

Study on optimization of bus scheduling

Yingxian Liu

School of Qingdao University, Qingdao, China.

Abstract: In order to respond to the national policy, energy saving and emission reduction, from the perspective of transportation, we should drive fewer private cars and take more buses and subways. Good bus scheduling can better meet the interests of passengers and bus companies. Through the analysis of passenger flow big data, a more reasonable scheduling scheme can be provided for bus operation. The optimization of bus scheduling can improve the service quality and benefit passengers, and also reduce the input cost of bus companies. This paper analyzes the existing public transportation scheduling problems, analyzes the current research results of public transportation scheduling, and finally makes a prospect for public transportation scheduling.

Keywords: Passenger flow big data, Passenger flow forecast, Bus scheduling, Genetic algorithm.

1. Introduction

With the improvement of social development level, people's travel modes are diversified, private cars are increasing, and the urban construction land area is constantly expanding, leading to traffic congestion. Advocating green travel can not only save economy, but also achieve low carbon and environmental protection. In order to maximize the revenue of bus companies and the comfort of passengers, it is necessary to optimize the layout of bus stops, frequency of departure, vehicle scheduling and route planning. The bus scheduling problem is to design a more reasonable traveling schedule based on the bus operating schedule. It aims to reduce the operating cost and improve the quality of users' travel.

2. The research of dynamic

Western developed countries, Europe and the United States and other countries on the bus scheduling system technology research started relatively early, in the basic theory and application technology has a relatively mature system, and there have been a lot of international examples to verify these results. Most of them will use the following four methods in bus scheduling and bus route network optimization, which are mathematical method, heuristic search method, neighborhood search method and evolutionary algorithm.

Automated bus scheduling technology has attracted more and more attention. Laurent proposed a heuristic multi-objective optimization algorithm combining iterative local search algorithm with neighborhood mechanism in order to minimize bus operation cost. Ceder proposed a heuristic algorithm in order to save the maximum number of vehicles.

The research on intelligent bus dispatching is relatively late in China, and most of it is still artificial. At present, it mainly uses big data technology to carry out data mining for passenger flow information, and combines the algorithm to improve the research.

In order to solve the bus operation schedule, Wang Qingrong et al. took the departure schedule as a reference and combined with genetic algorithm. Chen Cheng took the scheduling characteristics as the reference and combined with multi-objective genetic algorithm NSGA-II to conduct the research. In order to achieve smooth departure interval,

reduce vehicle investment, and reduce charging cost, Teng Jing constructed the dispatching plan of electric vehicles.

From what has been discussed above, we can see that recently at home and abroad of bus scheduling optimization scheduling, use all sorts of heuristic algorithm, can solve the problem of simple model and, but as the public transport network complexity and the complexity of the problem of expanding, the traditional calculation methods have been unable to satisfy the current situation, and sparsely populated abroad, Although there are a lot of studies on their theories and practices, they are not necessarily in line with China's national conditions. Therefore, the study of China's unique complex public transport needs specific analysis, especially the dynamic real-time study of public transport scheduling. At present, for the research of urban bus scheduling, the rules and characteristics of passenger flow are mined by big data, and then various heuristic methods are used to build the model and solve the problem. Genetic algorithm, simulated annealing algorithm, neural algorithm and tabu search algorithm can realize the optimization of bus scheduling.

3. Overview of bus scheduling problem

The main research content of this paper is mainly three parts, one is the data mining of public transportation big data, the second is to propose an improved genetic algorithm to solve the problem of intelligent bus scheduling, and the third is to develop the intelligent bus scheduling system.

(1) Data mining of the big data of bus

There are many steps in data mining, and the process of data preprocessing is also very important. The processed data directly affects the accuracy of the subsequent calculation results. Data preprocessing is accomplished through data cleaning, data integration, data transformation and data reduction.

Using the processing results of data mining from the bus database, the relevant information of the bus data is analyzed by data mining. Through the number of people on and off at each station, the number of people on and off at each station in the future is deduced by combining time and space.

The distribution characteristics of the bus passenger flow should be analyzed, and the reasons for the influence of the passenger flow should be summarized and analyzed, and the influencing factors should be processed numerously, and the

regression analysis model should be summarized, and the future passenger flow should be predicted using multiple linear regression according to the historical data.

