Can bees color maps better than ants?

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In mathematics, you need at most only four different colors to produce a map in which no two adjacent regions have the same color. Utah and Arizona are considered adjacent, but Utah and New Mexico, which only share a point, are not. The four-color theorem proves this conjecture for generic maps of countries, but actually of more use in solving scheduling problems, scheduling, register allocation in computing and frequency assignment in mobile communications and broadcasting.

Researchers in Algeria are taking inspiration from nature to help them devise an automated way to solve the map-coloring problem by looking at how so-called "swarm intelligence" of the kind observed in bee colonies might assist. Writing in the appropriately named *International Journal of Bio-Inspired Computation*, Malika Bessedik of the LMCS in Alger and her colleagues explain how bees could be much better than ants at map coloring.

Modeling the behavior of social insects, such as bees and ants has led researchers in many diverse areas of investigation to develop algorithms based on the behavior to help them solve problems in communication networks and robotics. Models of ant colony behavior leading to artificial intelligence systems have been particularly successful in these areas, while honey bee-based algorithms have been applied to engineering optimization problems.

The researchers explain that, honey bees are social insects that live in highly organized colonies with one or several queens and numerous drones, workers and broods. The queens specialize mating with drones

and laying eggs which are tended and cared for by the female workers. A mathematical model of this system known as "Marriage in honey bees optimization" (MBO) was developed in the early 2000s to help solve so-called combinatorial optimization problems, such as the traveling salesman problem of logistics and the minimum spanning tree problem for reducing the amount of resources and materials used in engineering, such as laying pipelines or fiber optic to fully connect a network. It mimics the genetic selection process in bees in which the queen mates with many drones and then randomly fertilizes her eggs with sperm from each male to generate a mixed pool of offspring among which only the fittest will thrive.

Bessedik and colleagues reasoned that that fact that MBO uses self-organization, unlike ant colony models, would allow it to solve one of the most complex problems - map coloring. The term map coloring belies the actual applications of the process because it is not used to color geographic maps but rather in solving engineering and mathematical problems. The team has now developed a new algorithm based on MBO that uses less computational power than other related algorithms.

More information: "How can bees colour graphs?" in *Int. J. Bio-Inspired Computation*, 2011, 3, 67-76

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