Algorithmic Trading Simulation Performance Report

Group 2

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We firstly want to let numbers tell the whole story and give you a sense of our overall performance. By the end of April 27th, 2023, we have experienced a 17.28% lost in our Interactive Brokers account, with a 1.33% volatility and a -3.67 sharpe ratio. For more ratios that may be helpful, we have a 21.12% maximum drawdown, a -4.14% sortino ratio, and a -0.29% mean return. Tracking error and information ratio are not applicable. We want to explain it more specifically:

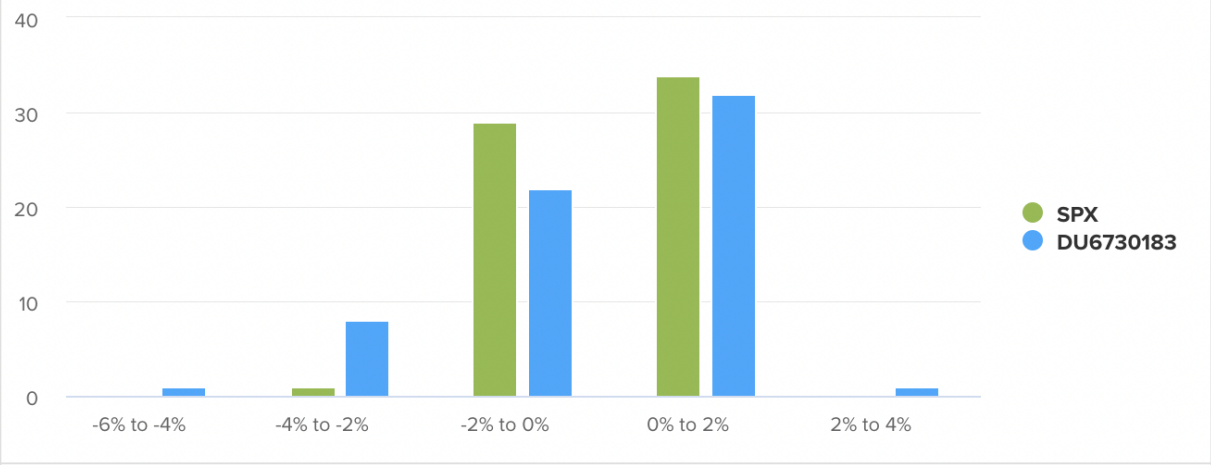
1. The value of our portfolio has decreased by 17.28% from its initial value. It is equivalent by stating that we start with $100,000 and we end up with $827,192.22;
2. The volatility is 1.33% indicates that our portfolio's returns have varied by an average of 1.33% from the mean return during the period;
3. The Sharpe ratio of -3.67 indicates that our portfolio's returns is 3.67 standard deviations below the risk-free rate, which is not desirable. Because it is negative, it also suggests that our portfolio's return is insufficient to compensate for the level of risk it has taken on, which suggests not as good performance as expecting;
4. The maximum drawdown of 21.12% indicates the maximum loss experienced by our portfolio during the period can be up to 21.12%;
5. The sortino ratio of -4.14 indicates the excess return of our portfolio has generated per unit of downside risk, and the negative value suggests that our portfolio has not been successful in generating excess returns;

6. The mean return of -0.29% indicates the average return earned by our portfolio during the period is -0.29%. It suggests that our portfolio has generated an overall loss.

We compare our data with normal S&P 500 index to let the whole story make more sense. For the same time period (2023-01-30 to 2023-04-27), SPX has a -0.36% return with a 7.75% maximum drawdown, a -0.29 sharpe ratio, a -0.4 sortino ratio, and a 0.93% volatility. In addition, the correlation is 0.64, beta is 0.91, and alpha is -0.75. These provide some extra information about SPX that there is a positive linear relationship between SPX and the whole market. In addition, alpha and beta suggest S&P 500 is underperforming with less volatile than the whole market. We call tell that though the real market was not performing super well, our strategy didn't even beat the market. If we invested in the S&P 500 stock index instead of our carefully chosen portfolio, we would loss less. (Does it imply that we'd better just keep money in the bank??) We had a much higher negative sharpe ratio, meaning for the same unit of risk taken, we generated a lower return. The slight bigger volatility suggests that over a given period of time, our portfolio experiences a larger fluctuation in returns. This higher risk statement corresponds with our high loss result. However, if our portfolio would beat the market, the higher risk also implies the higher return. Moreover, the similar or close enough peak to valley/positive period/negative periods mean that we are just a small microcosm of the market, though more risker, and thus more loss. The graph below is a performance report we find using IBKR.

