

## **Workshop 2 - System Analysis**

### **Observations and conclusions**

The purpose of this section of the document is to mention how each of the inputs of the system previously created to solve the salesman problem work, which is obtained as an output and some problems that were encountered during the development of the activity.

#### **Inputs**

In the problem that we will address, different inputs are evident that influence the function implemented by the ant colony optimization algorithm, these are:

- Number of cities
- Number of ants
- Number of iterations
- Alpha parameter
- Beta parameter
- Evaporation rate of the pheromone
- Quantity of pheromone per ant each time it passes along a path

#### **Number of cities:**

This input directly affects the complexity of the problem because the more cities there are, the more difficult it is to have a shorter route and in less time. Also it affects the time of execution of the algorithm and directly affects the probability of obtain the best path in extreme situations if there are less ants, because these have more routes to travel, the latter complicating the possibility of the ants taking the shortest route.

#### **Number of ants:**

This input has a great impact on the implementation of the ACO because it allows more routes to be traveled, thus increasing the possibilities of obtaining the best path. However, increasing this value to the extreme can cause the ants be more susceptible to deviating by less efficient routes, which would cause a counterproductive effect to what we expected, thus being a value that must be chosen with great care depending on the situation to be treated.

#### **Number of iterations:**

This input largely influences the precision of the data that we obtain, since regardless of the number of ants or how much pheromone they leave where they pass, the more iterations are done, the more precise the data obtained will be since the possible paths are traveled more, leaving more pheromone for those who are more efficient. On the other hand, it also affects the execution time because the more iterations are done, the longer it will take to obtain the results since more trips have to be made.

### **Alpha parameter:**

This input allows the ants to be influenced to make the decision of which route to take, mostly based on the pheromone left by the other ants. Increasing this value would mean that the ants rely more on the pheromone when making the decision than on distance or chance, so care must be taken because if this value is greatly increased it could cause them to take unwanted routes. as better roads, which we try to avoid by influencing this decision also by the distance to travel.

### **Beta parameter:**

This input, like the alpha parameter, influences the ants' decision when choosing which path to follow, but in this case this parameter tells us how influenced the ants are by distance. Increasing this value would mean that the ants now make a decision more based on the distance between their current city and those around them, so increasing it inadvertently could cause the ants take the longest route, therefore like the alpha value, great care must be taken when defining the value of this parameter.

### **Evaporation rate of the pheromone:**

This input establishes how long it takes for the pheromone to dissipate. This helps the iterations to be more efficient and the less pheromone a route has, the easier it is to discard it. Decreasing this value excessively could cause the algorithm to be inefficient since the pheromone would prevail for a very short time, so the most optimal routes would also be erased from the map more easily for each iteration, while increasing it excessively would also harm the efficiency of the algorithm. since the least efficient routes will have a greater chance of being chosen, which drastically affects the outputs of the code. Therefore, depending on the situation, an appropriate value should be chosen that favors the time in which the most optimal routes are preserved and the least optimal ones are discarded.

### **Quantity of pheromone per ant each time it passes along a path:**

This input establishes how much pheromone each ant leaves for each path it travels, this allows the most optimal routes to be chosen in each case since the path that has the most pheromone is the one that in one way or another will influence the ants the most. Decreasing this input would increase the need to do more iterations, which would spend more time to find a more optimal solution, and increasing it excessively could mark less efficient routes, so like most of the inputs mentioned above, an appropriate value must be established depending on the situation in which it is used.

## **Outputs**

This program has one output that is the best path. In this case the best path is the sequence of cities that the ants find and like an extra we add the distance that this route takes. Also, we add a map which shows in a 3D space the position of each city and the route obtained with the best path.

## **Conclusions:**

- The ACO is a great example of a swarm intelligence because it shows how a simple agent by itself can't realize a big work but using many agents and give them the correct instructions and restrictions, they can solve really hard works
- An observation that we do is that the probability must to be calculated by a quotient because there is a possibility where the probability in some cases throws negative values
- The ACO is an elegant and organized way to realize a brute force attack because we proof all the cases one per one but trying it quickly and simultaneously
- Is important consider all the inputs and the variables in a system because in this way we obtain the really information about how it works.