The application of tools of neural networks and artificial intelligence in the recreational sphere

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Abstract. The developed neural network mathematical model designed to assess the effectiveness of inbound tourism in various regions of the country. Using the mathematical model, the distribution of the significance of factors influencing the choice of tourists when visiting certain regions is revealed, which should be taken into account when adjusting the federal and regional policies in the field of tourism and recreational activities. The use of this kind of computer program will allow experts from relevant departments and travel agencies to increase the validity of managerial decisions and strategic developments. Thus, the competitiveness of the regions is enhanced and a new approach to the development of the recreational sphere is introduced.

1. Introduction
The recreational area, like any other business area, needs mathematical computer modelling. However, due to poor formalisability of knowledge, as well as a large number of factors affecting on the result of modelling, as a rule, it is not possible to build high-quality mathematical models by traditional deterministic methods in the field of tourism. In this case, the use of a neural network technology device can be effective. [1, 2, 3, 4].

2. Materials and methods
In the paper, there were used general scientific and special research methods to solve mentioned aim. There are graphical analysis, statistic, techno-economic, expert estimation method. It was studied theoretical and applied papers on the research topic [1-26], also official statistics data. For developing the neural network used Matlab and Nnstar module.

3. Results
Fuzzy neural networks are systems that operate in conditions of uncertainty, when the information supplied to the input may be incomplete or fuzzy. Using conventional information processing, it is not
possible to solve applied problems in many subject areas if it is impossible to obtain complete information for them and if their definition is not complete enough. This situation is typical for:

- complex technical systems;
- systems of economic planning;
- social systems of large dimension;
- decision making systems, etc.

Along with the term "soft computing", the term "computational intelligence" is used - a scientific field where artificial intelligence problems are solved on the basis of the theory of fuzzy systems, neural networks and evolutionary (genetic) computing. [6, 7, 8, 9, 10].

Fuzzy neural networks with genetic tuning of parameters (hybrid systems) demonstrate mutual enhancement of strengths and leveling of disadvantages of individual methods. The representation of knowledge in neural networks in the form of weight matrices does not explain the results of recognition or prediction, whereas in output systems based on fuzzy rules, the results are perceived as answers to the questions “why?” [11,12,13,14,15].

According to the World Tourism Organization at the UN (UNWTO), Russia ranks 16th in the world in the number of foreign tourists and 9th in Europe (25.8 million tourists in 2019).

A Strategy for the development of tourism in the Russian Federation until 2035 adopted. The data provided in the published document is not very encouraging. For example, placements available in the regions are filled on average by no more than 35%. More than 50% of taxes collected from collective accommodation facilities and public catering establishments are accumulated in the capital centers - Moscow and St. Petersburg. The tourist activity of the Russians remains low - only 46% of the country’s inhabitants have been vacationing outside their region for the past five years[16,17,18,19,20].

Only 5% of foreign visitors purchase package tours for traveling to Russia. The rest prefer to independently organize their holidays in Russia. At the same time, according to the survey, 18.4% of foreigners use aggregators like Booking.com to book their stay in hotels and other accommodation facilities. The average share of foreigners in the number of placed is 6.7%, and the average share of income from the provision of services to foreign citizens in revenue is 7.2%.

Also, experts considered that on average foreign tourists stay in Russia for about 8 days. Moreover, they often move between cities of Russia, spending in the same city no more than 1-3 nights. According to analysts, the average budget for a trip of a foreigner to Russia is 144 thousand rubles. About 23% of the total amount is spent on accommodation, 24% on international transport, 19% on food, and 9% on domestic passenger transport.

As for the official statistics of inbound tourism in Russia, everything is not so simple here.

The Federal State Statistics Service (Rosstat) keeps track of foreign tourists by region only by the number of accommodated in collective accommodation facilities, that is, in hotels. The data is updated every quarter, and the final, updated analysis for the year is done in the summer of next year. According to preliminary data, the number of foreign citizens placed in collective accommodation facilities in 2019, regardless of the purpose of arrival and length of stay, is 10 166 675 people (in 2017 - 8 040 846 people).

There is also information from the border service of the FSB of Russia on the number of foreign citizens entering our country, by country.

So, according to the FSB for 2019, 4.19 million foreigners entered our country for tourist purposes. The leaders were: China (1 256 515 people), Germany (451 467), Republic of Korea (342 308), USA (227 656), Israel (163 664), Italy (126 875), Great Britain (125 710), France (116 513), Spain (85 314), Japan (61 222).