Return & Risk

Benchmarks: SPX Add



	SPX	DU6730183
Return	-0.36%	-17.28%
Risk		
Ending Vami	996.42	827.15
Max Drawdown	7.75%	21.12%
Peak to Valley	02/02/23 - 03/13/23	02/01/23 - 03/23/23
Sharpe Ratio	-0.29	-3.67
Recovery	Ongoing	Ongoing
Sortino Ratio	-0.40	-4.14
Standard Deviation	0.93%	1.33%
Downside Deviation	0.68%	1.18%
Correlation	0.64	-
Beta	0.91	-
Alpha	-0.75	-
Mean Return	0.00%	-0.29%
Positive Periods	35 (54.69%)	33 (51.56%)
Negative Periods	29 (45.31%)	31 (48.44%)
Calmar Ratio	-	-
Tracking Error	-	-
Information Ratio	-	-
Turnover	-	-

We started on January 30th, 2023 and within the first month of trading (by Feburary 27th, 2023), we encountered a 6.14% loss. We were ambitious so that we invested all of our $1,000,000 at the starting point. Back at that time, we followed a simple momentum strategy that we mainly targeted at the S&P 500 index and selected based on the momentum indicator. We firstly downloaded data from Yahoo finance. The rate of change of a security's price over a specified number of period is 12 days and we selected the top ten stocks with the highest momentum and assigned equally weight to them. In addition, we rebalaned our portfolio based on a weekly basis, which implied that our strategy is low-frequency. Picture attached below is our first month performance.

Net Asset Value

	January 26, 2023	February 27, 2023			
	Total	Long	Short	Total	Change
Cash	0.00	97,111.84	0.00	**97,111.84**	97,111.84
Stock	0.00	840,980.25	0.00	**840,980.25**	840,980.25
Interest Accruals	0.00	554.19	0.00	**554.19**	554.19
Total	**0.00**	**938,646.28**	**0.00**	**938,646.28**	**938,646.28**
Time Weighted Rate of Return					**-6.14%**

Change in Combined NAV	Total
Starting Value	0.00
Mark-to-Market	-62,545.52
Deposits & Withdrawals	1,000,000.00
Dividends	514.20
Interest	210.66
Change in Interest Accruals	554.19
Commissions	-87.25
Ending Value	938,646.28

By the end of March 27th, 2023, we experienced a 12.4% loss compared to the starting point, and a 10.04% loss for the second month. The cause behind is that we implemented a new strategy. Since we were panic about other group's more than 10% gain, we switched to a new strategy that we firstly assigned 1 and -1 as labels of positive and negative log returns. We then calculated the eight chosen factors out (BBand, Chaikin A/D Line, Normalized Average True Range, MACD, RSI, Momentum, ROC, Directional Movement) and trained the moel. Finally we calculated the weigh assign to each stock. NATR (normalied average true range) and DI (directional movement index) are two features we paid detailed attention to. Because we wanted to make sure the factors are chosen effectively. For the model training, we used random forest

method basically because this is the only one we tried. We include a second month performance below.

Net Asset Value

	February 24, 2023	March 27, 2023			
	Total	Long	Short	Total	Change
Cash	97,111.84	32,024.75	0.00	32,024.75	-65,087.09
Stock	841,344.65	777,808.16	0.00	777,808.16	-63,536.49
Interest Accruals	554.19	164.04	0.00	164.04	-390.15
Total	939,010.68	809,996.95	0.00	809,996.95	-129,013.73
Time Weighted Rate of Return					-13.74%

Change in Combined NAV	Total
Starting Value	939,010.68
Mark-to-Market	-130,119.43
Dividends	1,408.52
Interest	526.11
Change in Interest Accruals	-390.15
Commissions	-438.78
Ending Value	809,996.95

And then it comes to April 27th, 2023. We faced a total of roughly 17% loss compared to Janrary 27th, which is a bit disappointing. But what is interesting and important is that the performance within last month is positive, a 3.34% increacement. This means that though we didn't do better than other outperformed group, we beat ourselves!!!

