Ant Colony Optimization with Multiple Objectives

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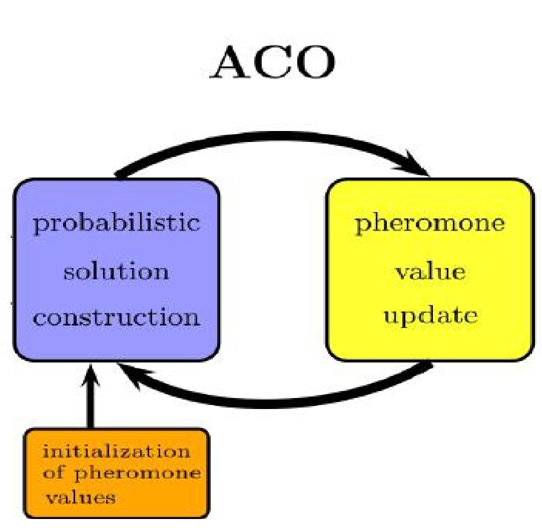
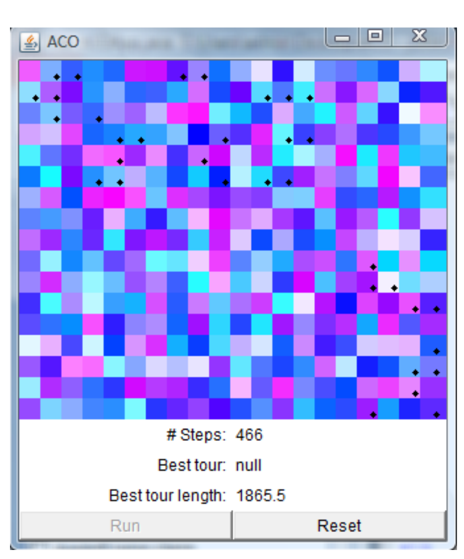
Abstract

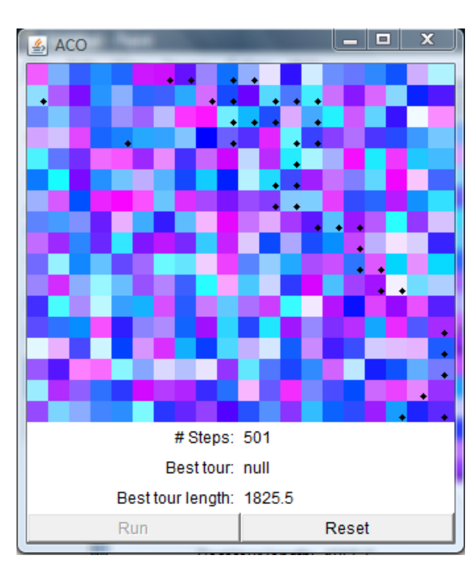
Ant Colony Optimization (ACO) is a useful method to find near optimal paths. The most common algorithms only works toward finding the best path with regard to one condition. However, it is often more realistic and useful to factoring other variables and constraints as well. This project will be to develop a way to consider two objectives and weigh their relative importance.

Introduction/Background

Ant Colony Optimization models how ants find a short path from their colony to a food source. As an ant travels back to its colony, it leaves behind a pheromone trail that other ants use. Pheromone builds up faster on shorter path than longer ones and evaporates over time. This allows the colony to weed out paths until only a near optimal one remains. The process does not guarantee an optimal solution, but the one it finds should be close. More than one factor generally affect which path is actually the best and focusing on only one means sacrificing others. The idea then is to implement a way to take multiple objectives into account.







Procedures and Methods

There are four main classes: The network contains all the nodes, edges, and ants. Nodes have an ID and two weights. The nodes' color reflects the value of the weights. Edges have two 'lengths' that is the absolute value of the difference of nodes' weights. Ants are released one at a time from the top left corner on the grid, until there are 100 on the net. Whenever an ant finishes another one comes out.

