

## Agenttipohjaisen tietojenkäsittelyn perusteet

## Laskuharjoitus 5

## Solutions

1. a) The costs of the tree routes are as follows:

Route	Time (min)	Cost (mk)
<i>I</i>	57	39
<i>II</i>	33	26
<i>III</i>	55	20

If the engineer salary  $a = 40$  mk, the cost function  $U(t, m) = m + at$  gives us the following values:

$$I : U(57, 39) = 39 + \frac{57}{60} \cdot 40 = 77$$

$$II : U(33, 26) = 26 + \frac{33}{60} \cdot 40 = 48$$

$$III : U(55, 20) = 20 + \frac{55}{60} \cdot 40 = 56.7$$

With given parameters the route *II* is the best.

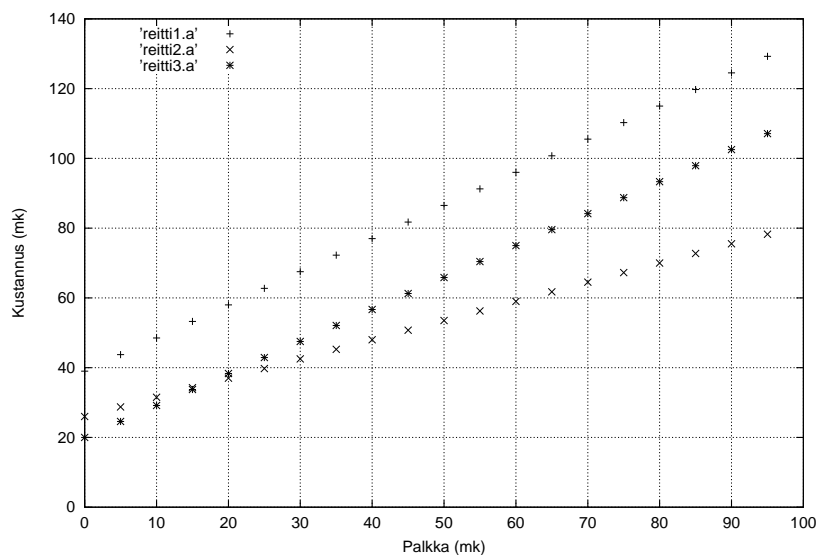
We find the point where *III* is better than *II* by solving the following inequality:

$$\frac{33}{60}x + 26 \geq \frac{55}{60}x + 20$$

$$x \leq 16.36,$$

so the engineer had to earn less than 16.36 mk/h for route *III* to be better.

The figure below gives the costs of different routes when  $a$  varies between 0–100.



We see that *I* is dominated by the two other routes so it can be left out of decision process.

- b) When we use the cost function  $U(t_1, t_2, m) = a_1 t_1 + a_2 t_2 + m$ , where  $a_1 = 1.5a$  and  $a_2 = 0.5a$  the situation is as follows:

Route	Time $t_1$ (min)	Time $t_2$ (min)	Cost (mk)
<i>I</i>	25	32	39
<i>II</i>	12	21	26
<i>III</i>	45	10	20

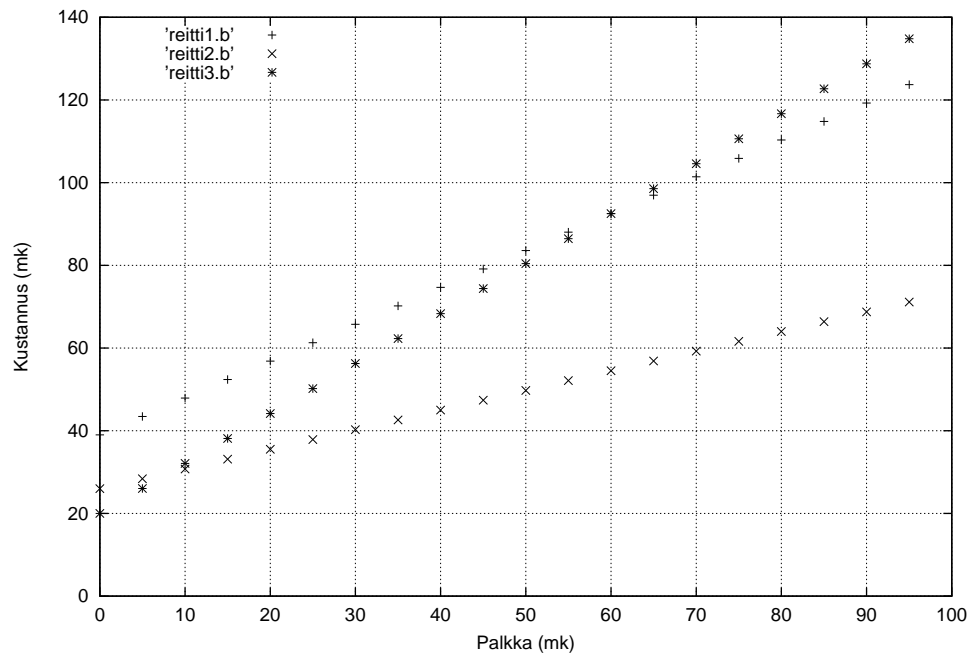
Thus, the costs of the routes are:

$$I : U(25, 32, 39) = 39 + \frac{25}{60} \cdot 60 + \frac{32}{60} \cdot 20 = 74.7$$

$$II : U(12, 21, 26) = 26 + \frac{12}{60} \cdot 60 + \frac{21}{60} \cdot 20 = 45$$

$$III : U(45, 10, 20) = 20 + \frac{45}{60} \cdot 60 + \frac{10}{60} \cdot 20 = 74.375$$

Again, *II* was better than the others. The following figure shows how the costs change as function of salary:



In this interval none of the options dominates the other ones.

- c) If the results of choices are not deterministic, we use the expected value  $E[U(X)]$  of the utility function as basis for the decisions.

The probability distribution of the three different routes is:

Route	$t$ (min)	$p(t)$
<i>I</i>	57	0.75
	58	0.20
	62	0.05
<i>II</i>	33	0.30
	34	0.20
	43	0.20
	48	0.30
<i>III</i>	55	0.16
	56	0.19
	57	0.03
	60	0.17
	61	0.04
	65	0.17
	66	0.03
	70	0.17
	71	0.03
	75	0.01

This gives us the following expected values and costs:

Reitti	$E(t)$ (min)	$U(t, m)$ (mk)
<i>I</i>	57.45	77.3
<i>II</i>	39.7	52.47
<i>III</i>	61.6	61.06

Again, we should choose route *II*.

