How Honey Bees Make Decisions

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Honey bees communicate through their dance language[1] and use it to gather nectar efficiently. The colony does not forage randomly, but selects the most profitable among the available nectar sources and strategically distributes foragers among them.[2] Though the colony collectively knows the best sources not a single individual carries this knowledge. We show how, like a collection of neurons, an intelligent colony emerges from a set of ill-informed individuals based on the premises that each bee responds with a fixed behavioral pattern to a given input.

We mathematically derive the strategy of source selection and forager distribution at the colony-level, starting from the known processes at the individual-level that have been studied for several decades.[1,2] Individual-level processes are: (1) the inputs to an individual that are supplied by three principle gauges carried by each bee, (2) the behavioral response to the inputs that are governed by two rules and (3) the communication methods between individuals. We show that the strategy of source selection is to select the most profitable sources in the field. Once selected, the strategy of forager distribution is to send a larger number of foragers to the source that takes a lesser time to collect nectar. We demonstrate that the mathematical model explains all the known controlled experiments[2] and allows a priori simulations of complex foraging scenarios.

1. Frisch K. von. The dance language and orientation of bees. (Harvard University Press: Cambridge 1967).
2. Seeley, T. D. The wisdom of the hive. (Harvard University Press: Cambridge 1995).

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