

The application of fuzzy taxonomy for classifying territorial administration units

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Summary

In the paper there are presented the problems of classifying territorial units of the region. For the study, the Western Pomeranian region was chosen, which had been called into being in 1999. For classification purposes, the algorithm and fuzzy taxonomy computer software were used. Both the attributes that describe territorial units and the classes are of fuzzy character. Practical results were obtained, in which territorial units (counties) had been divided into 4 classes. The obtained results are of great importance when inventing a strategy for economic and ecological development of the region.

Introduction

In 1999, a territorial reform was carried out in Poland, in the result of which 16 regions (voivodships) came into existence. Regional self-governments, that came into being thereafter, have been confronted with a task to define a strategy for regional development. One should add that regions are made of counties (provinces), the needs of which should include regional development strategies. The tasks, which regional self-government were confronted with, were frequently beyond their capabilities due to acquired competences, information resources and planning methods. In many regions, scientific research teams were appealed to for their help. Such a procedure have been taken up in Western Pomeranian region, where a number of research teams composed of different specialities scientific workers worked out the strategy of regional development (the authors of the present paper participated in a team assessing the level of development and economic capabilities of counties). The Western Pomeranian region is one of the largest in Poland in respect of the area and population, and is composed of 20 counties.

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Main activities carried on in the region are: shipbuilding, fishery, agriculture, forestry, and tourism in summer on the Baltic Sea coast.

In the study a need came out to classify new territorial units (counties) due to the level of development of the main trends of economy, environment protection and the quality of life. It allowed local self-governments to take economic decisions with regard to the existing: human resources, industry, communication and touristic infrastructure, as well as land resources.

Unfortunately, the information on basic economic and ecological attributes of the counties is not accurate at all times due to the character of measurement, and frequently is of fuzzy character. Also frequently are met such difficulties that territorial units cannot be explicitly classified to one class, as they showed attachment to many classes. Thus, the algorithm of fuzzy classification have been applied for classifying the counties due to fuzzy character of the objects.

The present paper is aimed at application of fuzzy taxonomy methods for classifying the counties of Western Pomeranian voivodship.

1. Methods

The existing hitherto methods of classifying objects due to the quality of information and the character of classes (with extreme limits defined precisely and with fuzzy classes) are presented in Figure 1.

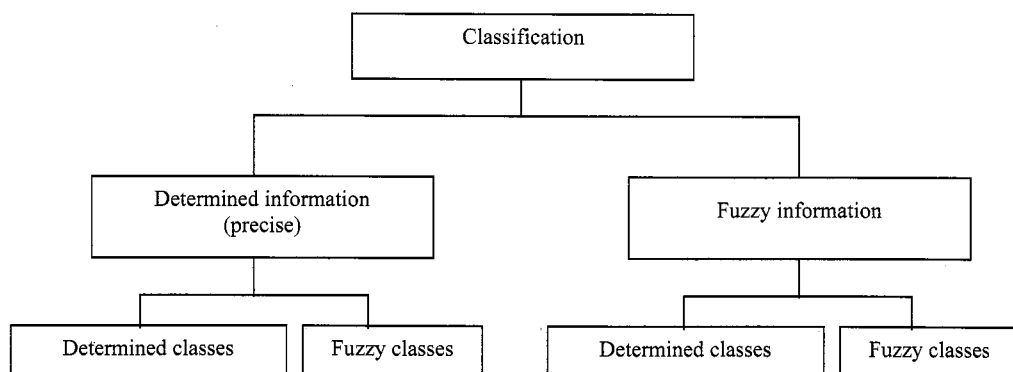


Figure 1. Classification due to the type of information on the character of objects and of the character of classes

The least known cases of classification in the literature are classifications, in

which both the information on objects attributes and the classes are of fuzzy character. In the present paper the algorithm and the Fuzzy Bear computer software, developed by Machowska-Szewczyk (2001), will be used when classifying the counties of Western Pomeranian voivodship. The algorithm and the software expand and complement the ISODATA method developed by Bezdek (1974) and Dunn (1974). In the new version, the ISODATA method has been generalised in case the objects information and the objects classes are fuzzy.

