



## A modified genetic algorithm for the flow shop sequencing problem to minimize mean flow time

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A modified genetic algorithm (MGA) is developed for solving the flow shop sequencing problem with the objective of minimizing mean flow time. To improve the general genetic algorithm (GA) procedure, two additional operations are introduced into the algorithm. One replaces the worst solutions in each generation with the best solutions found in previous generations. The other improves the most promising solution, through local search, whenever the best solution has not been updated for a certain number of generations. Computational experiments on randomly generated problems are carried out to compare the MGA with the general GA and special-purpose heuristics. The results show that the MGA is superior to general GA in solution quality with similar computation times. The MGA solutions are also better than those given by special-purpose heuristics though MGA takes longer computation time.

**Keywords:** Flow shop scheduling, mean flow time, modified genetic algorithm

### 1. Introduction

Genetic algorithms (GAs) were developed in the 1960s (Holland, 1975), as an adaptive searching technique for optimization, based on the mechanism of natural selection and evolution. Since then they have been applied to a wide variety of optimization problems. A survey on applications of GAs can be found in Goldberg (1989).

Much early work is focused on exploring new application areas of GA, suggesting genetic representations of the problems and ensuring compatibility of crossover functions with the genetic representations. Many efforts have also been made on improving the performance of the method to better suit the problems, for example, on gene pool selection, genetic operator selection, parameter setting, etc. Although GA is widely applicable and its performance has been well demonstrated, it still remains a difficult task in practical applications to seek a good balance between solution quality and computation time. Further improvements are needed to make it

more cost (time) effective. This paper attempts to improve the GA procedure by modifying its evolution process and to apply the modified GA to the flow shop sequencing problem to minimize the mean flow time.

Many multi-stage production systems can be modeled as flow shops. Therefore, flow shop sequencing problems have been extensively studied. Most of the studies try to minimize the makespan. In today's highly competitive global market, quick response to customer orders becomes increasing important. This requires us to use more relevant criteria in making scheduling decisions. An appropriate criterion is to minimize the mean flow time (or total flow time). The flow shop sequencing problem with mean flow time criterion can be stated as follows.  $n$  jobs are to be processed on a series of  $m$  machines. All the jobs are available at time 0. Each machine can process at most one job at a time, and each job can be processed on at most one machine at any time. No pre-emption is allowed. The processing time  $t(i, j)$  is given for any job  $i$  on any machine  $j$ . Given a permutation (processing sequence) of the jobs  $\{J_1, J_2, \dots, J_n\}$ , the

# Mean Flow Time Sequencing

**Martin Kenneth Starr**



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### Table of Contents Mean Flow Time Sequencing

1. Understanding the eBook Mean Flow Time Sequencing
  - The Rise of Digital Reading Mean Flow Time Sequencing
  - Advantages of eBooks Over Traditional Books
2. Identifying Mean Flow Time Sequencing
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in a Mean Flow Time Sequencing
  - User-Friendly Interface
4. Exploring eBook Recommendations from Mean Flow Time Sequencing
  - Personalized Recommendations
  - Mean Flow Time Sequencing User Reviews and Ratings
  - Mean Flow Time Sequencing and Bestseller Lists
5. Accessing Mean Flow Time Sequencing Free and Paid eBooks
  - Mean Flow Time Sequencing Public Domain eBooks
  - Mean Flow Time Sequencing eBook Subscription Services
  - Mean Flow Time Sequencing Budget-Friendly Options
6. Navigating Mean Flow Time Sequencing eBook Formats
  - ePub, PDF, MOBI, and More
  - Mean Flow Time Sequencing Compatibility with Devices
  - Mean Flow Time Sequencing Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Mean Flow Time Sequencing
  - Highlighting and Note-Taking Mean Flow Time Sequencing
  - Interactive Elements Mean Flow Time Sequencing
8. Staying Engaged with Mean Flow Time Sequencing

- Joining Online Reading Communities
- Participating in Virtual Book Clubs
- Following Authors and Publishers Mean Flow Time Sequencing
- 9. Balancing eBooks and Physical Books Mean Flow Time Sequencing
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Mean Flow Time Sequencing
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Mean Flow Time Sequencing
  - Setting Reading Goals Mean Flow Time Sequencing
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Mean Flow Time Sequencing
  - Fact-Checking eBook Content of Mean Flow Time Sequencing
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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