

Comparative Evaluation between Multi-objective and Single-objective Decision-making for Political Districting

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Abstract

This paper presents a comparative evaluation between a multi-objective and a single-objective decision-making to a political redistricting. Redistricting is defined as to draw territory lines for geographical or spatial zones for the purpose of space control. It is a spatial multiple criteria decision problem but there is a limited research attempts in term of decision-making. The limitations in existing solutions create an opportunity for designing a more structured and systematic method. Redistricting based on multi-objective definition helps consider relationship among objectives and it is a more realistic solution to the real-world redistricting problem. Therefore, there is a need to evaluate a multi-objective decision approach compared to a commonly used single-objective multi-attribute method. This study has conducted several testing and experiments to compare the quality of the results and computation effectiveness of the two approaches.

Keywords: Multiple criteria decision-making

1. Introduction

Redistricting is a normative spatial model for dividing land into territories for schools, sales/services, voting, and others for identifying sites or patterns of sites to provide service accessibility [3]. It serves two main purposes to describe the choice of existing facility locations and to prescribe the selection of a new location in a general location model. Redistricting is extremely significant because all human activities involve with locational decision-making either explicitly or implicitly in their attempts to describe the occurrence of existing location patterns.

Consequently, a thorough survey to compare a multi-objective and a single-objective multi-

attribute decision-making is extremely important to demonstrate the significance of the real world multi-objective solution for redistricting. The aspects of the survey are in terms of quality of the results and the running time of the approaches with respect to their changes according to the number of objectives defined and the problem size. The experiment aims to prove the effectiveness of the multi-objective decision-making method in comparison to a common single-objective multi-attribute environment.

2. Political Redistricting Problem Definition

The political districting data definition from [1] are adapted and used in the survey:

I = The set of all basic units (BU). For each unit, population data and geographical data are linked.

J = The set of basic units used as 'seeds'.

m = The number of zones to be created is given

p_i = The population capacity of unit i

$[a, b]$ = interval of the population capacity of any zone must lie.

The decision variables considered is to let x_{ij} be a binary variable equal to 1 if and only if unit i is assigned to seed j .

$$x_{ij} = 0 \quad \text{or} \quad 1 \quad (i \in I, j \in J) \quad (1)$$

The constraints include:

(1) Each basic unit is assigned to one district

$$\sum_{i \in I} x_{ij} = 1, (i \in I) \quad (2)$$

(2) The number of districts is equal to m

$$\sum_{j \in J} x_{jj} = m \quad (3)$$

(3) No basic unit can be assigned to an unselected seed

$$x_{ij} \leq x_{jj}, (i \in I, j \in J) \quad (4)$$

(4) Resources capacity is taken into account