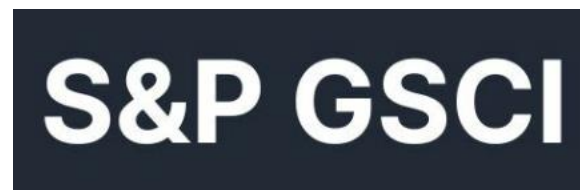
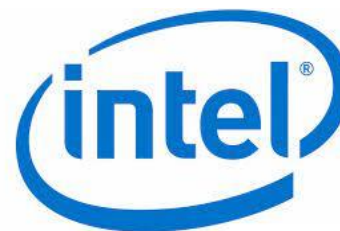


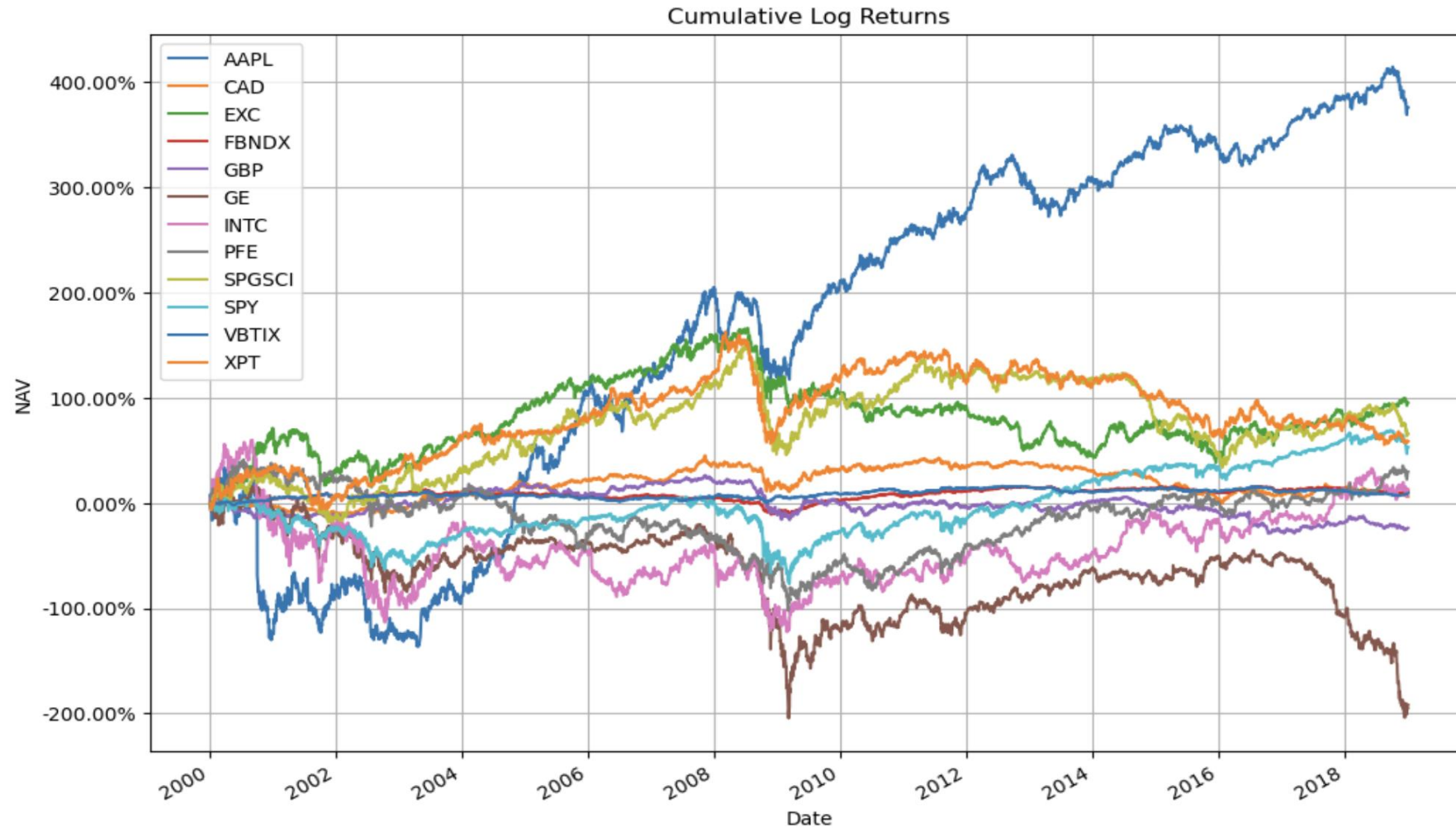
Group 7

Portfolio Analysis and Optimization

- Pruthvi Shaym Billa, Lakshita Garg, Satvik Narang, Kristina Sutliff, Thanmai Reddy Kadire



