP:

[Site Link](#)