The destination is the bottom right node, and the ants make decisions on which node to go to next utilizing pheromones deposited by ants that have completed the tour. As the program runs, it goes through each node, counts all the ants on that node, and has each ant calculate its next node (each ant also has a vector of all the nodes it has been to). If an ant has reached the end it deposits on the edges between nodes on its path. The program prints out the tour lengths. All the edges then update their weights based on new deposits.

After the system is constructed, the various variables controlling the movement of the ants and the pheromone are modified and tested.

Procedures and Methods cont.

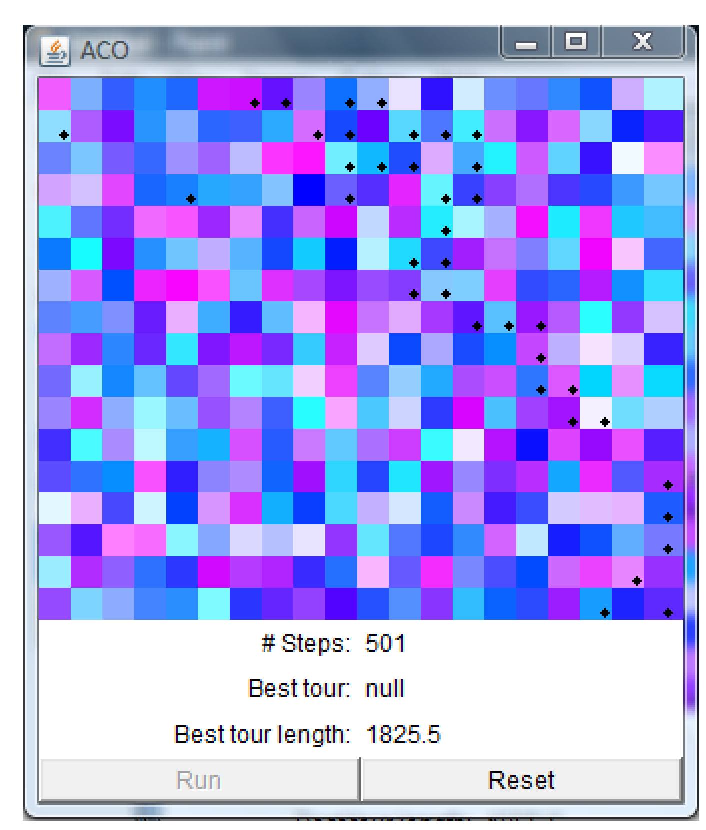
A variation of the Elitist Ant algorithm is used. This lets the ant that gives a best ever tour to deposit double the pheromone. The route is then reinforced each time until a better one is found.

Results

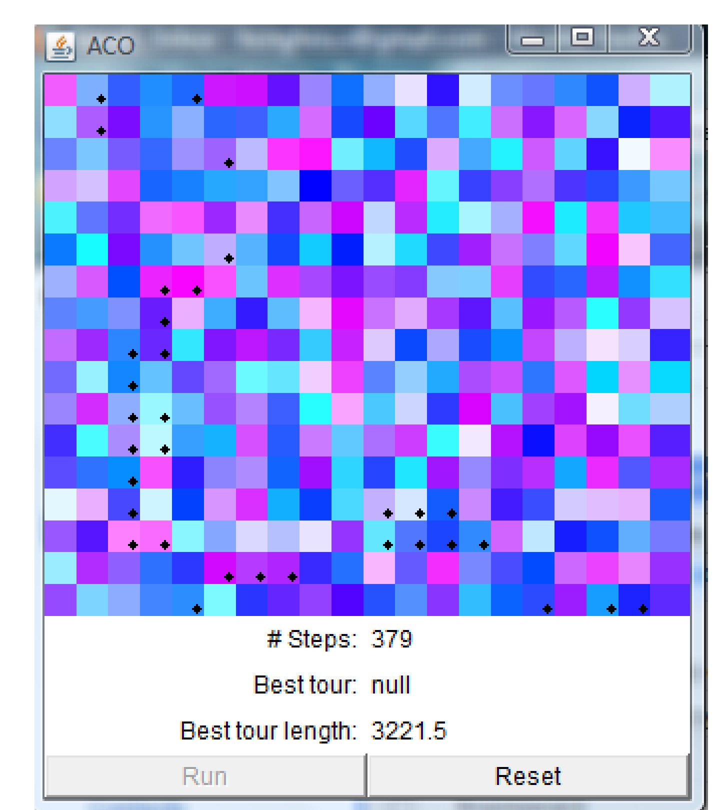
For each run, there is a best-ever-tour length and an average tour length.

