Chapter 2

Grey Optimization Problems Using Prey–Predator Algorithm

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ABSTRACT

The optimization problems are the problem of finding the best parameter values which optimize the objective functions. The optimization methods are divided into two types: deterministic and non-deterministic methods. Metaheuristic algorithms fall in the non-deterministic solution methods. Prey-predator algorithm is one of the well-known metaheuristic algorithms developed for optimization problems. It has gained popularity within a short time and is used in different applications, and it is an easy algorithm to understand and also to implement. The grey systems theory was initialized as uncertain systems. Each grey system is described with grey numbers, grey equations, and grey matrices. A grey number has uncertain value, but there is an interval or a general set of numbers, within that the value lies is known. In this chapter, the author will review and show that grey system modeling is very useful to use with prey-predator algorithm. The benchmark functions, grey linear programming, and grey model GM (1,1) are used as examples of grey system.

INTRODUCTION

The grey systems theory is designed to study uncertain systems which focus on the incomplete information that is due to small samples and poor information (Julong, 1982, 1989; K. Li, Liu, Zhai, Khoshgoftaar, & Li, 2016; Liu & Forrest, 2010; Liu, Yang, & Forrest, 2017). Grey systems have incomplete parameters, structure, or boundary of systems (Liu & Forrest, 2010; Y. Yang, 2010). They have been

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widely applied in areas like engineering, economics, and computer sciences (Liu & Forrest, 2010; Thissen, Pepers, Üstün, Melssen, & Buydens, 2004; Xie & Liu, 2009; Zavadskas, Kaklauskas, Turskis, & Tamošaitienė, 2009). There are many scientific applications of the grey systems for analysis, and modeling (Stanujkic, Magdalinovic, Jovanovic, & Stojanovic, 2012). For example Bing Liu developed the first grey systems modeling software for the Windows (Liu & Forrest, 2010); (Stanujkic et al., 2012) combine concept of interval grey numbers and MOORA method; (Kumar, 2016) developed the Grey Wolf Algorithm (GWA); (Razi & Shahabi, 2016) present an appropriate practical approach to select the optimal stock portfolio based on Grey Relational Analysis and C5 algorithm which is a model of decision tree; (K. Li et al., 2016) developed grey model based on particle swarm optimization algorithm; (Zhou, Ren, & Yao, 2017) integrated multi-objective optimization method with grey relational analysis, radial basis function neural network, and particle swarm optimization algorithm.

Optimization problems can be divided into two categories in terms of the level of available information, namely deterministic and non-deterministic (X.-S. Yang, 2010; Yang, 2011). Deterministic approaches include grid search, covering methods, and trajectory-based methods(Tilahun & Ong, 2014; X.-S. Yang, 2010). The deterministic techniques seek the minimum point based on the information given by the negative of the gradient (or sub-gradient) of the objective function. Naturally, the efficiency of these algorithms depends on several factors, such as the starting point, the accuracy of the descent direction evaluation and the method used to execute the line search as well as the stopping criteria. Non-deterministic methods include random search, clustering, and methods based on probabilistic models of the objective function(Yang, 2011). Metaheuristic algorithms are from the class of non-deterministic methods (W. A. Khan, Hamadneh, Tilahun, & Ngnotchouye, 2016; Tilahun & ONG, 2013; X.-S. Yang, 2010). Metaheuristic algorithms are formally defined to find the optimal solutions by systematically exploring and exploiting the search space (Tilahun, Ngnotchouye, & Hamadneh, 2017). It is efficient, not affected much by the behavior of the problem and an easy to use in different application (Durkota, 2011; Nawaf Hamadneh et al., 2013; Nawaf Hamadneh et al., 2012; W. S. Khan, Hamadneh, & Khan, 2017). Prey-predator algorithm uncomplicated metaheuristic algorithms with effectiveness in applying and use (Tilahun & ONG, 2013). The algorithm is designed for continuous optimization problems, and also to use for non-continuous problems (Nawaf Hamadneh, Tilahun, Sathasivam, & Choon, 2013; Tilahun & ONG, 2013). In this chapter prey predator algorithm will be used to solve grey optimization problems.
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