Visualisation of **Ant** Colony Optimisation

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github.com/poolik/visual-aco

MTAT.03.238 Advanced Algorithmics

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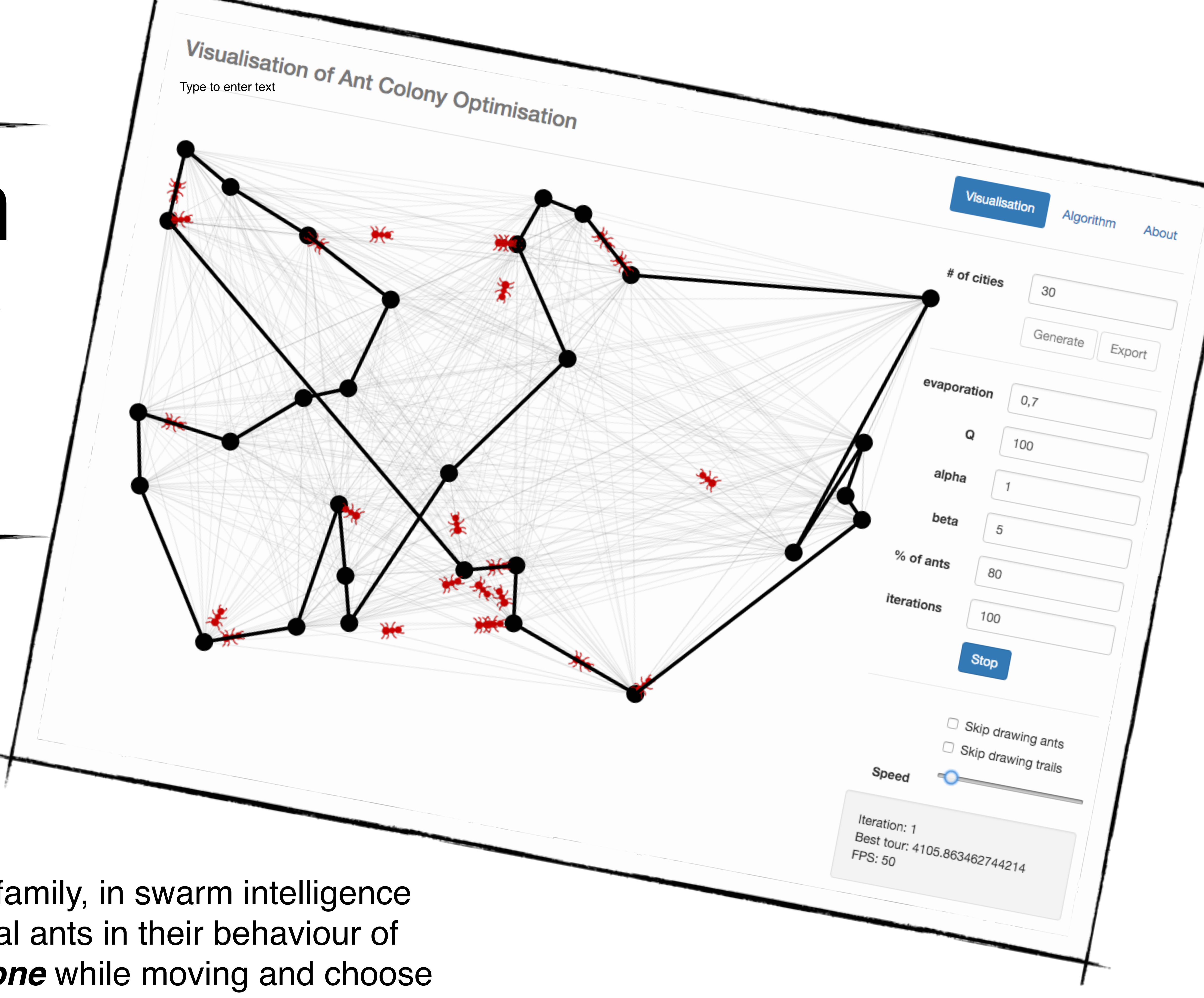
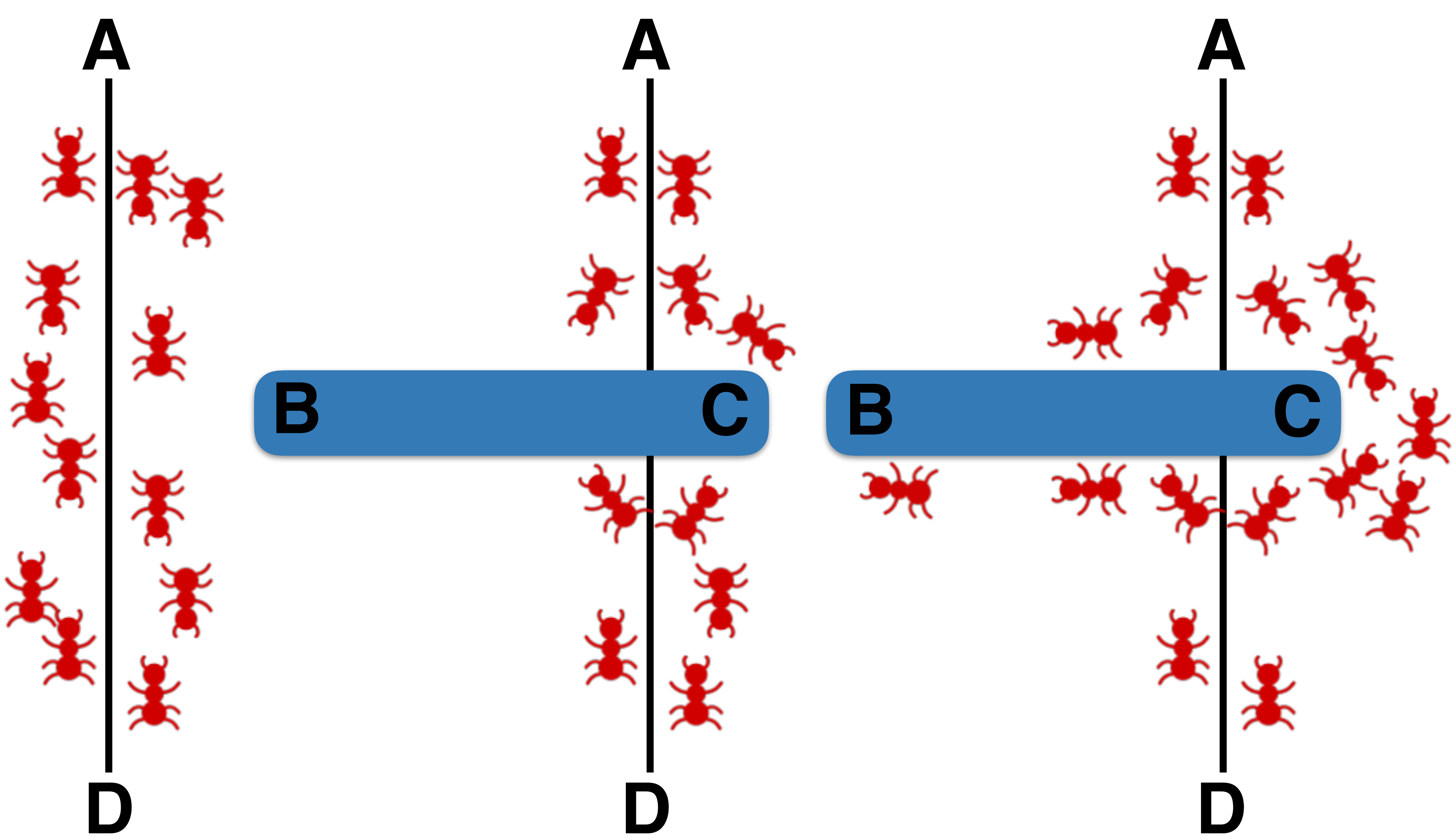


