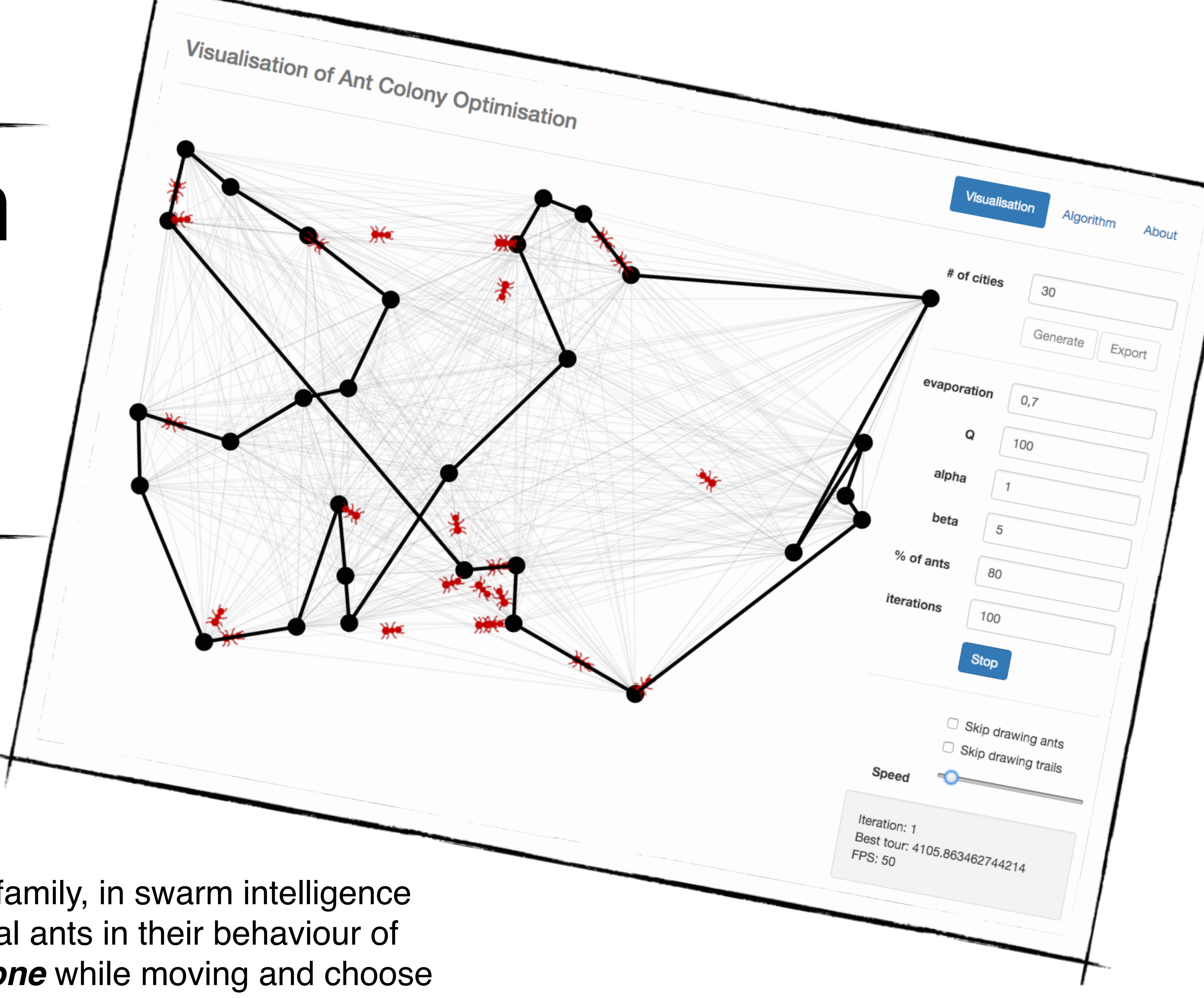
Visualisation of **Ant** Colony Optimisation

