Abteilung Algorithmik
Institut für Betriebssysteme
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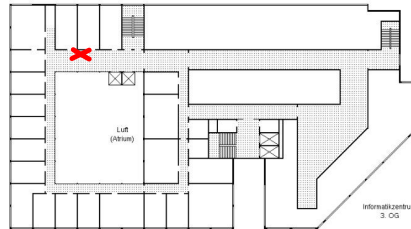Sebastian Morr

WS 14/15

Computational Geometry
Homework Set 2, 18.11.2014

Solutions are due Tuesday, November 25, 2014, until 9:45 in the mailbox for homework sheets or at the beginning of the lecture. **Please put your name on all pages!**

Exercise 1 (Monotonicity):
Prove Lemma 1.17 from the lecture: If a polygon has no interior cusp in direction d, then it is monotone with respect to this direction.

(10 points)

Exercise 2 (Doubly-Connected Edge Lists):
A data structure often used to represent arrangements in Computational Geometry is the so called *Doubly-Connected Edge List* (DCEL).

   a) Read the section on DCELs in the book "Computational Geometry" by de Berg, van Krefeld, Overmars and Scharzkopf. Write an overview on DCELs (this should not exceed 2 pages, and should include figures!), that enables a reader not familiar with DCELs to understand their usage and function, and would give you a good basis to present DCELs in class.

   b) How can a DCEL be used to visit all edges incident to a vertex v?

(10+10 points)

Exercise 3 (The Fortress Problem):
For the *Fortress Problem* we are interested in the number of guards (vertex guards for the purposes of this exercise) that are needed to see the exterior of a polygon of n vertices. Here an exterior point y is seen by a guard at vertex z iff the segment zy does not intersect the interior of the polygon.

   a) Prove that $\lceil \frac{n}{2} \rceil$ vertex guards are sometimes necessary to see the exterior of a simple polygon of n vertices.

b) Give an example that it is not sufficient to place a guard at every second vertex.

<div align="right">(10+10 points)</div>

Exercise 4 (Triangulation of monotone polygons):

Use the algorithm of Garey, Johnson, Preparata and Tarjan to triangulate the polygon P in figure 1. For each iteration give the stack and diagonals that are drawn. Give the final triangulation of P.
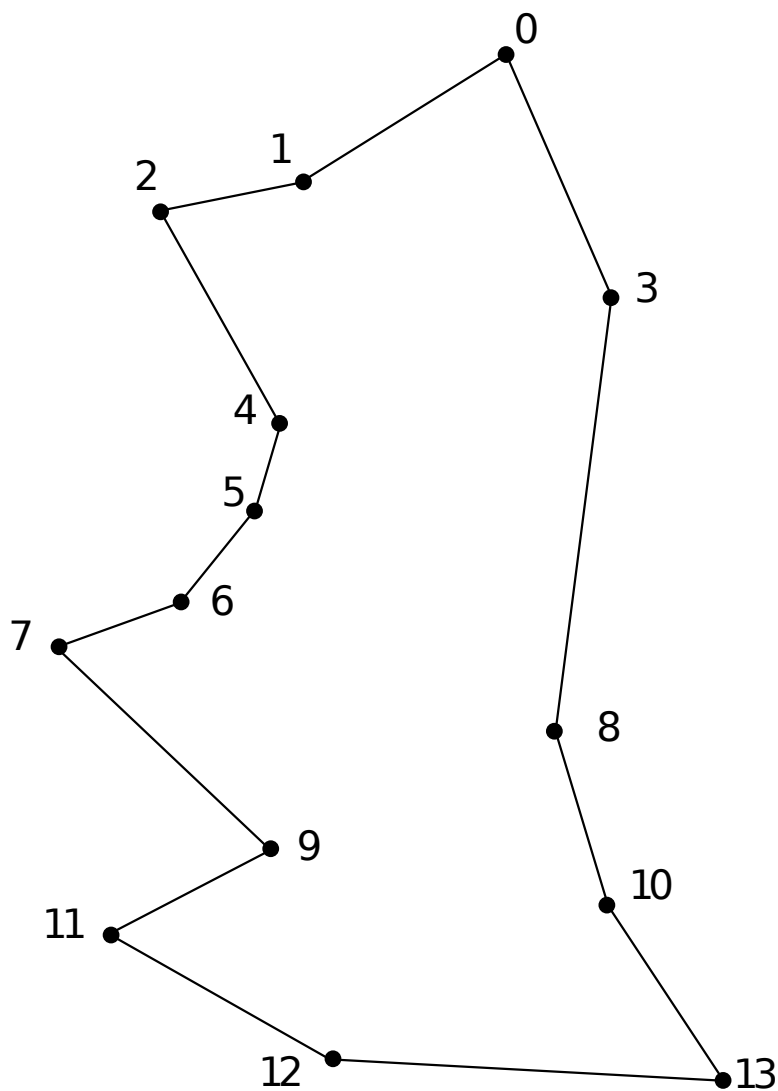

Figure 1: Polygon P.

<div align="right">(10 points)</div>