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Living Machines (continued)

The Swarmbots Are Coming

Ant algorithms get down to business. *by Marco Dorigo*

Ants are simple creatures, yet they can perform complicated tasks. They create highways leading to food, organize the distribution of larvae in the anthill, form cemeteries by clustering dead ants, build living bridges to cross gaps in their way, and assign tasks as needed without any centralized control. Thus, ants provide an excellent model for programming simple devices to achieve complex results.

Boil down ant behavior and what do you get? A new set of business tools known as ant algorithms: basic behaviors that can be programmed into a large number of independent software agents to solve human problems.

Consider the way ants forage. When an ant comes across food, it returns to the nest, leaving a scent trail. Other ants follow the trail, find the goods, and carry them back to the nest, reinforcing the path with their own scent, which attracts still more ants. Shorter routes get more traffic, so the scent becomes stronger along these, while it dies away along lesser-used ones. In this way, ants follow the shortest paths between their nest and nearby food sources.

This route-finding capability is remarkably handy. Colonies of simulated ants laying down digital scent trails can find the best way to send delivery trucks through city streets or data packets through communication networks. More generally, ant algorithms can find minimum-cost solutions to a variety of problems in distribution and logistics. Unilever uses them to allocate storage tanks, chemical mixers, and packaging facilities. Southwest Airlines uses them to optimize its cargo operations. Numerous consulting houses, such as the Swiss firm AntOptima, have embraced them as an indispensable tool.

But logistics are just the beginning. Ant algorithms are also being used to control a class of robots called swarm bots. Typically, a swarm bot is a collection of simple robots (s-bots) that self-organize according to algorithms inspired by the bridge-building and task-allocation activities of ants. For example, if an s-bot encounters an object too heavy to carry on its own, other s-bots will grasp either the object or other s-bots until they get it under control. Two or more can link up to cross a gap that exceeds a single s-bot's stride. As an ad hoc accretion of simple units, a swarm bot's form depends on its surroundings and the job it's doing. Such devices might prove helpful in activities like search-and-rescue and planetary exploration.

The ability to swarm, adapt, and optimize makes ant algorithms a crucial technology for the information age, especially as everyday objects become ever smarter. The rules that

insects live by turn out to be perfectly suited to the high tech anthill.

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