NAV Plots



Window Selection Analysis

Moving Averages(MA) strategy:

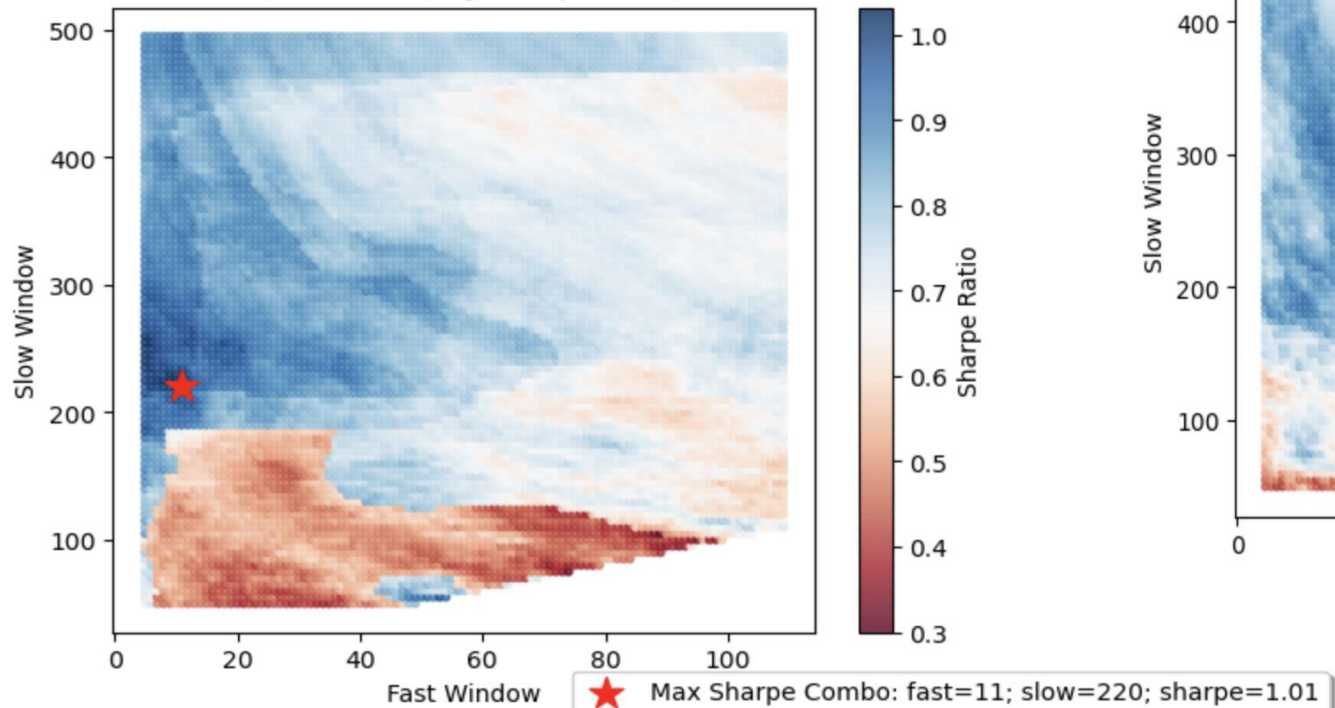
- `fastWindow = range(5, 110)`
- `slowWindow = range(50, 500, 5)`

Bollinger Bands strategy:

