ANALYSIS AND DEVELOPMENT FORECAST OF RUSSIAN TRUNK AIRLINE NETWORK

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Abstract. Trunk airline network in Russia is socially demanded, because it is aimed at meeting the transportation needs of the population. This research considers the network of domestic trunk airlines as a mathematical object. The research sets out eight basic optional models of existence conditions for through domestic air service in Russia, with different principles for choosing a set of elements for the training set, as well as principles for composing the elements as such. The research analyses the simulation model of domestic trunk airline network for 2006. Evaluation of the simulation model was based on the proportion of rightly forecasted existent and non-existent airlines.

Keywords. Airline network, existence conditions (for airlines), through air service, fuzzy modelling, fuzzy neutral network, network forecasting.

1 Introduction

This research is aimed at developing 10-15 years' forecast of passenger aircraft fleet sufficient for the predicted passenger traffic of the target airline. Traditional forecasting methods for passenger air travel, such as trend extrapolation, regression analysis and empirical modelling imply a strictly limited number of parameters, while other relevant parameters are not considered. That makes expedient forecasting via information models, based on a large number of relevant parameters, including statistical data.

2 Development of model of existence conditions for airlines

Complex system models and transportation models in particular prove to be inefficient as long as the initial description of original system is incomplete and imprecise. In such cases fuzzy modelling can be applied. [1] Framework of fuzzy sets theory and fuzzy logic allows to formalise linguistic data so that thay can be used to develop mathematical models.

Forecast of passenger air traffic for domestic Russian trunk airlines includes two stages (see Fig. 1). The first stage involves airline network forecast as well as identification of city pairs connected by through air service in the target year. For doing so existence conditions for airlines should be developed which are time-insensitive and do not change depending on a particular city pair. At the second stage forecast of passenger air traffic for the prepared model of airline network is made.

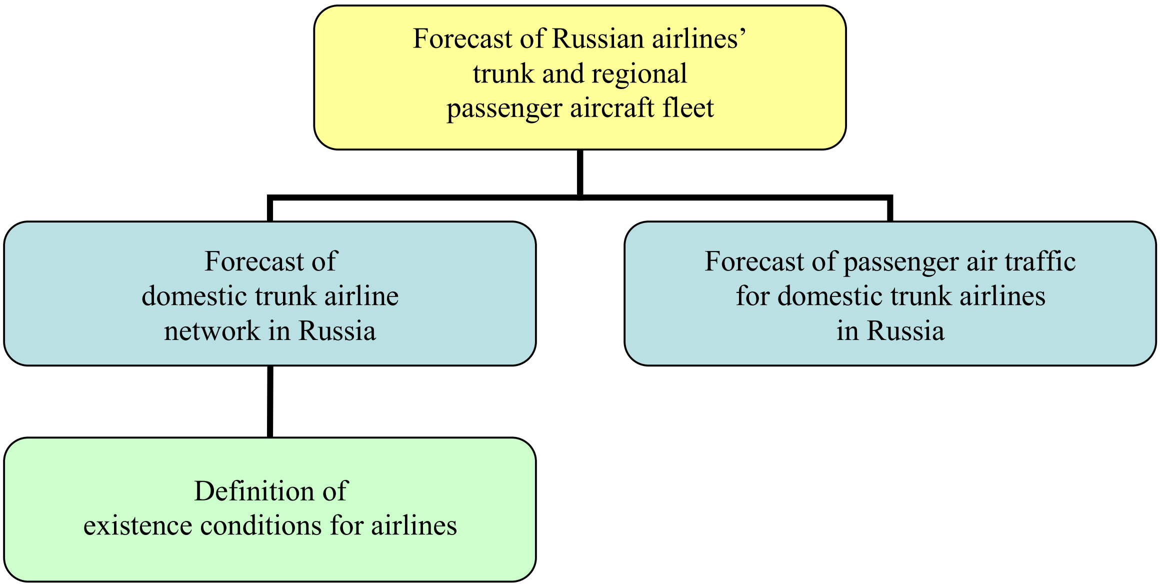

Figure 1: Analysis of passenger air traffic for trunk Russian airlines.