(2) Proposed an improved genetic algorithm to solve the problem of intelligent bus scheduling

Genetic algorithm is a search algorithm, it describes an individual evolution process, the principle of evolution is the survival of the fittest, some good individuals will be copied and inherited to the next generation, bad individuals will be eliminated in the process. Genetic algorithm has some disadvantages and is easy to fall into local optimum. By optimizing the three stages of selection, crossover and mutation in genetic algorithm, the problems of inaccurate convergence result, slow convergence and premature convergence are prevented. The design of dynamic fitness function can improve the selection. To prevent the destruction of good genes, the selection method of multiple copies of good individuals without putting back is adopted. The new crossover operator is designed. Because the initial group quality of the crossover operator is poor, it will be good in the later stage, so the optimized adaptive crossover function is used to solve the problems existing in the crossover. The concept of similarity is introduced and transformed into tabu mutation operator to optimize mutation.

It is also necessary to further study the mathematical relationship between passengers and bus operating companies, establish a mathematical relationship model between passengers and bus operating companies, and improve the genetic algorithm algorithm for some improvement design, so as to optimize the bus scheduling. The model is solved by improved genetic algorithm, and the optimal solution of bus scheduling optimization is obtained by using the final results.

(3) Develop intelligent bus dispatching system

Intelligent bus scheduling system is a medium of interaction with users. It is the main function of the system to provide users with dynamic and real-time bus scheduling scheme. The system should be functional, ease of use, safety and pressure resistance to meet the needs of users.

It is necessary to fully understand the requirements, design the system development process, select the development framework, and finally realize the function.

4. Survey of vehicle scheduling research

Since the 1960s, scholars in the field of operation optimization and transportation have been interested in the bus scheduling problem. According to the number of stations, the bus scheduling problem can be divided into single-yard bus scheduling problem and multi-yard bus scheduling problem. Single-yard bus scheduling means that both the departure and return of buses are one yard, which is generally reconstructed into network flow model, assignment model or minimum decomposition model. Single-yard bus scheduling can be regarded as a special case of multi-yard bus scheduling. After the 1990s, people mostly focus on the multi-depot bus scheduling problem. Multi - yard bus that is, buses can have different starting points and return points. Generally, the reconstruction model is set segmentation model or multi-commodity network flow model. The bus scheduling problem is also associated with many factors, such as fuel cost, vehicle type, departure schedule, driver scheduling and so on. Different scholars put different emphasis on different factors.

The bus scheduling problem is an integer programming

problem, which is proved to be NP-hard. There are two main ways to solve the bus scheduling problem:

(1) Integer programming method, generally based on heuristic methods. Bertossi et al. applied a relaxed Lagrange heuristic to the multi-depot bus scheduling problem, and proved the problem to be NP-hard. Amar et al. optimized the column generation algorithm to solve large-scale instances with highly degraded features. Oukil et al. focused on accelerating column generation within the framework of linear programming, and combined variable preprocessing, stable variables and column generation to solve large-scale multi-yard vehicle scheduling problems. ILP algorithm is a kind of accurate algorithm with good effect, but its speed is not good and it is not suitable for large-scale problems.

(2) Intelligent optimization method, which can solve fast but cannot guarantee the optimal solution, is suitable for solving large-scale problems. Shen and Xia applied 2-OPT strategy to design a vehicle scheduling method based on tabu search. Zhang Feizhou used the one-point and two-point crossover method of genetic algorithm to solve the scheduling scheme of different scale buses. Yao Yanjun combines these two methods to solve the bus scheduling problem. Tabu search algorithm combined with genetic algorithm has better solution quality than genetic algorithm. Each algorithm is analyzed by Pepin, and the heuristic method based on large-scale neighborhood search is fast and of good quality.

5. Optimization model of bus scheduling based on genetic algorithm

Overview of genetic algorithm solution

Genetic Algorithm (GA) was first proposed by Professor John H. Holland and his students in the University of Michigan in the late 1960s and early 1970s. The computational model algorithm draws on the Darwinian evolutionary theory of natural selection and genetic mechanism of biological evolution process. Many people have paid much attention to the algorithm, and have made great progress on the theoretical basis of the algorithm, which has been applied to genetic algorithm in many fields.

Basic steps of genetic algorithm solution:

(1) The first is coding. The solution of the problem is encoded in binary or real numbers, and these codes are defined as "chromosomes", also known as individuals. Then the population is initialized, that is, the initial solution of the population is given according to the coding rules, that is, a group of "individuals" is randomly generated.

