Exercise 6

Question 1

a) $p_{ij} = \begin{cases} \dfrac{\tau_{ij}^{\alpha}\,\eta_{ij}^{\beta}}{\sum_{i_l \in N(s^p)} \tau_{i_l}^{\alpha}\,\eta_{i_l}^{\beta}} & \text{if } i_l \in N(s^p) \text{ i.e. a city not visited} \\ 0 & \text{normalization} \end{cases}$

(α: pheromone weight, β: distance weight)

$N(s^p)$ is set of feasible components

$\eta_{ij} = \frac{1}{d_{ij}}$, where d_{ij} is distance between ij

b

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

τ_{ij}: pheromone concentration

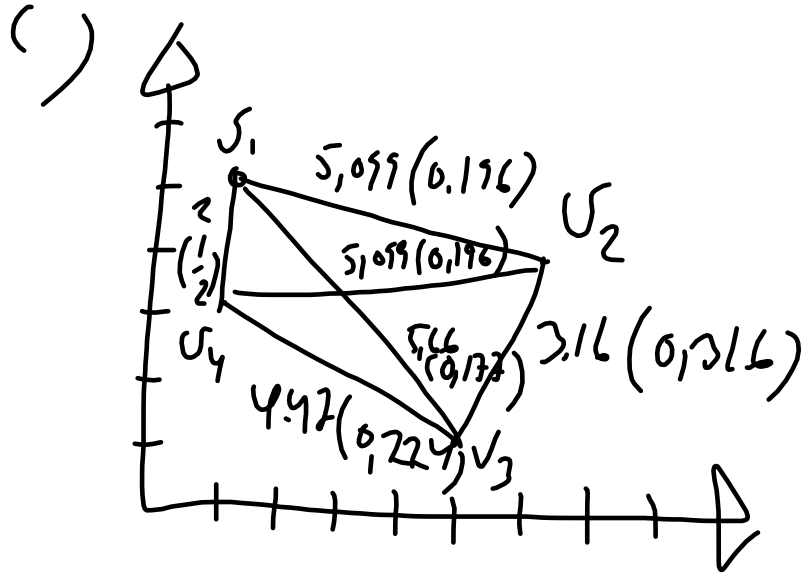
ρ: evaporation rate

$\Delta\tau_{ij}^{k}$ is pheromone laid by ant k on edge (i,j) if part of tour

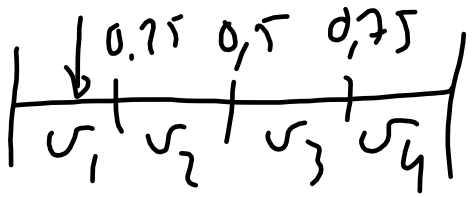
$$\Delta\tau_{ij} = \begin{cases} Q/L_k & \text{if ant } k \text{ used edge } (i,j) \text{ on tour} \\ 0 & \end{cases}$$

L_k: length of tour

$\Delta\tau$ is the same for all edges of the same tour


( )
v_1
5,099 (0,196)
v_2
5,099 (0,196)
2
$\left(\frac{1}{2}\right)$
v_4
5,66 (0,177)
3,16 (0,316)
4,47 (0,224)
v_3

Find out start city, rand = 0,15



start k = 1 in city v_1

* $v_i = v_1$

v_j could be v_2, v_3, v_4

$$\sum r_{ij} h_{ij}^{\beta} = 10^{-6}\left(0.196^5 + 0.172^5 + 0.5^5\right)$$

$$\approx 3.12 \cdot 10^{-8}$$

going to v_2

$$p_{12} = \frac{10^{-6} \cdot 0.196^5}{3.12 \cdot 10^{-8}} = \frac{10^{-6} \cdot 2.9 \cdot 10^{-4}}{3.12 \cdot 10^{-8}}$$

$$= 0.01$$

going to v_3

$$p_{13} = \frac{10^{-6} \cdot 0.177^5}{3,17 \cdot 10^{-8}} = \frac{10^{-6} \cdot 1,7 \cdot 10^{-7}}{3,17 \cdot 10^{-8}}$$

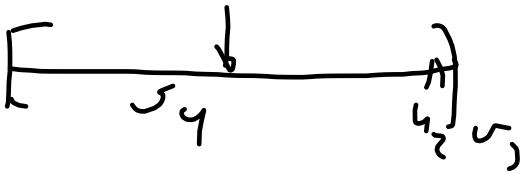
$$= 0.0001$$

going to v_4

$$p_{14} = \frac{10^{-6} \cdot 0.5^5}{3.17 \cdot 10^{-8}} = \frac{10^{-6} \cdot 3.1 \cdot 10^{-7}}{3,17 \cdot 10^{-8}}$$

$$= 0.98$$

rand = 0.5



Ant k=1 chose city 4 (after 1)

* $v_i = v_4$ v_j could be v_2 or v_3

$$\sum \tau_{ij}^5 \eta_{ij}^5 = 8.49 \cdot 10^{-10}$$

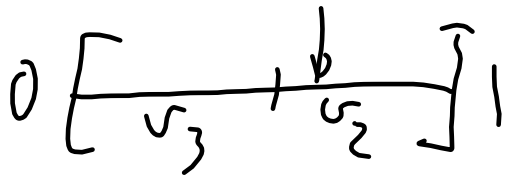
going to v_3

$$p_{43} = \frac{10^{-6} \cdot 0.224^5}{8.49 \cdot 10^{-10}} = 0.66$$

going v_2

$$p_{42} = \frac{10^{-6} \cdot 0{,}1775}{1.99 \cdot 10^{-10}} = 0.34$$

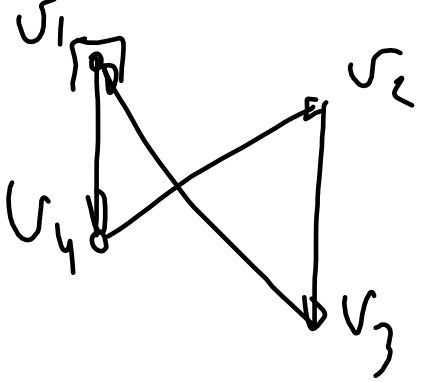
rand = 0,76



auto k=1 chose city 2 (after 4)

* $v_i = v_2$ v_j could only be v_3 ant $k=1$ chose city 3 (after 2) and returns home

So tour of ant $k=1$, $t=1$



$L_k = 2 + 5.099 + 3.16 + 5.66$
$= 15.95$

e)

$$\Gamma'_{ij} = (1-\beta)\Gamma_{ij} + \sum_{k=1}^{n} \alpha \Gamma^{k}_{ij}$$

$$\Gamma'_{14} = \left(1 - \frac{1}{2}\right) 10^{-6} + \frac{100}{15,92} + \dots\dots +$$

Γ'_{24}

Γ_{23}

Γ_{13}