Chapter 10
Nature-Inspired Algorithms in Wireless Sensor Networks

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ABSTRACT

Wireless sensor networks (WSNs) are becoming increasingly popular due to their applications in a wide variety of areas. Sensor nodes in a WSN are battery operated which outlines the need of some novel protocols that allows the limited sensor node battery to be used in an efficient way. The authors propose the use of nature-inspired algorithms to achieve energy efficient and long-lasting WSN. Multiple nature-inspired techniques like BBO, EBBO, and PSO are proposed in this chapter to minimize the energy consumption in a WSN. A large amount of data is generated from WSNs in the form of sensed information which encourage the use of big data tools in WSN domain. WSN and big data are closely connected since the large amount of data emerging from sensors can only be handled using big data tools. The authors describe how the big data can be framed as an optimization problem and the optimization problem can be effectively solved using nature-inspired algorithms.

NATURE INSPIRED ALGORITHMS

Real world problems are very challenging and difficult to solve and are sometimes NP hard problems as well. Optimization techniques are used to solve these problems but with no guarantee that optimization algorithms will provide the optimum solution. In fact there is no efficient algorithm for NP hard problems. They are solved usually by trial methods. New nature inspired algorithms are used to test their efficiency in solving these problems. Among these new algorithms many algorithms like particle swarm optimization, ant colony optimization, and biogeography based optimization have gained popularity due to their higher efficiency (Fister et al, 2013).

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Inspiration From Nature

In most of nature inspired algorithms, the source of inspiration is nature. Nature has inspired much research in many ways based on some successful biological phenomenon. Among biology inspired algorithms, a popular class of algorithms is derived from swarm based intelligence. Thus some of the biology inspired algorithms are termed as swarm intelligence algorithms. Few examples are ant colony optimization, cuckoo search, bat algorithm, particle swarm optimization etc (Yang et al, 2009). However, not all the optimization algorithms are nature inspired. Some of them may be inspired from physics, chemistry or even music. (Fister et al, 2013)Hence the sources of inspiration for algorithm development are very diverse, and consequently, the algorithms are equally diverse.

Nature inspired algorithms have been used extensively for many applications such as data mining, wireless sensor networks, image processing etc. Earlier genetic algorithm was introduced as an optimization algorithm. But genetic algorithms had some basic flaws. Consequently, more diverse and better algorithms are introduced. In past 2 decades, almost 40 nature inspired optimization algorithms are proposed with relative advantages. For instance, in 2008, Biogeography based optimization was introduced by Dan Simon. In BBO entire population is not changed at the end of each generation which was the case in genetic algorithms. Wireless sensor networks are extensively used in the present age. There is a huge amount of sensed data generated that is generated by the sensors in WSN domain. To efficiently manage, handle and use this large amount of dataset emerging from WSNs, we need big data tools. Since big data and WSN data are closely connected, we first analyze the implementation of some of the famous nature inspired techniques in WSN domain. Later in the chapter, we describe how these nature inspired techniques can be applied to big data.

Wireless Sensor Networks

Wireless sensor networks are becoming increasingly popular with their utility being proved in many areas such as their deployment in battle fields, fighter jets, agriculture, weather and many more. (Akyidliz et al, 2002; Abood et al, 2016) Wireless sensor networks consist of many small size sensor nodes used to sense useful information. Each node is assigned to a cluster head or gateway. Node sense useful information and transmit this information to the gateway. A gateway receives information from sensor node, aggregate this information and forward it to the sink. This entire scenario forms a cluster in a wireless sensor network (Abood et al, 2016).

Clustering is important in WSN as it provides a hierarchal, organized and structured schema to collect useful information from various sources and transmit this information to sink through cluster heads. Also, clustering reduces energy consumption in a WSN as all sensor nodes need not to communicate with the sink rather only cluster head communicate with the sink as a representative of all sensor nodes contained in the cluster. Cluster heads bear extra load of receiving, aggregating and transferring the data from sensor nodes to the base station. Therefore cluster heads dissipate their energy at much faster pace. Once a cluster head dies, the entire network can go down (Kuila et al, 2013; Kuila et al, 2014; Morteza et al, 2015). Thus we aim to perform clustering in a wireless sensor network (Simon, 2008) in such a way that energy consumption of a cluster head can be minimized and lifetime of a WSN can be optimized. A WSN scenario is shown in figure 1.