A Mixed Portfolio Theory Model on Genetic Algorithm and Vector Quantization

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1. Abstract

Portfolio theory considers a sequential portfolio selection procedure for investing in some investment media such as stock market, etc. with the goal of best analyzing and predicting the performance of the future market. The performance of a portfolio theory model is directly linked to the portfolio prediction. Applying artificial neural network, genetic algorithm and fuzzy logic for the stock market prediction has attracted much attention recently, which has better correlated the non-quantitative factors with the stock market performance. However these approaches perform less satisfactorily due to the memory less nature of the stock market performance.

In this Synopsis, we propose a data compression-based portfolio prediction model mixed with the fuzzy logic and genetic algorithm. In the model, the quantifiable microeconomic stock data are first optimized through the genetic algorithms to generate the most effective microeconomic data in relation to the stock market performance. The non-quantifiable microeconomic data are modeled with the fuzzification process. Finally, the prediction of the stock market performance with the stock data is de-fuzzified using the fuzzification model to produce a portfolio performance prediction.

Keyword: Defuzzificaion,
Genetic Algorithms, Pattern Matching,

2. Introduction

Portfolio theory considers a sequential portfolio selection procedure for investing in some investment media like stock market with the goal of performing as well as if we know the empirical distribution of future market performance. Traditionally, difference models are applied in the area of portfolio prediction. Two classical views on the prediction, namely, technical and quantitative are available.

Unit Trust is one kind of portfolio that provides investors with the opportunity to participate, according to the pre-determined terms offered by the counterparts. Unit trust as professionally managed portfolios is more often comprised of equities but also other financial instruments including bonds, commodities, currencies and warrants. The trust is divided into units and investors can buy and sell those units. As investors make more contribution to the pool, additional units are issued and the fund manager invests the cash on behalf of the unit holders. The value of each unit reflects the value of the securities in which the fund is invested. Unit trusts are usually valued daily and the prices are quoted in leading newspapers.

The technical view of markets is that the prices are driven by investor sentiment and that the underlying sequence of prices can be captured and predicated well using charting techniques. This method studies the action of the market as a dynamical entity, rather than studying the actual goods in which the market operator. This is a science of recording the historical market data, such as prices of stocks and the volume traded, and attempting to predict the future from the past performance of the function of the underlying security valuation, but also governed by investor sentiment, health of the economy and many others.

The quantitative view of markets is that the measurement on market efficiency. Market efficiency essentially states that the market is priced in such a way that all public information available is already included in the price of stock, and movements on the markets are only due to arrivals of new information. Larger numbers of investors insure that the prices on "-ve" analysis of risky assets such as stocks, based on the expected return. Which under the EMH is the mean expected value, and the risk, under EMH defined as the variance of portfolio. A portfolio is a vector valued time series of stocks and full in statistical model for performing hypothesis.

Applying artificial neural networks, genetic algorithm and fuzzy logic on stock market predication have attracted much attention recently. Artificial neural networks can be regarded, in one respect, as multivariate nonlinear analytical tools, and are known to be good at recognizing patterns from noisy, complex data. And estimating their nonlinear relationships. Many studies have shown that artificial neural networks have the capability to learn the underlying mechanics of the time series,

or, in the case of trading applications, the market dynamics.

Genetic algorithm is an effective algorithm on finding optimal or near optimal solutions to a wide variety of problems. It is an elegant generate-and-test strategy that can identify and exploit regularities in the environment, and converges on solutions that were globally optimal or nearly so. Fuzzy logic has been applied very successfully in many areas where conventional model based approaches are difficult or not cost-effective to implement. However, as system complexity increases, reliable fuzzy rules and membership functions used to describe the system behavior are difficult to determine.

Furthermore, Due to the dynamic nature of economic and financial applications. Rules and membership functions must be adaptive to the changing environment in order to continue useful.

3. Literature Review Today, stock investment has become an important means of individual finance. Apparently, it is significant for investors to estimate the stock price and selected the trading chance accurately in advance, which will bring high return to stockholders. [1]In the past long-term trading process, many technical analysis methods for stock market such as K-line figure and moving average etc. were put forward. Those traditional methods are all based on probability theory and statistical analysis, in which some kinds of distributions are often assumed. As a matter of fact, these assumptions generally are not reasonable and non-realistic. Besides, the traditional analysis methods are more or less lack of discrimination due to the nonstructural and nonlinear characteristics of stock market prediction.

