

Exploring the Emergent Behavior through Agent Swarm Computing

Applied Software Engineering Research Group



Figure 1: Bird Flocking Algorithm for Document Partitioning Clustering (a) Initial Articles Distribution. (b) Clustered Articles after 300 Iterations

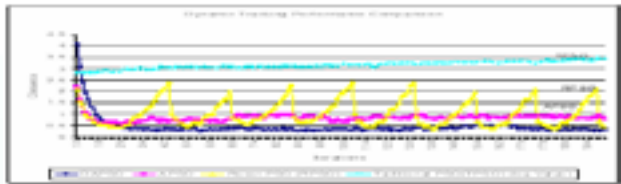


Figure 2: Distributed Adaptive Particle Swarm Optimization for Tracking Optimum in Dynamic Environment

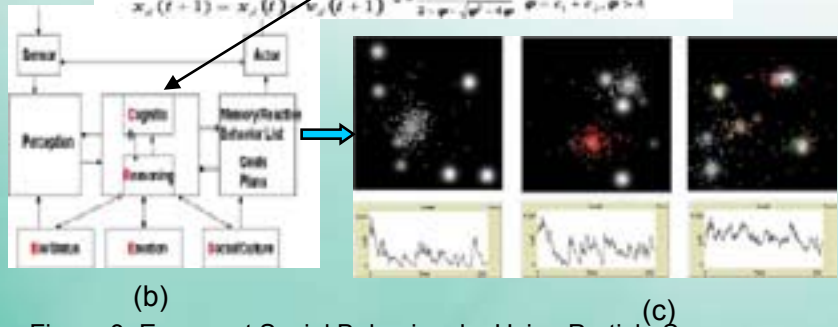
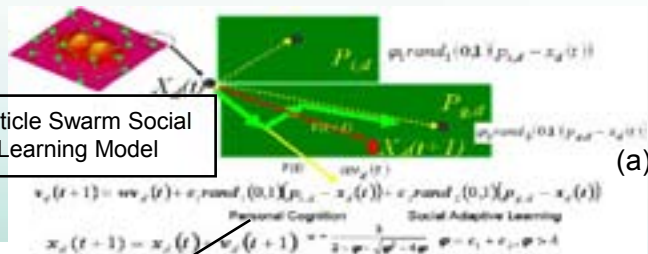


Figure 3: Emergent Social Behaviors by Using Particle Swarm Social Learning Model

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Problem Statement:

- Some problems are too complex to be solved by agents' work individually. The emergent behavior (EB) provides a synergistic ability for a collection of intelligent agents by producing better solutions to a problem than the sum of the abilities of all agents when they work individually. However, designing an agent system with EB properties is different than designing the traditional multi-agent system (MAS). In traditional MAS, the problem solving solutions are pre-programmed inside each agent. However, in an EB enabled agent system, neither individual agent has enough intelligence nor any goal or intention to solve the problem. The problem's solution emerges from the agents' direct or in-direct interaction(s). Scientists and/or engineers are challenged to build such a system.

Technical Approach:

- EB exists in many natural systems. Swarm Intelligence is a nature inspired emergent behavior intelligence research. Swarm intelligence algorithms are used in designing agent's individual-level rules, behaviors, and interactions for producing EB in a group of agents. By carefully tuning the interactions between individual agents, we could generate desired EB in a group level. This method helps us build different kinds of EB enabled systems without the need of directly coding solution in each software agent. The EB models of swarm intelligence, such as particle swarm algorithm, have also been expanded to model the emergent social behaviors in human groups.

Benefit:

- The benefit from EB agent swarm computing is significant. We have implemented a distributed agent system with multiple species flocking swarm model for document clustering (Figure 1). By using an adaptive particle swarm optimizer, a solution for tracking non-stationary optimals in dynamic environments (Figure 2) has been provided. A particle swarm social learning model has been developed for modeling the emergent and evolution of human social learning behavior based on social cultures and other demographic information (Figure 3 a, b). ORNL has used this model for scientifically understanding the self-organized insurgent groups' evolution trends and behavior patterns (Figure 3c).

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