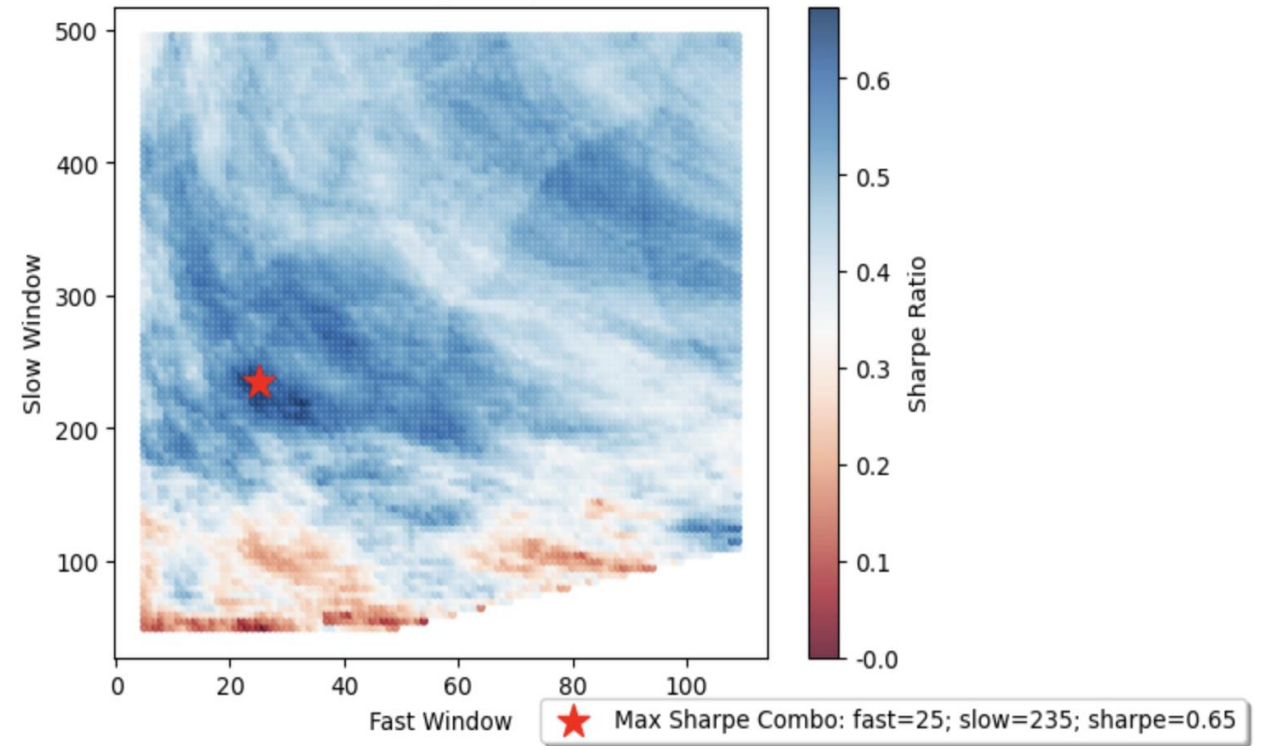
- `lookback_window = range(20, 50)`
- `stdev_band = range(1, 4)`

Moving Average Plots

AAPL MA "Go Flat" Crossover Combinations of (fast Window, slow Window)
Color Coded by Sharpe Ratio



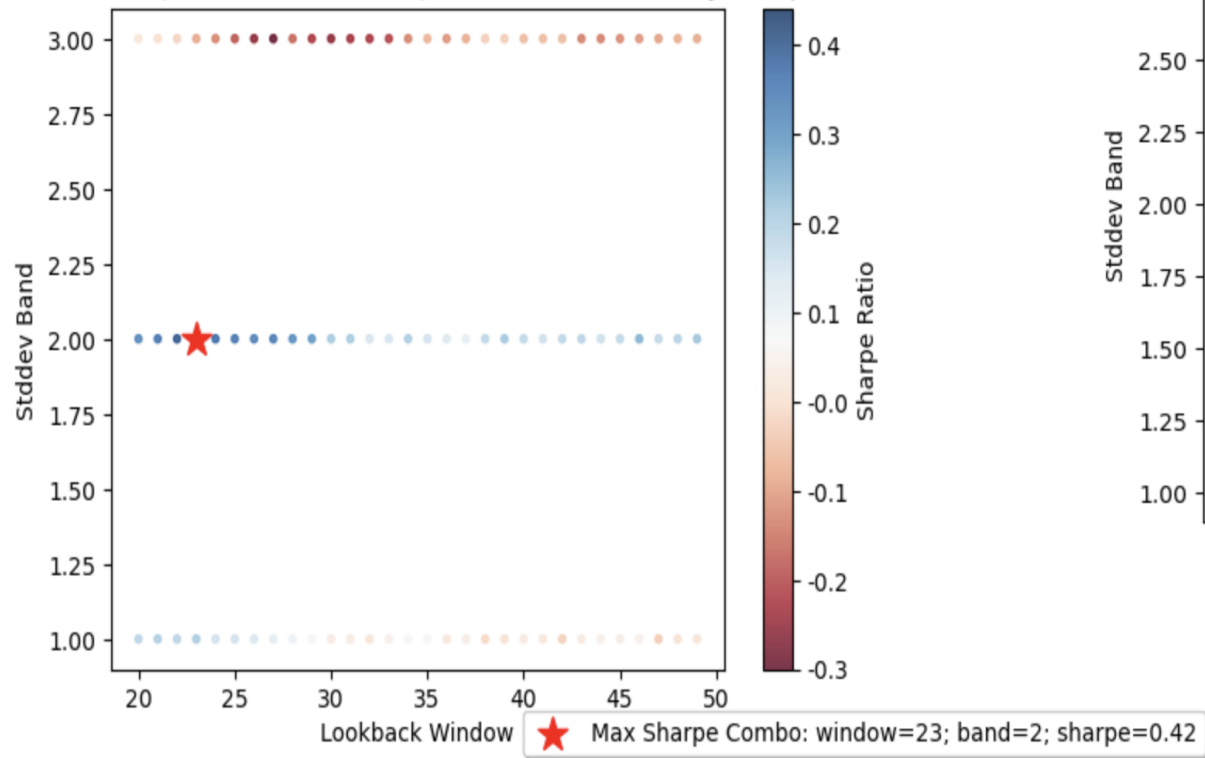
SPY MA "Go Flat" Crossover Combinations of (fast Window, slow Window)
Color Coded by Sharpe Ratio



