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Computer-Aided Design AND APPLICATIONS

Optimization Model of Urban Rail Transportation Planning Based on Evolutionary Algorithm of State Space Model

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Abstract. Urban mass transit (UMT) planning is a complex decision-making process with multi-objectives, multi-constraints, multi-uncertainties, unmeasurable factors, large capital expenditure and long term. As a branch of computer science development, artificial intelligence (AI) has played a great role in human production and life. Evolutionary algorithm based on state-space model (SEA) is an evolutionary algorithm based on discrete system state-space model. In this article, SEA and CAD technologies are used to build UMT planning optimization model, and the statistical analysis function of operational data collected by urban authorities is fully exerted. Based on GIS and traffic model platform, a targeted and responsive UMT network optimization system is realized by using CAD tools. The experiment highlights its effectiveness by comparing the proposed method with the traditional method, and takes particle swarm optimization (PSO) algorithm and genetic algorithm (GA) as comparison methods for common analysis and verification. The results show that the accuracy of traffic stream prediction of this algorithm is above 95%, and the accuracy of optimal path planning is about 13% higher than that of traditional GA. Therefore, it can be considered that applying SEA to UMT network CAD modeling can improve the efficiency of UMT planning.

Keywords: Urban Mass Transit; Artificial Intelligence; Evolutionary Algorithm Based on State-Space Model; CAD
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1 INTRODUCTION

UMT network model, as a large-capacity and efficient transportation mode, undertakes the important task of passenger turnover in the city and is an important link in the UMT system. With its advantages of large volume, high speed, high punctuality, low pollution and high safety, UMT has experienced explosive development in recent years and has become an indispensable UMT tool in large and medium-sized cities. Al Hilo et al. [1] monitored the status and condition of the traffic system and UAV in real time, and found and handled problems in time. Through real-time monitoring and early warning, the stability and safety of the traffic system can be ensured. By real-time monitoring of traffic conditions and drone status, dynamic adjustment of joint trajectories can be achieved. For example, in case of emergencies, the flight path and speed of UAV can be adjusted in real time to ensure the stability and safety of the traffic system. In the UAV assisted intelligent transportation system, cooperation and cooperation between UAVs can be realized through cooperative flight technology. Through cooperative flight, the flight path of UAV can be optimized, and the efficiency and safety of transportation system can be improved. In the UAV assisted intelligent transportation system, buffer management technology can be used to optimize the scheduling and resource allocation of UAVs. Through cache management, UAV tasks and resources can be reasonably allocated according to the needs of the transportation system, so as to improve the efficiency and reliability of the transportation system. In the UAV assisted intelligent transportation system, artificial intelligence technology can be used to achieve joint trajectory planning and cache management. At present, the urbanization degree and population density of major cities in China are developing rapidly, and the travel demand of residents is increasing day by day, but the development speed and service level of UMT can no longer meet the development needs of economic and social construction. BešInović et al. [2] analyzed and constructed artificial intelligence fuzzy analysis for machine vision. It proposes a structured research field for intelligent technology applications. Through the analysis of intelligent driving in traffic control, a solution has been found to optimize railway transportation management. Through machine vision technology, the status of trains can be monitored, such as their position, speed, acceleration, etc. Through artificial intelligence fuzzy analysis, precise judgment of these states can be achieved, thereby real-time monitoring and adjustment of train operation status. Through machine vision technology, the status of the track can be monitored, such as its shape, flatness, and whether there are defects in the track. Through artificial intelligence fuzzy analysis, precise judgment of these states can be achieved, enabling real-time monitoring and maintenance of the track status. Through machine vision technology, the status of traffic signals can be monitored, such as the brightness of signal lights and the timing of signal conversion. Through artificial intelligence fuzzy analysis, precise judgment of these states can be achieved, enabling real-time monitoring and adjustment of traffic signals. From the strategic perspective of sustainable development, we should make the overall transportation system of the city more scientific and perfect, better serve the citizens and better serve the economic construction of the city. The main function of UMT is to meet the travel needs of passengers. Whether it is the formulation of driving plan or the adjustment of operation strategy, it is need to master the law or real-time status of pedestrian volume. UMT network optimization system mainly analyzes the UMT network from four aspects: site layout, network planning, service level and capacity demand on the basis of geographic information system and urban traffic model, and makes auxiliary optimization and adjustment for regional UMT network, single line and transfer station on the basis of existing UMT network and pedestrian volume distribution. Based on the results of data analysis and mining, decision support can be provided, providing reference and suggestions for the management and operation of urban rail transit. For example, a reasonable train scheduling plan and station service plan can be developed based on the predicted passenger flow. Dong et al. [3] achieved real-time monitoring and warning of urban rail transit through the real-time monitoring and warning function of CGB. Use sensors and monitoring equipment to monitor the data of tracks, vehicles, signals and other aspects in real time, find abnormalities and potential risks, and send early warning signals in a timely manner. In summary, the visualization of urban rail transit basic evaluation based on CGB technology integration can achieve functions such as data collection and processing, CGB modeling, visual display, data analysis and mining, decision support, and real-time monitoring and warning. By integrating and integrating these functions, the management and operation level of urban rail transit can be improved, providing better travel experiences and services. Feng et al. [4] constructed the optimal combination of optimization models for urban rail transit service routes based on nonlinearity. By reducing the heuristic search algorithm of the hybrid Linear programming model, it developed a cost optimization model for railway operators. Select appropriate design and construction plans based on the characteristics of short bends, express lines, and local service lines. Zoom in and draw lines and circles in CAD software, and use object snap modes such as 45-degree polar snap to better complete circuit design. Develop a comprehensive safety management system based on the operational characteristics of short turns, express lines, and local service lines, strengthen the maintenance and repair of equipment and lines, and ensure the safe operation of rail transit. By improving service quality and efficiency, we aim to provide a more convenient and comfortable travel experience. For example, optimize the layout of station facilities and service facilities, improve the transfer efficiency of the station, and increase the information prompt and guidance in the station.

