Home Exercise 4: Recursive and Greedy Algorithms

Algorithms and Complexity lecture
at CentraleSupelec/ESSEC

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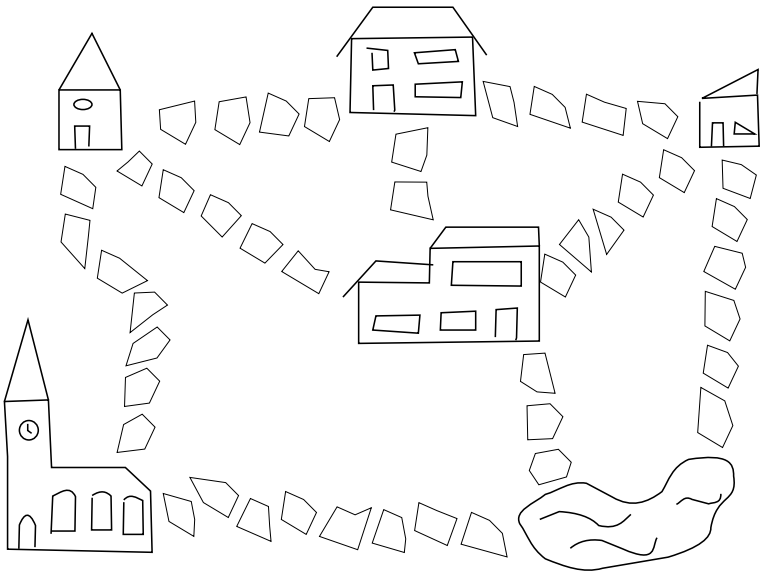
Abstract

Please send your solutions by email to Dimo Brockhoff (preferably in PDF format) with a clear indication of your full name until the submission deadline on October 14, 2019 (a Monday). Groups of up to 4 students are explicitly allowed and even encouraged. In the case of group submissions, please make sure that you submit maximally four times with the same partner!

1 Little Slopy Village (5 points)

You are the major of Lille Slopy Village, depicted below. Unfortunately, all roads are too muddy to drive and walk when it rains and you would like to replace the old streets by tarmac to prevent this. However, your city is not rich enough to rebuild all roads and you decide to spend only the minimal amount of money necessary that the inhabitants can get to any place on a tarmac road.

Model the problem as a minimum spanning tree problem and solve it with Kruskal's algorithm. Assume that the length of each street (and thus the costs of its remodeling) is proportional to the number of stones (polygones) in the below picture.



2 Bin Packing (5 points)

How many bins of capacity 6 are needed to fill the following items with the first fit strategy? Please show the intermediate steps of the packing as well.

The size of the items: 1, 4, 2, 5, 6, 3, 2, 3, 3, 1, 4

Is this packing optimal and why / why not?

3 Assisting in a Robbery (5+5 points)

Let us assume, you are witnessing a robbery in which the robber cannot carry all the items he or she would like to rob. Because the robber finds out that you are attending the algorithms and complexity course, he or she is asking you for advise. Assume that the robber can assign a precise value v_i to each of the n items and that, surprisingly, the robber also brought a scale to weigh each item (item i shall weigh w_i kilograms). Finally, the robber can only carry W kilogram overall (all v_i, w_i, and W can take any real number).

1. Suggest a greedy algorithm to the robber to decide on which items to take (and which to leave).
2. What is the overall runtime of your algorithm in the number of possible items, n?