Homework Set #2

Assigned: Wednesday, 9/12 Due: Wednesday, 9/26 *at **start** of lecture*

This assignment covers:
O'Rourke textbook material in Chapter 2
De Berg textbook material in Chapter 3
Introduction to CGAL

1. (100 points) The goal of this assignment is to give you a chance to explore the various ways CGAL allows you to partition a 2D simple polygon (without holes) into different types of convex pieces. Please use the sample CGAL/OpenGL code that is emailed to you as a starting point. The code provides menu choices for:

a. Y-monotone partitioning (as in de Berg *et al.*, Chapter 3)
b. Optimal convex partitioning (Greene's dynamic programming)
c. Approximately optimal convex partitioning (Hertel/Mehlhorn)
d. Approximately optimal convex partitioning (Greene's sweep starting from y-monotone partition as in de Berg)

Please try these various options for different shapes of 2D polygons and experiment with boundary cases and other things of interest. Here are some aspects to consider:

a. Y-monotone partitioning: When the algorithm is given a polygon that is already y-monotone, it should return that same polygon. How does the algorithm behave when an input polygon contains horizontal edge(s)?
b. Optimal convex partitioning: Are the results consistent with the bounds on fewest number of convex pieces Φ that we discussed in class (from O'Rourke p. 59)? If you supply polygons looking like O'Rourke's Figure 2.10 or Figure 2.11, does the code attain the lower and upper bounds on Φ?
c. Approximately optimal convex partitioning: Verify experimentally (for several interesting examples) that the result produced by the Hertel/Melhorn algorithm is a convex partition using diagonals. Check if the number of convex pieces is truly $\leq 4\,\Phi$.
d. Approximately optimal convex partitioning: Check that this convex partitioning algorithm does indeed start with the results of the y-monotone partition algorithm. Check if the number of convex pieces is truly $\leq 4\,\Phi$. If you have time, can you produce a sample polygon for which the number of convex pieces with this algorithm is small than what is found by Hertel/Melhorn?

The CGAL documentation claims that all of these partitioning algorithms operate without introducing Steiner points. For the examples that you use above, please verify that this is true. (How does this affect the ability to reach the upper and lower bounds on Φ?)