Portfolio optimization and trading strategies

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Introduction

Portfolio could be constructed using various methods and financial instruments. In our work, we concentrate on long/short (**Figure 1**) algorithms and use only equities for the portfolio trading. Two main things are: to define a ranking system for the large number of stocks so to select the most perspective and once we have such selection - to use optimisation algorithm to construct optimal weights for each of those assets. We want to find some insight which describe historical stocks performance and make assumptions about its future.

Factor Investing

The ranking rule is called factor. We can construct factors from company's statements, general economic indicators or any artificially generated features we want (trading mood analysis and etc). Factor can exist as individual feature or combined. The hardest and intelligent problem in the algorithmic trading is to define the right factor. That is, define the principal information which reflects the true causes for changings in companies prices.

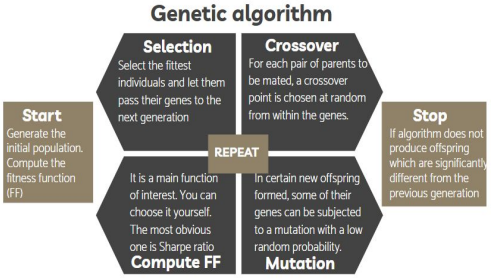
As we have our factor, we rank the stock universe based on that factor into n quantiles, short the first one and long the last.
For now, we understand which stocks should grow in prices and which one should fall. This expectation is a key thing to understand in long/short algorithms. Our factor should be meaningful and point on how the prices will change.

Analyzing factors

The crucial thing is to analyze factors in terms of predictivity power and feature importance. For this purposes, we used alphalens. The first thing to look on Information Coefficient (**Figure 3**). Its mean value show us how much information we can expect for the given forward look period. Now, that we know which factors have some insights, we want to look on how the quantiles perform (**Figure 2**). As we short the first one and long the last, we want the first quantile to give the worst negative returns and the fifth to give the largest positive returns. Ideally, there should not be an intercrossing of all the lines.

Weights Construction (Optimization algorithms)

The next important step is to know which asset allocation to place on the long/short bets. Our portfolio weights that change through time consists of those allocations. This task is a optimization problem where the best weights on each asset increase our profit. There is a place where we can use different types of optimisation algorithms. We tried to use basic optimisation tools that were given and our own algorithms like **Genetic** and **Elastic Asset Allocation (EAA)**.



Fitness function

Thought the widely used Fitness Function is Sharpe ratio it recommended to use VaR - Value at Risk as it is more accurate to measure and control the level of risk exposure with it and VaR does not penalise us for outlier gains.

Elastic Asset Allocation

The EAA combines the below factors into a scoring function to determine each asset's allocation.

Momentum looks for consistent strength in a stock's price movement.
Correlation calculating an index of all positions within the portfolio and then calculating the correlation of each individual position relative to that index.
Volatility common factor to define the risk of a stock or portfolio.
Elasticity geometric weights are known as elasticities because they reflect the relative change in the position size for each asset, when the above factors change.

EAA gave a fantastic results till the 2014 - year when this paper was published. We think it is mainly because of wide usage after that moment. But one very important feature about it that still exists - crisis resistance. We checked it through market falls of 2008 and 2020 and results are better than in S&P. It is a good field for further steps.

Model interpretability

Model interpretability is crucial in finance. Many models including Neural networks give a good predictability here but their output is hardly explainable. The nice thing about long/short strategy that it is totally interpretable. We understand the criteria for stock selection. We can tune them as much as we want, so we control which stocks algorithm is picking.

Results

A lot of our work was concentrated on factors analysis and combining them in one working algorithm. It was pretty successful as we've found working factors (as the one that you can see on graphs). Another part - with weights optimisation algorithms. Here we implemented Genetic algorithm (with combination with good factors it gives close to benchmark results) and EEA which was less successful but fantastically stress resistant.

Figure 1
Returns on five quintiles grouped by looking forward days. We short the first one and long the fifth.

