19th International Conference on Innovative Computing, Information and Control (ICICIC2025)
August 26-29, 2025, Kitakyushu, Japan

PS-8: ICICIC2025-WS04-06

Portfolio Optimization Strategy Based on Ant Colony Algorithm

Jian Xing* and Kaixuan Wu

School of Economics and Management (School of Tourism), Dalian University, Dalian 116622, P. R. China
*Corresponding author: 632340240@qq.com

Introduction

Due to the complexity and variability of the actual situation, Markowitz's mean-variance model is difficult to meet the practical needs. Especially when it comes to problems with more constraints and more complex portfolios, simple algorithms are not able to satisfy investment objectives. Ant colony algorithm, as an intelligent heuristic algorithm, has good results in traveler's problem, planning problem. Second, since the portfolio is a multi-planning problem that maximizes return and minimizes risk, the objective function is transformed into a single-objective planning problem of portfolio return minus portfolio risk for the convenience of the ant colony algorithm. At the same time, this paper revamps the relevant parameters in the ACO algorithm by linking the heuristic function, pheromone, etc. in the ACO algorithm to the stock's return and turnover. In the end, a portfolio is obtained that is more efficient than a single stock in terms of both return and risk.

Research Questions

The study found that ant colonies release what can be called "pheromones" on the paths they travel. The ants in the colony can sense the presence of the pheromone, and then they choose the path with the highest level of pheromone among all the paths, and each ant that chooses that path will release its own pheromone on that path. This creates a positive feedback mechanism, and after a period of time, the ants in the colony will travel the shortest path to the food source. The solution method evolved from the foraging behavior of ants is the ant colony algorithm, whose features include distributed computing, positive feedback of information, and heuristic search, etc. In fact, this belongs to a kind of global optimization heuristic algorithm in evolutionary algorithms.

Methodologies

In this paper, based on the analysis of the existing conventional portfolio model, we use the ant colony algorithm to improve the asset portfolio model. Instead of using the Markowitz mean-variance model as the underlying method for assessing return risk, the capital asset pricing model is chosen as the method for calculating stock returns and risks.

Mathematical Formulas

$$\sum_{i=1}^{n} w_i p_i \le M$$

$$\max R = \sum_{i=1}^{n} w_i r_i$$

$$\min \beta = \sum_{i=1}^{n} w_i \beta_i$$

$$P_{ij}^{k} = \begin{cases} \dfrac{[\tau_{ij}(t)]^{\alpha}[\eta_{ij}(t)]^{\beta}}{\sum_{s \in allow_k}[\tau_{ij}(t)]^{\alpha}[\eta_{ij}(t)]^{\beta}}, s \in allow_k \\ 0, s \notin allow_k \end{cases}$$

$$\begin{cases} \tau_{ij}(t+1) = (1-\rho)\tau_{ij}(t) + \Delta\tau_{ij} \\ \Delta\tau_{ij} = \sum_{k=1}^{n} \Delta\tau_{ij}^{k} \end{cases}$$

$$\tau_{ij}(t+1) = \rho\tau_{ij}(t) + \Delta\tau_{ij}(t)$$

$$maxR - \beta = \sum_{i=1}^{n} w_i R_i - |\sum_{i=1}^{n} w_i \beta_i|$$

Conclusion

The results show that the improved portfolio theory used in this paper is more advanced and more relevant to the general situation of the stock market. At the same time, this paper combines the traditional portfolio model with the ant colony algorithm by improving the parameters in the ant colony algorithm, and the final portfolio returns show that the improved portfolio model based on the ant colony algorithm in this paper is effective.