Chapter 31
Nature-Inspired Toolbox to Design and Optimize Systems

Satvir Singh
Shaheed Bhagat Singh College of Engineering & Technology, India

Arun Khosla
Dr. B. R. Ambedkar National Institute of Technology, India

J. S. Saini
Deenbandhu Chhotu Ram University of Science & Technology, India

ABSTRACT

Nature-Inspired (NI) Toolbox is a Particle Swarm Optimization (PSO) based toolbox which is developed in the MATLAB environment. It has been released under General Public License and hosted at SourceForge.net (http://sourceforge.net/projects/nitool/). The purpose of this toolbox is to facilitate the users/designers in design and optimization of their systems. This chapter discusses the fundamental concepts of PSO algorithms in the initial sections, followed by discussions and illustrations of benchmark optimization functions. Various modules of the Graphical User Interface (GUI) of NI Toolbox are explained with necessary figures and snapshots. In the ending sections, simulations results present comparative performance of various PSO models with concluding remarks.

INTRODUCTION

Since early 90's, investigations on new optimization techniques, based on the analogy of social behavior of swarms of natural creatures, have been started. Dorigo introduced Ant Colony Optimization (ACO) (Colorni et al., 1991) based on the social behavior of insects, especially ants where each individual exchanges information implicitly through pheromone. Eberhart and Kennedy developed PSO (Kennedy and Eberhart, 1995) based on the analogy of bird flock and fish school where each individual is allowed to learn from the experiences of its own and others.

PSO is a swarm based optimization tool which is useful, like other evolutionary algorithms, to evolve near-optimum solution to a problem. The evolution is initialized with a set of randomly generated potential solutions and then is allowed to search for the optimum one, iteratively. It

DOI: 10.4018/978-1-4666-4301-7.ch031

searches the optimum solution by observing the best performing particles. As compared to Genetic Algorithms, the PSO has much better intelligent background and could be performed more easily (Shi et al., 2007). Due to its advantages, the PSO is not only suitable for scientific research, but also engineering applications. PSO has attracted broad attention in the fields of evolutionary computing, optimization and many others (Angeline, 1998, Chang et al., 2005, Clerc and Kennedy, 2002, Trelea, 2003). Although the PSO is developed for continuous optimization problems, however, investigational studies have been reported that are focused on discrete problems as well (Kennedy and Eberhart, 1997).

ADDING NI TOOLBOX IN THE MATLAB ENVIRONMENT

Download NIT.zip folder from SourceForge.net (http://sourceforge.net/projects/nitool/) and follow these steps to embed it in the MATLAB environment:

1. Unzip the downloaded NIT.zip file. This contains two folders (a) nitool folder – copy into the/matlab/toolbox and (b) NI Toolbox folder – contains demo and make it your Work Directory.
2. In the MATLAB environment click Start → Desktop Tools → Path → Add Folder.
3. Specify the nitool folder path as/matlab/toolbox/nitool, Save and Close.
4. Now, NI Toolbox is ready to use. Type nitool in the MATLAB Command Window to run NI Toolbox for a fresh system description.

PARTICLE SWARM OPTIMIZATION

PSO belongs to the category of Swarm Intelligence (Kennedy and Eberhart, 2001) tool and is useful in solving global optimization problems. It was originally proposed by James Kennedy, as a simulation of social behavior, and was introduced as an optimization method in 1995 (Eberhart and Kennedy, 1995, Kennedy and Eberhart, 1995). PSO is an evolutionary computing technique related to artificial life, specifically to swarming bodies, as it involves simulation of social behaviors.

PSO implementation is easy and computationally inexpensive, since its memory and CPU speed requirements are low (Eberhart et al., 1996). Moreover, it does not require gradient information of the fitness function but only its values. PSO has been proved to be an efficient method for many global optimization problems and, in some cases, it does not suffer from the difficulties experienced by other evolutionary algorithms (Eberhart and Kennedy, 1995).

What differentiates the PSO paradigm from other instances of evolutionary computing is memory and social interaction among the individuals. In the other paradigms, the important information an individual possesses, usually called genotype, is its current position, however, in PSO, really important asset is the previous best experience. Each individual stores the best position, found so far, that drives the evolution toward better solutions.

PSO algorithm has originated as a simplified simulation of a social system. The first program was a graphical simulation of a bird flock (Heppner and Grenander, 1990, Reynolds, 1987). In this simulation, a point on the screen was defined as food, called the cornfield vector (Kennedy and Eberhart, 1995); the idea was to allow birds to find food through social learning, by observing the behavior of nearby birds, who seemed nearer to the food source. The optimization potential was realized in the initial experiments and the algorithm was modified to incorporate topological rather than Euclidean neighborhoods and multi-dimensional search was attempted successfully (Eberhart and Kennedy, 1995, Eberhart et al., 1996, Kennedy and Eberhart, 1995).