

Chapter 58

Natural Computing in Mobile Network Optimization

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ABSTRACT

Nature inspired computing has been widely used to solve various research challenges of mobile network. Mobile network refers to mobile network, sensor network and ad hoc network. This chapter has focused on the application of nature inspired computing in mobile network. In this chapter, the bio-inspired techniques for wireless sensor network, mobile ad hoc network and mobile cloud computing are discussed. Ant colony optimization is used in sensor network and mobile cloud computing for efficient routing and scheduling respectively. Bee swarm intelligence is used to develop routing schemes for mobile ad hoc network. Bird flocking behavior is used for congestion control in wireless sensor network. The research challenges of bio-inspired mobile network are also illustrated.

INTRODUCTION

Nature inspired computing (NIC) has grown up since more than a decade. NIC focuses at the development of new computing techniques with the ideas of how nature acts in different scenarios for solving complicated problems. NIC has become an interesting research area because of the technological growth in computer science. NIC techniques are applied in the field of physics, biology, economy, management, engineering etc. The models may be ant colonies or swarms, they are appropriate to model an intricate and dynamic system (Hu, Eberhart, & Shi, 2003). NIC techniques are flexible and applicable for various problems (Dorigo & Stutzle, 2010). These methodologies are adaptable because they can handle invisible

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data and are able to learn. The methods can manage the partially complete data set. Thus these methods are called robust. The vast majority of these algorithms are imitative from biological systems in nature.

Particle Swarm Optimization (PSO) is a popular NIC method that is developed by close scrutiny of the swarm behavior of fish and bird (Hu et al., 2003). The theory of particle swarm is basically originated from the simulation of the behavior of the real time living swarm. Observation of choreography of a bird flock leads to the preliminary theory for optimizing problem based on swarm intelligence incorporating nearest neighbor velocity matching, environmental ancillary variables, multi-dimensional search and acceleration by distance (Kennedy & Eberhart, 1995). Like genetic algorithm, it is also an evolutionary technique. In this technique, every possible solution with respect to the problem is considered as particle; hence few particles are chosen randomly to form a swarm. This swarm acts as the real time swarm such as bird flocks, ant colony etc. The behavioral activities of a swarm are reflected through mathematical model that has been applied on the computational swarm seeking for optimal solution for the problem. This is known as Particle swarm optimization technique. Like Genetic Algorithm (GA), PSO is popularly used as a population based optimization tool although PSO has no evolution operators like mutation or crossover (Bonabeau, Corne, & Poli, 2010). PSO is a stochastic optimization approach that is based on population and motivated by communal conduct of fish schooling or bird flocking (Pant, Radha, & Singh, 2007). Bee colony algorithm is discussed based on the honey collecting behavior of bee swarms (Yan, Zhu, Chen, & Zhang, 2013). An enhanced version of PSO is proposed by developing hierarchical interaction topologies and this is referred as Multi-swarm Particle Swarm Optimizer (Chen, Zhu, & Hu, 2010). Using swarm intelligence, Bat Algorithm (BA) is formulated on the basis of the echolocation of bats (Yang, 2010). Echolocation is basically a kind of sonar which is used by bats to perceive prey, evade hindrances and trace their roosting fissures in dark (Yang & Gandomi, 2012). In order to resolve the problem related to multi-objective optimization, BA is modified to form Multi-objective Bat Algorithm (MOBA) (Yang, 2011). Multi-objective optimization problems basically involve multiple criteria in decision making. Such types of problems find application in economics, finance, optimal control, optimal design and radio resource management. MOBA is tested using a subset of relevant test functions to get an efficient solution.

Ant Colony Optimization (ACO) is proposed on the basis of the behavior of ants seeking for paths between the source of food and their colony (Dorigo & Gambardella, 1997). In general, ants wander randomly in search of food and after finding food they revisit the colonies. On the path they release pheromone trails (Coloni, Dorigo, & Maniezzo, 1991). Other ants finding such a path follow the pheromone trails rather than moving randomly. However the pheromone trails get evaporated with time, thus reducing the effectiveness of the search. More the time taken by the ant to traverse the path more is the chance for the pheromone to get evaporated. Therefore when an ant gets a good short path for food in the colony, other ants go behind that path. Positive feedback finally leads all the ants to go after the path. Based on the honey collection behavior, bee swarm algorithm is discussed in (Karaboga, 2005). A survey on the existing NIC techniques is carried out in (Karaboga, Dervis, & Akay, 2009).

Extensive researches have been performed to obtain answers to the problems in the field of networking by observing similar situation occurring in the nature (Bonabeau, Dorigo, & Theraulaz, 1999). Figure 1 pictorially demonstrates that mobile network is categorized as:

1. Wireless Sensor Network,
2. Mobile Network and,
3. Mobile Ad Hoc Network.

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