Bollinger Bands Plots

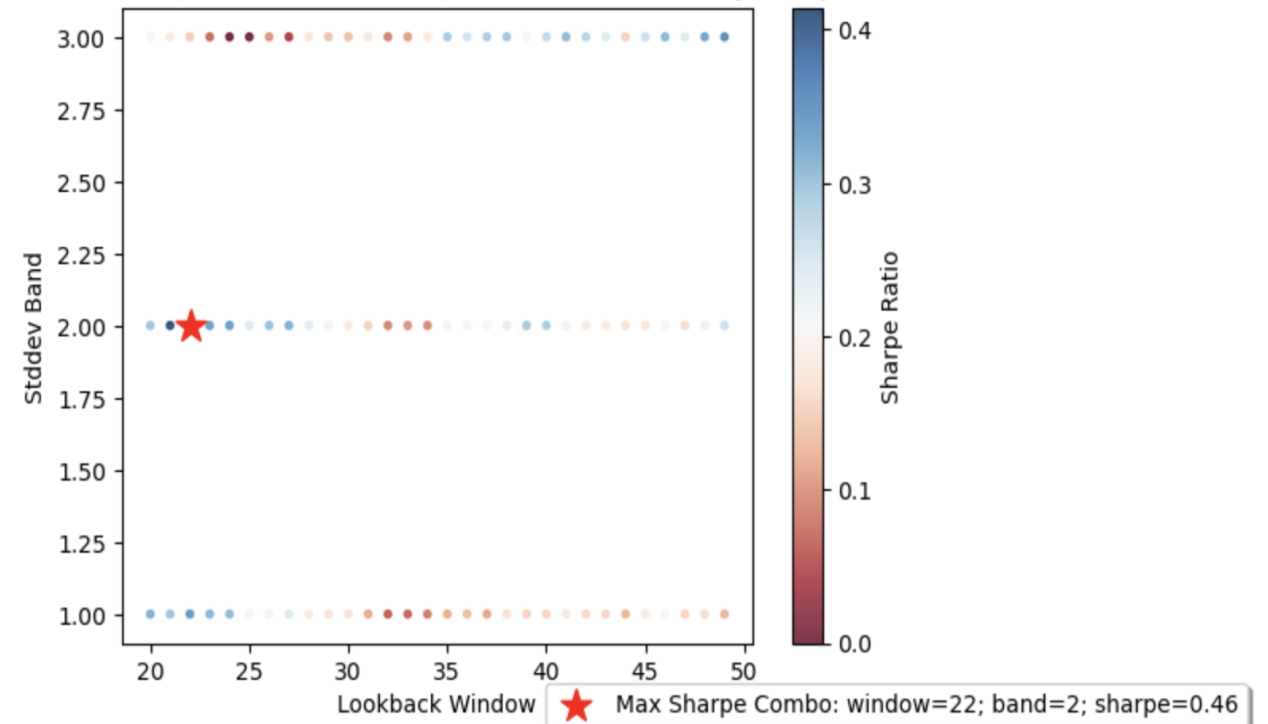
Instrument Name: INTC

Combinations of (window, stdevBand) for BB Color Coded by Sharpe Ratio



Instrument Name: PFE

Combinations of (window, stdevBand) for BB Color Coded by Sharpe Ratio



Chosen Strategies

<u>Sharpe</u>	AAPL	EXC	GE	INTC	PFE	SPY	FBNDX	VBTIX	SPGSCI	XPT	CAD	GBP
Returns	0.47	0.20	-0.33	0.02	0.06	0.15	0.15	0.13	0.15	0.14	0.03	-0.13
MAFlat	<u>1.01</u>	0.41	0.25	0.21	0.21	<u>0.65</u>	0.59	0.30	0.51	0.52	0.41	0.38
