CS380 Computational Geometry
Spring 2013

Homework:	**2**	**Professor:**	**Dianna Xu**
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Assignment 2

1. Let P be a polygon with vertices (x_i, y_i) ordered counterclockwise in the plane. Prove that the area of P is:

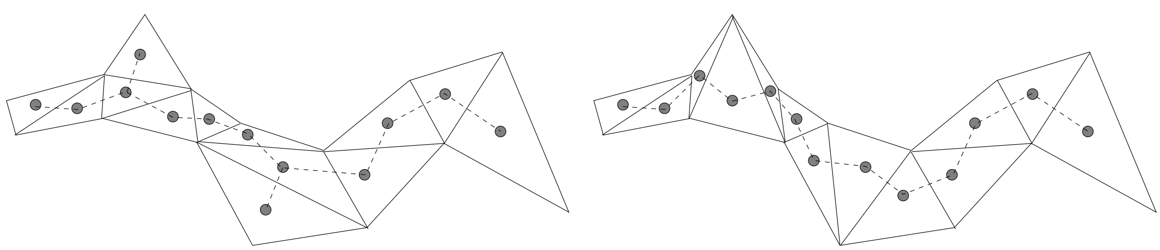
$$\frac{1}{2}\sum_{i=0}^{n-1}(x_i y_{i+1} - x_{i+1} y_i)$$

2. For each $n \geq 3$, find a polygon with n vertices with exactly two triangulations. Obviously, you should not list figures for all, but describe how your figure/construction generalizes.

3. Show that there is no polygon with $n + 2$ vertices ($n \geq 1$) with $C_n - 1$ triangulations.

4. Prove or disprove: every polygon with an even number of vertices may be partitioned by diagonals into convex quadrilaterals. What about just quadrilaterals, not necessarily convex?

5. The dual graph of any triangulation of a simple polygon is a free tree (we discussed this in class). A free tree is a *path* if it has no vertices of degree greater than two. Keep in mind that a polygon may have many different triangulations (see Figure 1). Prove or disprove: Every monotone polygon has a triangulation whose dual graph is a path. (If you prove this statement, you will need to show that you can always find a triangulation whose dual is a path. If you disprove it, you will need to show an example of a monotone polygon that has no triangulation whose dual is a path.)



(a) (b)

Figure 1: Two triangulations of the same polygon. (a) Dual is not a path. (b) Dual is a path.

6. Given n points in the plane, sorted by x-coordinates, describe an algorithm which constructs a simple polygon whose vertices are those points. There may be many such polygons; your algorithm needs to output just one. Your algorithm should run in $O(n)$ time. Show that it does.

7. There is a two-piece dissection of the 18x18 square to the left, and the 23x15 rectangle to the right with a centrally placed 7x3 hole, see Figure 2. Each is composed of 324 unit squares. Try to find the disssection!

8. Show that a regular tetrahedron can not be scissors congruent with a cube.

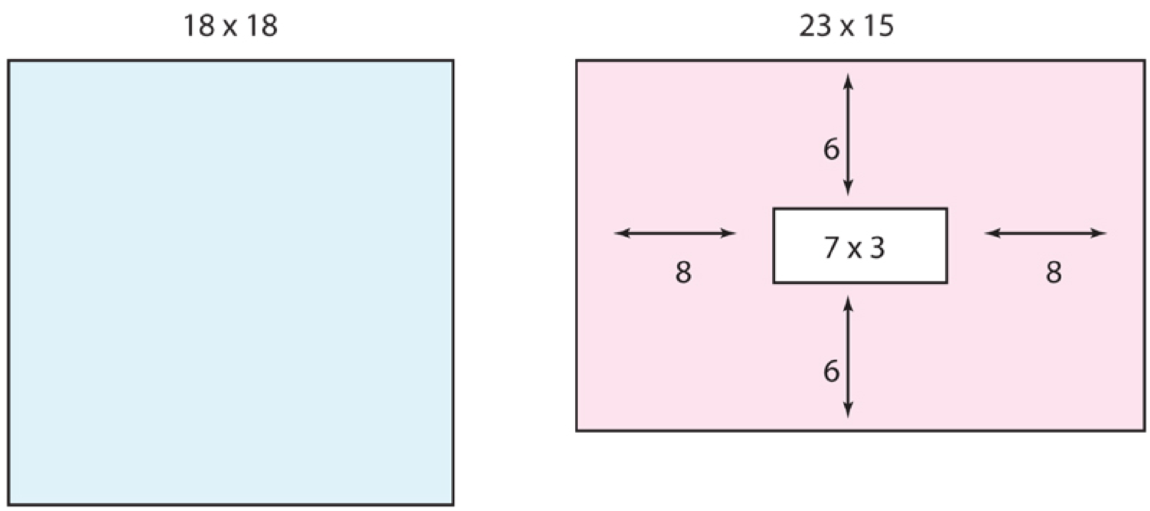


Figure 2: There is a two-piece dissection that takes one figure to the other