Chapter 7
The Genetic Algorithm: An Application on Portfolio Optimization

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ABSTRACT

The portfolio optimization is an important research field of the financial sciences. In portfolio optimization problems, it is aimed to create portfolios by giving the best return at a certain risk level from the asset pool or by selecting assets that give the lowest risk at a certain level of return. The diversity of the portfolio gives opportunity to increase the return by minimizing the risk. As a powerful alternative to the mathematical models, heuristics is used widely to solve the portfolio optimization problems. The genetic algorithm (GA) is a technique that is inspired by the biological evolution. While this book considers the heuristics methods for the portfolio optimization problems, this chapter will give the implementing steps of the GA clearly and apply this method to a portfolio optimization problem in a basic example.

INTRODUCTION

Portfolio optimization has been one of the most studied subjects by practitioners and researchers in the last decades. Portfolio optimization is intended to ensure to gain maximum return with minimum risk. There are various methods used to establish the optimum portfolio. In some cases, it is difficult to use the mathematical models, because of the long calculation time and its constraints in the parameters. Therefore,
researchers and practitioners have used heuristic techniques that do not involve the problems of these methods. With the implementation of heuristic methods in the field of finance, the solution of complex models has been facilitated as time and cost. It also expedites the understanding of these processes through the use of heuristic methods in the modeling and control of dynamic financial systems.

Optimization is defined as maximizing the desired factors, minimizing the undesirable factors, under the given restrictions to find the solution that is most cost-effective or exhibits the highest performance. In a sense, optimization is the process of doing something better. The complexity of the optimization problems causes some difficulties in solving by deterministic methods. Therefore, heuristics algorithms, which are the optimization algorithms based on natural events, were developed to solve them. The simplicity of these algorithms, give opportunity to researchers for implementing easily this algorithm in all area of science. Portfolio optimization problem, under certain expectations and constraints, is the search for a solution for selecting the most suitable alternative among all financial stocks. The aim of the portfolio optimization problems is to comprise portfolios by giving the best return at a certain risk level from the stock pool or by selecting stocks that give the lowest risk at a certain level of return Yeo et al. (2002). Solving portfolio optimization problems in modern finance is one of the important areas of study. This chapter focuses on one of the heuristic optimization techniques that proceeds from the genetic evaluation: The Genetic Algorithm (GA). The GA is an algorithm that is inspired by the biological evolution. It is developed by simulating the natural generation stages such as selection and mutation in biological evolution. It has come into prominence within heuristics with the simplicity in adapting to various kinds of problems. It is considered as one of the most important heuristic algorithms. The aim of this chapter is to explain the application of GA for generating the optimum portfolio for the selected stocks. For this purpose, basic components and the application steps of the Genetic Algorithm are explained and related literature is searched. For GA’s portfolio optimization application, the 6 shares traded in Borsa Istanbul are discussed. The daily price movements for the years between 2015 and 2018 are considered for the dataset. Their returns were calculated by the logarithmic function. These returns are used in order to achieve the optimum risk by using GA and Nonlinear Programming. The results showed that the GA method generally yielded near-optimum results.

**EVOLUTIONARY ALGORITHMS**

Evolutionary Algorithms (EAs) are the metaheuristics algorithms that are based on population (Vejandla, 2009). The algorithms use processes from the biological
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