Homework Assignment #10
Computational Geometry (Winter Term 2016/17)

Exercise 1

Prove that the worst case running time of algorithm 3DConvexHull is $O(n^3)$, and that there are sets of points where a bad choice of the random permutation makes the algorithm 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 “rotating” a plane over known edges of the convex hull, thereby discovering new facets. Give a detailed description of 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.

a) 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 a convex simple polytope with $n$ vertices. [5 points]

b) Describe how to test in $O(n)$ time whether a query point lies inside a simple polytope with $n$ vertices. [5 points]

This assignment is due at the beginning of the next lecture, that is, on January 18 at 10:15. Solutions will be discussed in the tutorial on Friday, January 20, 14:15–15:45 in room SE I.