Genetic Network Programming with Changing Structures for a Novel Stock Selection Model

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ABSTRACT

Stock selection involves the continuous quest for the *margin of safety*, or a favorable difference between the stock price and its intrinsic value. Although this variable might not be quantified with exact precision, it may be approximated through the underlying relationships in financial markets and the real economy.

We propose *Genetic Network Programming with changing structures(GNP-cs)*, a novel evolutionary based algorithm to approximate these relationships through graph networks, and build asset selection models to identify the prospective stocks in the context of changing environments. *GNP-cs* uses functionally distributed systems to monitor the change of the economic environment and execute the strategy for stock selection adaptively. The comparison shows that the proposed scheme outperforms the standard stock selection styles using the stocks listed in the Russell 3000 Index.

This paper suggests that the use of evolutionary computing techniques is an excellent tool to tackle the stock selection problem, whose advantages imply the usefulness to manage the risk and safeguard investments.

Categories and Subject Descriptors

I.6.3 [**Computer Applications**]: Simulation and Modeling - Applications

General Terms

Algorithms

Keywords

genetic network programming, adaptive stock selection, stock markets, risk management, portfolio selection

1. INTRODUCTION

Stock selection, the process concerned with identifying the prospective assets, relies implicitly on approximating the *margin of safety* through the underlying relationships in the financial markets and the real economy. Different from the *portfolio approach*, the stock selection guides toward the most profitable businesses for a given period of time.

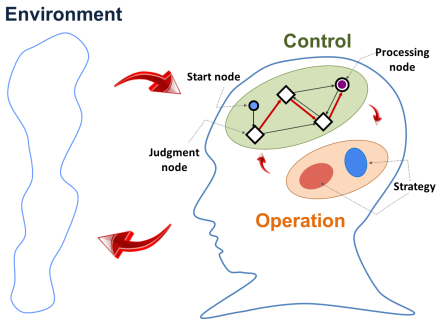

Figure 1: Basic idea of *GNP-cs* model

We propose an evolutionary approach, *Genetic Network Programming with Changing Structures(GNP-cs)*, for the adaptable stock selection. The unique point of GNP-cs is the use of a guiding mechanism to self-change the strategy for stock selection depending on the fluctuations in the market environment. The basic idea of this mechanism comes from biologically adaptable systems that incorporate control functions in their organizational structure to guide the self-adaptation ability in changing environments as Fig. 1 shows.

The distinguishing features of *GNP-cs* from other evolutionary based stock selection schemes are the following points:

- *GNP-cs* incorporates an evolutionary based control mechanism, which not only enlarges the search space over the economic factors that determine the *margin of safety* of stocks, but also enhances the adaptability to external changes in the economy.
- *GNP-cs* uses functionally distributed networks consisting of *judgment* and *processing* nodes connected through directed graphs. This feature enables the effective modeling of useful rules for *decision making* guidance.
- *GNP-cs* covers flexible solutions over longer periods of time. Instead of using heuristics or statistical based techniques, we deal with a compact network structure to guide the current sock selection strategies depending on the changes of the economic environment.

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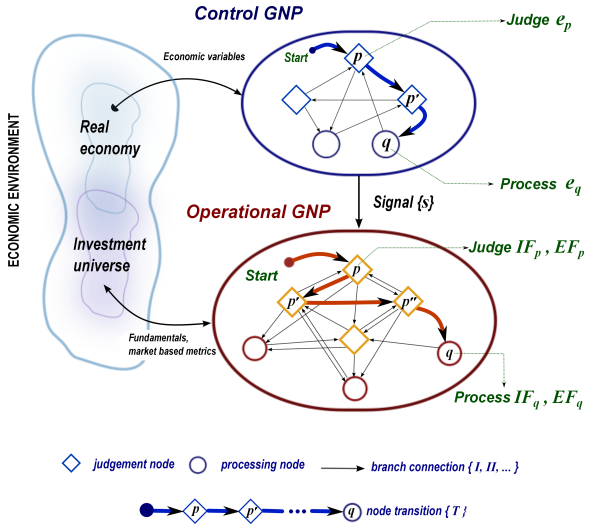

