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Discrete and Computational Geometry

Winter semester 2024/2025

Assignment 3

Problem 1: (4 Points)
Modify the Graham-Scan (Lecture 5, Algorithm 1) such that it also computes the convex hull of points that are not in *general position*, i.e.:

- For a given set of points in the plane we may assume that no three points lie on a common line.
- For points in the plane we may assume that no two points have the same x-coordinate or y-coordinate.

The modified algorithm should still run in $O(n \log(n))$ time and $O(n)$ space.

Problem 2: (4 Points)
For $n \geq 8$, describe a construction of an input instance of n points in $\mathbb{R}^3$ and a permutation of this input instance, where Algorithm 7.1 takes $\Omega(n^2)$ steps. Describe for which operations the algorithm needs to take this many steps.

Problem 3: (5+4 Points)
Consider Algorithm 7.1 from Lecture 7. The algorithm needs to find the cycle of horizon edges L that lie on the boundary of $Conflicts(i)$.

(a) Design an algorithm for this step that takes $O(|Conflicts(i)|)$ time in the worst-case. Use the pointers of the DCEL. Show correctness and running time of your algorithm.

(b) Show that the expected total time spent on computations for finding horizon edges during the course of the algorithm is in $O(n)$.