Jiang et al. [5] constructed a network state model for urban rail transit. It conducts inference modeling of the system state through urban passenger flow simulation under a multi track network. In the process of keyword-based hybrid multi task coordination method, the integration of railway basins has been realized. It is necessary to collect passenger flow data of the urban rail transit network, including passenger flow of each line, passenger flow distribution timetable, passenger flow travel patterns, etc. By analyzing these data, a preliminary understanding of the distribution of passengers can be obtained. In CAD software, three-dimensional space models can be established according to the spatial distribution of urban rail transit network, including tracks, stations, transfer facilities, surrounding buildings, etc. Through spatial Data modeling, the distribution of passengers can be more accurately simulated. In addition to spatial Data modeling, it is also necessary to consider the impact of time factors on passenger distribution. In CAD software, a time series model can be established based on historical passenger flow data to simulate the distribution of passengers in different time periods. Liu [6] conducted in-depth analysis and optimization of intelligent system adaptability for railway transportation. It constructs a resource mobilization analysis framework for different sites and business processes. The computer-aided decision-making system for railway dispatch and command requires efficient data collection and processing capabilities. Data sharing and integration with the railway dispatch system can be achieved through the data interface in CAD software, improving data accuracy and real-time performance. In CAD software, an intuitive and concise visual interface can be designed to facilitate the operation and viewing of dispatch and command personnel. The computer-aided decision-making system for railway dispatch and command requires efficient dispatch algorithms to improve the efficiency and accuracy of dispatch and command. Different scheduling algorithms can be simulated and tested through the calculation and analysis functions of CAD software to find the optimal solution. The computer-aided decision-making system for railway dispatch and command needs to have comprehensive safety assessment and early warning functions to ensure the safety and stability of railway dispatch. Security evaluation and early warning of scheduling schemes can be carried out through collision detection, structural analysis, and other functions in CAD software to identify potential risks and issues. UMT route planning is a complex decision-making process with multi-objectives, multi-constraints, multi-uncertainties, unmeasurable factors, large capital expenditure and long term. The huge scale of operation brings a lot of operating costs. Therefore, the application of AI technology in UMT is deeply analyzed and explored, and specific implementation plans are put forward to build a safe, efficient, convenient and green smart urban rail, which will help the intelligent and information-based growth of UMT and realize the sustainable growth of smart UMT operation. Mastering the fluctuation law of UMT pedestrian volume is conducive to improving the scientific and accurate operation management, and is also an important basis for operation managers to make decisions. In this article, AI and CAD technologies are introduced into UMT planning, and SEA is used to predict traffic stream. Combining with different working scenarios, this algorithm is compared with other intelligent transportation planning methods, and the improvement of driving efficiency and safety by SEA compared with traditional intelligent planning methods is discussed.

With the increase of pedestrian volume and the complexity of the network, the operation and management of UMT also faces new challenges, which also puts forward higher requirements for passenger service. The formation of the final planning scheme of the track line is mainly determined by the planners' preference for the weights of various planning objectives and the constraints. Evolutionary algorithm based on state-space model (SEA) is an evolutionary algorithm based on discrete system state-space model. The algorithm introduces the idea of GA, adopts real number coding method, and realizes the search function of the algorithm by constructing a state evolution matrix, which makes the algorithm have strong search ability and high search accuracy, and can quickly find the global optimal solution of the problem. In this article, the optimization strategy of UMT planning combined with AI algorithm is studied, and the following innovations are made:

(1) This article uses SEA to build UMT planning optimization model, and uses CAD tools to realize UMT network optimization system with strong pertinence and quick response.

(2) SEA uses the construction of state evolution matrix to guide the search direction of the algorithm, which breaks through the traditional GA's solution mode and makes the solution stage of the problem be represented by discrete system dynamics process. Then the algorithm approaches the optimal solution of the problem through the selection mechanism of the survival of the fittest in the seed selection pool.

Firstly, this article introduces the significance of UMT planning research, and puts forward the application of AI algorithm and CAD technology. Then the idea is realized in the method part, and the UMT planning optimization model based on SEA and CAD is constructed. Then the application effect of the model for UMT planning optimization is tested by experiments. Finally, the contribution and limitations of the research are summarized, and the future improvement direction is put forward.