Figure 2: Basic architecture of *GNP-cs* model

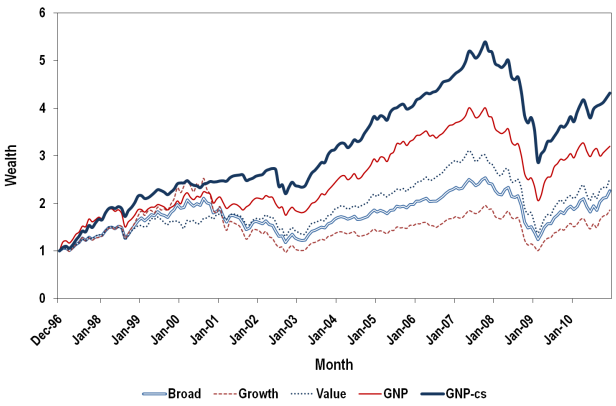

Figure 3: Wealth during the testing period

2. GENETIC NETWORK PROGRAMMING WITH CHANGING STRUCTURES

2.1 Basic Architecture

GNP-cs is essentially an evolutionary computing algorithm with self adaptive properties that handles the modeling and optimization of *decision making* systems through evolvable networks in changing environments. GNP-cs uses *control* and *operational* functions in a collaborative manner to enhance the self-adaptive of a model, as shown in Fig. 2.

- The *control* function(*Control GNP*) monitors the changes in the environments through the economic variables e_p, embedded in the *judgment* nodes p and *processing* nodes q, to issue the signal s of the perceived future economic episode, i.e., $s = \{Ex, Co\}$, where $\{Ex\}$ refers to *Economic Expansion* and $\{Co\}$ refers to *Economic Contraction*. This system answers the question of what is happening outside in the environment.

- The operational function(*Operational GNP*) uses the signal s, *fundamentals* and *market oriented* variables to build and execute *strategies* for stock selection. The output of this system is a set S of the prospective stocks. This system answers the question of what action to take given the current state and recent changes in the environment.

The optimization of the GNP-cs system uses the *training* - *testing* mechanism under evolutionary computing with collaborative principles, where the quality of both signal s and evolved *strategies* determines the fitness.

2.2 Simulations results

To evaluate the effectiveness of the proposed method, experiments from 1995 to 2010 to identify the set of prospective investable stocks S out of market index M are carried out. Each experiment consists of two-year *training*, for optimal GNP-cs model building, and one-year *testing*, for GNP-cs model validation. For example, the first experiment to build an optimal stock selection model based on GNP-cs consists of a *training* phase between Jan-1995 and Dec-1996; and a *testing* phase between Jan-1997 and Dec-1997. The resulting set S is hypothetically invested using a simple trading strategy, i.e. buy and hold with updates over 1 month. All subsequent experiments' *training* and *testing* are lagged by one year through the sliding time windows to consider recent arrived data and avoid overfitting issues. In our study, the investment universe M is the set of common stocks in the Russell 3000 Index, representing approximately 98% of the investable U.S. security market.

Fig. 3 shows the accumulated wealth over all the experiments' *testing* periods, i.e., 168 months between Jan-1997 and Dec-2010. The initial wealth is represented by the totality of the initial funds(100%) in Dec-1996; and subsequent monthly returns in the form of gains or losses are accumulated.

- Both standard GNP[1] and GNP-cs significantly outperform the *Value* based approach because the optimal combination of factors, whether *intrinsic* or *extrinsic*, is decided by evolved networks, implying a more robust scheme to build exhaustive risk pricing mechanisms for stock selection.

- GNP-cs significantly outperforms the selected benchmarks during long periods of time in the *testing* period, mainly due to its enhanced adaptability. Tracking changes in the economic cycles by the *Control GNP* and guiding systematically the strategies for stock selection in the *Operational GNP* implies an enhanced risk management ability, since the changing factors concerned with the real economy are reflected not only in the state of financial markets but also in the investors's return performance as shown in Fig. 3.

3. REFERENCES

[1] V. Parque, S. Mabu and K. Hirasawa, "Asset Selection in Global Financial Markets using Genetic Network Programming", In Proc. of the 2010 IEEE International Conference on Systems, Man, and Cybernetics, pp. 677-683, 2010.