Depending on the objective weight, different lengths result. For weight of 1, the length average is around 2100 while for a weight of 0, the length average is around 3600. With a weight of 0.5, the average is actually the lowest at about 1600.

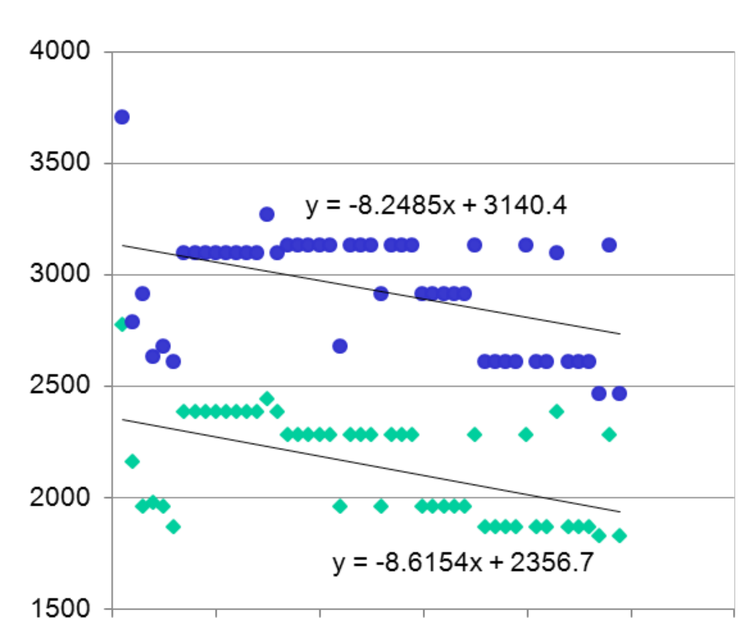
The ants generally congregate to a path between 450 and 500 steps

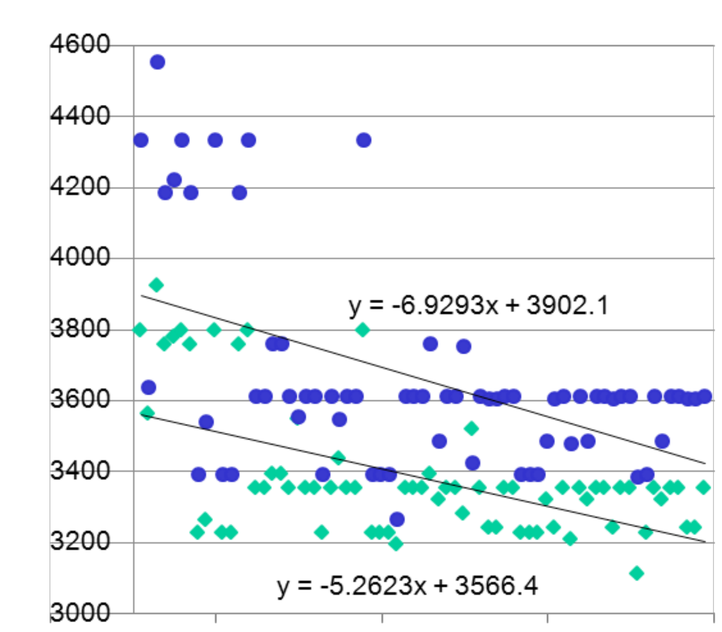


Objective weight = 1



Objective weight = 0





Conclusion

The system generally works as expected. When the objective weight is focused on one objective that objective reduces in length more and at a faster rate compared to the other. It is interesting that the optimal result overall and individually is achieved when both objectives are taken into account.

References

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