Existence conditions for airlines are developed with the help of mathematical framework used in fuzzy neural network, which encompasses the advantages of both artificial neural networks and fuzzy logic systems. The neural network in question was developed in ANFIS (Adaptive Neuro-Fuzzy Inference System) which is a part of MATLAB [2] neural network toolbox (see Fig. 2). ANFIS models Sugeno's fuzzy interference method using a feed-forward neural network with five layers.

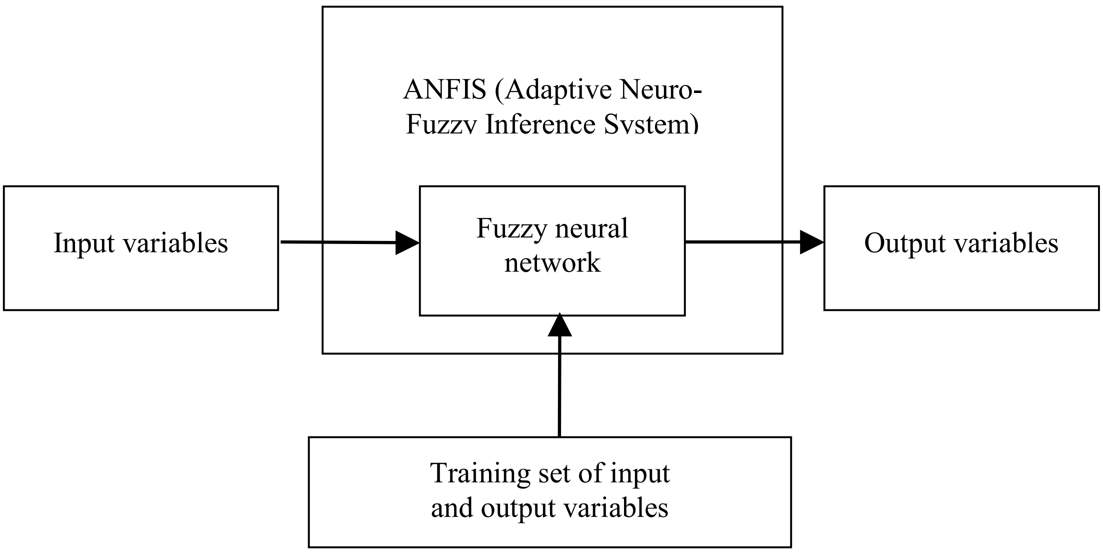

Figure 2: Adaptive neuro-fuzzy output system.

The key stage of neural network deployment is the learning process [3]. Our research sets out eight alternative training sets, the so-called models of existence conditions for airlines. The models are grouped on the basis of 2 parameters, the principle for choosing a set of elements for the training set and the principle for composing the elements as such. A training set element comprises seven characteristics: existence/non-existence of an airline between a given city pair, and 6 characteristics of the connection as ‘the key demand generator’ and the cities as ‘destination’. The training set uses statistical data on variable parameters for 2006 [4, 5, 6], as well as data on existing domestic trunk airlines in Russia for 2006, which are set out in OD matrix below (see Fig. 3).

Figure 3: OD matrix showing data on airlines between cities in Russia for 2006
(airlines existent in 2006 are shown in black, those non-existent are shown in white).

3 Results evaluation

The learning process results in a set of rules, defining whether an airline in the model exists between the city pair under the given values of variable parameters. The results are set out in the model OD matrix below (see Fig. 4). Evaluation results of element-by-element comparison of the two matrices (Fig. 3-4) indicates how valid the developed models of existence conditions for airlines are.