In the recent years, the genetic algorithm (GA) and the neural network system (NNs) have been widely used to solve financial decision-making problems due to their excellent performances in treating non-linear data with self-learning capability. However, both of them more or less suffer from the slow convergence, black-box and occasionally involve in a local optimal solution. On the other hand, fuzzy logic (FL) as a rule-based development in artificial intelligence can not only tolerate imprecise information, but also make a framework of approximate reasoning; this avoids the black-box. The disadvantage of fuzzy logic is the lack of effective learning capability. To overcome these drawbacks mentioned above, we have developed a genetic fuzzy neural network

(GFNN) which is capable of using genetic algorithms to optimize the weights and parameters of fuzzy neural network. Also the new GFNN model has been applied to stock price prediction and the results indicate that the predictive accuracies obtained from GFNN are much higher than the ones obtained from original NN system.

[2] Neural network has very strong learning ability, and has been applied widely in artificial intelligence, pattern recognition, and automatic control and etc. Back propagation (BP) algorithm is currently one of the most widely used and mature neural network models. But due to the gradient search techniques adopted in BP algorithm, there is bound to slow convergence, local minimum and so on. The design of the structure of BP neural network is primarily based on the experience of designers. Experiments are repeated in large sample space to select parameters of the structure. There is no theoretical guidance and their weights are usually determined by the gradient method. Thus, it is often difficult to find the optimal network structure and weights through repetitious experiments. But the genetic algorithm (GA) is an optimal search method based on natural selection and principles of genetics, with the characteristic of parallel computing. It can improve the calculation speed and achieve the global optimization. Therefore, the proposal of genetic algorithms to optimize the BP network weights provides a new way for neural network design and training.

BP algorithm has the characteristic of precise optimization, while the genetic algorithm has a strong global search capability and good performance of global optimization. Therefore GA and BP network are combined. GA is adopted to optimize in training [2]; and when the search rang becomes narrow, the BP network is applied for accurate optimizing.

4. Proposed System

Previous work on portfolio prediction was mainly on technical analysis (charting technique), statistics analysis, and pattern matching and pattern re-occurrence. Some approaches recently developed use Neuro Fuzzy or Neuro Genetic engine. For prediction on memory less natured stock market. They are still not sufficiently powerful.

The market is fair, and always converges towards equilibrium. The price history of the market does not affect the future, and consequently, no investor can consistently outperform the buy-and-hold strategy.

Under the efficiency hypothesis, no predictive technique is expected to consistently outperform the market. There is, however, considerable quantitative evidence that points to market being non-efficient. Statistical technique will be applied on nonlinear market model. The efficient markets hypothesis (EMH) was a fundamental driving force for development of the modem portfolio theory. Modem portfolio theory provides the tool for a quantitative a more realistic approach may include both quantified and non-quantified factors. I proposed mixed vector quantization, fuzzy logic and genetic algorithm-based portfolio theory model, which will accommodate both quantified and non-quantified factors to make a better prediction on the relative growth of a portfolio.

5. Methodology

This new model will employ genetic algorithms to find out the effective polynomial function of the training data and then the effective price growth will be constructed by the effective price. Effective price growth will be divided into training vectors and learnt by vector quantization engine. Vector quantization engine will perform non-memory less analysis on the training vectors and the analysis result will store in codebook. The influence of non-quantified factors against the deviation between the actual growth rates will be fuzzified. The data from stock market is given to system as sample dataset. They will be converted into effective growth vector by genetic algorithms engine and next growth rate will be predicated by vector quantization engine using non-memory less analysis. Adjustment on the predicated growth will be performed by de-fuzzificaion process. The predicted price can be calculated by multiplying last closing price with adjusted predicated growth. The model is depicted in the following block diagram.

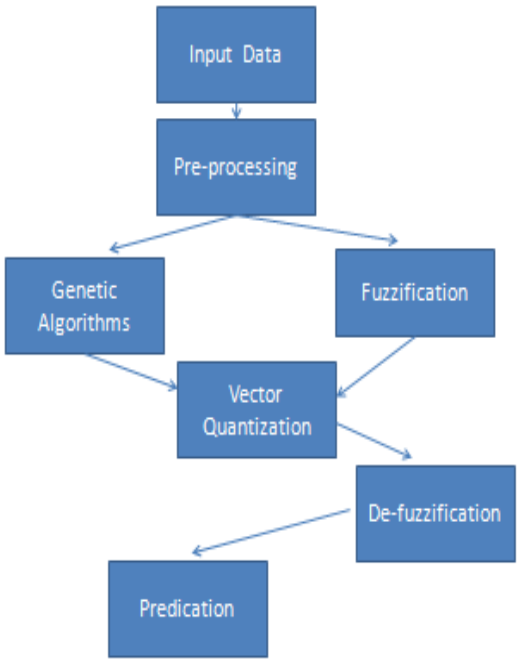

Fig1: The Schematics Description of the Mixed Portfolio Theory Model

5.1 Genetic Algorithms Engine.

The relationship between UT unit price and related indexes can be represented by a polynomial function such that

