Swarm Intelligence — Class Exercises **2**

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1. What is the difference between the pheromone update of Ant system and Max–min ant system?
2. What would be the effect of removing the upper and lower limits for the pheromone in Max–min ant system?
3. What is the initial pheromone value (τ_0) and how it is related with exploration?
4. Based on the description provided in the course of Max–min ant system, is it τ_{max} constant during all iterations?
5. Assume the following symmetric tsp instance:

	A	B	C	D	E
A	–	1	2	2	6
B	1	–	6	8	10
C	2	6	–	12	4
D	2	8	12	–	1
E	6	10	4	1	–

Figure 1(a): TSP instance (tsp)

	A	B	C	D	E
A	–	0.125	0.125	0.012	0.012
B	0.125	–	0.012	0.125	0.012
C	0.125	0.012	–	0.012	0.125
D	0.012	0.125	0.012	–	0.125
E	0.012	0.012	0.125	0.125	–

Figure 1(b): Pheromone matrix (τ) (iter. 12)

A Max–min ant system algorithm is applied to this instance using $\alpha = 2$, $\beta = 1$, $\rho = 0.5$, $\#ants = 3$, $\eta_{ij} = 1/\mathsf{tsp}_{ij}$ and $a = 5$.

   (a) On the first iteration the solutions found are $DEBCAD$ with $cost = 21$, $ABDECA$ with $cost = 16$ and $ACBEDA$ with $cost = 21$. What is the resulting pheromone matrix after the update?

   (b) After iteration 12 the solutions found are $EDBACE$ with $cost = 16$, $BACEDB$ with $cost = 16$ and $EDBACE$ with $cost = 16$. The resulting pheremone matrix (τ) is shown above in Figure 1(b). What can you conclude?

6. What is the effect of ρ in MMAS? What happens for high and low settings of ρ, and what is the difference with AS?
7. What is the effect of the local update rule in ACS? How the behaviour differs with respect to MMAS?
8. What is the effect of setting $q_0 = 0$?