2 RELATED WORK

Luan et al. [7] conducted a matrix analysis and planning of information entropy for public transportation using a weighted information model by constructing a network route planning for urban rail transit. Through data driven guidance on the weighted model, a multi criteria network information entropy model was analyzed and constructed. Through data collection and analysis, the operational situation and performance of the light rail transit network can be understood. The data interface of CAD software can be used to obtain data on passenger flow, vehicle speed, operating costs, and other aspects of the light rail network, and data analysis tools can be used for integration and analysis. Through the modeling and prediction functions of CAD software, a performance evaluation model can be established and the future performance of the light rail transit network can be predicted. Based on performance evaluation and prediction results, alternative optimization models can be proposed to improve the performance of the light rail transit network. According to the alternative optimization model, the simulation and optimization functions of CAD software can be used to simulate and test different optimization schemes to find the optimal solution. Mo et al. [8] constructed a dynamic flow constraint model for integrated locomotive overlap. By analyzing the impact of nonlinear constrained flow, it considers the carrying capacity of train track flow to avoid maximum overlap. By optimizing the train diagram, train schedules and times can be reasonably arranged to avoid excessive congestion and waste. Reasonable train operation diagrams can be developed based on factors such as passenger flow needs and train maintenance needs to achieve energy-saving and efficient operation. By introducing an intelligent scheduling and monitoring system, the operational status and passenger flow of trains can be monitored in real-time, and dynamic adjustments and optimizations can be made based on this information. For example, during peak passenger flow periods, train schedules can be increased to improve transportation capacity. Adopting energy-saving design and technology, such as using low resistance and low energy consumption trains, and adopting energy-saving station design, can reduce train operating costs and energy consumption. Porru et al. [9] conducted an analysis of the mobility challenge of land environmental planning in smart cities. It elaborates on the challenges of urban mobility environment in the context of rural environment. The land environment planning of smart cities requires the ability to dynamically adjust and optimize. With the development and changes of cities, planning needs to constantly adapt and update. At the same time, it is necessary to consider how to balance the needs of different stakeholders, such as developers, residents, environmental organizations, etc. Urban land environmental planning needs to consider sustainability and ecological protection. In the planning process, it is necessary to balance the economic needs of urban development and the needs of environmental protection to ensure the sustainable development of the city. By strengthening public participation and transparency, understanding the needs and opinions of the public, and improving the democracy and acceptability of planning. Various methods can be adopted, such as public hearings and online interactions, to promote public participation. By introducing sustainability and ecological protection concepts, balance the economic needs of urban development with the needs of environmental protection.

Samir et al. [10] analyzed and discussed the urban planning and construction of an intelligent transportation system for vehicle network. The joint optimization scheduling strategy was analyzed by using network sensor information indicators of autonomous driving. During the process of executing trajectory planning, drones need to dynamically adjust and optimize according to the actual situation. When encountering obstacles or changing targets, the trajectory can be re planned to ensure the efficiency and safety of task execution. In the intelligent transportation system, effective communication and coordination are required between UAVs and between UAVs and ground stations. Through communication, information can be shared and tasks can be coordinated to improve the efficiency and reliability of the entire system. Through the implementation of the above measures, the goal of information perception trajectory planning of UAVs in the intelligent transportation system can be achieved, and the efficiency and safety of UAVs in the auxiliary transportation system can be improved. At the same time, it is necessary to comprehensively consider multiple aspects such as the performance of drones, the characteristics of traffic scenarios, and safety factors for comprehensive optimization and management. Sarram and Ivey [11] analyzed the data driven experimental framework of Transportation planning. The review efficiency of Transportation planning performance management can be greatly improved by reviewing data online through CAD evaluation. The traditional review method requires on-site investigation and manual data collection, while CAD evaluation can achieve a fast and accurate review process through online review of data. CAD software can conduct in-depth data analysis on review data and present the results in a visual form. This can help managers understand the performance of Transportation planning more intuitively and develop corresponding improvement measures. CAD evaluation online review data enhances the potential of traditional Transportation planning performance management, which plays an important role in urban management. By making full use of the data analysis and visualization functions of CAD software, the efficiency and accuracy of Transportation planning can be improved, providing better support and guarantee for urban management. Stojanovski [12] has constructed a regional service method for rail transit development in public spaces. Through the commercial analysis of the bus space station, it constructs the optional view mode Spatial analysis. In urban design, it is important to consider the visual proximity between public transportation stations and routes and the surrounding environment in order to improve the utilization rate of public transportation. For example, designing attractive buildings and landscapes around public transportation stations to make it easier for people to choose public transportation. Generating adversarial Sexual network (GAN) is a powerful deep learning technology, which can be used to promote the intelligent rendering of urban rail master planning. Ye et al. [13] conducted an artificial intelligence algorithm based urban master planning analysis model. It has conducted professional training on the urban planning model through technical quantitative analysis of urban data. It uses a large amount of data to train and generate an adversarial Sexual network. In the training process, the ability to generate and judge the network can be improved by adjusting the network parameters, optimizing the Loss function and other means. Use the trained generated adversarial Sexual network to predict or generate the image of urban rail according to the input random vector or traffic flow data. Different urban rail images can be generated by adjusting the input random vectors or traffic flow data. Apply the generated intelligent urban rail image to the actual overall planning of urban rail transit. The dynamic update and optimization of the overall urban rail planning can be achieved by adjusting the parameters of the image or adding new traffic flow data. The efficiency and accuracy of urban rail planning can be effectively improved by generating an adversarial Sexual network to promote the intelligent drawing of urban rail master planning.

