454e Robustness of Networks in Particle Swarm Optimization

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Particle Swarm Optimization[1] (PSO) is a biologically inspired optimization technique that uses a swarm of particles to explore a function space in order to locate an optimum. PSO has its roots in artificial life, social sciences and computer science[2]. The search proceeds using a swarm of particles, which move through the space while communicating their locations and local function values to one another, and the movement of each particle is influenced by the information it receives from others. This mimics the cooperative behavior exhibited by social insects[3,4] as well as some birds, particularly in the search for food. The individual particles in PSO have very little intelligence or knowledge of the function space. They possess only a rudimentary set of rules that instructs them how they should communicate with other particles and how they should respond to communication received from the other particles. Although individual particles may fail altogether at the search task if they were to work in isolation, the swarm as a whole often succeeds at locating the optimal solution; in other words, a complex cooperative behavior is born out of the inter-particle interaction.

In this paper, we examine the robustness of PSO networks to node loss, which is a common occurrence in reality. The structural robustness and efficiency of Minimum Spanning Trees was examined by Venkatasubramanian *et. al*[5]. Some of the earlier studies have also concentrated on evaluating the robustness of a network on a structural basis[6]. In this work we explore the effect of network topology on the functional robustness of networks to node loss. We look at 16 representative networks covering a broad category of network topologies. We introduce random failures of nodes at various intervals of the optimization process in Particle Swarm Optimization. The resulting effect on the performance of the swarm is studied. We discuss our results and offer some general conclusions about the applicability of this technique to process systems optimization problems.

References

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