(2) Calculate the fitness, obtain the fitness value of each individual through the fitness function, select the individuals with large fitness for replication, and to obtain offspring, crossover and mutation are needed.

(3) Repeat step 2. Before reaching the termination condition, multiple generations of evolution will be carried out, and finally the individual who is most adapted to the environment, namely the optimal solution of the problem, will be obtained. The solving flow chart of genetic algorithm is shown in Figure 1.

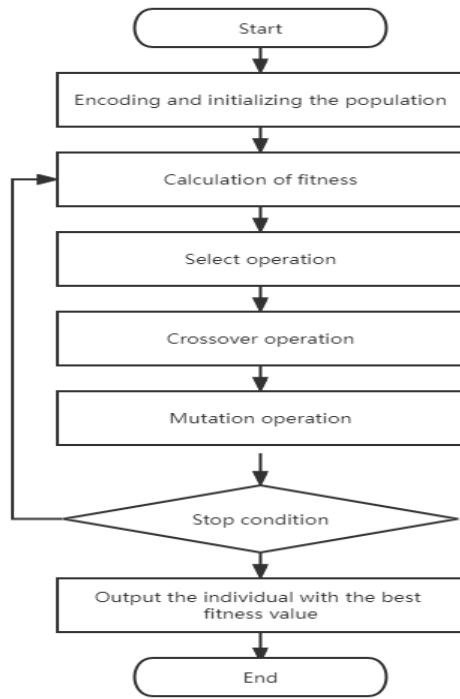


Fig. 1 Flowchart of solving basic genetic algorithm

The genetic algorithm is applied to bus scheduling, and the processing methods of each link are as follows:

1) coding. The accuracy of solving the problem is closely related to the encoding method. The binary encoding has randomness, which is not conducive to local search, and it is not ideal in the problem of high accuracy. It is better, therefore, to encode with real numbers, and the real values of the decision variables become the genes of the chromosomes. The departure interval of each period is represented by chromosomes.

2) Initial population. The individual values in the initial population can be chosen empirically. During peak hours, the passenger flow is large and the departure interval is small. 5-15 can be set as the departure interval time. During peak hours, the passenger flow is small and the departure interval is large. 15-15 can be set as the departure interval time.

3) Fitness value function. The quality of the individual is judged by fitness, which is evaluated according to the

objective function of the problem. The solution of the bus scheduling problem is evaluated by the fitness function. The fitness function of bus scheduling model is a minimization problem, so the fitness function is $fD = \min(MF1 + NF2)$.

4) Operator selection. Selection, crossover and mutation are all operators in genetic algorithms, which simulate biological mate selection, mating and gene mutation respectively. The roulette wheel selection operator is used to solve the bus scheduling problem. The arithmetic crossing operator is used to cross. Uniform mutation operator is used for mutation.

5) Termination conditions. In dealing with the bus scheduling problem, a maximum evolutionary algebra can be set, and the computation will terminate when the specified algebra is run.

6. Summary

It is of great value for bus companies and passengers to find the optimal bus scheduling scheme. Both bus operating cost and passenger satisfaction should be taken into account. The mathematical model of bus scheduling is established through the multi-angle passenger flow of some bus lines and solved by genetic algorithm. Using the optimized bus scheduling mechanism, the effect is better than the traditional way, which provides a certain reference significance and value for the optimization of bus scheduling in the future.

References

- [1] Liu Yingxin, Luo Xinggang, Cheng Shengping, Yu Yang, Tang Jiafu, Wang Tingsong. Dynamic Bus Scheduling of Multiple Routes Based on Joint Optimization of Departure Time and Speed[J]. *Discrete Dynamics in Nature and Society*, 2021, 2021:
- [2] Shi Qingshuai, Zhang Ke, Weng Jiancheng, Dong Yuqiang, Ma Siyong, Zhang Mengyuan. Evaluation model of bus routes optimization scheme based on multi-source bus data[J]. *Transportation Research Interdisciplinary Perspectives*, 2021, 10:
- [3] Yang Xinfeng, Qi Yicheng. Research on Optimization of Multi-Objective Regional Public Transportation Scheduling [J]. *Algorithms*, 2021, 14 (4):
- [4] liu li. application of genetic algorithm in bus scheduling problem [J]. *Fujian computer*, 2021, 37(07):97-99.