Homework assignment no. 2

1. (a) Draw a polygon P and place guards in it, such that the guards cover the boundary of P, but there exists a point in the interior of P that is not seen by any of the guards.

   (b) Define a family of polygons $P_6, P_8, P_{10}, \ldots$, such that P_k has k vertices and there is a way to place $k/2$ guards at every other vertex of P_k so that *not* every point in P_k is seen by a guard.

2. Give an efficient algorithm to determine whether a polygon P with n vertices is monotone with respect to some line, not necessarily a horizontal or vertical one. [dBCvKO]

3. A simple polygon P is *star-shaped* if there exists a point $c \in P$, such that for every point $p \in P$ the line segment $\overline{cp}$ is contained in P. The point c is called a *center point* of P.

   Let P be a star-shaped polygon with n vertices, and let c be a center point of P. Show that, after linear-time preprocessing, one can determine in $O(\log n)$ time whether a query point q lies in P.

4. Prove that the query time of a 3-dimensional kd-tree is $O(n^{2/3} + k)$.

5. Let $R = \{R_1, \ldots, R_n\}$ be a set of n axis-parallel rectangles in the plane. We would like to build a football stadium somewhere in $A = R_1 \cup \cdots \cup R_n$. For this purpose, we need an efficient algorithm for finding the largest-area axis-parallel rectangle that is contained in A. Describe such an algorithm.

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