An ant-inspired approach to mathematical sampling

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Researchers observed the exploratory behaviour of ants to inform the development of a more efficient mathematical sampling technique. Credit: Pixabay

In a paper published by the *Journal of The Royal Society Interface*, a

team of Bristol researchers observed the exploratory behavior of ants to inform the development of a more efficient mathematical sampling technique.

Animals like ants have the challenge of exploring their environment to look for food and potential places to live. With a large group of individuals, like an ant colony, a large amount of time would be wasted if the ants repeatedly explored the same empty areas.

The interdisciplinary team from the University of Bristol's Faculties of Engineering and Life Sciences, predicted that the study species—the 'rock ant' - uses some form of chemical communication to avoid exploring the same space multiple times.

Lead author Dr. Edmund Hunt said: "This would be a reversal of the Hansel and Gretel story—instead of following each other's trails, they would avoid them in order to explore collectively.

"To test this theory, we conducted an experiment where we let ants explore an empty arena one by one. In the first condition, we cleaned the arena between each ant so they could not leave behind any trace of their path. In the second condition, we did not clean between ants. The ants in the second condition (no cleaning) made a better exploration of the arena—they covered more space."

In mathematics, a probability distribution describes how likely are each of a set of different possible outcomes: for example, the chance that an ant will find food at a certain place. In many science and engineering problems, these distributions are highly complex, and they do not have a neat mathematical description. Instead, one must sample from it to obtain a good approximation: with a desire to avoid sampling too much from unimportant (low probability) parts of the distribution.

The team wanted to find out if adopting an ant-inspired approach would hasten this sampling process.

"We predicted that we could simulate the approach adopted by the ants in the mathematical sampling problem, by leaving behind a 'negative trail' of where has already been sampled. We found that our ant-inspired sampling method was more efficient (faster) than a standard method which does not leave a memory of where has already been sampled," said Dr. Hunt.

These findings contribute toward an interesting parallel between the exploration problem confronted by the ants, and the mathematical sampling problem of acquiring information. This parallel can inform our fundamental understanding of what the ants have evolved to do: acquire information more efficiently.

"Our ant-inspired sampling method may be useful in many domains, such as computational biology, for speeding up the analysis of complex problems. By describing the ants' collective behavior in informational terms, it also allows us to quantify how helpful are different aspects of their behavior to their success. For example, how much better do they perform when their pheromones are not cleaned away. This could allow us to make predictions about which behavioral mechanisms are most likely to be favored by natural selection."

More information: Edmund R. Hunt et al. The Bayesian superorganism: externalized memories facilitate distributed sampling, *Journal of The Royal Society Interface* (2020). DOI: 10.1098/rsif.2019.0848

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