Research on the north polar tourism resources evaluation model based on BP neural network algorithm

Lili Jin1*

1South China College Guangdong University of Foreign, Guangzhou,510545, China
*Corresponding author’s e-mail: 204033@gwng.edu.cn

Abstract. Polar tourism resources have unique properties. The Polar resource evaluation is comprehensive and multi-angle based on communication value, cultural value, economic value, educational value and so on. A scientific and reasonable evaluation model can provide the basis for the exploitation and utilization of polar tourism resources. The purpose of this paper is to apply BP neural network algorithm to self-learning intelligent evaluation, especially those not fully explored polar tourism resources. The subjective random factors are avoided to objectively evaluate polar tourism resources.

1. Introduction

The polar regions refer to the land and sea areas within the north and south polar regions of the earth. The Arctic region refers to the north of the Arctic Circle, including the Arctic Ocean, marginal land coastal zones and islands, the Arctic tundra and the outer Taiga belt. The arctic lands outside the Arctic Ocean are divided and belong to eight countries respectively, including Russia, Canada, the United States, Norway, Denmark, Iceland, Sweden and the Netherlands. Many places are inhabited by indigenous people. Polar tourism has been on the rise in recent years, and although there are no exact statistics, the arctic tourism demand is likely to grow. The development of polar tourism represents both an opportunity and a challenge for the indigenous people living in the polar regions and for the whole world.

This paper adopts BP neural network evaluation method which is in line with the development of modern information technology, the analytic hierarchy process (AHP), expert scoring method to construct the BP network evaluation model. The model is simple to operate, and has strong fault-tolerant ability and self-learning function. It can simulate the human brain and make automatic and intelligent evaluation of tourism resources, achieving a technological breakthrough in the evaluation of Arctic tourism resources.

2. Construction of index system of arctic tourism resource evaluation model

2.1. Tourism resource evaluation index system designing

With the general understanding of arctic tourism resources, referring to relevant literature, in combination with the actual Arctic tourism situation, such dimensions as historical value, natural resource conditions, tourism environmental impact, development conditions, economic value and social value are selected with 17 specific indicators to construct the evaluation index system for BP neural network evaluation model. Four experts are invited to score 12 well-known scenic spots of Arctic tourism, and 48 data samples are obtained in the end as training input data of BP neural
network evaluation model. The specific evaluation index system is shown in Table 1. According to the evaluation indexes at each level, we construct the comprehensive factors set of arctic tourism resources [2]:

\[ U = \{C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17\}. \]

**Table 1.** Evaluation indicators of Arctic tourism resources

| The first indicators | The secondary indicators                                      |
|---------------------|-------------------------------------------------------------|
| Historical value(B1) | Cultural Heritage Value (C1)                               |
|                     | Adventure Value (C2)                                        |
|                     | Artistic Value (C3)                                         |
| Natural resource conditions(B2) | Mineral Resources (C4)                          |
|                     | Living Resources (C5)                                       |
|                     | Geothermal Resources (C6)                                  |
|                     | Marine Resources (C7)                                       |
| Tourism environmental impact (B3) | Environmental Pollution and Protection (C8)               |
|                     | Ecological Balance and Restoration (C9)                    |
|                     | Impact of Human Living Environment (C10)                   |
| The development condition(B4) | Pleasure (C11)                                             |
|                     | Singularity (C12)                                           |
| Economic value(B5) | Tourism Value (C13)                                         |
|                     | Reuse Value (C14)                                           |
| Social value (B6) | Standard of Living (C15)                                    |
|                     | Social Security (C16)                                       |
|                     | Economic Growth and Social Development (C17)                |

2.2. Determining the weight of the evaluation indicators of Arctic tourism resources

In this paper, four tourism experts from universities in Guangdong province were selected and 48 questionnaires were distributed. We selected 12 tourist attractions in the Arctic region, including Svalbard, Iceland, Greenland, Lapland, Longyearbyen, Tromso, Yakutsk, Magadhan, Dikesi, Chukchi, Alaska, and the North Pole. So there are 48 questionnaires, and all the expert questionnaires recollected are valid. Through expert questionnaire data, using the analytic hierarchy process (AHP) to construct judgment matrix of tourism resources evaluation index system, we compared the importance of two factors, adopted the method of 1 to 9 scale, given the number of scale, so as to get the original weight of each evaluating index of arctic tourism resources, and the weight ranking of all indicators (see Table 2), and the degree of consistency of indicators is relatively high [3].

