Honey Bees Improve Internet Server Efficiency

By Bob Ewing Nov 18, 2007 in Internet

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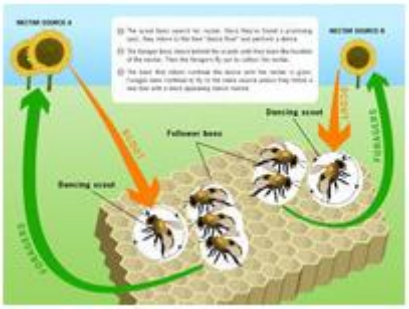
Let nature be your inspiration is the guiding phrase when it comes to the work of two researchers who studied the honey bee dance in order to improve the efficiency of Internet servers.



The phrase, busy as a bee, may take on a new meaning, thanks to a recent research project conducted by Georgia Institute of Technology. A research team has examined the swarm intelligence of the highly organized honey bee and states that this ability can also be used to improve the efficiency of Internet servers faced with similar challenges.

The research team has created a communications system that was inspired by the bees' activity and their system will assist Internet servers that would normally be devoted solely to one task move between tasks as needed, reducing the chances that a Web site could be overwhelmed with requests and lock out potential users and customers.

The honeybee system has been shown to improve service 4 to 25 per cent in tests based on real Internet traffic. The research was published in the journal Bioinspiration and Biomimetics.

Craig Tovey, a professor in the H. Milton Stewart School of Industrial and Systems Engineering at Georgia Tech, was studying the efficiency of honeybees and in conversation with Sunil Nakrani, a computer science colleague visiting from the University of Oxford, came to the realization that bees and servers had strikingly similar barriers to efficiency.

"I studied bees for years, waiting for the right application," Tovey said. "When you work with Biomimetics (the study of how biological principles can be applied to design and engineering), you have to look for a close analogy between two systems — never a superficial one. And this definitely fit the bill."

As the conversation between the two researchers evolved they became more certain that somehow the bees' strategies for allocating limited resources in an unpredictable and constantly changing environment could be applied to Internet servers.

The number of worker bees that are available at any given time is limited but they workers still need to fly out to flowers, collect nectar, return to the hive and repeat until the nectar source is depleted.
The amount of nectar that is available will vary and the bees live within a constantly changing ecosystem. Shifts in weather conditions, clouds, wind and rain, for example impact on the bees duties. When the two researchers considered the dynamic system within which the bees operated, they asked the question how they do what they do.

Typically the Internet servers that are used to provide the computing power necessary to run Web sites have a set number of servers devoted to a certain Web site or client. The servers provide the computing power for users to access a Web site, until all the requests to access and use the site have been fulfilled.
The demand for access will vary, sometimes it is high and sometimes it is low. It can be difficult to predict this behaviour and often servers are overloaded and later become completely inactive at random.
The method that bees use to tackle their resource allocation problems is referred to as the bee dance and the dance works like this:

First, the scout bees fly our on their quest for nectar. When they are successful and a nectar source is located, they return to the hive "dance floor" and perform a dance. The direction of the dance provides the forager bees with the direction to fly, the number of waggle turns conveys the distance to the flower patch; and the length conveys the sweetness of the nectar.
Then, the forager bees learn the correct steps from following the scout bees and imitating their moves until they are in sync, the result looking something like a conga line. The forager bees then fly out to collect the nectar detailed in the dance.
The dance continues until the nectar supply runs out, or new information that is provided by a new dance, that says hey the nectar over here is even better, is provided.

This many not sound like anyone's ideal efficiency model but it's actually optimal for the unpredictable nectar world the bees inhabit, Tovey said. The system allows the bees to seamlessly shift from one nectar source to a more promising nectar source based on up-to-the-minute conditions. This all takes place with no clear leader or central command to slow the decision making process.
"But the bees aren't performing a computation or strategy, they ARE the computation," Tovey added.
In comparison, Internet servers are theoretically optimized for "normal" conditions, which are frequently challenged by fickle human nature. The system works reasonable well under normal conditions and poorly under conditions that strain demand. If demand for one site swells, many servers will sit idly by as the assigned servers reach capacity and begin shifting potential users to a lengthening queue that frustrates users and has them go elsewhere.

Tovey and Nakrani have developed a virtual "dance floor" for a network of servers. It works like this; upon receiving a user request for a certain Web site, an internal advertisement (standing in a little less colorfully for the dance) is placed on the dance floor to attract any available servers.
How long the ad runs will depend on the demand on the site and how much revenue its users may generate. Longer stays on the dance floor result in more power from available servers being devoted to serving the Web site requests advertised.