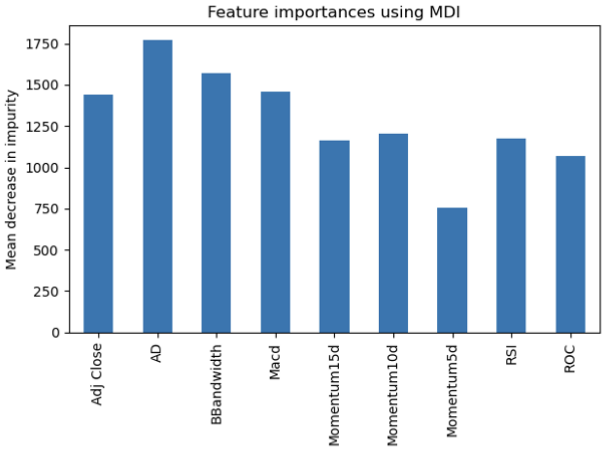
Net Asset Value

	March 24, 2023	April 26, 2023			
	Total	Long	Short	Total	Change
Cash	32,024.75	83,445.92	0.00	83,445.92	51,421.18
Stock	764,856.36	740,097.64	0.00	740,097.64	-24,758.72
Interest Accruals	111.87	50.77	0.00	50.77	-61.10
Total	796,992.98	823,594.33	0.00	823,594.33	26,601.36
Time Weighted Rate of Return					3.34%

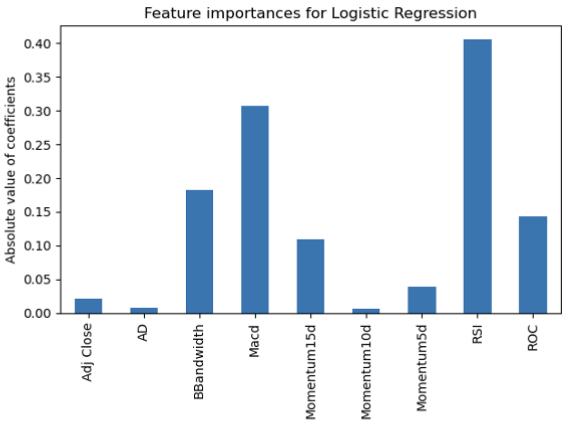
Change in Combined NAV	Total
Starting Value	796,992.98
Mark-to-Market	24,851.41
Dividends	2,447.88
Interest	177.48
Change in Interest Accruals	-61.10
Commissions	-814.31
Ending Value	823,594.33

And what cause this small triumph? A combination of changing features and including more models. We found that the LightGBM method produced with the highest out-of-sample AUC so that we chose it to predict the future trend of the stocks in the S&P 500 constituent stocks. We then selected the top ten stocks with the highest probability of going up after five trading days and allocated weights based on risk. Thus, the importance plot for random forest method using Mean Decrease in Impurity can be plotted. During the tree construction, the RandomForestClassifier computes the decrease in impurity for each feature by calculating the difference in impurity before and after each split at every node. The decrease in impurity is weighted by the number of samples in the node. Once the RandomForestClassifier has been

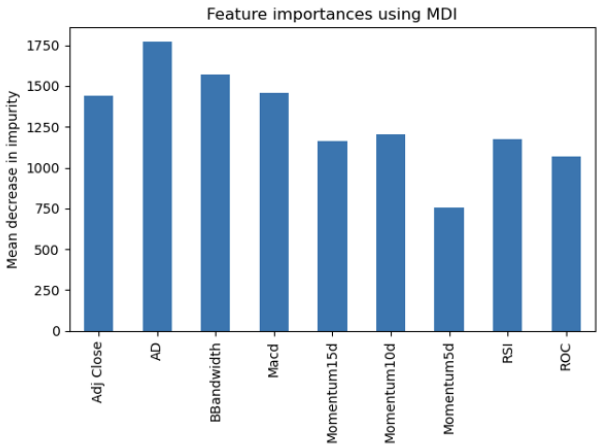
trained, it calculates the average decrease in impurity (MDI) for each feature across all the decision trees in the ensemble. Below are our feature importance and we can tell AD and Bollinger Band Width are the two most important features.



