GAGP Tutorial 6 (week 9)
Ant Colony Optimisation

This tutorial is on the travelling salesman problem and ant colony optimization.

Consider the following (very small) TSP:

$d(A,B) = 2, d(A,C) = 3, d(A,D) = 5, d(B,C) = 3, d(B,D) = 3, d(C,D) = 4$

1. How many different tours are possible? How many tours are possible with a TSP containing N cities?

2. What is the optimal (shortest) tour for the TSP given above?

3. The probability that an ant can move from i to j is p(i,j) in the lecture slides. This can be viewed as an element in a matrix, the pheromone matrix.

Use the Ant Colony Optimisation Probability Rule given below and an initialised pheromone matrix with $\tau(i,j) = 1.0$ for all i,j, i $\neq$ j (and 0.0 for i=j). Calculate the probabilities that an ant placed initially on city A will move to B, C or D.

$$Pr(i,j) = \frac{\tau(i,j).[\eta(i,j)]^{\beta}}{\sum_{\text{allowed}j} \tau(i,j).[\eta(i,j)]^{\beta}}$$

$\eta(i,j) = 1/d(i,j), \beta = 2$

4. Now use the following pheromone values and recalculate the probabilities for Pr(A,B), Pr(A,C) and Pr(A,D). What about Pr(B,A)?

$\tau(A,B) = 4.0, \tau(A,C) = 4.0, \tau(A,D) = 0.2, \tau(B,C) = 0.4, \tau(B,D) = 2.0, \tau(C,D) = 4.0,$

5. Assume that A-B-D-C-A is the fittest of the current iteration, that the evaporation (ρ) is 0.75 and that the reinforcement value is 1.0. Update the values above using the pheromone update rule:

$\tau(i,j) = [\tau(i,j) * \rho] + \Delta(i,j)$

where $\Delta(i,j)$ is 1.0 if i-j or j-i is a link in the best solution and 0.0 otherwise.

What happens if ρ is smaller? Does that seem reasonable? How could you use this phenomenon? (see Q. 6)

6. Assume that ants are allowed to lay pheromone on a path at every timestep, so that the pheromone update rule is applied at each timestep. Come up with a combination local/global updating scheme that encourages exploration and exploitation– consider what parameters influence this.

7. How would you apply ACO to finding the cheapest way to fly from Edinburgh airport to Bora Bora airport?