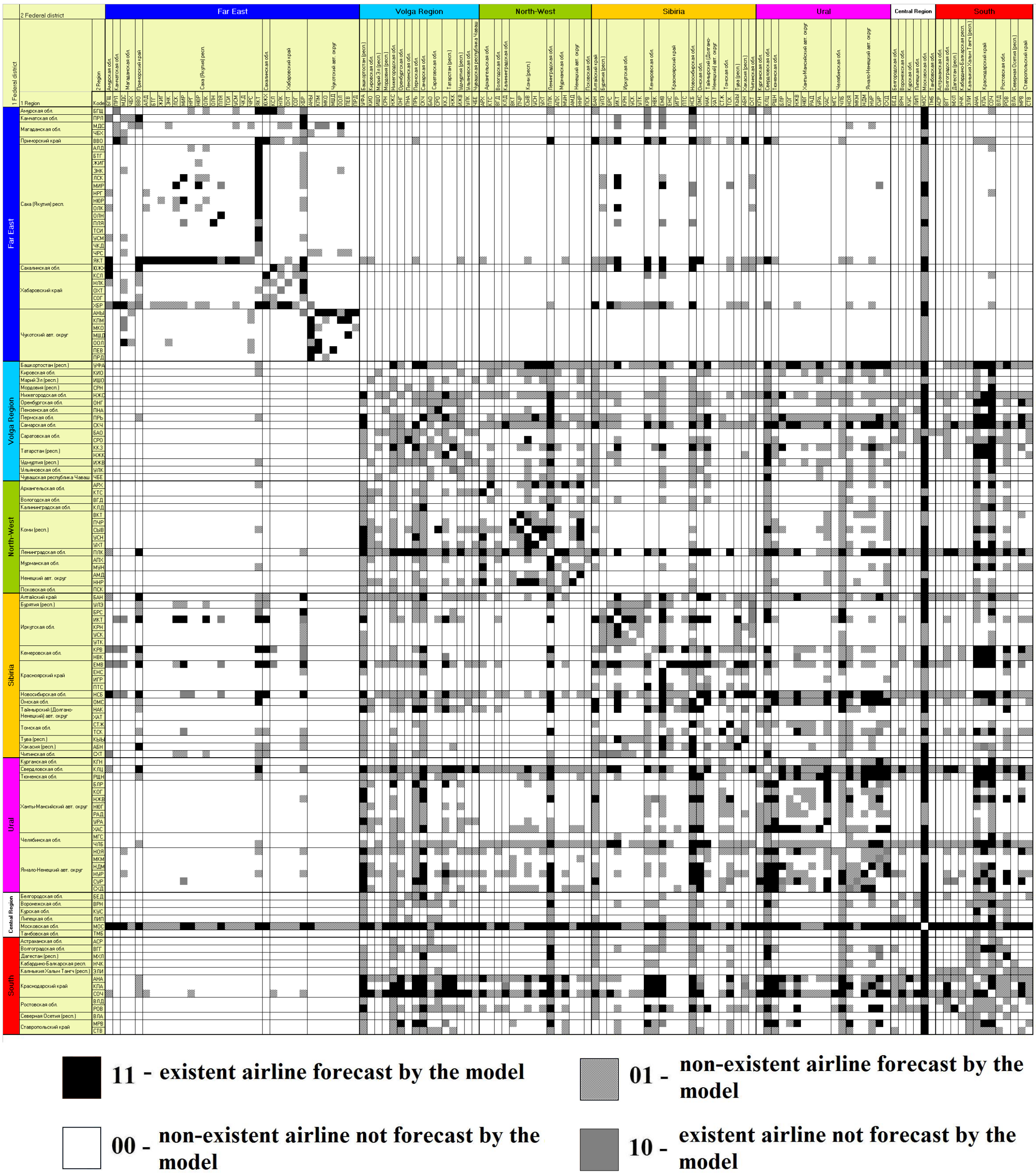

Figure 4: Sample model OD matrix

4 Conclusion

After solving a number of problems, it was concluded that efficient forecast of airline network needs to be based on information models and state-of-the-art mathematical methods, including neural programming, factor analysis and fuzzy modelling.

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