Solutions to the Site Selection of MNCs based on Language Research

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Abstract: Our team had completed the required research and analysis of trends in development of the global languages, and then we had solved the questions of the number and location of the site selection of international offices for multinational companies. On one hand, using the GM-BPANN combinatorial model, the trend of the number of users in the ten major languages given in the topic was predicted. Based on this, the number of users in different languages over time was described. On the other hand, considering the multiple factors, we selected 12 alternative locations; the PCA-TOPSIS model was then used to calculate the relative closeness degree of the 12 candidates addresses and sorted out the 6 cities that were ranked at the top. That was the location of establishing global offices. They are in Mexico City, Istanbul, Paris, Bangkok, Tokyo and Melbourne. They use Spanish, Turkish, French, Thai, Japanese, Chinese. Finally, we conducted a sensitivity analysis of these models to verify the robustness and stability of the models.

Keywords: GM-BPNN model; TOPSIS model; Multi-objective programming; Population migration algorithm based on ANN

1. Introduction

Currently, about 6900 languages are still uesd all over the world[1]. Nowadays, the distribution of languages and their population in the world is very uneven. About half of the world's population is native speakers of one of the following ten languages (arranged by language usage): Mandarin (including standard Chinese), Spanish, English, Hindi, Arabic, Bengali, Portuguese, Russian, Punjabi and Japanese, with as many as 96% of languages being used by only 4% of the world's population. Most languages are used by very few people. However, many people in the world speak a second language, and when considering the total number of speakers in a particular language (native speaker or second and third language users), a language and its list of available native languages The order of arrangement will change. The total number of speakers in one language may increase or decrease over time, with many variables, such as the language used and promoted by a government, the language used in schools, social pressures, immigration and assimilation of cultural groups , As well as immigrants and immigrants from countries that speak other languages. In addition, as globalization progresses, the geographical distribution of languages continues to change as a result of population movements and population movements, enabling even those geographically distant languages to increase their global travel through international business relationships Industry, electronic communications and the use of social media and other factors; In addition, it also brought great convenience to the recruitment of transnational corporations[2].

2. Restatement of the Problem

We were called upon to investigate the development trend of global languages, establish model analysis and predict the future changes and geographic distribution of various languages. Take into account this, we will address the issue of siting international offices under multinational service companies and strive to reach a site based on a combination of factors Problem optimization. The list shows list of languages by total number of speakers and list of 50 million or more total speakers.
We face mainly five problems:
First of all, establish a mathematical model to describe the changes in the number of people in different languages over time;
Secondly, predict the number of native speakers and the total number of people using the language in the next 50 years and analyze the changes in the current ten languages in the future;
Thirdly, Analyze population migration patterns and predict trends in the geographical distribution of languages in the next 50 years;
Then, comprehensive analysis, select the best six international offices location and language;
Finally, optimize the number of international offices to obtain a minimum number.

3. Establishment of GM-BP Neural Network Combination Model

Combining with the above processed numbers of people in various languages of the world from 1960 to 2016, we

use the gray prediction model to predict the future number of users in each language. At the same time, the BP neural network is used to further improve the accuracy of the prediction data and predict trends of the number of language users. The following is the process of establishing BP neural network model[3]-[6] :

The BP neural network algorithm obtains the proper linear or non-linear relationship between input and output through the "training" event. The process of "training" can be divided into two stages: forward transmission and backward transmission:

Step1: Forward transmission phase:

Take a sample from the sample set P_i , Q_j , Enter P_i into the network. Calculate the error metric E_1 and the actual output :

$$O_i = F_L(\ldots(F_2(F_1(P_iW^{(1)})W^{(2)})\ldots)W^{(L)}) \quad (1)$$

Adjust each weight value $W^{(1)}W^{(2)}W^{(3)}\ldots W^{(L)}$, Repeat this cycle until $\sum E_i < \varepsilon$.

Step2: Back propagation stage - Error propagation stage:

Calculate difference between the actual output O_p and the ideal output Q_i ;Output layer weight matrix is adjusted by error of output layer;

$$E_i = \frac{1}{2}\sum_{j=1}^{m}(Q_{ij} - O_{ij})^2 \quad (2)$$

This error is used to estimate the error of the direct predecessor of the output layer and then the error of the preceding layer of the output layer to estimate the error of the previous layer so that the error estimates of all other layers are obtained.

