Chapter 11
Fuzzy Nominal Classification using Bipolar Analysis

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ABSTRACT

The process of assigning objects (candidates, projects, decisions, options, etc.) characterized by multiple attributes or criteria to predefined classes characterized by entrance conditions or constraints constitutes a subclass of multi-criteria decision making problems known as nominal or non-ordered classification problems as opposed to ordinal classification. In practice, class entrance conditions are not perfectly defined; they are rather fuzzily defined so that classification procedures must be design up to some uncertainty degree (doubt, indecision, imprecision, etc.). The purpose of this chapter is to expose recent advances related to this issue with particular highlights on bipolar analysis that consists in considering for a couple of object and class, two measures: classifiability measure that measures to what extent the former object can be considered for inclusion in the later class and rejectability measure, a degree that measures the extent to which one should avoid including this object into that class rendering final choice flexible and robust as many classes may be qualified for inclusion of an object. This apparent theoretical subject finds applications in almost any socio-economic domain and particularly in digital marketing. An application to supply chain management, where a certain number of potential suppliers of a company are to be classified in a number of classes in order to apply the appropriate strategic treatment to them, will be considered for illustration purpose.

INTRODUCTION

Many decision problems rising in different activities and domains such as social, economics, engineering, management, marketing, among others, concern the assignment or classification of objects according to their scores for a certain number of criteria or attributes to classes that are characterized by some features. These problems constitute, therefore, multi-criteria or multi-attributes (attributes of the object to classify) and multi-objectives (multi-features classes to choose) decision making problems. A unified framework is therefore needed to consider these problems because in the literature these two decision

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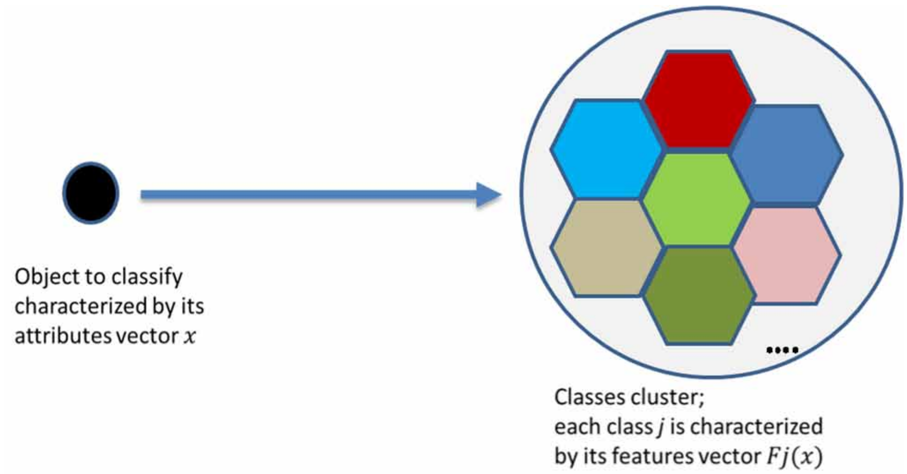
Figure 1. Illustration of nominal classification process



sub-problems have been almost always considered separately, see for instance references (Brans *et al*, 1984; Brans *et al*, 1986; Hurson and Zopounidis, 1997; Pomerol and Barba-Romero, 1993; Rigopoulos *et al*, 2008; Roy and Bouyssou, 1993; Saaty, 1980; Saaty, 2005; Steuer, 1986; Vincke, 1989) that consider these problems in different ways. Bipolar analysis that is being developed, see (Tchangani and Pérès, 2010; Tchangani, 2010; Tchangani *and al*, 2012), attempts to create this unified framework. The majority of contributions to classification problems encountered in the literature concern mainly the ordered classification case (that actually constitutes a relative evaluation process as objects to classify must be compared with regards to each other), objects must be ordered, let say, from most/least desired object to least/most desired one, see for instance (Doumpos and Zopounidis, 2002). Nominal classification process is illustrated by Figure 1, where one must choose from a cluster of classes where to include a given object.

Formally the nominal classification problems considered in this chapter are defined by the following materials.

- An object *u* to be classified is characterized by a set of *m* attributes or criteria and the value (numeric or rendered numeric by a certain procedure) of attribute *l* is given by x_l so that this object can be designated by its attributes vector $x \in \Re_+^m$ (where $\Re_+^m$ represents the set of vectors of dimension *m* with non-negative real entries); that is $x = \begin{bmatrix} x_1 & x_2 & \dots & x_m \end{bmatrix}^T$ where M^T stands for the transpose of vector or matrix M.
- The former defined object must be assigned to one of the *n* classes of the set $C = \left\{c_1, c_2, \dots, c_n\right\}$; each class or category c_j is defined by n_j features, conditions, or constraints through scalar functions $f_j^k\left(x\right) \in \Re,\ k = 1, 2, \dots, n_j$, of the attributes vector $x \in \Re_+^m$; a feature is a mapping from attributes evaluation space $\Re_+^m$ onto the real number set $\Re$. A class is therefore completely determined by its features vector $F_j(x) = \begin{bmatrix} f_j^1(x) & f_j^2(x) & \dots & f_j^{n_j}(x) \end{bmatrix}^T$.