How Do Ants Maintain Consensus in the Context of Changing Decisions?

: Investigating Ants' Sharp Turn During Collective Transport Using Simulation

Jooseok Lee and Sitong Lu

Problem description & significance

Paratrechina longicornis ants can form consensus quickly during collective transport and make a sharp turn without stalling [1]. We plan to investigate the mechanism behind this phenomenon where ants change their collective direction and form consensus quickly by extending an existing approach on collective decision-making. When faced with two options, each individual in an animal group makes their choice based on how many others made the same choice [2]. The Bayesian decision model proposed in [2], however, could not effectively explain the phenomenon where ants make sharp turns maintaining a consensus when they are faced with a wall. In order to explain this phenomena, we propose to extend the existing decision-making model by adding two factors (i.e., decaying preference and short-term memory), which reduce the preference for existing direction when ants travel without any rewards (i.e., getting closer to the colony). In addition, we also plan to introduce a synchronization mechanism similar to [3] in the preference decaying process to ensure quick formation of consensus. Finally, we will simulate the extended model and see if we could get the expected results in the context of two choices: if we could see sharp turns and quick formation of consensus.

The proposed model would broaden our understanding of the collective decision-making process among animals especially in the context of changing decisions. If it is proven to be effective, the model could also be used in diverse domains including cooperative robotics to help agents deal with dynamic environments where they need to frequently change their original decision.

Background & related work

Forming a consensus during collective decision-making is one of the most important aspects for group survival. Various studies were conducted to explain how different kinds of animal groups come up with a consensus, resulting in numerous decision-making models. A unified decision-making rule, where each individual makes a decision with Bayesian estimations based on the number of others with the same choice, was proposed in [2] to consolidate the previous efforts.

The collective movement of Paratrechina longicornis ants were analyzed in [2]. It was observed that Paratrechina longicornis ants can maintain a consensus not only when they are collectively transporting but also making a sharp turn in the presence of obstacles [1], which could not be effectively explained with the decision-making rule proposed in [2].

Various synchronization mechanisms were studied to understand how a group of animals shows a collective and coordinated behavior. Mathematical analysis of synchronization between oscillators was conducted in [3]. The information transferring mechanism proposed in [4] showed that a school of fish can achieve a highly accurate collective movement and make consensus decisions even with conflicting information. It was also shown that introducing a variable refractory period enabled social spiders to effectively synchronize their hunting strategy in noisy environments [5].

Plan of execution

We plan to use a 2D grid where each cell represents an individual. Each individual will choose either to go right or left based on the extended model we propose. The collective movement speed will be calculated by aggregating every individual's decision: the higher the degree of consensus, the faster the collective movement will be. We aim to see the effectiveness of the model we propose by analyzing the collective movement; the number of sharp turns and average time to take forming a consensus. In addition, we plan to limit the number of other opinions that an individual can see. Qt framework, used for developing multi-platform applications, will be used to build a simulation model.

	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10
Writing a proposal										
Developing an environment setting										
Developing an extended decision-making rule										
Implementing the extended decision-making rule										
Implementing a simulation model										
Preliminary data analysis										
Modifying the decision-making rule										
Data analysis										
Preparing a presentation										
Writing a final report										

Bibliography

Jooseok Lee is a first year professional master's student in the department of Computer Science at CU Boulder, specializing in data science and engineering. He previously worked as a data scientist at Netmarble for 3.5 years. He also majored in Industrial and Management Engineering at POSTECH. His main interest is in applying machine learning and stochastic modeling techniques to various domains.

Sitong Lu is a second year professional master's student majoring in Computer Science at CU Boulder, with a subplan in Software Systems and Cloud Computing. He also majored in Computer Science and minored in both Writing and Mathematics at CU Boulder during his undergraduate studies. He is currently working as a backend database engineer at QI Path. He does not have a main interest in any specific area/direction and is currently treating himself as a full stack developer.

Reference

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