Swarm Intelligence — Class Exercises 1

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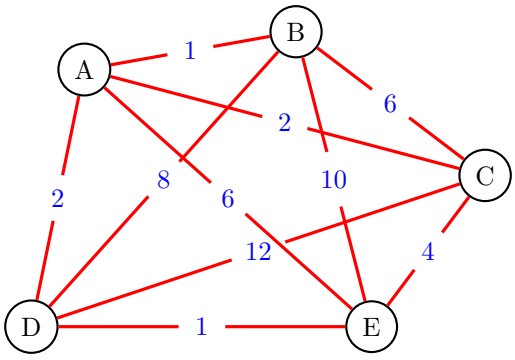
1. What kind of algorithm is Ant system (AS)? Does AS guarantees to eventually find the optimal solution or to determine that no solution exists?
2. Is it possible to use AS with $\{\alpha = 0, \beta = 1\}$ or $\{\alpha = 1, \beta = 0\}$? What is the effect in each case?
3. How ρ relates with the exploration and exploitation performed by AS? What about α and β?
4. In class we used a minimization problem (TSP) as example. Consider now the problem of finding the maximum length tour: what modifications are needed to solve this problem using AS?
5. Assume the following symmetric TSP instance:



(a) Distance between each city.

	A	B	C	D	E
A	–	0.56	0.66	0.60	0.50
B	0.56	–	0.60	0.56	0.60
C	0.66	0.60	–	0.50	0.56
D	0.60	0.56	0.50	–	0.66
E	0.50	0.60	0.56	0.66	–

(b) Pheromone matrix (τ) at iteration 1

An Ant System algorithm is applied to the TSP instance shown in Figure (a) using $\alpha = 2$, $\beta = 1$, $\rho = 0.5$, $\#ants = 3$, $\eta_{ij} = 1/d_{ij}$ and $\tau_0 = 1$. After the first iteration, the pheromone matrix (τ) is the one given above in Figure (b).

(i) What is the meaning of the values in τ? Why $\tau_{C,D} = 0.5$?

(ii) Using the information shown in Figure (a) and (b), and random numbers $\{0.76, 0.80, 0.27, 0.88, 0.47, 0.05, 0.98, 0.23, 0.06\}$, generate the first solution of iteration 2.
Note: use the same roulette wheel of the random proportional rule to select the initial city assuming uniform probabilities for all cities.

(iii) The following solutions generated by the algoritm are $AEDCBA$ with $cost = 26$ and $DECBAD$ with $cost = 14$. Update the pheromone using this information.

(iv) Figure 2 shows the pheromone matrix after 12 iterations. Would you advice to continue executing more iterations? Why?

	A	B	C	D	E
A	–	0.4285	0.0004	0.4285	0.0003
B	0.4285	–	0.4286	0.0003	0.0003
C	0.0004	0.4286	–	0.0003	0.4285
D	0.4285	0.0003	0.0003	–	0.4286
E	0.0003	0.0003	0.4285	0.4286	–

Figure 2: Pheromone matrix (τ) (iteration 12)

Remember: the tour length is computed starting and ending in the same city.