2. Empirical results

Using the methods of mathematical statistics, the most significant attributes were selected that describe the economic and ecological character of the counties. From among over 40 attributes, the following diagnostic variables were chosen:

- X_1 - gross value of fixed assets in industrial enterprises of the county (in thousand PLN per capita),
- X_2 - wheat crops area in total crop area in the county (in per cent),
- X_3 - county roads with improved hard pavement in total length of county roads (in per cent),
- X_4 - telephone subscribers per 1000 population of the county,
- X_5 - mortality of infants per 1000 live births in the county,
- X_6 - engaged in medical and social service per 1000 engaged in the county,
- X_7 - number of night accomodation given in the county,
- X_8 - area of grounds under legal protection in total area of the county (in per cent),
- X_9 - investment expenditures on environment protection in PLN per 1 resident of the county,
- X_{10} - carbon dioxide concentration in the county (in micrograms per cubic meter, mean annual concentration),
- X_{11} - nitric oxide concentration in the county (in micrograms per cubic meter, mean annual concentration),
- X_{12} - carbon monoxide concentration in the county (in micrograms per cubic meter, mean annual concentration),
- X_{13} - dust pollution concentration in the county (in micrograms per cubic meter, mean annual concentration).

The variables mentioned above describe 20 objects (counties) of Western Pomeranian voivodship. These variables are of fuzzy character in the form of trapezoidal numbers.

As the result of applying the Fuzzy Bear software - Machowska-Szewczyk (2001) – there was obtained a division into 4 classes with the highest degree of classification quality. The detailed division into classes according to the highest value of membership function is presented in Table 1.

Table 1. Classification of Western Pomeranian voivodship counties

Class number	County name	Membership function value
1	Szczecin (municipality)	0.41
	Koszalin (municipality)	0.31
	Świnoujście (municipality)	0.74
	Kamień Pomorski	0.47
	Kołobrzeg	0.50
2	Gryfino	0.47
	Police	0.64
	Pyrzyce	0.40
3	Choszczno	0.79
	Drawsko	0.38
	Myslibórz	0.79
	Szczecinek	0.37
	Wałcz	0.57
4	Białogard	0.77
	Goleniów	0.64
	Gryfice	0.41
	Koszalin (landed)	0.61
	Stargard	0.73
	Sławno	0.37
	Świdwin	0.36

The obtained division describes well the character of classified objects. In class 1 there are 5 counties, including 3 largest municipalities in the voivodship. The isolated class is of industrial and touristic character. It is connected with marine economy, i.e. with shipbuilding industry, sea fish culture and tourism. Three counties: Świnoujście, Kamień Pomorski and Kołobrzeg, are summer tourism centres on the Baltic Sea coast as well as health resorts. Class 2 is characterised by high agricultural production, processing industry in agriculture and fertilizer production for agriculture. Class 3 is distinguished by poor soils for agricultural production, low population density, poor industrial infrastructure,

large afforestation, and good quality of natural environment. Class 4 shows an intermediate character between class 1, 2 and 3. It can be described as agricultural and industrial. The conditions for agricultural production are on the average level; small industrial enterprises are numerous here as well. Also the communication infrastructure is average in relation to that of the region.

The made classification allowed to estimate and compare the economic and ecological position of the examined units. This is a valuable indicator for self-government organs of the voivodship in making decisions that refer to the strategy of territorial units development. It is seen clearly that counties grouped in class 3 need economic assistance first and foremost, since they are not able to secure themselves funds for further development. The poor quality of soils suggests development of forestry through afforestation and agrotourism due to the high quality of natural environment. In the counties belonging to class 1 one should go on strengthening marine economy and tourism. In the counties belonging to class 2 one should solidify agricultural production. On the other hand, in the counties belonging to class 4, one should intensify development of small enterprises as well as existing large farms.

Conclusions

The presented results referring to classification of regional administration units in the region had brought practical information in respect of their economic and ecological development.

Since the regional units examined had been established recently, thus there were studies on their taxonomy hitherto. The division made into 4 classes exposed large differences in the levels of county groups development. The obtained information allow regional self-government to support decisions on economic and ecological development directions of particular counties within regional development strategy.

References

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