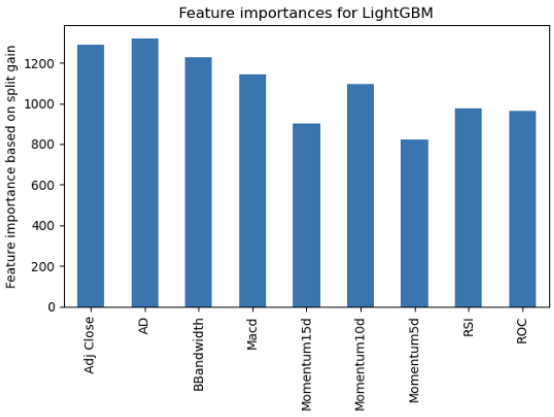
Random Forest



Logistic Regression



Random Forest

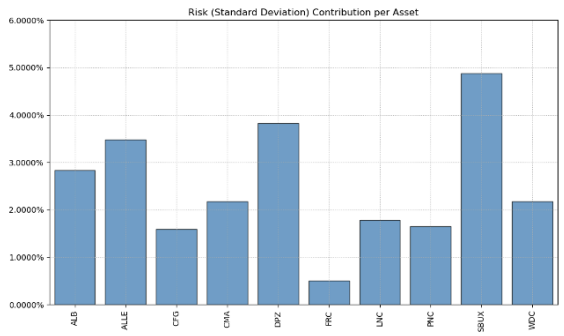


Lightgbm

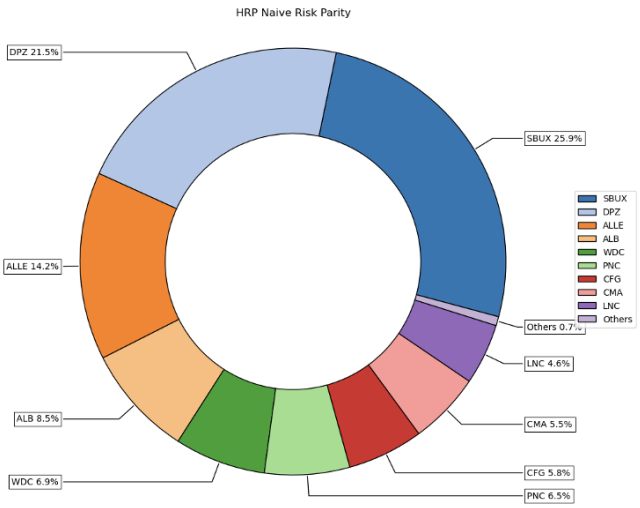
Since we the feature importance based on split gain for lightgbm model, we can observe that the feature importance plot of LightGBM bears a striking resemblance to that of RandomForest, showcasing similarities in their representation of feature significance. Finally, to construct portfolio, our team chose Hierarchical Risk Parity(HRP), which is a portfolio construction

methodology that allocates risk to clusters of assets, rather than individual assets. Since the method is particularly useful in portfolios with high correlations among assets, we use Pearson correlation to measure the strength of the relationship between pairs of variables and Mean Variance (MV) as a measure of risk and Single linkage as a clustering method for constructing portfolios. Below is our results.

Results



Risk Contribution



Portfolio Composition

To put things in a nutshell, though our strategy's overall performance is not super satisfising, we did learn a lot in between and the performance in last ⅓ period actually did improve a bit. From simple momentum strategy to multi-factor strategy with random forest method to LightGBM method with Bollinger Bands width, we are learning and improving. One important takeaway we learn is always don't invest your whole money at the beginning :)