Optimizing Investment Strategies based on Companies Earnings using Genetic Algorithms

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ABSTRACT

This work proposes an investment strategy using Genetic Algorithms applied to the stock market. In order to build a portfolio of promising stocks we look at fundamental analysis by using indicators such as earnings volatility and growth, Price-to-Earnings ratio and Price/Earnings to Growth ratio. Additionally technical indicators such as moving average crossovers and Relative Strength Index are used to adapt the portfolio to the market's trends. The proposed solution was applied to the S&P500 Index during the period from 2006 to 2011. In order to evolve a robust strategy these are evaluated according to the average return on investment, Drawdown and Sharpe ratio. The results obtained are promising with the solution outperforming the market with a considerable lower level of risk.

Categories and Subject Descriptors

I.2.M [Artificial Intelligence]: Miscellaneous

Keywords

Computational Finance, Technical Indicators, Fundamental indicators Evolutionary Computation, Investment Strategies

1. INTRODUCTION

When studying financial markets the main issue is of course predicting price movements, but these are highly noisy systems, being influenced by a myriad of economic and politic factors such as companies' earnings, news or natural disasters. As such they are extremely hard to predict, nonetheless investors widely use market analysis techniques to study and forecast market movements. These methods are technical analysis which studies the price and volume of the assets, using past information to predict the future, and fundamental analysis that deals with various economic and politic factors, looking down from the global economy all the way to the company itself.

Therefore, this work proposes an application of a method from Evolutionary Computation, the Genetic Algorithms, to the stock market, which together with technical and fundamental analysis, can help an investor to decide where and when to invest.

The presented paper is structured as follows: Section 2 describes the architecture of the developed application. Section 3 evaluates the developed system. According to a validation procedure based on various financial metrics the application's performance is discussed. In Section 4 the conclusions are drawn.

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2. ARQUITECTURE SOLUTION

Fundamental analysis focuses on the factors and trends that impact the success of a company, it studies basic financial information to forecast profits, supply and demand, management and competitive ability as well as other intrinsic factors in general to access a stock's value.

One of the key factors studied by fundamental analysis are companies' earnings, this is the most straightforward approach to comparing companies since earnings reflect the company's capacity to generate revenue, its value and positioning are the most important factor for determining the stock's price, as it gives a fair measure of the long term profitability of the company.

The importance of earnings is reflected in works such as [1] that studies the relevance of a set of various financial variables over earnings, [2] supports this and expands on macro-economic and industrial relationships.

Most, of the studied works based on GA were able to beat the benchmarks, typically an index tracker or the Buy and Hold strategy. The use of genetic algorithms using fundamental information has been reported in [3], the use of technical indicators with GA algorithms was reported in [4].

In order to classify the stocks according to earnings four fundamental metrics were implemented. The first two measures are the earnings growth and volatility and as names imply the first measures growth in earnings and the second measure their volatility. With these the application should be able to find stocks that having low volatility and steady growth exhibit similar behavior in its price movements, or stocks that having high growth and volatility values could have above market rises and declines in price. The other two measures are the Price-to-Earnings ratio and Price/Earnings to Growth ratio, these are two popular measures that compare the earnings with the stock's price this way measuring if a stock in over or undervalued.

The proposed solution simulates an investment based on the fundamental and technical rules. The fundamental rules are used for ranking the stocks by their attractiveness/value while the technical rules are used for choosing the right time for buying/selling the stocks chosen by the fundamentals while also choosing the appropriate strategy (short/long) to apply to each stock. Based on these the system manages a stock portfolio over time evaluating the performance of the rules.

For this purpose we start by investing the available capital in equal amounts over a number of stocks. The weekly procedure is started by ranking the available stocks in regard to the fundamental indicators. Each weekly ranking is affected not only

by the most recent scores but by past scores as well, in order to do so, each company's weekly score is an Exponential Moving Average (EMA) of the past scores, and the smoothing factor of the EMA being controlled by the Genetic Algorithm.

3. RESULTS

For the following case study it was used data from 273 stocks, for which there was both price and earnings data without missing records, from the SP500 Index from August of 2006 to August of 2011. From this data 70% is used for training and the remaining 30% for testing as presented below. In order to access the performance of the developed strategies, and to be able to compare it between our various solutions and the results of other works we define the following measures.

