NEURAL NETWORKS
(ELEC 5240 and ELEC 6240)
Swarm Intelligence

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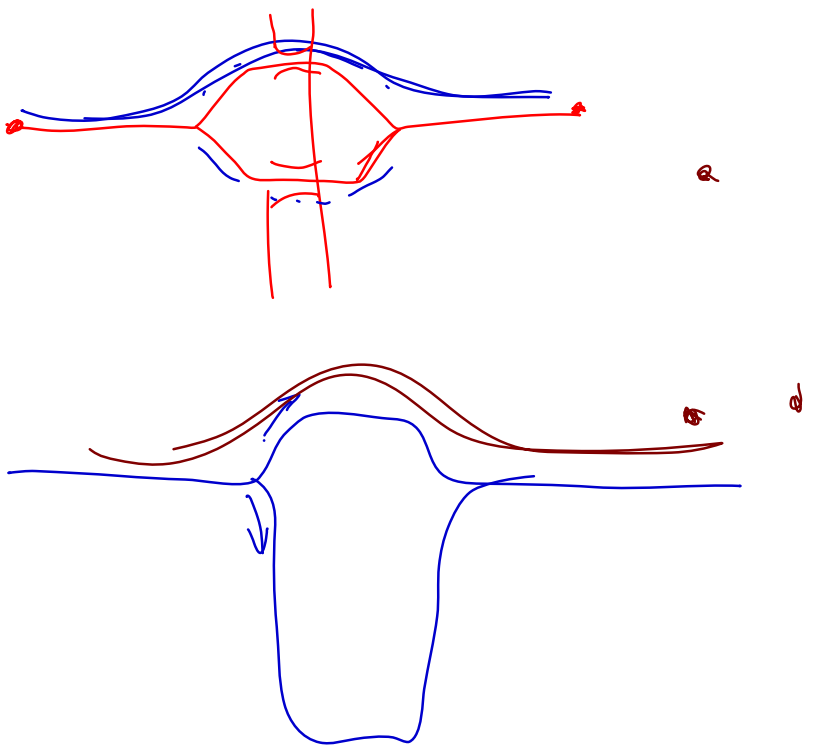
Swarm Intelligence

Swarm intelligence (SI) is an artificial intelligence technique based around the study of collective behavior in decentralized, self-organized systems. The expression "swarm intelligence" was introduced by Beni & Wang in 1989, in the context of cellular robotic systems
SI systems are typically made up of a population of simple agents interacting locally with one another and with their environment. Although there is normally no centralized control structure dictating how individual agents should behave, local interactions between such agents often lead to the emergence of global behavior. Examples of systems like this can be found in nature, including ant colonies, bird flocking, animal herding, bacteria molding and fish schooling.

Swarm Intelligence

ACO Ant colony optimization

Ant colony optimization or ACO is a metaheuristic optimization algorithm that can be used to find approximate solutions to difficult combinatorial optimization problems. In ACO artificial ants build solutions by moving on the problem graph and they, mimicking real ants, deposit artificial pheromone on the graph in such a way that future artificial ants can build better solutions. ACO has been successfully applied to an impressive number of optimization problems



Swarm Intelligence

PSO Particle swarm optimization

Particle swarm optimization or PSO is a global optimization algorithm for dealing with problems in which a best solution can be represented as a point or surface in an n-dimensional space. Hypotheses are plotted in this space and seeded with an initial velocity, as well as a communication channel between the particles. Particles then move through the solution space, and are evaluated according to some fitness criterion after each time step. Over time, particles are accelerated towards those particles within their communication grouping which have better fitness values. The main advantage of such an approach over other global minimization strategies such as simulated annealing is that the large number of members that make up the particle swarm make the technique impressively resilient to the problem of local minima.

Swarm Intelligence

SDS Stochastic diffusion search

Stochastic Diffusion Search or SDS is an agent based probabilistic global search and optimization technique best suited to problems where the objective function can be decomposed into multiple independent partial-functions. Each agent maintains a hypothesis which is iteratively tested by evaluating a randomly selected partial objective function parameterized by the agent's current hypothesis. In the standard version of SDS such partial function evaluations are binary resulting in each agent becoming active or inactive. Information on hypotheses is diffused across the population via inter-agent communication. Unlike the stigmergetic communication used in ACO, in SDS agents communicate hypotheses via a one-to-one communication strategy analogous to the tandem running procedure observed in some species of ant. A positive feedback mechanism ensures that, over time, a population of agents stabilize around the global-best solution. SDS is both an efficient and robust search and optimization algorithm, which has been extensively mathematically described.

Swarm Intelligence

Applications

Swarm Intelligence-based techniques can be used in a number of applications. The U.S. military is investigating swarm techniques for controlling unmanned vehicles. NASA is investigating the use of swarm technology for planetary mapping. A 1992 paper by M. Anthony Lewis and George A. Bekey discusses the possibility of using swarm intelligence to control nanobots within the body for the purpose of killing cancer tumors. Artists are using swarm technology as a means of creating complex interactive environments. Disney's *The Lion King* was the first movie to make use of swarm technology (the stampede of the wildebeests scene). The movie "Lord of the Rings" has also made use of similar technology during battle scenes. Swarm technology is particularly attractive because it is cheap, robust, and simple. [7]

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