$$Z = \sum_{i=1}^{n} X_i Y_i \text{ -----1}$$

Z= Closing price of trust

X=coefficient

Y= Closing price of quantitative factors

The objective for the GA engine is to find the effective coefficients so the optimized price *P* can be recalculated based on the following formula

$$P = \sum_{i=1}^{n} X_i Y_i \text{ -----2}$$

The problem is represented by a double data type chromosome with seven genes and the initial chromosome constructed from current portfolio reported by current stock Dataset.

Random mutation is applied for generating new chromosomes. Single point crossover is applied on pairs of chromosomes and the crossover point is random generated. Fitness is measured by average distortion between the actual price and optimized price. The stopping criteria is converging measurement within user specified number of generations. Based on the optimized price, the relative growth rate *R(k)* at time ***k*** can be calculated by the following formula

$$R(k) = \frac{P(k)}{Z(k-1)} \text{------- 3}$$

5.2 Vector Quantization Engine

Second component of the model is the vector quantization engine. Codeword is a double data type vector on dimension 1 X **4,** and Lloyd algorithm exits with a codebook if the percent change in distortion from one pass to the next is less than the threshold. If there are any empty cells, Lloyd will try to split the most populous cells. Lloyd will attempt to split cells up to limited size unless the distortion is zero. If the distortion is zero, then those codewords are retuned. This ensures that the zero distortion codebook is returned to the user, but allows that the program terminates normally.

5.3 Fuzzy Logic Engine.

The defined fuzzy data is the inter-bank interest rate. Inter-bank interest rate can reflect economic in certain extents. if inter-bank interest rate is low it means that there is plenty of cash and promote investment. There exists distortion between actual and predicated JF growth rate. In fact the

deviation is the consequence of the non-quantified factors.

Fuzzy rule can be represented as follow,

IF: Inter –bank momentum is in range X

And Actual JF is in range Y

Then Distortion is within range of Z

6. Conclusion.

With the help of stock market data set, we try to find out best prediction model. This model helps to analysis the growth of a stock price in drastic changing economic environment.

The Results of a GA on Asian Data [11] is as follows.

Days	Model	Right Prediction	Wrong Prediction	Accuracy
136	GA	73	63	53.68%

Table1: Results of a GA on Asian Data set

Days	Model	Right Prediction	Wrong Prediction	Accuracy
10	GA	6	4	60%

Table2: Results of GA on Applied Data set

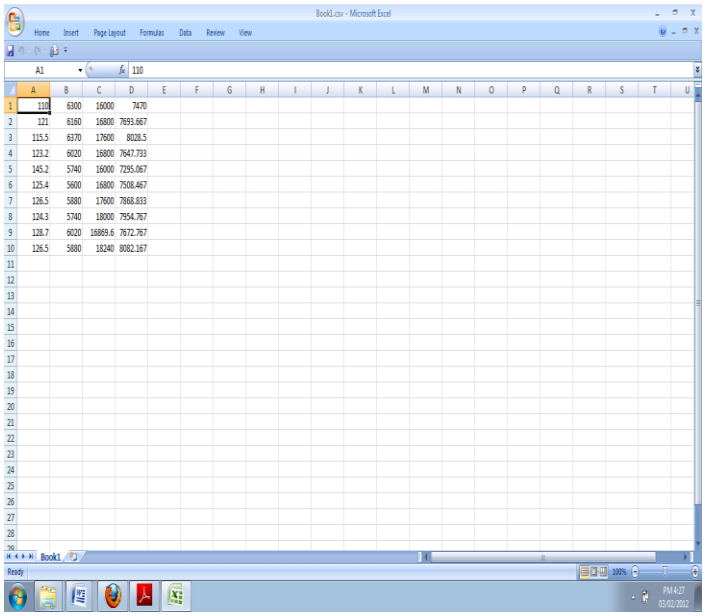

Fig:2 The list of Appled Dataset which is used for GA

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