ACO is part of the ant colony algorithms family, in swarm intelligence methods. The main idea is to simulate real ants in their behaviour of choosing a path. Ants lay down ***pheromone*** while moving and choose the paths with higher quantities of pheromone with higher probability. A crucial aspect is also that pheromone ***evaporates*** over time.



Ants move between **A** and **D** happily until an obstacle appears on their path. At first they will essentially randomly choose whether to go towards points **B** or **C** to get passed the obstacle. But those who went towards **C** arrive at the other side of the obstacle much sooner and *pheromone* attracts additional ants towards **C**. Ants arriving via **B** will also have taken more time so more pheromone would have evaporated making the choice a less attractive one.

Algorithm

1. Set initial amount of pheromone on $\tau_{ij}(0)$ to some low constant c for all i, j
2. Distribute m ants among the n cities randomly
3. For each ant until their tour is complete
   (a) Choose the city j to move to, with probability $p_{ij}(t)$
   (b) Mark town j as visited for this ant
4. Compute the tour length L^k for the k-th ant
5. Find the shortest tour among all ants, update global shortest tour if we found a shorter one
6. Update the amount of pheromone by calculating $\tau_{ij}(t+n)$ for each i, j
7. If we should continue, clear each ant's tour and go to step 2. Otherwise report global shortest tour

- n - nr of cities
- m - nr of ants
- ρ - pheromone evaporation rate
- $\tau_{ij}(t)$ - amount of pheromone on the edge between cities i and j at time t
- $p_{ij}(t)$ - probability of choosing the edge between cities i and j at time t

The formula for updating the pheromone

$$\tau_{ij}(t+n) = \rho * \tau_{ij}(t) + \Delta\tau_{ij}(t, t+n)$$

where

$$\Delta\tau_{ij}(t, t+n) = \sum_{k=1}^{m} \Delta\tau_{ij}^{k}(t, t+n)$$

$$\Delta\tau_{ij}^{k}(t, t+n) = \begin{cases} \frac{Q}{L^k} & \text{if k-th ant uses edge ij} \\ 0 & \text{otherwise} \end{cases}$$

Q is a constant and L^k is the tour length of the k-th ant.

Probability of choosing the edge ij at time t is:

$$p_{ij}(t) = \begin{cases} \frac{(\tau_{ij}(t))^{\alpha} * (\eta_{ij})^{\beta}}{\sum_{k \in allowed} (\tau_{ik}(t))^{\alpha} * (\eta_{ik})^{\beta}} & \text{if can go to the city j} \\ 0 & \text{otherwise} \end{cases}$$

where

$$\eta_{ij} = \frac{1}{d_{ij}}$$

d_{ij} is the distance between cities i and j