This report outlines the tasks completed as an integral component of the coursework for the Optimization Methods in Finance (MA60269) course project.

by

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Paper Details

A Heuristic Crossover for Portfolio Selection

By

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[(PDF) A heuristic crossover for portfolio selection (researchgate.net)]

Dataset

The dataset was created by extracting information from the National Stock Exchange (NSE) website, incorporating data from 49 companies as of August 25, 2023. It includes the opening prices for each asset within the index, spanning the timeframe from August 26, 2022, to August 25, 2023.

Overview of paper

The paper explores the application of Genetic Algorithm (GA) in optimizing the selection of an optimal portfolio of stocks from the Ghana Stock Exchange. Three crossover techniques—Arithmetic, Heuristic, and Uniform—are evaluated using an objective fitness function (Sharpe ratio) . The study concludes that Heuristic crossover outperforms the others, providing the best combination of weights, return, and risk. Investors seeking maximum returns with lower risk are advised to use Heuristic crossover, as it demonstrated superior performance in portfolio allocation. The paper contributes valuable insights into the application of GA and crossover techniques for portfolio optimization with real-world constraints.

Methodology

• Generate an initial population of chromosomes randomly. Each chromosome represents a potential solution or portfolio allocation.

• Evaluate the fitness of each individual in the population based on a predefined objective function (Sharpe Ratio). The fitness function assesses how well each portfolio performs in terms of specified criteria.

• Stochastically select multiple individuals from the current population based on their fitness. Individuals with higher fitness are more likely to be selected, simulating a natural selection process.

• Apply crossover (recombination) to create a new population. This involves combining genetic information from selected individuals to produce offspring. The paper considers three crossover techniques: Arithmetic, Heuristic, and Uniform.

• Introduce mutation to the new population. Mutation involves making small random changes to the genetic information of certain individuals. This helps introduce diversity into the population.

• Utilize the new population in the next iteration of the algorithm. Repeat steps 2-5 for a predetermined number of iterations or until a stopping criteria is met. The algorithm terminates when either a maximum number of generations is achieved or when an acceptable fitness level is reached for the population. This ensures that the algorithm converges to a solution or stops after a predefined number of iterations.

Analysis and Results

I successfully implemented the code, adhering to the methodology outlined in the paper, and conducted comprehensive evaluations on the dataset that I scraped. The results obtained support the claims made in the paper, specifically highlighting that the heuristic crossover method emerged as the optimal choice for achieving favorable outcomes in terms of weights, return, and risk.

This alignment between the implemented code and the paper's methodology not only validates the effectiveness of the heuristic crossover but also underscores the robustness of the approach in optimizing portfolio selection. These findings contribute to the growing body of evidence supporting the practical application of genetic algorithms, especially with heuristic crossover, in addressing complex financial optimization problems.

	Returns	Risks
Arithmetic_crossover	0.080656	0.001093
uniform_crossover	0.115524	0.001642
heuristic_crossover	0.191852	0.000026

The reported results correspond to the outcomes obtained after running the algorithm for 25 generations.

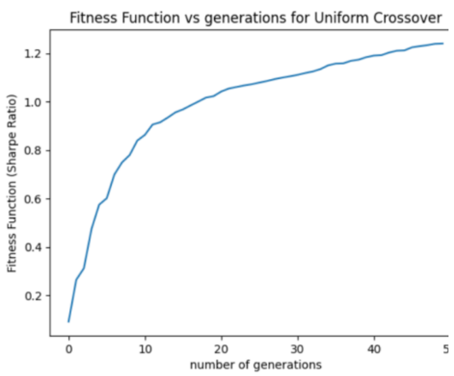
	Returns	Risks
Arithmetic_crossover	0.097625	0.001177
uniform_crossover	0.123657	0.001693
heuristic_crossover	0.198010	0.000001

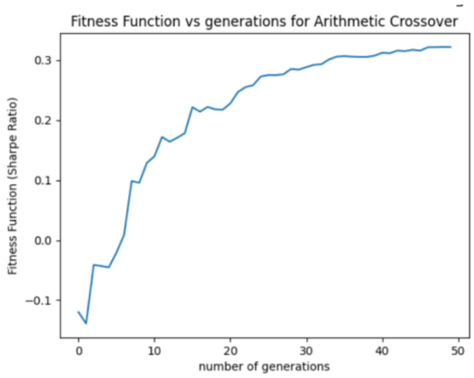
The reported results correspond to the outcomes obtained after running the algorithm for 50 generations.

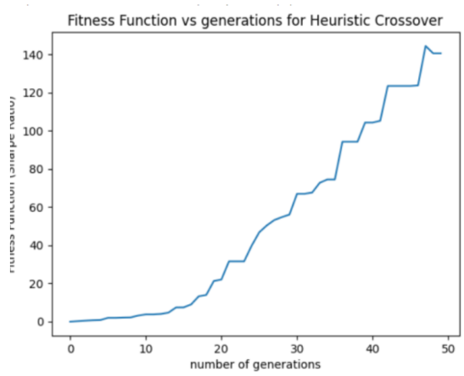
In light of these promising results, it's worth noting that further optimization may be achieved by exploring the impact of increasing the number of generations in the genetic algorithm. A more extensive exploration across generations could potentially uncover refined solutions and enhance the convergence of the algorithm. As part of future work, an investigation into the sensitivity of the results to variations in the number of generations would provide valuable insights into the optimal configuration for maximizing the efficiency of the portfolio optimization process.

	Returns	Risks	fitness(Sharpe Ratio)
Arithmetic_crossover	0.079697	9.680263e-04	0.321314
uniform_crossover	0.121261	1.727763e-03	1.240458
heuristic_crossover	0.191059	7.454182e-07	140.562907

The provided table also encompasses the concluding values of the fitness function.







The preceding graphs illustrate the fluctuation of the fitness function with the number of generations for different crossovers.

THANK YOU