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Programming Exercise 1

Exercise P.1. Implement a program that computes the following items for a set of points in the plane $\mathbb{R}^2$ w.r.t. ℓ_1-distances:

(a) the bounding box netlength with a runtime of $O(n)$,

(b) the clique netlength with a runtime of $O(n \log n)$,

(c) the star netlength with a runtime of $O(n \log n)$,

(d) the length of a minimum spanning tree with a runtime of $O(n^2)$,

(e) a Steiner tree according to the algorithm from exercise 4.3with a runtime of $O(n^3)$.

The input should be read from an input pipe. Write the 5 numbers to the standard output. Fill non-computed numbers with '-1', if you are not able to implement all tasks. The data is given as a set of lines. Each line defines a pin through its x/y-coordinates, which are all integral. The following instance defines an example with four pins:

```
1 0
1 1
0 1
0 0
```

The program must be written in `C` or `C++` and must compile and run on Linux. You are allowed to use any `C++` standard including `C++17`. You can use any tool available in the standard library. Your program must compile with either Clang (any version $\geq$ 3.4.2) or Gcc (version $\geq$ 4.8.3) with `-Wall -Wextra -Wpedantic -Werror` and cannot link to any external library. To achieve the maximum score, your program must not leak any memory and must be well documented.

Run your program on the following instances and create a table with the results:

`http://www.or.uni-bonn.de/~held/vlsi_design_ss08/SteinerInstances.tar.gz`

You can use the GeoSteiner program on these instances to compute optimum Steiner trees and compare with your results:

`http://www.geosteiner.com/`

(5+5+5+10+15 points)

Deadline: May 29th, via email to bihler@or.uni-bonn.de. The websites for the lecture with all exercises and test instances can be found at:

`http://www.or.uni-bonn.de/lectures/ss18/chipss18.html`