Exercises from lecture 9 (SI)

Question 1

a)

$$p_{ij}^{k} = \begin{cases} \dfrac{\tau_{ij}^{\alpha} \cdot \eta_{ij}^{\beta}}{\sum_{c_{il} \in N(s^p)} \tau_{il}^{\alpha} \cdot \eta_{il}^{\beta}} & \text{if } c_{il} \in N(s^p) \end{cases}$$

i.e. a city not visited

Normalization

where α, β are non linear control parameters

Pheromone weight, distance weight

$\eta_{ij} = \frac{1}{d_{ij}}$ inverse distance between i and j b)

$$\tau_{ij} \leftarrow (1-\rho)\tau_{ij} + \sum_{k=1}^{m} \Delta\tau_{ij}^{k}$$

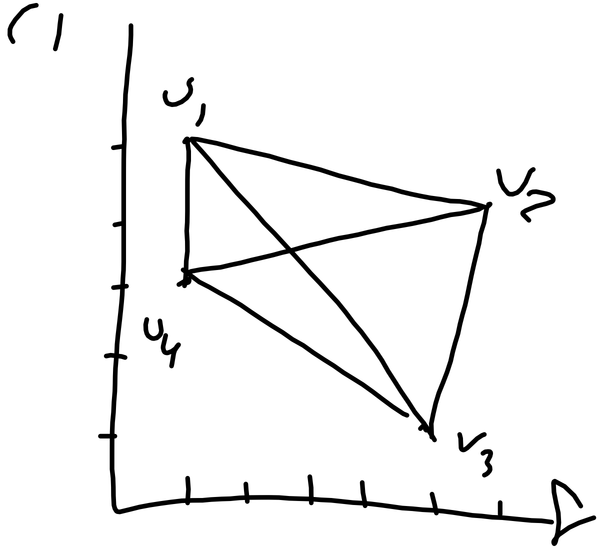
where τ_{ij} is pheromone concentration

ρ is evaporation rate

$\Delta\tau_{ij}$ is pheromone laid by ant k on edge ij if part of tour

$$= \begin{cases} Q/L_k & \text{if ant } k \text{ used edge } (i,j) \text{ on tour} \\ 0 & \end{cases}$$

L_k is length of tour



$d_{12} = 5{,}099$

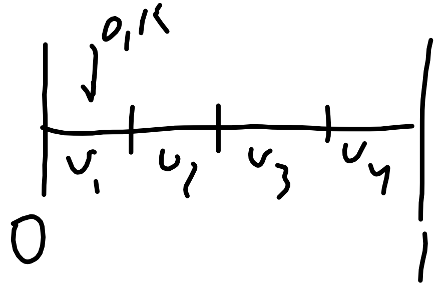
$d_{23} = 3{,}16$

$d_{34} = 4{,}47$

$d_{14} = 2 = \sqrt{(1-1)^2+(5-3)^2}$ $k=1$ in v_1

$d_{13} = 5{,}657$

$d_{24} = 5{,}099 = \sqrt{(6-1)^2+(4-3)^2}$



* $v_i = v_1$ $\quad v_j$ could be v_2, v_3 or v_4

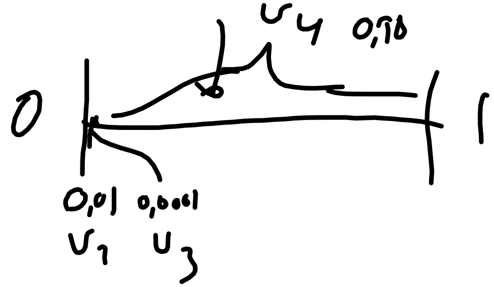
$$\sum \tau_{ij} \eta_{ij}^{\beta} = 10^{-6}\left(0.176^5 + 0{,}177^5 + 0{,}5^5\right) = 3{,}17 \cdot 10^{-8}$$

going to v_2

$$p_{12} = \frac{10^{-6} \cdot 0{,}196^5}{3{,}17 \cdot 10^{-8}} = 0{,}01$$

going to v_3

$$p_{13} = \frac{10^{-6} \cdot 0{,}177^5}{3{,}17 \cdot 10^{-8}} = 0{,}0001$$



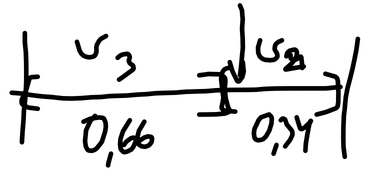
going to v_4

$$p_{14} = \frac{10^{-6} \cdot 0{,}5^{5}}{3{,}17 \cdot 10^{-8}} = 0{,}98$$

and $k=1$ chose city 4 (after city 1)

* $v_i = v_4$ could visit city v_2 or v_3

$$\sum \tau_{ij} \eta_{ij}^{5} = 10^{-6}\left(0{,}196^{5} + 0{,}274^{5}\right) = 8{,}47 \cdot 10^{-10}$$



going to v_3

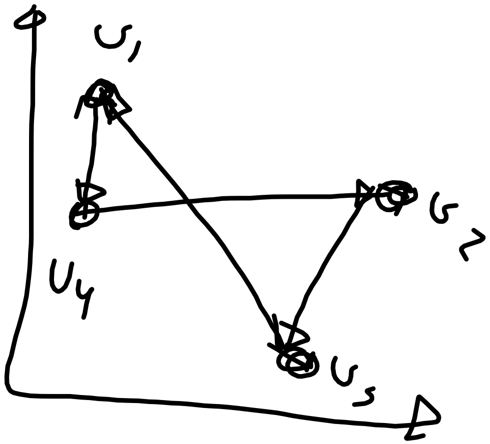
$$P_{43} = \frac{10^{-6}\cdot 0{,}774^{5}}{8{,}49\cdot 10^{-10}} = 0{,}66$$

going to v_2

$$P_{42} = \frac{10^{-6}\cdot 0{,}177^{5}}{8{,}49\cdot 10^{-10}} = 0{,}34$$

ant $k=1$ chose city 2 (after 4)

* $v_i = v_2$ must go to v_3



Tour length $L = 2 + 5{,}099 + 3{,}16$
$+ 5{,}66$
$= 15{,}92$

d) Simulate by computer

e)

$$T_{ij} = (1-g)\,T_{ij} + \sum_{k=1}^{n_k} \Delta T_{ij}^{k}$$

$$T_{14} = \left(1-\frac{1}{2}\right)10^{-6} + \frac{100}{15{,}96} + \ldots + $$

$$= 0{,}5 \cdot 10^{-6} + 6{,}78 + \ldots$$