*This and the other figures are examples of how we can analyze factors. Factor here is a combination of EPS, momentum and style score of a stock

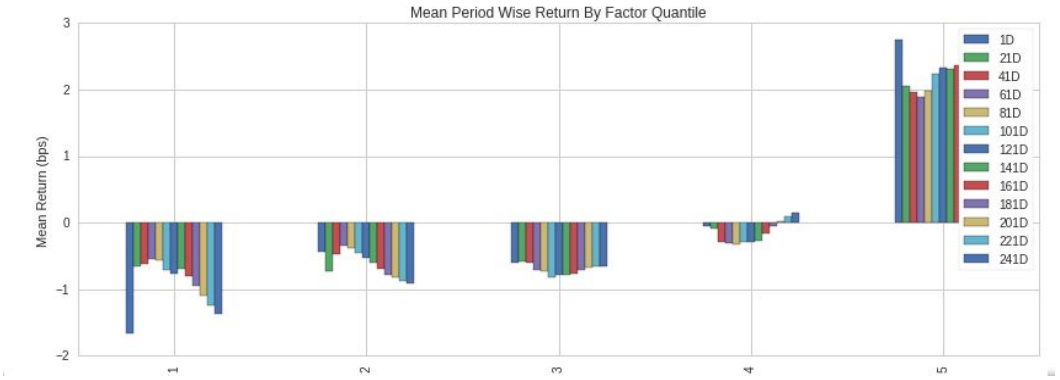


Figure 2
Historical returns on each quantile.

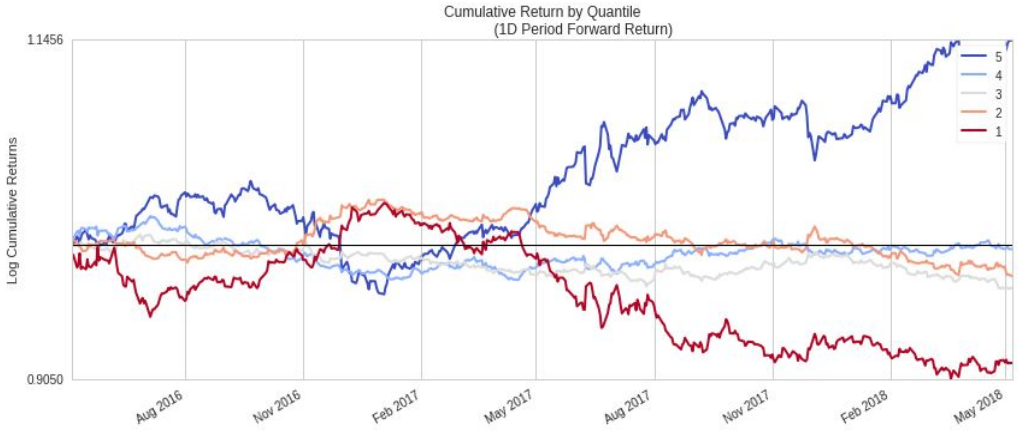


Figure 3
Information Coefficient decay.

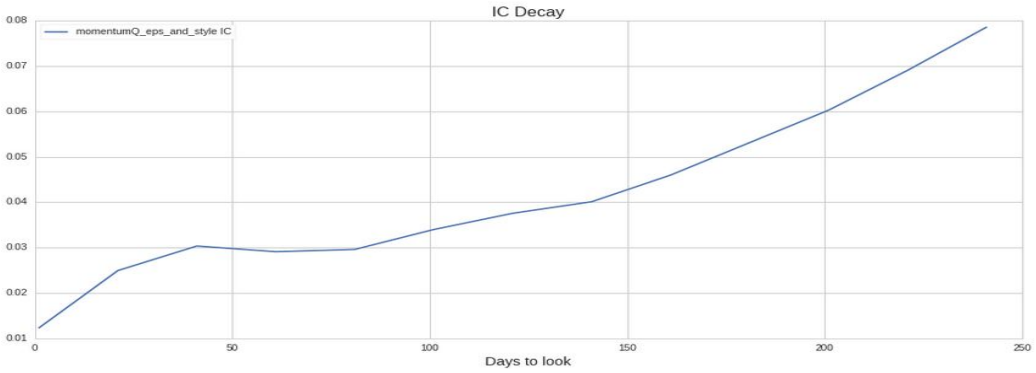


Figure 4
Returns for portfolio that are based on suggested factor