**Table 2.** Overall weight and ranking

| Level | B1 0.3818 | B2 0.0921 | B3 0.0948 | B4 0.1264 | B5 0.2605 | B6 0.0443 | Weightings | Sorting |
|-------|-----------|-----------|-----------|-----------|-----------|-----------|------------|---------|
| C1    | 0.2003    |           |           |           |           |           | 0.2003     | 1       |
| C2    | 0.1274    |           |           |           |           |           | 0.1274     | 2       |
| C3    | 0.0541    |           |           |           |           |           | 0.0541     | 7       |
| C4    | 0.0520    |           |           |           |           |           | 0.0520     | 8       |
| C5    | 0.0098    |           |           |           |           |           | 0.0098     | 15      |
| C6    | 0.0137    |           |           |           |           |           | 0.0137     | 13      |
| C7    | 0.0165    |           |           |           |           |           | 0.0165     | 12      |
| C8    | 0.0247    |           |           |           |           |           | 0.0247     | 10      |
| C9    | 0.0600    |           |           |           |           |           | 0.0600     | 6       |
| C10   | 0.0101    |           |           |           |           |           | 0.0101     | 14      |
| C11   |           | 0.1054    |           |           |           |           | 0.1054     | 4       |
| C12   |           | 0.0651    |           |           |           |           | 0.0651     | 11      |
| C13   |           |           |           |           |           | 0.1954    | 0.1954     | 3       |
3. The construction of the Arctic tourism resource evaluation model

3.1. Data collection and collation
The questionnaire is designed according to the comprehensive evaluation index system of Arctic tourism resources, then scored by relevant experts and scholars, in which the data in this paper are obtained.
At the same time, we designed a questionnaire according to the Likert scale, that is, according to the five-level assessment method, including "very important", "important", "ordinary", "unimportant" and "very unimportant", 5 marks is the full mark. Then according to the weights determined by AHP, we calculated the weighted average score, so as to obtain the final score of each scenic spot.

3.2. Evaluation model designed based on BP neural network algorithm

3.2.1. Determine the layer number of BP neural network. At present, there is no specific rule for determining the number of layers in the neural network, so we can set one or more hidden layers. Generally, a three-layer neural network can map the space from Y dimensions to X dimensions. In addition, with the increase in the number of hidden layers, the network training accuracy of current training can be improved. In this paper, we use three-layer BP neural network to construct the Arctic tourism resource evaluation model.

3.2.2. Determine the number of neurons in each layer. The number of neurons in the input layer refers to the number of input vectors, that is, the number of evaluation indicators of Arctic tourism resources in this paper. Therefore, the number of neurons in the input layer is 17. In addition, the final comprehensive evaluation scores are determined by the designated scenic spot, so the number of neurons in the output layer is 1. For the hidden layer, we use the empirical formula to calculate, and finally, 14 is determined as the appropriate number of hidden layer neurons.

3.2.3. Select the initial value. BP neural network specifically deals with the problem of linear inseparability, and Sigmoid function is generally used as the transfer function. Sigmoid function maps the input range from negative infinity to positive infinity between (-1,1) or (0,1). When setting the initial value, we must pay attention to the fact that if the value is too large, it is easy to cause the weighted sum of the input belong to the saturation area of S-type activation function, then fail to complete the training target. Therefore, it is necessary to normalize the data, and make the value range between (-1,1), so that the larger data can fall in the region where the large gradient of the transfer function.

