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Optimizing Elevator Dispatching Strategy Based on Perceptron Algorithm

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Abstract: With the rapid development of high-rise buildings, the application of elevator is increasing day by day. In order to solve the problem of more reasonable and efficient operation of elevator in the peak of passenger flow, this paper identifies the characteristics of passenger flow by counting the number of up calls and down calls in a period of time, which provides a basis for the optimization of elevator scheduling and coordination control. In this thesis, the perceptron model in machine learning is used to realize the elevator traffic pattern recognition. Through the training of the existing data to construct the traffic pattern recognition model, and then through the recognition of the model to verify the test data, finally we can achieve the correct identification of the elevator traffic pattern.

1. Introduction

Generally speaking, a single elevator or multiple elevators will often encounter varied passenger flow conditions, such as ascending peak, descending peak, inter-floor traffic and idle mode[1]. Different elevator dispatch strategies should be used in changeable situations. The traditional multi-elevator group control algorithm cannot identify and learn different passenger flow conditions, resulting in poor adaptability, and thus resulting in low elevator transportation efficiency [2].

In order to solve this problem, this paper divides two traffic modes according to the passenger flow-- upward mode and downward mode. In the uplink mode, the elevator is assigned to the first floor in order to optimize the traffic conditions during the uplink rush hours. In the descending mode, the elevator is assigned to the popular floor in priority to optimize the traffic conditions during the descending peak hours.

2. Perceptron Overview and Data Analysis

2.1 An Overview of Perceptron

In this paper, the problem of elevator traffic pattern recognition is solved. The research activity will involve the application of perceptron model in machine learning. Perceptron is one of the simplest feed-forward neural network models, which it is a linear classifier composed of a linear combinator and a binary threshold element. The model can solve simple linear separable problems and achieve the effect of binary classification. To solve the problem of linearly indivisibility, multiple perceptron can be constructed to carry out variety of classification operations. The learning method of this model is supervised learning.

2.2 Data Collection

In order to obtain data samples for perceptron to learn, the author collected elevator data by visiting some of residents nearby. And then divided the data samples into two categories, one is training data (blue dots in Figure 1), the other is test data (yellow dots in Figure 1). The training data is taken as the learning sample of the perceptron model, and the test data is used as the test sample to verify the feasibility of the model.

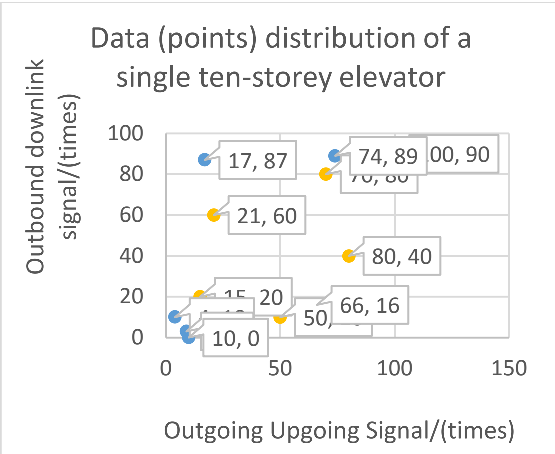

Figure 1: Data distribution of a single ten-storey elevator

3. Perceptron Modeling

3.1 Structural Perceptron

As shown in Figure 2. Two input neuron nodes P1 and P2 are determined. The former and the latter are respectively the up-going and down-going times of the external call collected by the elevator at the same time.

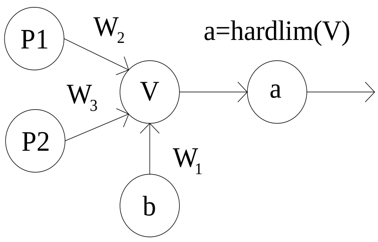

Figure 2: Perceptron structure topology

Each neuron has its own corresponding weight, respectively: w_1, w_2, w_3. The weight represents the strength weight of connections between different elements [3]. If the weight of node P1 to node V is larger, it means that node P1 has a greater influence on node V. Besides, node b as bias of neurons, it is the additional input neurons, the value is always 1, offset represents the degree of the activation of neurons, if the offset parameter is set too large, then it is easy to activate neurons, in the pattern recognition of the paper, easy to be activated to 1 class, if the offset parameter is set too small, the neurons are difficult to be activated, in the pattern recognition of this paper, it is easy to be classified into class 0. For convenience purpose, we can take the bias is treated as a fixed input with its own weight W_3 [4]. The V node is the process of all the input vectors multiplied by their respective weights to draw a hyperplane.