Yin and Peng [14] conducted a spatial clustering model analysis of hierarchical density layout among railway stations. It uses 3D layout and clustering analysis to simulate the ideal location of the station. In CAD software, it is possible to establish a three-dimensional spatial model based on the spatial distribution of urban rail transit lines, including stations, tracks, and transfer facilities. Through the optimization of station layout, the reasonable location and scale of the station can be determined to improve the passenger's travel experience. In urban rail transit planning, route selection design needs to be carried out based on passenger flow demand and station layout. In CAD software, line planning tools can be used to simulate the passenger flow conditions of different routes based on different route options, and select the optimal route plan. In CAD software, a transfer facility modeling tool can be used to create a three-dimensional model of the transfer facility, and optimize the design and layout of the transfer facility based on passenger flow and station layout. Zhang et al. [15] conducted an analysis of the architecture of a kidney deficiency learning model for urban rail transit. It proposes a systematic model capture framework for subway stations by integrating abstract information from network topology models. After the model construction is completed, it is necessary to train and optimize the model. The Backpropagation, random gradient descent and other optimization algorithms can be used to optimize the model parameters to improve the prediction accuracy and stability of the model. Based on the predicted results of the model, analysis and application of passenger flow prediction can be carried out. For example, decisions such as traffic scheduling, resource allocation, and safety management can be made based on the predicted results to improve the operational efficiency and safety of urban rail transit. In the process of model application, it is necessary to evaluate and update the model. Cross validation, Receiver operating characteristic and other evaluation methods can be used to evaluate the performance of the model, and update and improve the model according to the evaluation results. Zhao et al. [16] analyzed the communication transmission efficiency signal analysis of rail trains. It introduces broadband signal transmission based on 5G mobile communication information through analysis of urban rail transit. In the future, 5G technology can provide faster, stable, and secure network connections, enabling more intelligent scheduling and autonomous driving functions. Through 5G network connection, more accurate, efficient and safe train dispatching and operation control can be achieved, and the operation efficiency and safety of rail transit system can be improved. The future 5G oriented urban rail transit system needs to fully consider intelligent dispatching and automatic driving, Big data analysis and intelligent decision-making, intelligent passenger flow guidance and safety monitoring, Artificial Intelligence for IT Operations and management, as well as intelligent services and user experience, and achieve more efficient, safe and reliable operation and development of urban rail transit system through 5G technology. Zhu et al. [17] analyzed the energy consumption, braking, and energy storage effects of urban rail transit. By simulating the parameters of the complex energy coupled network of high-speed trains, an equivalent model of the railway network was constructed. And the comprehensive method of capacity configuration has been improved in transmission efficiency. The traction power parameters of urban rail transit need to be calculated and optimized based on parameters such as vehicle operating speed, passenger capacity, and line slope. Through the calculation and simulation functions of CAD software, it is possible to simulate the operating status of vehicles under different traction power parameters and find the optimal traction power parameters. The energy storage system of urban rail transit needs to be designed based on the operating mode, operating time, and energy requirements of the vehicle. Through the modeling and simulation functions of CAD software, the effects of different energy storage system designs can be simulated to find the optimal energy storage system design scheme. Through the simulation and optimization functions of CAD software, the optimal collaborative solution for traction and energy storage systems can be found, achieving efficient energy conversion and utilization.

3 UMT PROGRAMMING OPTIMIZATION MODEL

3.1 UMT Traffic Forecast

Due to the continuous growth of UMT, the UMT network is gradually formed, the coupling degree between lines is constantly improved, the radiation range is expanded, the accessibility is significantly improved, and the proportion of transfer passengers between lines is gradually increased, which fully embodies the convenient and fast characteristics of UMT and greatly improves the pedestrian volume of the whole network. An in-depth analysis of the complexity of UMT is of great significance to the scientific research and management of UMT. Therefore, the application of AI algorithm to UMT research has aroused great interest of researchers. When using AI algorithm to solve practical engineering problems, there are also some problems, such as low detection level of foreign aggression and low optimization efficiency of internal learning mechanism. Evolutionary algorithm based on state-space model (SEA) is an evolutionary algorithm based on discrete system state-space model. The algorithm introduces the idea of GA, adopts real number coding method, and realizes the search function of the algorithm by constructing a state evolution matrix, which makes the algorithm have strong search ability and high search accuracy, and can quickly find the global optimal solution of the problem. Whether in the planning and construction of UMT project or in the operation management after completion, UMT pedestrian volume prediction is an important work, which provides the basis for designers or operation managers to make decisions. In this article, SEA is used to construct the optimization model of UMT planning, so that the solution stage of UMT planning problem can be expressed by discrete system dynamics process, and then the algorithm approaches the optimal solution of the problem through the selection mechanism of the survival of the fittest in the seed selection pool. The operation stage of SEA is shown in Figure 1.

