How Honeybee Research Improved Your Internet Experience

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The Washington Post
September 21, 2016

Question: What’s the most efficient way for a colony of honeybees to harvest nectar from your garden? The answer, it turns out, is helping make your work on the Internet quicker and more efficient.

The story begins with three Georgia Tech systems engineers — Craig A. Tovey, John J. Bartholdi III and John Hagood Vande Vate — who in 1988 were inspired by a National Public Radio feature on the foraging practices of honeybees. The story focused on Cornell University biologist Thomas D. Seeley, who described how bees, with no central authority, efficiently gather nectar for honey. “Would the bees be any more efficient if they hired us as consultants?” they wondered.

Systems engineers make systems — in manufacturing, transportation and other sectors — operate more efficiently. These engineers were intensely curious about the system operating inside a honeybee colony. Seeley and others had studied how an individual forager bee operates, but no one had addressed the system as a whole.

The engineers contacted Seeley, and with financial support from the National Science Foundation and the Office of Naval Research, the four researchers developed a model that theorized how the bees would be allocated among flower patches of varying “profitability.” They predicted that the honeybees had developed a flexible system that brought large returns and allowed the colony to adapt to an ever-changing work environment — different flower patches going in and out of bloom in changing weather and seasons.

Tovey joined Seeley at the Cranberry Lake Biological Station in upstate New York to test their engineering model in the field. To track the bees’ behavior, Seeley labeled 4,000 honeybees in his research colony for identification. (How do you apply a label to a bee? Very carefully. Actually, you immobilize the bee by lowering its body temperature.) The bees did in fact follow their engineering model, operating at near-maximum efficiency.

Now the engineers had a “honeybee algorithm” – a self-organizing, highly efficient and highly adaptable system for gathering nectar. But they couldn’t figure out how to make use of it.

More than a decade later, knowing nothing about Tovey’s foray into honeybee behavior, an Oxford graduate student studying at Georgia Tech, Sunil Nakrani, approached Tovey about working with him on his dissertation. Nakrani wanted to determine the most efficient way to allocate Web-hosting computer servers among various applications to meet the demands of ever-changing Internet traffic. These shared servers make possible everything from your banking services to your social media activities.

Tovey realized that the Web-hosting problem was a near-perfect analogy to the honeybee foraging problem and began working with Nakrani to apply the honeybee algorithm to the digital world, so that servers would self-organize to allocate themselves to clients — just as honeybees do to flower patches. When they tested their biologically inspired algorithm against other methods, including some in use by major companies at the time, theirs outperformed the others by as much as 20 percent.

Today, we benefit from the greater efficiency created by the honeybee algorithm every time we use the Internet because it helps deal with sudden spikes in demand and prevents long queues. At least one major company is using it, and other companies' algorithms have benefited from it. Companies in the growing $50 billion global market for Web-hosting services can bring in as much as 20 percent more revenue by more efficiently allocating their servers. Moreover, the rapidly expanding field of self-organizing systems and biomimicry is leading to innovations ranging from biologically-derived adhesives to systems engineering solutions inspired by bees, ants and other social insects.

Because this unusual research had such an unexpected impact, it is receiving a Golden Goose Award this year. Today, when a budget crunch threatens the future of federally funded research, and some challenge funding for research without an obvious practical purpose, this story should send a message to Congress. Our leaders need to ensure robust funding for science and ignore those who say we should support only easily explained or justified research. The stories of the honeybee algorithm and this year's other Golden Goose awardees show how science can lead to innovations that benefit society in unexpected ways.

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