Artificial Intelligence in Portfolio Optimization: When Genetics Meets Finance

Master's Thesis

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September 13, 2019

Abstract

Genetic algorithms are a form of Artificial Intelligence (AI) and, in particular, machine-based learning techniques, which have their roots in Genetics. They belong to the family of Evolutionary Algorithms and have been developed by Holland (1975).
The peculiarity of GA is the capability of solving complex optimization problems using a human-based approach, to *"learning from history"*.
An important area of application of GA is finance and economics and, in particular, with regard to portfolio optimization.
The application of GA in portfolio optimization is the topic on which this thesis will focus.
The objective is to compare and investigate the portfolio selection with a heuristic human-based optimization approach such as GA and with an optimization approach based on mathematics, such as the Markowitz model, in terms of maximizing the Sharpe Ratio and portfolio performances.
The study will be conducted on a daily price observation database for 12 investment funds that have traded securities, bonds, and commodities over a period of 9 years.
The problem of optimization is the maximization of the Sharpe Ratio under the condition of long position only: for the GA approach, the optimization problem will be designed in the fitness function, while for the Markowitz problem, the optimization will focus on the allocation of the tangency portfolio, which represents the efficient combination with the highest Sharpe ratio.
The sample will consist of 96 monthly of Sharpe Ratio observations for each optimization method, and the difference between them will be tested.
The question investigated in the experiment is whether an allocation made through a GA optimization approach could lead to a higher Sharpe ratio than a tangency portfolio allocation of Markowitz optimization under the same conditions.
A second aspect is a comparison with regard to the portfolio performance for the two allocation approaches under a buy-and-hold strategy.
As a result, the hypothesis that the GA approach could lead to a higher Sharpe Ratio cannot be rejected, and portfolios appear to perform better under a human-designed approach.
The thesis also includes an illustration of models, developed by academics, that use GA for multi-objective optimization and to overcome the perfect market hypothesis in the Markowitz model, adapting it to real markets with the presence of transaction costs and cardinality constraint.