Optimal Portfolio Using Genetic Algorithm*

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Introduction

Portfolio optimization is one of the main financial investment decisions. Distributing the amount of money to invest in each stock of a portfolio, while maximizing return and minimizing risk is even more complicated. A genetic algorithm will be utilized in order to accomplish this task. A fitness function will determine the effectiveness of the portfolio distribution. A five stocks, five years portfolio example is used to illustrate the applicability and efficiency of a genetic algorithm. A crossover will be applied in order to see how the genetic algorithm converges towards the optimal solution. The crossover, in combination with the fitness function allows the best distributions to merge in order to form even better distributions.

Genetic Algorithm in Finance

A genetic algorithm generates solutions to optimization problems using techniques inspired by natural evolution. In summary, it produces a random population, where the individuals are portfolio distributions in this case, evaluates the fitness of all distributions, selects the fitter distributions, merges them and creates the new, desired and best distribution, the optimal portfolio. A distribution that maximizes return and minimizes risk.

Data

Mean return for each stock

<table>
<thead>
<tr>
<th>Stock 1 (Tech)</th>
<th>Stock 2 (Financial)</th>
<th>Stock 3 (Consumer)</th>
<th>Stock 4 (Health)</th>
<th>Stock 5 (Industrial)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2352</td>
<td>0.0722</td>
<td>0.2491</td>
<td>0.1339</td>
<td>0.1259</td>
</tr>
</tbody>
</table>

Fitness function

The expected return of each stock \(i\) is \(E(d_i)=d_ir_i\), where \(d_i\) is the distribution of one stock and \(r_i\) the expected return. Therefore, the total expected return of the portfolio is \(F=\Sigma E(d_i)\), which will be maximized. In order to minimize risk the final fitness function is \(H(d_i)=F(d_i)-\sigma^2(d_i)\) where \(\sigma^2(d_i)\) is the portfolio variance.

Results

Optimal Portfolio Distribution

<table>
<thead>
<tr>
<th>Stock 1 (Tech)</th>
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<th>Stock 3 (Consumer)</th>
<th>Stock 4 (Health)</th>
<th>Stock 5 (Industrial)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2127</td>
<td>0.0016</td>
<td>0.7798</td>
<td>0.0024</td>
<td>0.00308</td>
</tr>
</tbody>
</table>

Average Return: 0.245
Fitness Value: 1.105
Computing Time: 11 minutes and 37 seconds

Conclusion

The genetic algorithm method was applied in order to find an optimal portfolio with the best distribution, which maximizes profit and minimizes risk. The method was applied on a five stocks throughout five years portfolio. The results obtained confirm the efficiency of the genetic algorithm for its convergence towards the better solution and interesting computing time. The best portfolio distribution provided by the genetic algorithm produced a 25% return. Also, it was shown that the bigger the population, in this case distributions, the more accurate the results. The greatest return was produced when 10 millions of distributions were generated, but the computing time was more than an hour.

References


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