

# COMP 411 Lab 9 Report

William Schlieper

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## 1 The Program

The program `rob` generates the Robinson triangle and Penrose rhombus tilings in PGM format. These tilings are notable for fivefold rotational symmetry and never repeating itself exactly the way more common tilings do. The Robinson tiling is composed of two types of triangles: the acute triangle, whose sidelengths are in a  $1 : 1 : \varphi - 1$  ratio, and the obtuse triangle, whose sidelengths are in a  $1 : 1 : \varphi$  ratio, with  $\varphi$  being the golden ratio:

$$\varphi = \frac{1 + \sqrt{5}}{2}$$

To actually create the Robinson tiling, one takes advantage of a recursive division of each triangle into a copy of the other triangle with  $1/\varphi$  the area and a copy of the same triangle with  $1/\varphi^2$  the area; however, there are two ways to divide each triangle, so one must be careful in creating the image. By repeating this division on a regular decagon composed of ten acute triangles, one can create a large chunk of either five-fold symmetric version of the Robinson tiling. The Penrose tiling can be derived from the Robinson tiling by combining pairs of each triangle along their bases, creating rhombi with a common sidelength.

## 2 Command line options

The Robinson triangle tiling program is run from the command line as follows:

`rob [-a] [-A] [-p] [-t thickness] [-o output_file] width height sidelen`

A more detailed explanation is as follows:

- a Select the alternate tiling; there are actually two ways to arrange Robinson triangle/Penrose tilings such that they have fivefold symmetry; the default tiling is the one I consider slightly more aesthetically pleasing.
- A Do not plot any pixels except white and black, effectively turning off anti-aliasing; the lines become “jagged”. Note that this is for if you wish to color in the triangles or rhombi using some simplistic software such as MS Paint, as it does not switch to the more size-conscious PBM format.
- p Draw the Penrose tiling instead of the Robinson.
- t In combination with a floating-point value, describes the thickness in pixels of the lines.
- o In combination with a filename, sets the file to output to. If not included, `rob` will print to standard output. With ImageMagick installed, this allows you to display your images with a command like `rob 500 500 50 | display` or create a PNG image directly from the command line with a command like `rob 500 500 50 | convert - robinson.png`.

`width` The width of the image output.

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`sidelen` The length of either the equal sides of the triangles or the sides of the rhombi.

### 3 Code miscellanea

- The code originally used a relatively straightforward translation of Xiaolin Wu's algorithm for anti-aliased lines. However, that algorithm, because it draws lines with a vertical(or horizontal) height of one, near-diagonal lines end up being thinner than near-vertical or near-horizontal lines by a factor of about  $\sqrt{2}$ . Thus, this code uses a similar algorithm that instead takes width into account; also, because multiple lines always meet at a point, the code does not bother drawing endpoints.
- Due to the way the Penrose tiling is created, each line is drawn twice. In order to preserve the anti-aliasing, because the plot function performs a multiplication, the square root is used so that the lines will look normal after being drawn twice.
- PGM is an incredibly easy format to render. The code for displaying it is three lines, one of which is `int i`.