More than 7.25 million people came to Russia for business purposes. But here the top ten leaders look different: Uzbekistan (about 1.4 million people), Tajikistan (790 thousand), Poland (603 thousand), Ukraine (593 thousand), Finland (557 thousand), Kyrgyzstan (531 thousand), China (362 thousand), Estonia (354 thousand), Armenia (330 thousand), Kazakhstan (268 thousand). Although citizens of Uzbekistan, Tajikistan, Kyrgyzstan and other former Union republics who come to work for us are difficult to call tourists, they all fall into the general statistics of the industry.
Using a neuromodel, an attempt was made to rank the regions of the country by the level of development of inbound tourism. For the rating, the following criteria were selected for assessing the regions:

- the total number of foreign tourists accommodated in collective accommodation facilities according to the Federal State Statistics Service (Rosstat) for 2019;
- the number of accommodated foreign tourists per year per 1000 inhabitants of the region (according to the Rosstat for 2019);
- increase (decrease) in the number of foreign tourists compared to the previous year (data for 2018 and 2019 provided by the Rosstat).

So, the first, “golden” rating group with the code name “5 stars” included the regions from 1st to 20th place is presented in Figure 1.

Design, optimization, training, testing of the neural network and experiments on the neural network mathematical model were performed using Neural Network Toolbox (NNT). The optimal structure of the neural network was a perceptron with 12 input linear neurons, 8 sigmoid neurons of the hidden layer and 7 sigmoid output neurons [21, 22, 23].

Testing of a trained and optimized neural network was carried out using examples obtained using similar polls, but which were not used for training and optimization of the neural network [24, 25, 26].
Real estimates of experts and predicted values of the neural network coincide in 87.2% of cases, thus, the error of its forecasts on test cases was 12.8%.

A table was prepared for each of the criteria and a corresponding ranking was conducted from 1st to 85th place. The first place in each table gave 8.5 points. For each subsequent place, 0.1 points were removed. So, three intermediate tables formed a summary table, where the leaders and outsiders of the National Inbound Tourism Rating-2019 were determined by the total points.

Also, the compilers gave informal names to the rating groups. They are associated with the classification of hotels and designations of the level of service, adopted around the world: "5 stars", "4 stars" and "3 stars".

Moscow is the undisputed leader in the number of foreign tourists received. The northern capital is the second most popular region among foreigners. Primorye turned out to be in third place by chance (read the comments of our experts). The region bypassed the Moscow region, which took 4th place in the ranking, in such indicators as the number of tourists per 1000 inhabitants, and the growth of foreigners. It turned out to be the only Far Eastern region in the group called “5 stars”.

Located in 5th place, Krasnodar Territory is one of the 9 regions of the "golden" twenty that hosted the matches of the World Cup in 2018. The increase in the number of tourists compared to last year (criterion No. 3) allowed them to occupy leading positions in the ranking. So, the Sverdlovsk region, in the capital of which, Yekaterinburg, hosted matches, the only one from the Ural Federal District fell into this group. At the same time, explaining their high positions with one football is wrong. Yekaterinburg is the largest business center of the Urals. The Krasnodar Territory is the sea, beaches and health resorts, to which foreign tourists from neighboring countries, the CIS countries, travel in large numbers.

The hit in the TOP-20 of the Murmansk region is explained by the fact that the region is mostly located beyond the Arctic Circle and tourists from all over the world come here to see the northern lights. The only representative of the Siberian Federal District in the twenty was the Novosibirsk region, which took 19th place in the ranking. The capital of Siberia has one of the largest airports in the country with a passenger flow of more than 5.9 million people in 2019. Unfortunately, not a single region of the North Caucasus Federal District is included in the group of leaders, and there is something to think about for the relevant ministries and departments.

An attempt was also made to zoning the stable and unstable states of the recreational sphere based on the MATLAB option to identify peaks of stable zones.

Figure 2 shows the distribution of investment efficiency and the level of competitiveness of individual regions in the field of tourism and recreation.

![Figure 2](image-url)
4. Conclusions
The developed neural network mathematical model designed to assess the effectiveness of inbound tourism in various regions of the country. Using the mathematical model, the distribution of the significance of factors influencing the choice of tourists when visiting certain regions is revealed, which should be taken into account when adjusting the federal and regional policies in the field of tourism and recreational activities. The use of this kind of computer program will allow experts from relevant departments and travel agencies to increase the validity of managerial decisions and strategic developments. Thus, the competitiveness of the regions is enhanced and a new approach to the development of the recreational sphere is introduced.

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