3.2.4. Determine the learning rate and the expected error. When training neural network, a suitable learning rate is needed, because it affects the variation of weight. If the set value is too large, the network will be unstable; if the set value is too small, the training time will be increased, the convergence will be slowed down, and the error cannot be approached to the minimum. Therefore, when network training is carried out, a smaller learning rate should be set so that the network can be ensured to be relatively stable. Generally, the learning rate is between 0.01 and 0.8.
The expected error is not set randomly according to anyone’s requirements, but by testing with different error values, and finally, a suitable value can be determined. So the expected error value is related to the number of neurons in the hidden layer.
3.2.5. **Data preprocessing.** In order to speed up the neural network training and ensure its training accuracy, some methods must be used to process the input and output data. In this paper, we use the deviation standardized formula to normalize data, that is, convert the input data and result data into the data between (0,1).

3.3. **Realization of arctic tourism resource evaluation model**

In this paper, we use Python3.7 to construct BP neural network model. We collected 12 samples in the study, the first 10 samples are training samples and the last 2 samples are test samples. Then we input data to training samples and test samples. Among them, each group of samples contains three types of data: actual output, expected value and input. The input value is the score of the input 17 indicators; The actual output value is the final score of each sample obtained from network training; Expected output value is the weighted average score of each scenic spot evaluated by experts. [4].

The model results and errors after the training can be seen in Table 3. The difference between the final actual output value and the expected output value is already very small. That is to say, through the training of BP neural network, the output results ("actual output" column) are basically consistent with the actual scoring results of experts ("expected output" column), and the error has been within the acceptable range, which can meet the modeling requirements of statistics[5].

| Table 3. Analysis table of training sample results |
|---------------------------------------------------|
| The training sample | 1 | 2 | 3 | 4 | 5 |
|---------------------|---|---|---|---|---|
| The output          | 0.9894 | 0.2085 | 0.5539 | 0.3667 | 0.8197 |
| Expectation result  | 1 | 0.2143 | 0.5533 | 0.3694 | 0.8340 |
| Error               | 0.0106 | 0.0129 | 0.0005 | 0.0027 | 0.0143 |

After completing the neural network training in the previous step, put the selected test samples into the current network for testing. The results are shown in Table 4[6]:

| Table 4. Sample test results analysis Table |
|---------------------------------------------|
| The training sample | 1 | 2 |
|---------------------|---|---|
| The output          | 0.7276 | 0.0179 |
| Expectation result  | 0.7175 | 0 |
| Error               | -0.0101 | 0.0118 |

According to the final output results of the test samples, the error of the simulation results is below 0.02, which is a good evaluation result. The result also shows that the BP neural network can be used to evaluate the knowledge and experience of experts to a large extent, and the test data can be judged accurately and reliably. It also proves that the neural network can be used to evaluate the Arctic tourism resources.

4. **Conclusion**

In this paper, BP neural network evaluation method is adopted to train and test data of 12 scenic spots in the Arctic, then we obtained a relatively stable Arctic resource evaluation network system, to verify the stability and accuracy of the Arctic tourism resource evaluation model. The main research results are as follows:

(1) Establishing an index system of the Arctic tourism resource evaluation model, to comprehensively evaluate the representative scenic spots of the Arctic tourism resources. In terms of the weight value of the indicators, the top four are cultural heritage value, adventure value, tourism value and pleasure
sense, indicating that the evaluation of the Arctic tourism resources should focus on historical value, development value and economic value.

(2) Establishing an index system of the Arctic tourism resource evaluation model based on BP neural network, which can serve as a stable, objective and reliable assessment tool for the Arctic tourism resources evaluation. In this paper, we collected 12 arctic tourist attractions data by expert scoring method, and selected 10 scenic spots data as training data, adjusted the weights and thresholds, and changed the number of hidden layers by empirical value. The training didn’t stop until stable and reliable neural network model with the error value within 0.001 was established. Then, the data of the other two scenic spots are taken as samples to test the stability and reliability of the neural network system. We obtained scores from the evaluation model, then according to the pre-set rating level, the rating position of the input scenic spot can be determined.

Acknowledgments
Research on the Construction of Tourism Cooperation Mechanism between Guangdong and Arctic countries, project No.: 19JD001A

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