These estimates are used to modify the weight matrix, forming a process that steps the error shown at the output stage by stage to the output stage in the opposite direction of the output signal.

Network Error Measurements for the Whole Sample Set: $E = \sum_i E_i$.

Through MATLAB software, We apply the processed data into the above gray prediction - BP neural network combination model, then you can get the next few decades the trend of changes in the number of languages. Here we take the prediction of English as an example, the same can be obtained, we can get the number of predictions of the number of other languages in the future. The trend of the number of languages in the coming decades over time is shown as follows. From the figure, we can see that the number of most languages in the coming decades is increasing, but the magnitude of each language varies greatly. Among them, Hindi has the largest increasement, which is expected to overtake Chinese around 2024, becoming the world's most-used language, and in the next 50 years it will have maintained a high growth trend; English, which has the slowest trend of growth distribution in the current world, to be overtaken by Arabic in about 2064; similarly, Spanish will be transcended in Arabic in 2039; Russian has the smallest increasement, and the number of speakers of Russian in the future will be less than other languages.

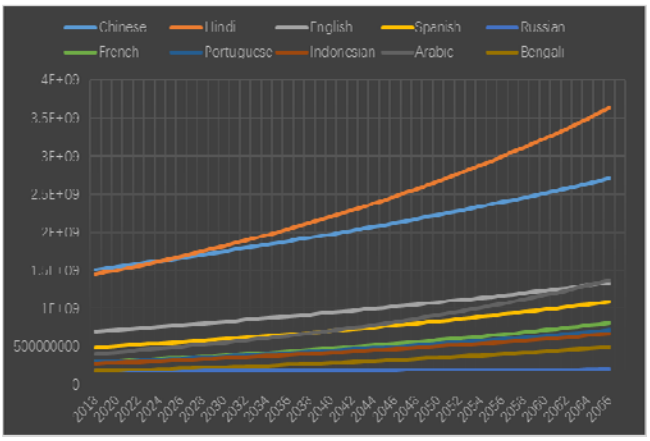

Figure 1. Prediction of the number of speakers in the world's major languages

Based on the above gray prediction-BP neural network combination model, we get the number of users in various languages of the world for the next 50 years as the following table shows:

Table 1. The Current Top Ten List of Languages

1	**2**	**3**	**4**	**5**
Chinese	English	Hindi	Spanish	Arabic
6	**7**	**8**	**9**	**10**
Indonesian	Russian	Bengali	Portuguese	French

Table 2. The List of Top Ten Languages after Fifty Years

1	**2**	**3**	**4**	**5**
Hindi	Chinese	Arabic	English	Spanish
6	**7**	**8**	**9**	**10**
French	Urdu	Portuguese	Nigerian	Indonesian

It can be seen from the table that Bengali is no longer in the top 10 list, and Urdu is added. Other languages that are still in the top 10 are also slightly changed in rankings. The number of Native Hindi speakers will be more than Chinese and become the first language in about 2024 . This is in line with the higher population growth rate of India in recent years;, Arabs The number of speakers who have been used as their mother tongue will be the third highest respectively in English and Spanish, followed by English and Spanish in fourth and fifth respectively in 2039 and 2064.

4. Establishment and Solution of PCA-TOPSIS Combination Model

According to the data about the influencing factors in each city obtained from the first step, we establish the principal component analysis model and obtain the weight of each attribute through the SPSS software.[7] The result is as follows:

Table 3. Weight of Each Factor

Index	Weights
Population/ Thousand	0.193432
GDP/Billion dollars	0.257604
Construction costs/ Thousands dollars	0.088439
Infrastructure investment/ Billion dollars	0.182554
Government subsidies/ Thousands dollars	0.27797

According to the data about the influencing factors and weights of the various influencing factors obtained in the second step from the first step, we set up the TOPSIS model and calculate the relative closeness of each place by MATLAB software to sort them. The six final locations are: Mexico City, Istanbul, Paris, Bangkok, Tokyo, Melbourne.