MAShort	0.82	0.42	<u>0.59</u>	0.26	0.26	0.57	<u>0.69</u>	0.31	0.61	<u>0.64</u>	0.51	<u>0.56</u>
Bollinger Bands	0.08	0.50	0.15	<u>0.42</u>	<u>0.46</u>	0.42	0.23	0.27	0.16	0.11	0.36	0.16

Window Selection Results

Moving Averages(MA) strategy:

- Equity: (fastWindow, slowWindow) = (11, 220)
- Fixed income/Commodity/Currency: (fastWindow, slowWindow) = (93, 104)

Bollinger Bands strategy:

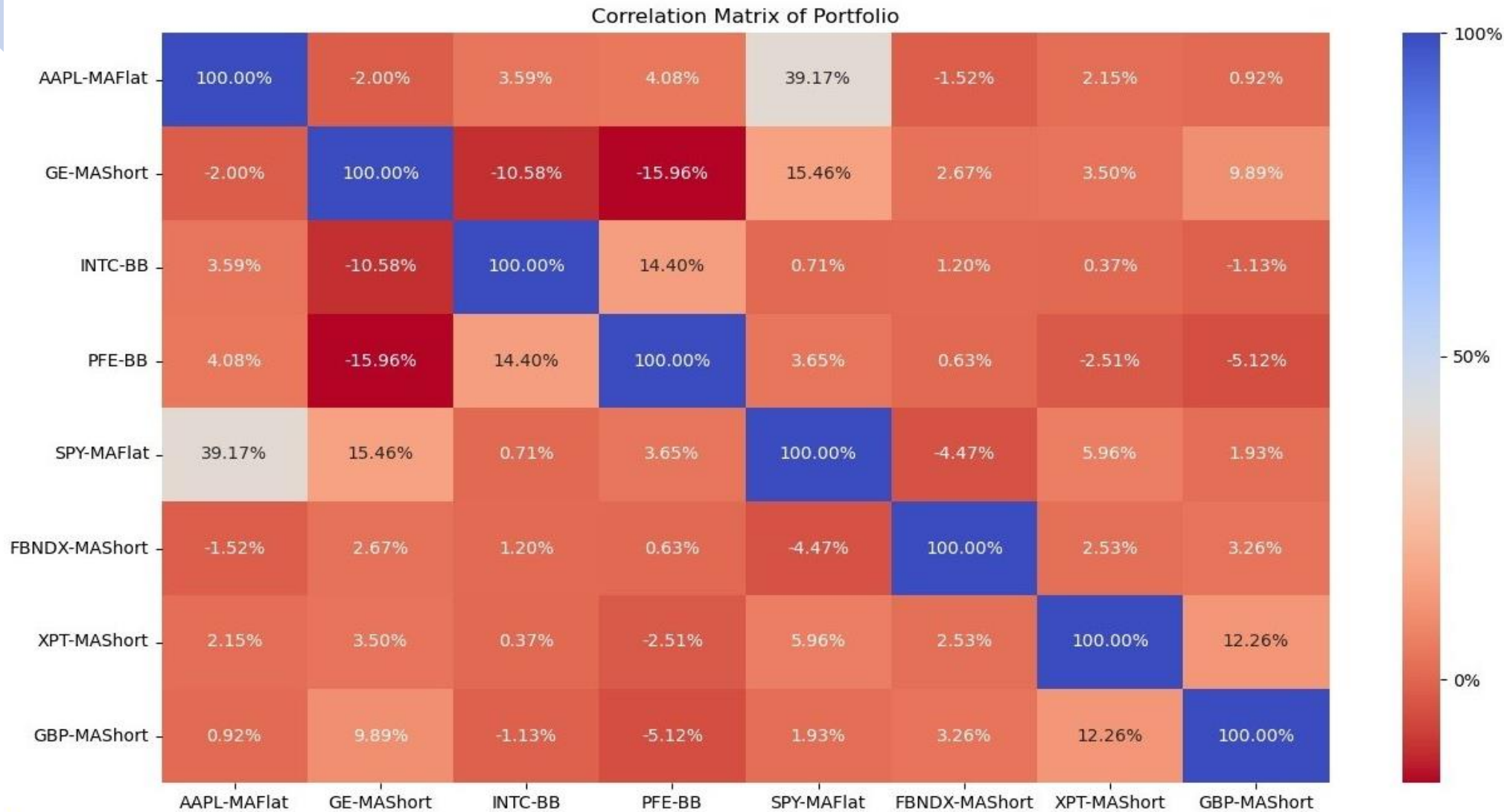
- All instruments: (lookback_window, stdev_band) = (22, 2)

