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A Flexible Neural Network-Fuzzy Data Envelopment Analysis Approach for Location optimization of Solar Plants with Uncertainty and Complexity

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Abstract—This study presents a flexible approach for optimization the location of solar plants. It is composed of artificial neural network (ANN) and fuzzy data envelopment analysis (FDEA). The intelligent approach of this study is applied to an actual location optimization of solar plants in Iran. First, FDEA is validated by DEA, and then it is used for ranking of solar plant units (SPUs) and the best α -cut is selected based on test of Normality. Also, several ANNs are developed through multi layer perceptron (MLP) for ranking of solar plants and the best one with minimum MAPE is selected for further considerations. Finally, the preferred model (FDEA or ANN) is selected based on test of Normality. The implementation of the flexible approach for solar plants in Iran identifies FDEA at α = 0.3. This indicates that the data are collected from the uncertain and fuzzy environment. This is the first study that presents a flexible approach for identification of optimum location of solar plants with possible noise, non-linearity, vague and fuzzy environment.

Keywords: Fuzzy Data Envelopment Analysis (FDEA); Artificial Neural Network (ANN); Location Optimization; Solar Plant Unit (SPU); Uncertainty; Complexity

1. Introduction

Solar energy is the most ancient source, and it is origin of almost all fossil and renewable types, but due to environmental and technical consideration, recently solar energy attracted a lot of attention in all over the world Solar plants are one of the most used applications of solar energy which have great potential for supplying energy, especially in the remote and shiny regions [1].

The bibliography by [2] lists more than 1500 references dealing with location and layout problems, and many more contributions have appeared since then. There are 4 components that characterize location problems; these are: (1) customers, who are presumed to be already located at points or on routes, (2) facilities that will be located, (3) a space in which customers and facilities are located, and (4) a metric that indicates distances or times between customers and facilities [3]. A survey of many distinct applications of location models is provided by [4], ranging from traditional applications involving newspaper transfer points [5], solid waste transfer points [6 and 7], bank branches [8], and motels [9] to the more unusual location problems such as the location of a church camp [10], the determination of apparel sizes [11], ingot sizes [12], and the location of rain gauges [13]. For a list of location applications, readers are referred to [14].

In this paper a flexible approach consists of fuzzy data envelopment analysis (FDEA) and artificial neural network (ANN) is applied for ranking and assessment of potential place for locating solar plants. DEA has been used as an optimization method for indicating the most efficient location [1]. Since DEA is focused on frontiers or boundaries, any noise or error from data can cause a variation in the obtained solutions by DEA. Therefore, the input or output data should be accurate in order to successful application of DEA [15]. In some real world problems, the data for evaluation of DMUs are often not precisely defined and may be cannot accurately measured. This means that the inputs and outputs are uncertain and fuzzy. Therefore FDEA is used to overcome this weakness. Furthermore in some cases the data are corrupted and are associated with complexity and non-linearity. Thus ANN is applied to deal with these kinds of problems. The preferred model is selected based on test of Normality according to central limit theorem, because the data are collected from various sources and are associated with accumulated error.

2. Method: The Flexible ANN-FDEA Approach

We proposed a new approach namely, ANN-FDEA to alleviate these problems. According to the proposed approach, first the standard inputs and outputs are determined, collected and preprocessed.