Before modification:

$$v = \sum_{i=1}^{N} x_i w_i + b \tag{1}$$

After modification:

$$v = \sum_{i=0}^{N} x_i w_i \tag{2}$$

Node A is the output node, and the results of node V are binarized by the activation function hardlim, thus dividing the results into two categories. Hardlim function is a threshold transfering function, and its output value Y is a matrix composed of 0 and 1.

3.2 Process Diagram

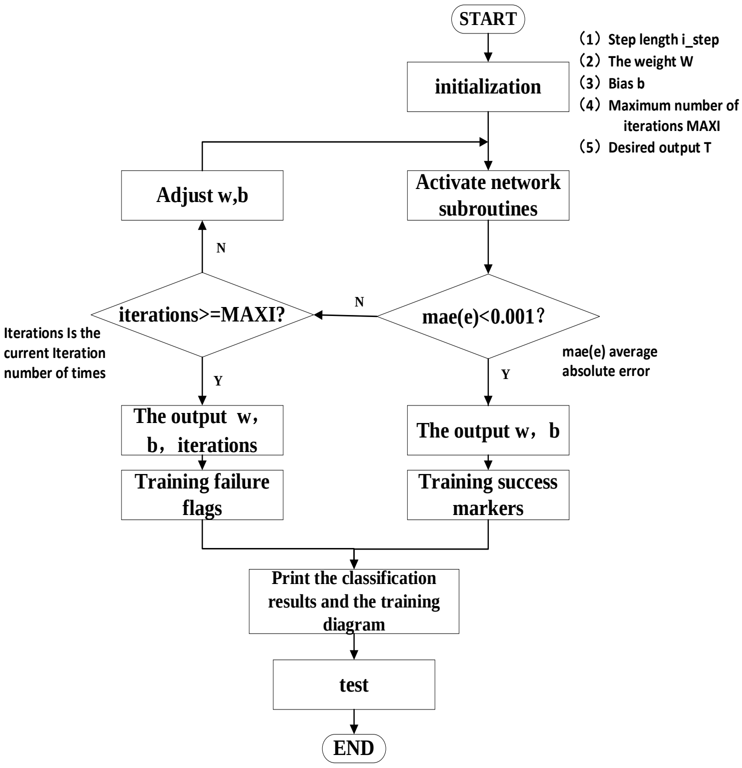

Figure 3: The flow chart

The data of the training samples collected above were taken as the input matrix P(3), and P was the sum of neurons P1, P2, and bias b. Batch input was made into the perceptron model, and various parameter variables were initialized, as shown in Figure 3.

The matrix will be put into the activation function (6) for binarization, and the two classification results are obtained, either 0 or 1. The corresponding pattern of the elevator in a training sample is judged by human experience, and the expected value of the training sample (7) is given, which means "correct answer" for the perceptron to learn. The perceptron compares its "correct answer", then the error value (8) is obtained. Using the MAE function (9) to calculate the average absolute error, we are sure to confirm the MAE function a function of net work performance one, evaluate the error range of the model and judge the feasibility of the perception model.

$$P=\begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 1 \\ 15 & 50 & 21 & 70 & 80 & 100 \\ 20 & 10 & 60 & 80 & 40 & 90 \end{pmatrix} \tag{3}$$

$$V=\sum_{i=1}^{N} W_i P_i \tag{4}$$

According to the summation formula, multiply the two matrices P and W:

$$V=WP=\left[0,0,0\right]\begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 1 \\ 15 & 50 & 21 & 70 & 80 & 100 \\ 20 & 10 & 60 & 80 & 40 & 90 \end{pmatrix} \tag{5}$$

Y is the activation function:

$$Y=\text{hardlim}(V) \tag{6}$$

T is the expected output

$$T=\left[0,1,0,0,1,1\right] \tag{7}$$

$$e=T-y \tag{8}$$

MAE function:

$$MAE=\frac{\sum_{i=1}^{N}\left|e_i\right|}{N} \tag{9}$$

The error analysis is carried out by MAE function to judge whether the perceptron can stop training. Assume that the given error range MAE is (0-0.001).

When mae(e)>0.001, if it exceeds the target value, it indicates that it is not up to the standard and enters the judgment of iteration number.

When mae(e)<0.001, within the error range, it indicates that the training meets the standard. Then, weight W and bias b are directly output to provide the symbol bit of successful training, and the classification result and training situation chart are printed to end the training.