Return on Investment (ROI) is perhaps the most important and simple measure for evaluating an investment. This is simply the gain over a specific period.

Drawdown (DD) is a useful measure of risk, it measures the maximum loss incurred over the investment time. It is usually defined as the percent difference between a peak and posterior decline. The drawdown is very important for the investor as it measures how much he may lose during the investment.

Sharpe Ratio (SR) is a popular measure that measures reward against risk, more specifically it measures the excess return against a risk free investment per unit of risk. This ratio calculates the excess gain against a risk free investment and then adjusts it by the strategy's risk, this way the Sharpe Ratio measures if the investor is being appropriately rewarded for the risk he is taking.

3.1 Case Study – Bull/Bear Separation

Based on the classification of the market trend as Bull or Bear, the current experiment computes the performance separately for the Bear and Bull periods in order to guarantee that each individual has a good performance for both trends. The classification is based on an RSI of 8 weeks with some 'noise removal' so that each sub-period lasts longer than one month. The fitness value is computed separately for each, with the final value being the product of the two fitness values (with the sign being logically adjusted). The results are presented in Table 1.

Table 1 – Results for the Overall and Bull/Bear Solutions

		Overall		Bull/Bear	
		Training	Test	Training	Test
ROI	Maximum	20.01%	7.14%	20.69%	15.15%
	Average	15.04%	1.93%	16.16%	5.57%
	Minimum	10.11%	-4.11%	12.46%	0.57%
DD	Maximum	11.47%	20.49%	13.53%	15.99%
	Average	7.54%	15.16%	7.95%	12.60%
	Minimum	4.72%	10.20%	5.59%	9.05%
SR	Maximum	0.514	0.099	0.522	0.344
	Average	0.368	-0.040	0.430	0.068
	Minimum	0.243	-0.281	0.317	-0.074

The solutions for which the performance was measured separately for Bull and Bear phases outperform the overall solution. Since the solutions should exhibit good performances during both ascending and descending markets, solutions which amassed great results during one of the market trend but were bad at the other are filtered as the Bull/Bear solution should filter some over-fitting. This improvement is evident as the results during test for the separated performance solutions (Bull/Bear) are considerably better than those for the overall performance solution. The same applies to drawdown where when testing the solutions evolved via the separated performance model successfully reduce drawdown values to around 14% for most cases against 20% for the Overall performance solutions.

This later model presents notable improvements from the simpler GA but there is still a considerable downgrade in the solutions performance when testing. This can be seen below where the evolution of accumulated ROI is depicted during the training and test periods for the Best and Typical/Average GA (during Test) against the Index B&H.

It is noticeable, as we can see in Figure 1, that the typical GA has a better performance until the market crash but that afterwards the best (during test) GA quickly outperforms the typical GA solution.

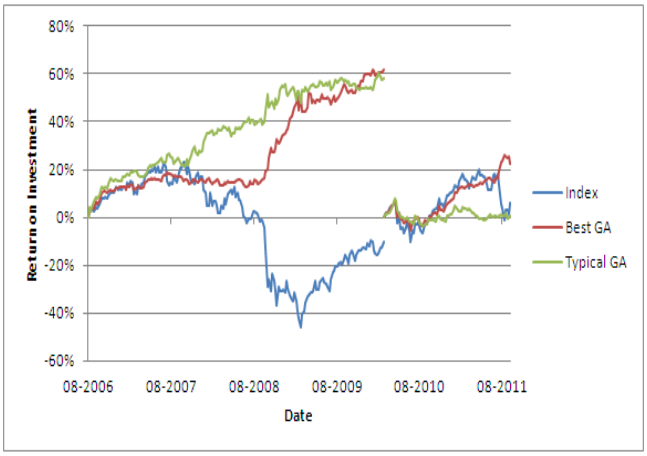

Figure 1 - Results of the Best and Typical Bull/Bear Solutions

4. CONCLUSIONS

This work presented an application of Genetic Algorithms for optimizing investment strategies applied to the stock market. For this purpose the application uses fundamental analysis for finding promising stocks and building a portfolio, and uses technical analysis for managing the portfolio according to price movements. The testing of the case study using training with a Bull and Bear market separation outperform the solution based in a single type of market, creating a more robust implementation.

5. REFERENCES

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