Performance Statistics of Portfolio Strategies

	AAPL-MAFlat	GE-MAShort	INTC-BB	PFE-BB	SPY-MAFlat	FBNDX-MAShort	XPT-MAShort	GBP-MAShort
Average Annual Return	27.81%	12.14%	10.82%	9.06%	5.46%	1.47%	14.30%	4.30%
Annual Risk	27.47%	31.02%	25.95%	18.56%	10.58%	3.80%	22.16%	9.52%
maxDD	-55.13%	-90.44%	-45.33%	-30.51%	-19.50%	-12.36%	-66.89%	-31.53%
Success Ratio	65.92%	51.80%	74.71%	74.19%	69.56%	63.84%	52.63%	51.32%
Sharpe Ratio	1.012515	0.391275	0.416923	0.487879	0.515852	0.387584	0.645098	0.451441

- Inner join of the chosen strategies resulted in portfolio returns of 4560 rows (total rows of original df - largest window)

Correlation Structure



- APPL-MAFlat and SPY-MAFlat are highly correlated with 39.17%.
- GA-MAShort and PFE-BB are negatively correlated.

Equal Weights

Portfolio Return => $R_p = W \cdot R^T$

Portfolio Risk => $\sigma_p = \sqrt{W^T \cdot \Sigma \cdot W}$

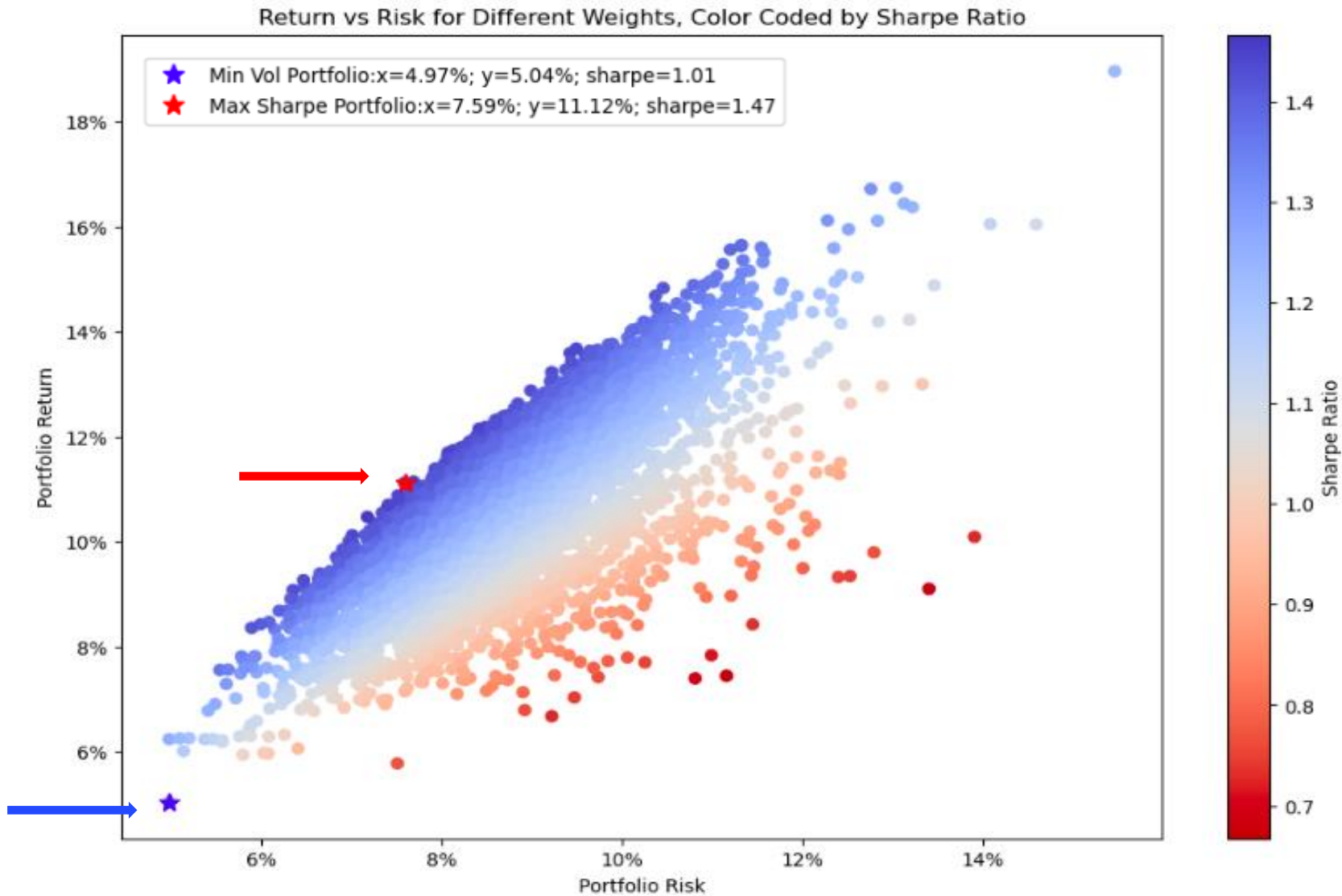
$$\text{Sharpe Ratio} = \frac{\text{Annualized Portfolio Return}}{\text{Annualized Portfolio Risk}}$$