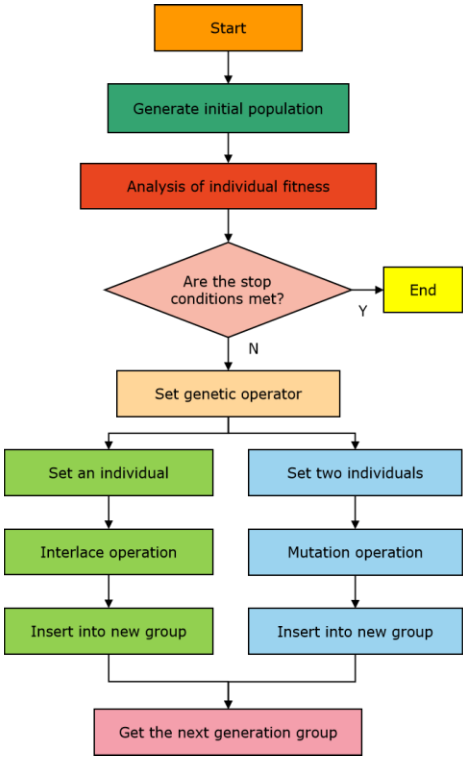

Figure 1: Operation stage of SEA.

It is assumed that $x_i \in R^n$ is the factor affecting the UMT flow forecast, and y_i is the UMT flow forecast value. Improving the traffic stream forecasting model based on SEA is to find the relationship between x_i and y_i :

$$f : R^n \rightarrow R \tag{1}$$

$$y_i = f(x_i) \tag{2}$$

Where: R^n is the factor that affects the UMT flow forecast. According to the SEA, the establishment of the traffic stream forecast model seeks the following expression:

$$f(x) = \sum_{i=1}^{k}(a_i - a_i^*)K(x, x_i) + b \tag{3}$$

Where: x is the factor affecting traffic stream, x_i is the i sample among k samples, $K(x, x_i)$ is the kernel function, and the kernel function adopts radial basis function:

$$K(x, y) = \exp\left|-\frac{\|x-y\|^2}{2\sigma^2}\right| \tag{4}$$

Network-level short-term inbound flow forecasting needs to consider many factors, such as data scale and model structure, which are quite different from station-level short-term inbound flow forecasting. Time dependence, spatial dependence, network topology dependence and other factors need to be considered, and the model structure is more complicated. The growth of deep learning provides a better solution for this. In the modeling stage of multi-objective optimization of train operation curve, the method of accurately establishing train energy consumption and time model needs to be improved. The dynamic programming algorithm adopts multi-stage decision-making method, which can simplify the modeling process, improve the accuracy of the model and have global optimal convergence. The basic neuron model of UMT traffic prediction is shown in Figure 2.

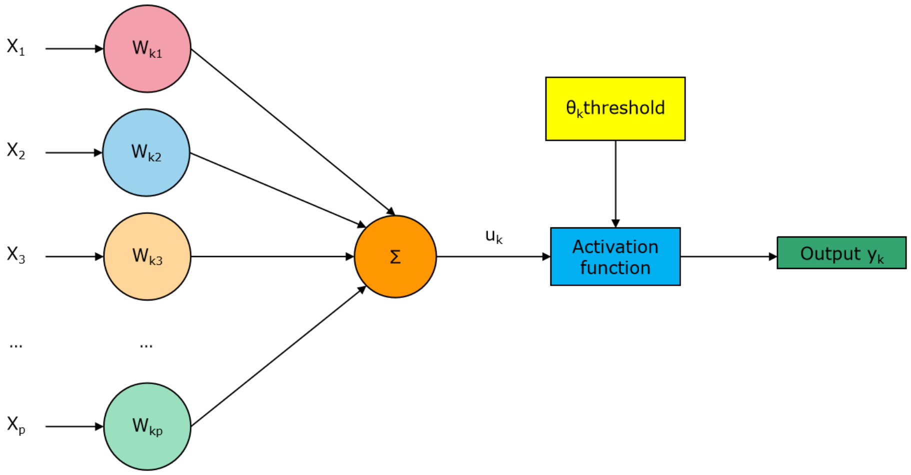

Figure 2: Basic neuron model for UMT traffic prediction.

Multi-objective optimization design requires that all component objectives are optimal, and it is of course very ideal to obtain such a result. However, it is generally difficult, especially when the optimization of each sub-goal is contradictory. Therefore, it is a complex problem to solve the multi-objective optimization design problem. UMT network is a complex and huge system. UMT pedestrian volume is influenced by many internal and external factors, and the accuracy of pedestrian volume forecast needs to be improved continuously. The iterative direction of the optimal solution is generally to minimize the empirical risk, but it is easy to fall into over-fitting, so the regularization term is introduced to constrain the complexity of the model. Generally speaking, there are some opposites between them, but their goal is the same, that is, to minimize the expected risk.

