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Chapter X

Optimization Using Horizon-Scan Technique: A Practical Case of Solving an Industrial Problem

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Abstract

This chapter introduces a new Computational Intelligence algorithm called Horizon Scan. Horizon Scan is a heuristic based technique designed to search for optimal solution in non-linear space. It is a variant of the Hill-Climbing technique and works in contrary to the temperature-cooling scheme used in Simulated-Annealing. Initial experiments on the application of Horizon Scan to standard test cases of linear and non-linear problems have indicated promising results (Chand & Sugianto, 2003a; Chand & Sugianto, 2003b; Chand & Sugianto, 2004). In this chapter, the technique is described in detail and its application in finding the optimal solution for the Scheduling-Pricing-Dispatch problem in the Australian deregulated electricity market context is demonstrated. It is hoped that the proposed approach will enrich the existing literature on Computational Intelligence, in particular to solve optimization problems, such as those that exist in the deregulated electricity industry around the globe.

Introduction

The objective of this chapter is to introduce a heuristic Computational Intelligence (CI) algorithm called Horizon Scan (HS). Horizon Scan is a new heuristic-based global search technique for optimizing non-linear problems. In demonstrating the application of this algorithm, the chapter depicts an industrial problem in today's competitive electricity market environment that exhibits an auction process.

The chapter begins with a discussion on the optimization problem, its characteristics, the classification of linear and non-linear problems, as well as conventional techniques to deal with each class of problem. It also introduces the notion of optimal value for several possible solutions. Next, it describes the concept, the algorithm and the characteristics of the Horizon Scan technique, including the intelligence in its search mechanism, alternative scanning methods and the search termination criteria. In this chapter, the proposed technique has been applied to optimize the energy market in the current Australian National Electricity Market (NEM) setting. The chapter also presents several case examples depicting simplified market models with non-linear constraints.

Optimization Problem

Optimization is often understood as a procedure to obtain the optimal (best) solution to a problem. An optimization problem is characterized by the fact that there exists more than one possible solution and that the solution cannot be identified simply by inspection. A small subset of problem modelling that exhibits a linear relationship between the objective function and the constraints can be solved with Linear Programming. With the available computing power today, such a numerical procedure of optimization can yield an optimal solution in a very short time. However, solutions obtained in such cases are accurate and satisfactory only in very limited circumstances. This is because most practical problems do not fall into the linear category. A substantial proportion of phenomena and problems in real life fall into the non-linear category.

Non-Linear Programming deals with the optimization of non-linear functions subjected to linear and/or non-linear constraints. When more constraints are modelled into the problem, it becomes harder for feasible solutions to be identified. Classical non-linear optimization methods have centered on gradient functions. These involve the calculation of first-order derivatives and in some cases the second-order derivatives of the objective functions. The Newton and its variant methods use Taylor's expansion to approximate the derivates. These techniques gained popularity because of their ability to approximate solutions using the first and second derivates. However, the convergence of the solution is not always guaranteed (Taha, 1997).

For a range of non-linear optimization problems (Al-Turki, 2001; Anderson, 1996; BaykasoImagelu, 2001; Bertsekas 1999; Glover & Laguna, 1993; Lewis, 2000; Pham & Karaboga, 2000; Pirlot, 1996; Rutenbar, 1989; Youssef, 2001), there exists a class of techniques known as heuristic-based techniques, such as Hill Climbing, Simulated