- The annualized sharpe of an equal weighted portfolio is 1.38.

- **Outperformance Insight:**

The equal-weighted portfolio outperforms every individual strategy which indicates that, on a risk-adjusted basis, the portfolio is superior to investing in any single strategy alone.

Return vs Risk for Different Weights



Weight Allocations

	Minimum Volatility Portfolio	Maximum Sharpe Portfolio
AAPL-MAFlat	0.21%	17.14%
GE-MAShort	1.96%	7.62%
INTC-BB	2.14%	6.32%
PFE-BB	2.02%	17.25%
SPY-MAFlat	27.56%	3.78%
FBNDX-MAShort	28.49%	16.81%
XPT-MAShort	7.9%	13.94%
GBP-Short	29.72%	17.11%

Max Sharpe Portfolio VS Individual Strategies

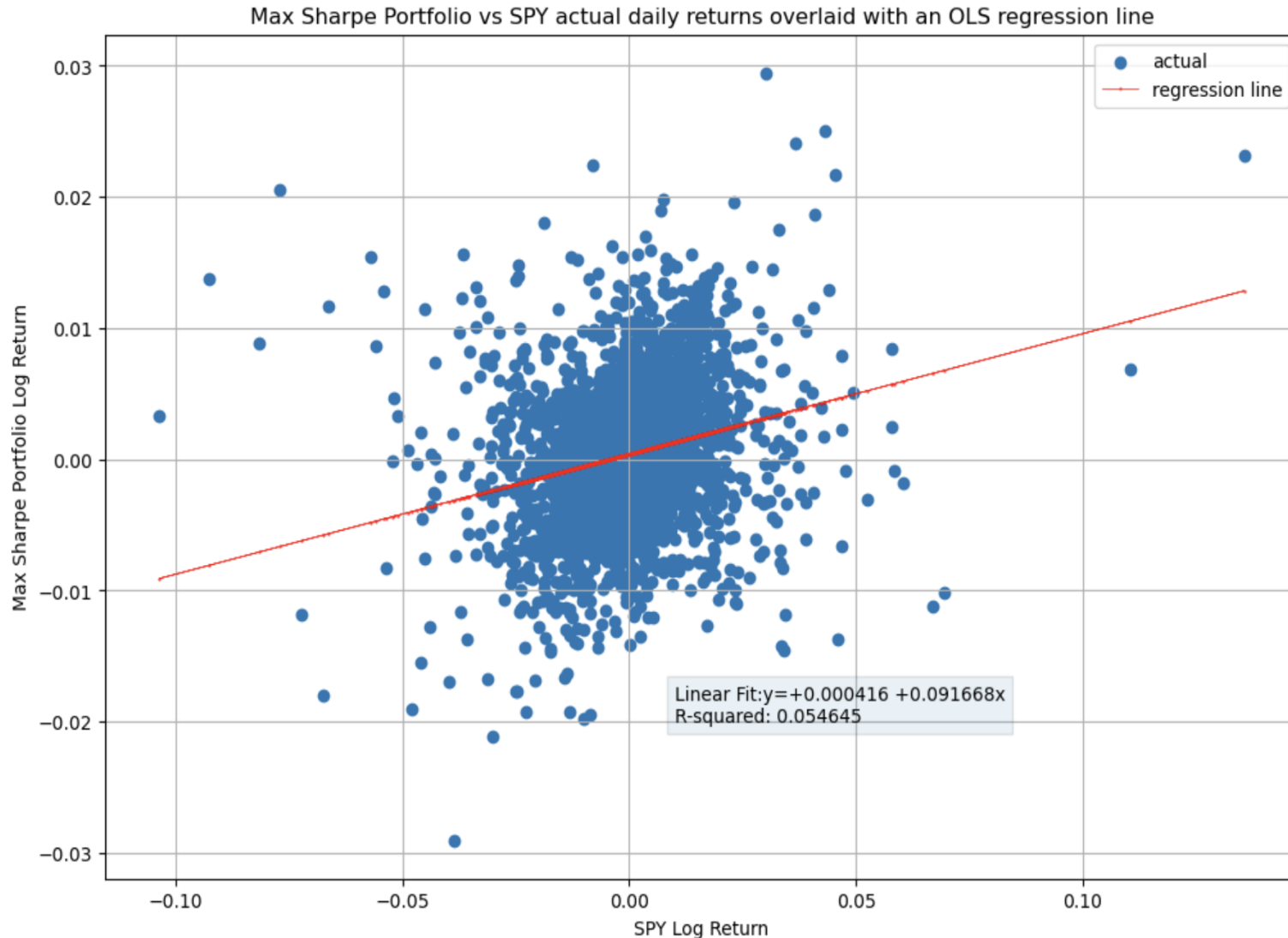
	AAPL-MAFlat	GE-MAShort	INTC-BB	PFE-BB	SPY-MAFlat	FBNDX-MAShort	XPT-MAShort	GBP-MAShort	Max Sharpe Portfolio
Average Annual Return	27.81%	12.14%	10.82%	9.06%	5.46%	1.47%	14.30%	4.30%	11.12%
Annual Risk	27.47%	31.02%	25.95%	18.56%	10.58%	3.80%	22.16%	9.52%	7.59%
maxDD	-55.13%	-90.44%	-45.33%	-30.51%	-19.50%	-12.36%	-66.89%	-31.53%	-8.80%
Success Ratio	65.92%	51.80%	74.71%	74.19%	69.56%	63.84%	52.63%	51.32%	53.97%
Sharpe Ratio	1.012515	0.391275	0.416923	0.487879	0.515852	0.387584	0.645098	0.451441	1.466141

