International Journal of Swarm Intelligence and Evolutionary Computation

OPEN ACCESS Freely available online

Editorial

Swarm Intelligence: Studies and Application

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DESCRIPTION

Swarm intelligence is that the discipline that deals with natural and artificial systems composed of the various individuals that coordinate using decentralized control and self-organization. In particular, the discipline focuses on the collective behaviours that result from the local interactions of the individuals with each other and with their environment. Examples of systems studied by swarm intelligence are colonies of ants and termites, schools of fish, flocks of birds, herds of land animals. Some human artifacts also fall under the domain of swarm intelligence, notably some multi-robot systems, and also certain computer programs that are written to tackle optimization and data analysis problems.

Clustering behaviour of ants

Ants build cemeteries by collecting dead bodies into one place within the nest. They also organize the spatial disposition of larvae into clusters with the younger, smaller larvae within the cluster centre and therefore the older ones at its periphery. This clustering behaviour has motivated variety of scientific studies. Scientists have built simple probabilistic models of those behaviours and have tested them in simulation. The basic models state that an unloaded ant features a probability to select up a corpse or a larva that's inversely proportional to their locally perceived density, while the probability that a loaded ant has got to drop the carried item is proportional to the local density of comparable items. This model has been validated against experimental data obtained with real ants. In the taxonomy this is often an example of natural/scientific swarm intelligence system.

Nest building behaviour of wasps and termites

Wasps build nests with a highly complex internal structure that's well beyond the cognitive capabilities of one wasp. Termites build nests whose dimensions (they can reach many meters of diameter and height) are enormous in comparison to one individual, which may measure as little as a couple of millimeters. Scientists are studying the coordination mechanisms that allow the development of those structures and have proposed probabilistic models exploiting stigmergic communication to elucidate the insects' behaviour. Some of these models are implemented in computer programs and wont to produce simulated structures that recall the morphology of the important nests. In the taxonomy this is often an example of natural/scientific swarm intelligence system.

Flocking and schooling in birds and fish

Flocking and schooling are samples of highly coordinated group behaviours exhibited by large groups of birds and fish. Scientists have shown that these elegant swarm-level behaviours are often understood because the results of a self-organized process where no leader is responsible and every individual bases its movement decisions solely on locally available information: the space , perceived speed, and direction of movement of neighbours. These studies have inspired variety of computer simulations that are now utilized in the pc graphics industry for the realistic reproduction of flocking in movies and computer games. In the taxonomy these are examples respectively of natural/scientific and artificial/engineering swarm intelligence systems.

Particle swarm optimization

Particle swarm optimization may be a population based stochastic optimization technique for the answer of continuous optimization problems. It is inspired by social behaviours in flocks of birds and schools of fish. In particle swarm optimization (PSO), a group of software agents called particles look for good solutions to a given continuous optimization problem. Each particle may be a solution of the considered problem and uses its own experience and therefore the experience of neighbour particles to settle on the way to move within the search space. In practice, within the initialization phase each particle is given a random initial position and an initial velocity. The position of the particle represents an answer of the matter and has therefore a worth, given by the target function.

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Received date: May 7, 2021; **Accepted date:** May 21, 2021; **Published date:** May 28, 2021

Citation: Sanei V (2021) Swarm Intelligence: Studies and Application. Int J Swarm Evol Comput.10: e220

Cooperative behavior in swarms of robots

There are sort of swarm behaviors observed in natural systems that have inspired innovative ways of solving problems by using swarms of robots. This is what is called swarm robotics. In other words, swarm robotics is that the application of swarm intelligence principles to the control of swarms of robots. As with swarm intelligence systems generally, swarm robotics systems can have either a scientific or an engineering flavour. Clustering during a swarm of robots was mentioned above as an example of artificial/scientific system. An example of artificial/engineering swarm intelligence system is that the collective transport of an item too heavy for one robot, behavior also often observed in ant colonies.