Select an appropriate kernel function and combine it with the discriminant function of support vector machine (SVM) to identify traffic jams and unconstrained conditions. SVM is proposed for the best classification under the condition of linear separability, and has the following classifiers:

$$f(x)=\operatorname{sgn}(wx+b)=\operatorname{sgn}\left(\sum_{i=1}^{l}\alpha_i^* y_i(x_i x_j)+b^*\right) \tag{5}$$

Among them, α_i is the optimized solution of the quadratic problem.

$$\min_{\alpha}\frac{1}{2}\sum_{i=1}^{l}\sum_{j=1}^{l}y_i y_j\alpha_i\alpha_j(x_i x_j)-\sum_{j=1}^{l}\alpha_j \tag{6}$$

$$Subjected\ \ \text{to}\ \ \sum_{i=1}^{l}y_i\alpha_i=0 \tag{7}$$

$$y_i\left[\sum_{i=1}^{n}\alpha_i(x_i x)+b\right]-1=0 \tag{8}$$

When linearity is inseparable, the kernel function of SVM is used for nonlinear transformation:

$$\mathrm{K}(\mathrm{x_i},\mathrm{x_j})=(\varphi(\mathrm{x_i})\varphi(\mathrm{x_j})) \tag{9}$$

In the representation of kernel function, the selection of kernel function type and parameters is the key to construct the matrix, and a compromise is made between smoothing accuracy and model complexity.

3.2 CAD Modeling of UMT Network Model

Although the pedestrian volume of UMT is affected by many uncertain factors, its pedestrian volume fluctuation still has certain regularity. Therefore, before pedestrian volume forecast, it is need to mine the hidden information in historical pedestrian volume data. Scientific and reasonable UMT network is the basis for the good operation of UMT network model. The optimization research of UMT network aims to improve the service level of UMT, facilitate residents' travel, improve the operational efficiency of UMT enterprises, and have a positive impact on the whole UMT system. In the initial stage of UMT construction and operation, there were few UMT lines, each line operated independently, there was no intersection, the coverage area of the lines was limited, the accessibility was low, and less passengers were attracted. Although the pedestrian volume is on the rise, the absolute amount and relative proportion of the increase are not large. In order to improve the operating efficiency of UMT trains and save operating costs, most UMT lines adopt mobile block signal systems. The signal system has no fixed block partition, and the interval train can obtain the position and speed information of the preceding vehicle through communication means, so that the tracking target point can move forward continuously, and its running curve can be changed in real time according to the tracking target.

Considering the setting of UMT lines, on the one hand, it is need to maximize the toughness of the whole traffic system, that is, to minimize the weighted function of network congestion and average travel time, on the other hand, it is need to minimize the generalized cost generated by the whole road network. Because SEA can not only describe the population information in the form of minimum information, but also clearly show the individual state changes in the iterative optimization stage of the algorithm, which makes the expression and solution stage of the problem more intuitive and efficient. The shortest path planning stage of dynamic traffic is shown in Figure 3.

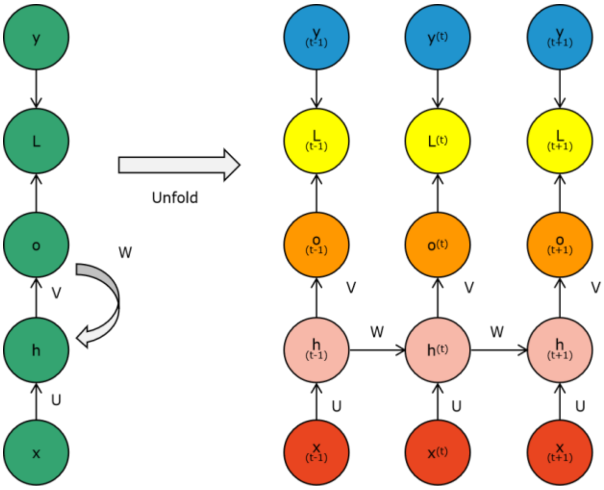

Figure 3: The shortest path planning stage of dynamic traffic.

In addition to the pedestrian volume created by this line, the newly-built line has improved the accessibility of UMT through the transfer between lines, which has brought a lot of induced pedestrian volume to itself and other lines. At the same time, the characteristics of UMT, such as punctuality, quickness and large volume, have been fully reflected, and the transfer pedestrian volume of UMT network has also been continuously increased, and the pedestrian volume of the whole network has increased substantially. By issuing dispatching instructions to stations in different dispatching areas, the stations will implement the traffic tasks after receiving the instructions issued by their superiors.

The distribution of UMT pedestrian volume is closely related to the land use and development degree of the radiation area of each station, and the length of the line and the connection between lines will also have a great influence on the pedestrian volume. Therefore, the pedestrian volume of each section in the network is also different because of the different spatial and temporal distribution of the boarding and landing volume of each station. UMT Ring Road is mostly located in the central city, distributing pedestrian volume along the line and providing transfer function between other UMT lines. All the land along the line has been fully developed and utilized, which runs through many urban functional areas and realizes transfer and connection with many lines. There is little difference between the boarding and descending volumes of each station, and multiple transfer paths homogenize the pedestrian volume area of the line section, so the pedestrian volume of each section is relatively balanced.