- Sharpe ratio is considerably higher for combined portfolio with different weights as compared to any of the individual portfolios.
- The maximum Sharpe portfolio has lower return compared to some of the individual strategies like AAPL-MAFlat, GE-MAShort and XPT-MAShort BUT the corresponding risk for maximum Sharpe portfolio is significantly lower.
- Adjusting risk for Max Sharpe portfolio by considering AAPL-MAFlat (instrument with highest return):

	AAPL-MAFlat	Max Sharpe Portfolio
Average Annual Return	27.81%	40.25%
Annual Risk	27.47%	27.47%

- Risk and return were adjusted with a factor of $27.47/7.59 = 3.6192$ for Max Sharpe Portfolio
- After equalising risk, Max Sharpe portfolio has a return of **40.25%** as compared to **27.81%** for AAPL-MAFlat

Beta of Max Sharpe Portfolio to the S&P 500



- Beta: 0.091
- Max Sharpe Portfolio and S&P 500 are positively correlated (23.38%) leading to positive beta.

	Max Sharpe Portfolio	SPY
Max Sharpe Portfolio	100.0000%	23.3764%
SPY	23.3764%	100.0000%

- Beta of 0.091 implies that if S&P 500 goes up by 1%, portfolio is expected to go up by 0.091%
- As Beta is less than 1, it also indicates that portfolio is less volatile than S&P 500. It can be seen as a form of diversification that offers some protection during market downturns

Equal Weighted Portfolio

Variations of the equal weighted portfolio containing the 8 instruments:

- Sharpe of an equal-weighted Benchmark portfolio : 0.186
- Sharpe of an equal-weighted MAFlat portfolio : 0.621
- Sharpe of an equal-weighted MAShort portfolio : 0.436
- Sharpe of an equal-weighted BB portfolio : 0.062

None of these 4 portfolios outperform the chosen Max Sharpe Portfolio of **1.47**

The image features a white background with four decorative geometric shapes in the corners. The top-left and bottom-right corners contain overlapping squares in shades of blue and light blue. The top-right and bottom-left corners contain overlapping squares in shades of yellow and light yellow. The text "THANK YOU" is centered in the middle of the image.

THANK YOU