Improve the Foraging Performance of Complete Resource Collection

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The foraging behavior is defined by the behavior of ants when they search for seeds in a large unknown arena and deliver them to the nest. The foraging task is the abstraction of many real-world applications, such as search and rescue, environment monitoring, demining, and space exploration.

In multiple robot systems, we develop foraging algorithms for a group of robots to search for and deliver resources (gold or survivors) to a specific collection zone as much as possible.

In my current work, robots search for resources randomly. They report the location where they found resources to the server in the collection zone. We call it the *virtual pheromone waypoint* [1]. The weight of the waypoint is defined based on the density of resources around the waypoint. The waypoint will stay in the server for a certain time and will be removed as the pheromone decay.

When other robots are in the collection zone, they can access the shared pheromone waypoints. They will choose a pheromone waypoint based on their weights. The one with a higher weight, will be selected with a higher probability.

However, when more than 80% of resources are collected, it becomes harder for robots to find the last few resources [2]. Because robots search for resources randomly, some locations are visited multiple times and other locations will never be visited. Can you modify the current foraging algorithm [1] to improve the foraging performance. As shown in [2], it takes 50% of time to collect the last 20% of resources.

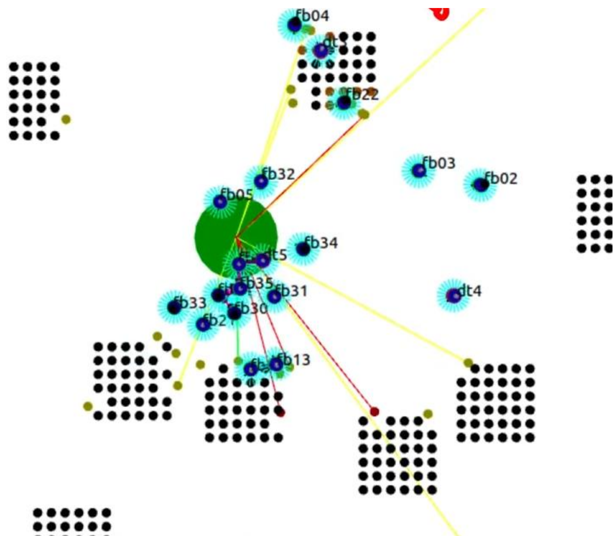
The goal is, can you reduce the time to find the last 20% of resources. You may design a mechanism which is like the pheromone waypoint. So, the server can provide a list of possible locations which are not visited or less visited.

Here are some limitations and assumptions.

1. Robots can not communicate directly. They can only communicate with the server when they are in the collection zone.
2. The server has limited storage space. It can save virtual pheromone waypoint information for a while, but they will be deleted after a certain time which is like the decay of real pheromone. If you let the server, remember other locations, this information can be saved for a certain time and should be deleted as well. Or you can convert the list of locations to other formats of information. For example, you can use a circle or rectangle to represent a group of locations or points. Otherwise,

the server cannot handle a large amount of information if the group of robots is large, e.g., thousands of robots. We can this is the scalability of robot swarms.

3. Robots also have limited storage space. We assume each robot can remember 50 locations at most in each round of foraging trip. Once it shares the location information with the server, it will delete the information in its memory. For example, we can let a robot to save location information every 5 seconds. If the number of locations is 50, it will only be remembered for the last 50 locations.



References:

1. Joshua P. Hecker and Melanie Moses. Beyond pheromones: evolving error-tolerant, flexible, and scalable ant-inspired robot swarms. Swarm Intelligence. Vol 9, pages 43-70, 2015.
2. Joshua P. Hecker, Justin Craig Carmichael, and Melanie Moses. Exploiting clusters for complete resource collection in biologically inspired robot swarms. 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).

Videos:

1. https://youtu.be/0dXPQMYKfcg