A network structure model of UMT is established by CAD method. Transforming UMT network into a mathematical model:

$$G=(V,E) \tag{10}$$

Among them, V represents the set of nodes. If the UMT includes n stations, there are:

$$|V|=n \qquad V=(v_1,v_2,v_3,\ldots,v_n,) \tag{11}$$

E represents the set of edges. If the UMT includes m section routes, there are:

$$|E| = m \qquad E = (e_1, e_2, e_3, \ldots, e_m,) \tag{12}$$

In UMT network, the passenger travel path includes two parts, one is the station and the other is the section. The reference transit time of the route is equivalent to the time spent by most passengers on the route, such as the arrival time, the boarding time, the departure time and possibly the transfer time. Let C_w^k denote the total time spent by most passengers traveling on the k th route between the traffic trip volume pair W, then:

$$C_k^w = J_o + \sum_{i,j} T_{i,j} \delta_{ij,k}^w + \sum_i e_i^{l,m} \varphi_{i,lm}^{w,k} + K_d \tag{13}$$

SEA is an optimization algorithm which adopts real number coding and introduces the basic idea of GA. The algorithm guides the search direction of the algorithm by constructing the state evolution matrix. This construction method breaks through the solution mode of traditional GA, so that the solution stage of the problem can be expressed by discrete system dynamics process, and then the algorithm approaches the optimal solution through the selection mechanism of the survival of the fittest in the seed selection pool.

4 ALGORITHM TESTING AND ANALYSIS

4.1 Traffic Stream Prediction Simulation

In this article, SEA is used to realize traffic stream forecast. SEA uses the construction of state evolution matrix to guide the search direction of the algorithm, which breaks through the solution mode of traditional GA and makes the solution stage of the problem can be expressed by discrete system dynamics process. Because the construction of state space model can not only express the population characteristics with less information, but also clearly show the individual state changes in the iterative process. The algorithm replaces the crossover and mutation operators in GA by constructing a state evolution transition matrix, and then forms a new population, and produces a better population through the selection of seed pool. In order to further illustrate the effectiveness of this method, the experiment compares the proposed method with the traditional method to test its effectiveness. The prediction error test of the algorithm is shown in Figure 4. The prediction precision test of the algorithm is shown in Figure 5.

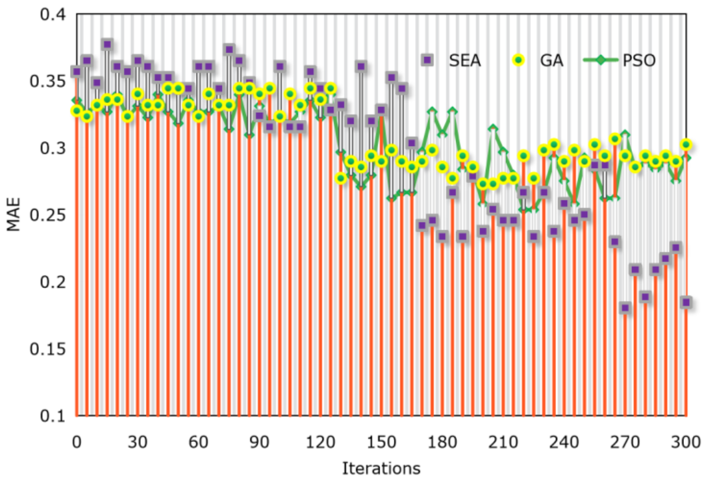

Figure 4: Prediction errors of different algorithms.

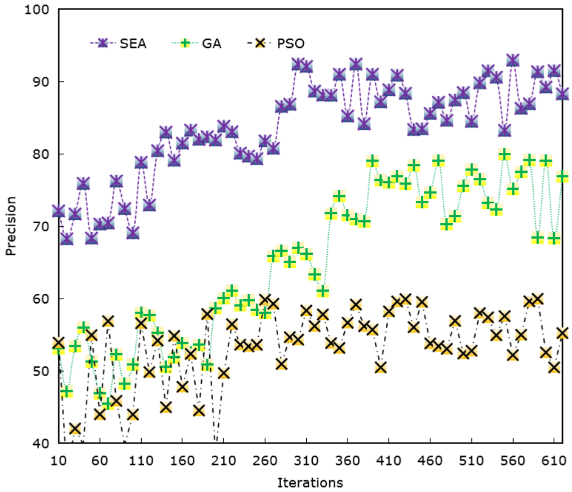

Figure 5: Prediction precision of different algorithms.

The time of UMT should be divided into smaller time periods. For the precise division of time and space, it depends on the scale of the problem and the demand of precision. With the complexity of the problem, the probability of search results is getting smaller and smaller, which requires constant adjustment of population number and search times during the search process.

4.2 Comparison of UMT Network Optimization Performance

In the transportation system, UMT network model has its own operating mechanism, and it is also influenced and restricted by external environmental conditions. Therefore, the objective factor of traffic stream should be considered when analyzing UMT network model, and the balance between UMT network model and urban master plan and external system should be sought. In order to test the efficiency of the algorithm, 9:00 am is taken as the departure time, 10 road sections are randomly selected in the road network, and the shortest path of each route is calculated by UMT planning algorithm, PSO algorithm and GA based on SEA optimization, and the calculation time of the three algorithms is shown in Figure 6.