Tõnis Pool

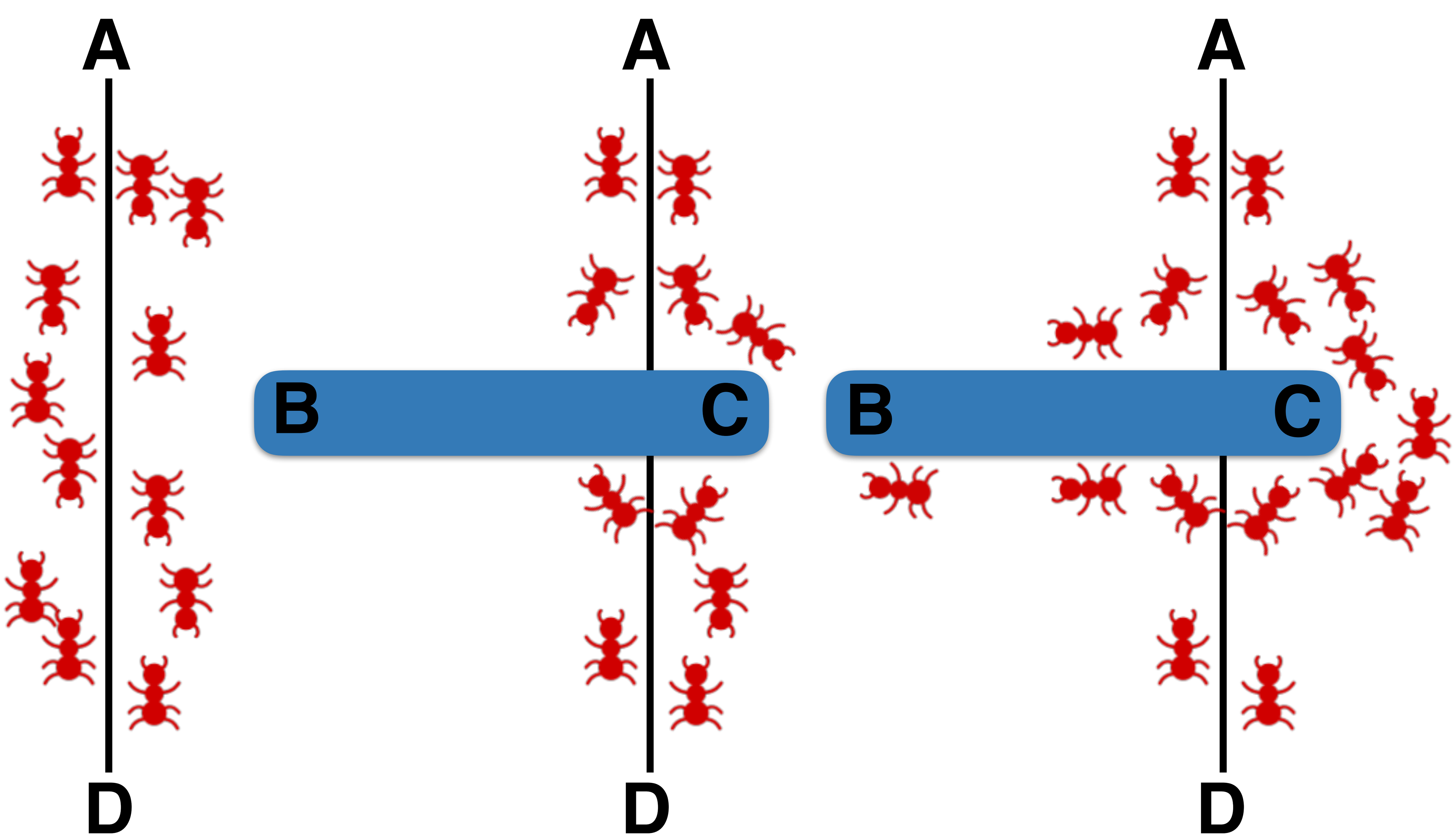
github.com/poolik/visual-aco

MTAT.03.238 Advanced Algorithmics

University of Tartu



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