After the error analysis, the number of iterations was analyzed again to prevent the training from failing to converge, because the maximum number of iterations (training) had been set at the third step initialization, Maxi =200.

When $\text{iterations}>200$, if the maximum number of iterations (training) exceeds, it means that the training cannot converge. Then, Z connects the output weight W, offset b, and the current training iterations, and provides the mark place of training failure, and the training is ended.

When $\text{iterations}<200$, within the maximum number of iterations (training), it means that the training has not been completed, then the weight W and offset b are readjusted and the training continues.

Readjusting the weight and bias is to make the perceptron correct by summarizing its mistakes in the last iteration, reducing the weight value for the samples with high weight and increasing the weight value for the samples with low weight. Since the bias already exists in the matrix of weights, adjusting the weight is equal to adjusting the bias. Finally, the new weight and bias (11) can be obtained by adding the weight increment (10) on the basis of the old weight.

The calculation formula of the increment of weight

$$\Delta W = n * e * P' \tag{10}$$

The new weight calculation formula

$$W_{new} = W_{old} + \Delta W \tag{11}$$

The final classification result is shown in figure 4 figure can be seen that perception machine through continuous training, could be divided into two types of model accurately, the red dot represents the downward pattern, dot represents the uplink mode, and the orange line is the classification hyperplane, figure 6 training case diagram can be seen that the number is 20 times, with the constant training perception machine, has been to reduce the error direction. As a result, the standard allowed by the error range can be reached, and the goal of successful training can be realized finally.

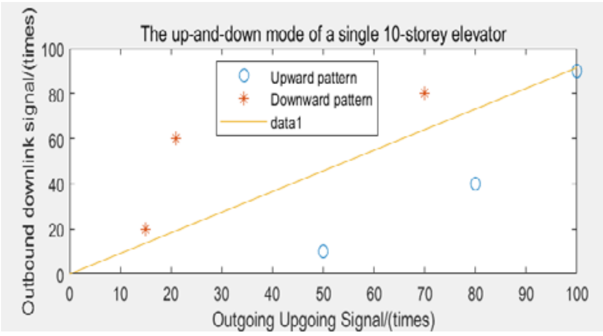

Figure 4: Classification result chart

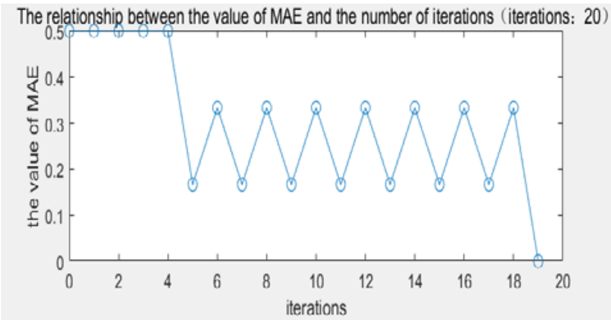

Figure 5: Training chart

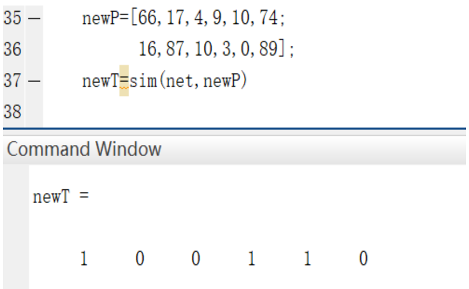

Figure 6: The calculation results

Finally, the test data was used to verify the model, and the test data was brought into the trained perceptron model (as shown in Fig. 5) for testing. The results obtained (as shown in Fig. 6) were all in line with the established pattern classification rules, and the accuracy rate was 100%. In this way, it is proved that the perceptron can judge the simple pattern classification problem more accurately.

4. Summary

The increasing world population has led to a lot of serious problems such as fossil energy depletion and climate warming, and the elevator related problems in modern high-rise buildings are also facing the same dilemma. Therefore, the severe objective reality has put forward more urgent response requirements for the optimization of the operation efficiency of the elevator as well as energy conservation and emission reduction.

Considering the reasonable application of intelligent optimization algorithm to this design project is important, therefore, this research topic in the perceptron algorithm for traditional elevator control system with the intelligent design elements, it is understood that the main goal of this article is by making ladder strategy, optimization in order to improve its efficiency, in the actual elevator operation so as to achieve the elevator dispatching elevators strategy optimization of winning trophies.

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