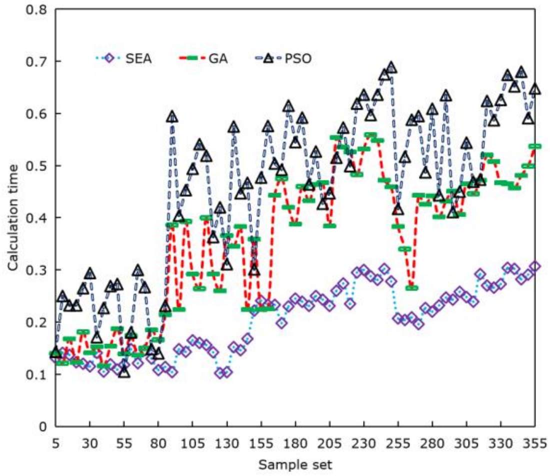

Figure 6: Computational time of three algorithms.

The calculation time of UMT planning algorithm optimized by SEA is much less than that of PSO algorithm and traditional GA. In the whole stage of UMT planning, the other two algorithms have to re-plan the flight path many times. The optimization method of UMT network based on SEA is to solve the planning problem once by processing the traffic situation of each point in the UMT network in advance.

The feasible region constraint can be based on the possible connection relationship of the track line and the possible number of stations, and ensure the feasibility of the line and stations within this range. Other constraints can be dealt with by penalty function, and the constraints outside the feasible region can be punished by penalty function. The connectivity of rail network can be handled by special pasting operators. In order to test the correctness of UMT planning method based on SEA, the accuracy of obtaining the optimal path by three methods is compared. The results obtained are shown in Figure 7.

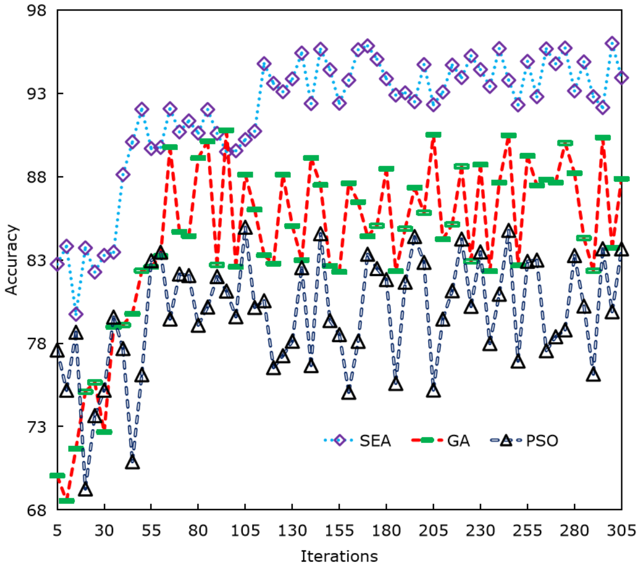

Figure 7: Accuracy of optimal path planning.

The UMT planning algorithm optimized by SEA classifies the road network according to the multi-scale information of the road network on the one hand, and restricts the search area reasonably on the other hand. The results show that the SEA algorithm is used to optimize the modeling stage of UMT network model CAD, and the accuracy of optimal path planning has obvious advantages over PSO and traditional GA. Experiments show that the accuracy of traffic stream prediction of this algorithm is above 95%, and the accuracy of optimal path planning is about 13% higher than that of traditional GA. Therefore, it can be proved that the application of SEA to the CAD modeling of UMT network model can improve the efficiency of UMT planning. The optimization of line network by AI algorithm can make the line optimization more scientific, rigorous and effective, enhance the toughness of line network, and improve the disaster tolerance, disaster resistance and recovery ability of large UMT line network in the face of emergencies.

5 CONCLUSIONS

UMT route planning is a complex decision-making process with multi-objectives, multi-constraints, multi-uncertainties, unmeasurable factors, large capital expenditure and long term. In this article, AI and CAD technologies are introduced into UMT planning. On the basis of the improvement of traditional GA, SEA is used to realize traffic stream prediction. Combined with different working scenarios, this algorithm is compared with other intelligent traffic planning methods. Experiments show that the accuracy of traffic stream prediction of this algorithm is above 95%, and the accuracy of optimal path planning is about 13% higher than that of traditional GA. Using technology to design UMT lines can improve the design level and efficiency and reduce the work intensity of designers. The optimization of CAD by AI algorithm can make the line optimization more scientific, rigorous and effective, enhance the toughness of the network, and improve the disaster tolerance, disaster resistance and recovery ability of large UMT network in the face of emergencies.

In this article, the research on UMT planning optimization focuses on model construction and algorithm evaluation, without human-computer interaction, and without specific consideration of external factors affecting the short-term pedestrian volume change law. The influence and sensitivity analysis of various factors on the change law in the prediction process, and how to consider these factors in the modeling process need further discussion.

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