6.849: Geometric Folding Algorithms
Fall 2012 — Prof. Erik Demaine

Problem Set 3

Due: Tuesday, October 2nd, 2012

We will drop (ignore) your lowest score on any one problem.

Problem 1. Design and fold a piece of origami using Tomohiro Tachi's Freeform Origami software or Alex Bateman's Tess. Submit the physical folded piece in class with your name on it, and send a digital copy of the crease pattern.

- Freeform Origami can be downloaded from http://www.tsg.ne.jp/TT/software/#ffo

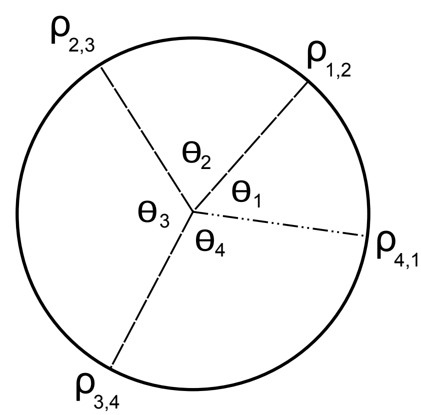
  (Windows only. If you do not have a Windows machine, use a Windows Athena cluster, e.g., in building 37-3.)

- Tess can be downloaded from http://www.papermosaics.co.uk/software.html

  (Requires Perl/Tk, or use the Windows binary.)

Problem 2. Given a flat-foldable degree-4 vertex, we can represent its configuration in 3D space by the four angles between the creases $(\theta_1, \theta_2, \theta_3, \theta_4)$ and by four *folding angles* $(\rho_{1,2}, \rho_{2,3}, \rho_{3,4}, \rho_{4,1})$, as shown on the right. We measure a folding angle between $-180°$ and $180°$: a folding angle of 0 indicates no folding, while a folding angle of $\pm 180°$ indicates a mountain/valley flat fold. Prove that, for any 3D configuration of a flat-foldable degree-4 vertex, $|\rho_{1,2}| = |\rho_{3,4}|$ and $|\rho_{2,3}| = |\rho_{4,1}|$. (For the mountain-valley assignment in the figure, $\rho_{1,2} = \rho_{3,4}$ and $\rho_{2,3} = -\rho_{4,1}$.)

Hint: Use spherical trigonometry.



Problem 3. Make a cool maze-folding design using the following webapp:

http://erikdemaine.org/fonts/maze/

Email us a link to your design using the "link to this view" feature. You do not need to fold this piece. If you decide to try folding it, we will expect a much less complex design.

Problem 4. Prove that the following problem is NP-hard:

> Given a 1D piece of paper with a 1D crease pattern, find the subset of creases to fold that produces the smallest length of the resulting flat folding.

Note that not all creases need to be folded and there is no mountain-valley assignment.

Hint: Reduce from Partition.