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Topic (ii): Development strategies for statistical information system

MUNICIPALITIES CLASSIFICATION BASED ON FUZZY RULES

Supporting paper

Submitted by Infostat, Slovak Republic¹

Summary

1. A knowledge-based fuzzy system for municipality classification is presented in the paper. Real data from the MOŠ/MIS information system (Mestská a Obecná Štatistika/ Mestský Informačný Systém – Urban and municipality statistics/ Urban information system) are used as a starting point in the process of knowledge-based system development. The MIŠ/MOŠ Information system is in official use at the Statistical Office of the Slovak Republic. This information system meets the crucial requirements of the Statistical Office on national level as well as on sublevels of the regions and districts. The requirements are: collecting data, updating the database for all urban areas and municipalities, data distribution on the national level, and data verification. Data collection covers 25 groups of indicators for all 2891 municipalities. There are 803 indicators in total. Data updating is performed every year for almost all indicators. Standard procedures exist for calculating indicators for higher territorial levels. These hierarchical levels are defined according to the system NUTS. The information system allows different outputs of these indicators, for different hierarchical levels and reports.

2. The aim of the research presented in this paper is to illustrate how this amount of data and fuzzy inference systems can be used in classification and ranking problems. Classification and ranking of the territorial units is of significant importance for the planning of the optimal regional development. The paper aims to present abilities of fuzzy systems as an alternative approach to classic statistical methods for the purpose of efficient classification.

3. To solve classification and ranking problems within a knowledge-based fuzzy system, it is necessary to describe the elements of the fuzzy systems and provide results in a usable and understandable form. The basic elements of the fuzzy system methodology described in the paper are: fuzzification, knowledge representation using fuzzy rules, inference machine, and defuzzification. For the first two elements, a knowledge acquisition

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from experts has been performed. The next two elements are calculation procedures based on fuzzy logic. Mamdani and Sugeno type models for fuzzy reasoning have been analysed and implemented. The classification possibilities and techniques are presented with the purpose of estimating and rough planning of road maintenance needs in winter.

4. The application of the system is illustrated by the example of classification municipalities in one of the eight regions in the Slovak Republic. The relevant indicators from the MOŠ/MIS database were analysed using the fuzzy set approach and processed by fuzzy rules. The knowledge-based system is developed using MatLab, in particular its Fuzzy Inference System is used. As a result, a hierarchical ranking of the municipalities can be obtained. The suggested methodology is supported by GIS technology for the purpose of visualization of the geographic data. Presentation of the classification results by GIS on the map offers a better view on the territorial distribution of the needs for road maintenance in winter. The ranking results may vary with changes in selected indicators, fuzzification methods, applied rules and method of defuzzification.

5. The obtained fuzzy system is analysed by the adapted neuro-fuzzy inference system (ANFIS) for improving the fuzzification process, i.e. for improving the process of determining membership functions. Membership functions obtained in fuzzification process depends on parameters and changing the parameters will change the shape of the membership function. Because of sensitivity to expert choices of the membership function parameters, these membership function parameters can be modified automatically using ANFIS. Some possibilities of ANFIS to solve the problems are discussed.

Key Words: Municipality, Classification, Fuzzy Logic, Fuzzy System, ANFIS, MOŠ/MIS
