Assignment 5

This assignment is worth 40 points. Solutions should be submitted by 15.1.2020. Form groups of two students for this assignment until 5.1.2020 and write your names in the provided spreadsheet.

Optimization

Write at least two optimization programs that solve the below given vehicle routing problems.

One of the optimization programs must use local search and the other one can use any optimization approach. All problems are minimization problems.

Write your results into the spreadsheet available here (You can click on last "here", even if it is not visible in some pdf readers). Each group should fill their results as soon as possible so that other peers can see what are currently the best obtained results for comparison.

Write a report with your results and description of used approaches. Report should include results for each tested method separately and a short description of each method (1-2 pages for each method). Submit your code, report and solutions on e-ucilnica. Solution for each problem should be provided in separate file named solution1.txt, solution2.txt, etc.

Final grade will be based on quality of results, quality of report, oral presentation, number of methods tested and code quality.

Vehicle Routing Problem Description

You are trying to optimize the cost of collecting garbage for a garbage disposal firm. You have three types of garbage to collect (organic, plastic and paper). Each truck can only collect one type of garbage on a single route. You have unlimited number of trucks and workers available. A truck must pick up garbage on a visited site if it has available capacity while travelling past the site. It also must pick everything from a given site and cannot partially empty a location. Each truck must return to the disposal facility at the end of a day.

Some roads between towns are one way roads and some include bridges which have max carrying capacity.

The cost of collection is composed of the fixed fee for each trip, the distance travelled by the truck and hourly pay for the employee. Each trip has a fixed cost of 10€. The distance travelled has cost 0.1€ per km. The hourly cost for an employee is 10€ per hour. The average speed of a truck is 50km/h and it takes on average 12 minutes to collect garbage on each site irrelevant of the amount of garbage. If the time of a route exceeds 8 hours the extra employee time costs double. Time for unloading when the trucks returns to the firm is 30 minutes.

Problem description

Each problem is given in a separate file. Every value in the file is separated by comma. First line tells you the number of sites available and the maximum capacity of each truck. Site 1 is always the garbage disposal firm from which all the trucks start and finish.

After the fist line descriptions of the sites are given. Each line includes the index of a site, x coordinate, y coordinate, amount of organic garbage to collect, amount of plastic garbage to collect and amount of paper garbage to collect in this order.

After the site info road information is given. Each line represents the connection between two sites given with the fist two indexes, the third number is the distance between two sites. The fourth number tells you if the road is one way road (0 is two-way road, 1 is one-way road going only from first index to second). The last value is the maximum capacity the road. If the truck has more load than maximum road capacity it cannot travel over it. Also note that two sites can be connected by 1 or sometimes more roads. If possible you always choose the shortest road.

Example of a input file:

```
5,100
1,2.375864,2.864949,0,0,0
2,7.824403,3.614628,72.65013,11.8694,51.84442
3,5.038958,6.564542,4.61077,12.90976,76.93038
4,1.22205,6.255063,35.09712,41.66061,4.507426
5,3.776397,8.558841,75.22943,46.65396,24.542
4,2,8.973133,0,100
1,3,5.395846,0,100
1,2,6.829697,0,100
1,5,5.907405,0,100
2,3,4.486293,1,100
2,5,8.208778,0,100
5,2,6.617438,0,100
2,1,6.610899,0,100
1,4,4.218883,0,61.44958
5,3,2.687808,1,100
```

Solution description

In the report write each solution as:

```
1,1,4,1
2,1,2,3,4,1
3,1,4,2,1
1,1,4,2,3,1
```

where the first number on each line is the index of the type of garbage to collect and the rest are the order of sites the truck visits.

This example shows that we had four trucks. Two of them were collecting organic (1) garbage, one plastic (2) and one paper (3). We assume that the truck on line 1 collected garbage at site 4 and the truck on line 4 just passed by that site.