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Geodesic paths in simple graphs for some social insects

Social insects are an important example of complex collective behavior. In particular, ant colonies develop different tasks as foraging, building and allocation [1]. While they search for food they deposit a pheromone that it is considered as a crucial element in the mechanism for finding minimal paths. The experimental observations suggest that the model should include the presence of pheromone and the persistence (tendency to follow straight paths in the absence of other effects).

In our study, we will consider ants as random walkers where the probability to move in one or another direction is influenced by the concentration of pheromone near them (*reinforced random walks*). We are mainly interested not in an individual random walker but rather on a large number of random walkers, their collective behavior, and the possibility for them to aggregate forming geodesic paths between two points in some simple networks.

We investigate the behavior of ants in a two node network and in a three node network (with and without directionality constraint). Our analytical and computational results show that in order for the ants to follow shortest paths between nest and food, it is necessary to superimpose to the ants' random walk the chemotactic reinforcement. It is also needed a certain degree of persistence so that ants tend to move preferably without changing their direction much. Another important fact is the number of ants, since we will show that the speed for finding minimal paths increases very fast with it.

References

[1] B. Hölldobler and K. Wilson, *The ants*, Berlin: Springer, 1990
[2] M. Vela-Pérez, M. A. Fontelos and J. J. L. Velázquez,*Ant foraging and minimal paths in simple graphs*, Submitted for publication