Chapter 38
SIDE:
A Decision Support System Using a Combination of Swarm Intelligence and Data Envelopment Analysis

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ABSTRACT

To make sound decisions, managers analyze data from multiple sources using different dimensions and eventually integrate the results of their analysis. This study proposes the design of a multi-attribute-decision-support-system that combines the analytical power of two different tools: data envelopment analysis (DEA) and particle swarm optimization (PSO), one of the major algorithms using swarm intelligence. DEA measures the relative efficiency of decision making units that use multiple inputs and outputs to provide non-objective measures without making any specific assumptions about data. On the other hand PSO's main strength lies in exploring the entire search space. This study proposes a modeling technique that jointly uses the two techniques to benefit from the two methodologies.

INTRODUCTION

A business organization's objective is to make better decisions at all levels of the firm to improve performance. Typically organizations are multi-faceted and complex systems that use uncertain information. Therefore, making quality decisions to improve organizational performance is a daunting task. Organizations use decision support systems that apply different business intelligence techniques such as statistical models, scoring models, neural networks, expert systems, neuro-fuzzy systems, case-based systems, or simply rules that have been developed through experience. Managers need a decision-making approach that is robust, competent, effective, efficient, and integrative to handle the multi-dimensional organizational entities. The decision maker deals with multiple players in an organization such as products, customers, competitors, location, geographic structure, scope, internal organization, and cultural dimension (Porter, 1980). Sound decisions include two important concepts: efficiency (return on invested resources) and

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effectiveness (reaching predetermined goals). However, quite frequently, the decision maker cannot simultaneously handle data from different sources. Hence, we recommend that managers analyze different aspects of data from multiple sources separately and integrate the results of the analysis. This study proposes the design of a multi-attribute-decision-support-system that combines the analytical power of two different tools: data envelopment analysis (DEA) and particle swarm optimization (PSO), one of the major algorithms using swarm intelligence. DEA evaluates and measures the relative efficiency of decision making units that use multiple inputs and outputs to provide non-objective measures without making any specific assumptions about data. On the other hand PSO's main strength lies in exploring the entire search space. This study proposes a modeling technique that jointly uses the two techniques to benefit from the two methodologies. A major advantage of the DEA approach is that it clearly identifies the important factors contributing to the success of a decision. In addition, I also propose the use of a particle swarm optimization to assess the global minima or maxima that can aid the decision-maker in making decisions regarding the implications of a decision. One of the important characteristics of population-based search algorithms is their ability to improve the exploration of the search space without falling in the pitfalls of local minima and maxima. The objective of this study is to find a minima solution (ideal loan) nearest to a given loan application using a limited number of iterations. However, not all solutions found using PSO may be true minima so we use the DEA algorithm, a benchmarking technique, to assess the worthiness of the closest optimal solution. The DEA model benchmarks the performance value of the loan application (both original and optimized) against a set of previous loans. Thus, a decision maker can easily analyze and understand any decision using the power of the efficiency frontier algorithm (DEA) and global search algorithm (PSO) to analyze the credit-worthiness of a loan application. The rest of the paper is organized along the following lines. In section II, we provide a review of previous studies on loan evaluation. Section III discusses the model that we use in this study. Section IV discusses the data and methodology used in this study. In section V, we provide an empirical analysis of our results. Section VI summarizes and concludes our study.

LITERATURE REVIEW

Swarm Intelligence Literature Review

Swarm intelligence, based on collective artificial intelligence, is an emerging area in the field of optimization. Many researchers have developed algorithms that model the behavior of different swarm of animals and insects such as ants, termites, bees, birds, fishes, and elephants. In 1990s, researchers introduced two important algorithms – ant colony optimization (Dorgio et al., 1991) and particle swarm optimization (Kennedy & Eberhart, 1995) based on fish schooling and bird flocking. PSO mimics the movement of birds in a flock sharing information with each other and the way they interact with each other (Acan and Gunay, 2005) defined by topology. The birds in the swarm represent parameter samples called particles. Birds fly around randomly, but keep an eye on others to follow the bird closest to food. Similarly, each particle in the swarm keeps track of its own best solution found so far and shares the information with topological neighbors to fly towards optimal solutions (Brits et al., 2007). These algorithms have inspired many researchers to create new versions to solve problems in different areas. Researchers have used these models to solve difficult real world problems such as traffic routing, networking, games, industry, robotics, economics, and design of artificial self-organized distributed problem-solving devices. One