Table 4. Relative Closeness of Locations

City	Mexico City	Istanbul	Paris	Bangkok	Tokyo	Melbourne
Closeness	0.999998	0.959052	0.614224	0.607759	0.575970	0.524784
City	**London**	**Moscow**	**Sao Paulo**	**Madrid**	**Dubai**	**Singapore**
Closeness	0.509698	0.312500	0.146552	0.079741	0.010237	3.69E-08

Six locations were marked with blue solid dots on the map, the distribution is as follows:

Figure 2. Distribution of six locations

Based on the final results of the model, we propose to set up international offices in six locations: Mexico City, Istanbul, Paris, Bangkok, Tokyo and Melbourne.[8] The six international offices will use Spanish, Turkish, French, Thai, Japanese, Chinese (second language of Australia). In the long run, there will be a big change in the number of people in all languages in the world, so in the long run, the locations of international offices will be slightly different[9].

5. Sensitivity Analysis

5.1. The change of the forecast years in the grey prediction model

Gray prediction model is suitable for short-term prediction. We use MATLAB software to predict the number of speakers in the next 50, 60, 70, 80, 90, 100 years. We find that there is a big error in predicting the number of years over 90 years, When the prediction is less than 90 years, the error is within our acceptable range.

5.2. The increase of the number of schemes in the TOPSIS model

The weight of each attribute value of a small disturbance Δw_i, $\Delta w = \{\Delta w_1, \Delta w_2, \ldots \Delta w_n\}$, If the disturbance of the weight coefficient satisfies $\|\Delta w\| < \frac{h}{n\|V\|}$, then the result of the decision remains unchanged in this disturbance.[10] Each property value of the small disturbance Δx_{ij}, $\Delta A = (\Delta x_{ij})$, If the disturbance value of the property value satisfies $\|\Delta V\| < \frac{h}{n\|w\|}$, then the result of the decision remains unchanged in this disturbance.

6. Conclusion

In this article, we have built a total of two models and evaluate these four models. First of all, this paper establishes a gray prediction - neural network combination model to predict the language development trend in the next 50 years and analyzes the changes of language usage. Then, in combination with the company's site selection criteria, 12 alternative addresses are selected to establish the Principal Component Analysis-TOPSIS Combinatorial Model to evaluate these 12 locations, then select the top 6 locations as the company's new international office location; And finally, we build a multi-objective optimization model that maximizes revenue and minimizes costs six locations were optimized to determine if the number of new international offices could be less than six. At the end of the thesis, the above models are evaluated and the main advantages and disadvantages are summarized, and verify the robustness and stability of the model.

References

[1] Chen, Chun-I., and Shou-Jen Huang. "The necessary and sufficient condition for GM (1, 1) grey prediction

model." Applied Mathematics and Computation 219.11 (2013): 6152-6162.

[2] Hsu, Che-Chiang, and Chia-Yon Chen. "Applications of improved grey prediction model for power demand forecasting."Energy Conversion and management 44.14 (2003): 2241-2249.

[3] Kumar, Ujjwal, and V. K. Jain. "Time series models (Grey-Markov, Grey Model with rolling mechanism and singular spectrum analysis) to forecast energy consumption in India."Energy 35.4 (2010): 1709-1716.

[4] M. Brenzinger, Langues minoritaires: unéritage eulturel, Diogèue , No. 161,1993

[5] http://www.shihang.org/

[6] Karsoliya, Saurabh. "Approximating number of hidden layer neurons in multiple hidden layer BPNN architecture."International Journal of Engineering Trends and Technology3.6 (2012): 714-717.

[7] Hu, Hsiu-Yuan, et al. "Using BPNN and DEMATEL to modify importance–performance analysis model–A study of the computer industry." Expert Systems with Applications 36.6 (2009): 9969-9979.

[8] Kashem, Mohammod Abul, et al. "Face recognition system based on principal component analysis (PCA) with back propagation neural networks (BPNN)." Canadian Journal on Image Processing and Computer Vision 2.4 (2011): 36-45.

[9] Holland, Steven M. "Principal components analysis (PCA)."Department of Geology, University of Georgia, Athens, GA(2008): 30602-2501.

[10] Zong_yuan, Zhou Yong_hua Mao. "A New Search Algorithm for Global Optimization: Population Migration Algorit hm (I)[J]."Journal of South China University of Technology (Natural Science) 3 (2003).