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# A genetic network programming model for portfolio optimization by generating risk-adjusted trading rules

Akbar Esfahanipour
Assistant Professor, Department of Industrial Engineering and Management Systems, Amirkabir University of Technology,
Tehran, Iran
esfahaa@aut.ac.ir

Maryam Tayari
Master of Science in Industrial Engineering, Garmsar Branch, Amirkabir University of Technology,
Tehran, Iran
m-tayari@aut.ac.ir

***Abstract*— Genetic network programming (GNP) as an evolutionary computation method has been used for stock trading recently. Former researches confirm the efficiency of trading rules which are created by GNP. In this paper, GNP has been applied for stock portfolio optimization by generating risk-adjusted trading rules. There are two main novelties in this paper: 1) we use conditional Sharp ratio as a risk-adjusted measure for generating trading rules, 2) in our GNP model, binary trading rules have been extended to more realistic rules which are called trinary rules using three signals of buy, sell and no trade. We applied our GNP model on ten stocks from Tehran Stock Exchange (TSE). The numerical results show that our proposed model with three signals outperformed the previous model with two signals of buy and sell in terms of excess return and excess risk adjusted return.**

***Keywords: genetic network programming; portfolio optimization; technical trading rules; risk-adjusted measures; Tehran Stock Exchange (TSE)***

## I. INTRODUCTION

Evolutionary Computation is well-known for producing the solutions in optimization problems. Genetic Network Programming (GNP) is an extended method of Genetic Algorithm (GA) and Genetic Programming (GP). It has been clarified that GNP is an effective method mainly for dynamic problems since GNP represents its solutions using graph structures. Compact structures and implicit memory functions are some of inherent characteristics of GNP's graph structure that contribute to creating effective action rules [1].

In this paper, we intend to describe a model of stock portfolio optimization which has two important novelties relative to the previous studies. First, using risk adjusted measure as a fitness function, second, using three signals in generating trading rules instead of forcing model to use only two signals.

The foundation of portfolio optimization was laid by Markowitz in 1959, where he proposed a mean-variance optimization model. He states that investors should decide the allocation of their investment on the basis of a trade-off between risk and expected returns [2].Although there are many nonlinear constraints in the real-world problems, evolutionary computation methods were developed to solve these kinds of problems.

Genetic algorithm (GA) is a heuristic search method inspired by nature which has been applied to financial problems. GA as the most popular heuristic optimization techniques was developed by Holland in 1975 [3]. Lin et al. solved the model of portfolio selection problem through taking into consideration the multi-objective genetic algorithm [4]. Oh et al. proposed a new portfolio selection algorithm based on portfolio beta using GA [5]. Xia Lau Yang applied GA method with a dynamic portfolio optimization system to improve the efficiency of the stock portfolio [6]. Chang et al. introduced a heuristic approach to portfolio optimization problems in different risk measures using GA [7].

Genetic programming (GP) has been developed by Koza in 1992 for the first time as an extension of GA [8]. The main difference between GP and GA is the representation of the solutions. In GP, the population members are not fixed length character strings that encode possible solutions to the problem at hand, they are programs that, when executed, are the candidate solutions to the problem. These programs are expressed in genetic programming as parse trees rather than as lines of code [9]. Although GP is widely used in the financial field, it occasionally causes some bloating problems for its tree structure. GP has been applied for stock trading model by