Chair of Computer Science I
Algorithms and Complexity
University of Würzburg

Würzburg, Jan 08, 2020

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Homework Assignment #9
Computational Geometry (Winter Semester 2020/2021)

Exercise 1

Show that there are sets of points where a bad choice of the random permutation makes the algorithm Rand3DConvexHull actually need $\Theta(n^3)$ time. **[5 points]**

Exercise 2

The convex hull of a set P of n points in 3-dimensional space can also be computed by the method of "rotating" a plane. If we already know an edge of the convex hull, we can rotate a plane over this edge to discover new facets and edges. Describe an algorithm using this approach. Make sure that your algorithm has running time $O(n^2)$ and prove this bound. **[5 points]**

Exercise 3

Define a simple polytope to be a region in 3-dimensional space that is topologically equivalent to a ball (i.e., it has no holes, but is not necessarily convex) and whose boundary consists of a finite number of planar polygons. Denote by n the number of vertices of a simple polytope.

a) For a *convex* simple polytope, describe a data structure that can be constructed in $O(n \log n)$ time and allows you to test in $O(\log n)$ expected time whether a query point lies inside the *convex* simple polytope. **[5 points]**

b) Describe without preprocessing how to test in $O(n)$ time whether a query point lies inside a simple polytope, which is not necessarily convex. **[5 points]**

This assignment is due on January 20th. The solutions will be made available on January 22d.