Assignment 0: Warmup

Due date: Tuesday, 13 January, 12:00pm

The primary purpose of this assignment is to ensure that you are correctly set up to use the tools and technology that power this course. If there are going to be problems, it's better to reveal them immediately. Most of these questions are trivial to anybody who took CS 115x. The final question, a Processing refresher, is the only one that requires any programming.

Question 1: Course web page

Visit the course web page at `https://www.student.cs.uwaterloo.ca/~cs116/x/` and familiarize yourself with the material there. This will be the primary place to obtain publicly visible course information.

Question 2: Piazza

Like last term, we'll use Piazza for course-related discussion and timely announcements. We'll be inviting you to this term's Piazza site automatically, using your UWaterloo email address. Please make sure you receive this email message. When you do, sign up for the course and visit the site at least once. Check there regularly for announcements. If you do not receive the invitation by the end of the week, contact us.

Question 3: LEARN

Log in to LEARN at `http://learn.uwaterloo.ca`. You should see a link to "CS 116X - Winter 2015" among your courses. (If not, there may be a problem with your registration in the course, and you should speak to an undergraduate advisor immediately.) Visit the course's page on LEARN. We will use LEARN for assignment submission and marks. We will post links to public course material there as well—the links will take you back to the course web page mentioned above.

Question 4: Clickers

If you took CS 115x then you should already have an iClicker. If not, you'll need to purchase one. There's an extensive FAQ about clickers at `http://www.math.uwaterloo.ca/~pkates/CTE/clickers/clicker-student-faq.html`.

You will need to register your iClicker with the course in order to have your in-class participation mark recorded. Visit `https://www.student.cs.uwaterloo.ca/~cs116/cgi-bin/clicker-form.cgi` to do so.

Question 5: Spiral phyllotaxis

A *Spiral phyllotaxis* is a mathematical arrangement of points that mimics patterns found in many places in the plant world. The most obvious example is the distribution of seeds in a sunflower, but the same pattern can be found in many other flowers, as well as in the scales on pine cones and pineapples, and even the layout of leaves around the stems of many plants.
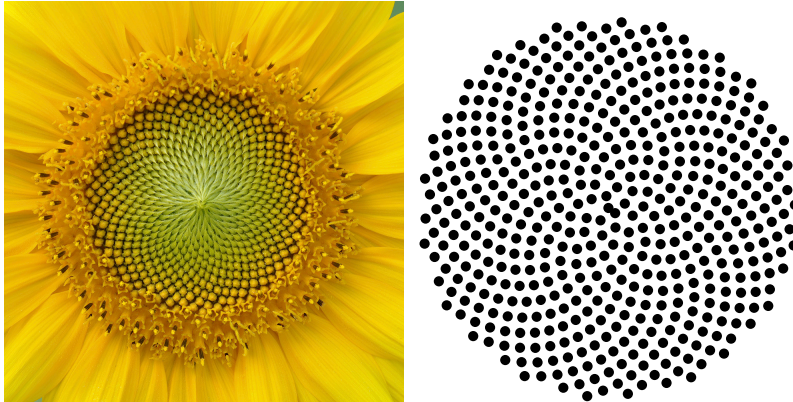
Perhaps surprisingly, this pattern of dots can be described with a very simple mathematical formula that tells you the position of each dot as you get progressively farther from the centre of the design. In polar coordinates, the nth dot lives at position $(c\sqrt{n}, \phi n)$. The value of c is arbitrary, and controls how "spread out" the design will be. The constant π is the usual $3.14159\ldots$. The constant ϕ is the "golden angle", the angular equivalent of the famous Golden Ratio, and is equal to $2\pi\frac{\sqrt{5}-1}{2}$ radians, or about 137.508 degrees.

You will create a Processing sketch that draws an arrangement of dots like the design on the right above.

a. Practice saying "spiral phyllotaxis" with casual smugness, so that you can bring it up at parties. "Phyllotaxis" sounds a bit like the three words "fill oat axis" smoothed together.

b. To start, create a Processing sketch that draws a fixed phyllotaxis growing out of the centre of the window. I suggest drawing 500 solid circular dots (filled, no stroke), each with a 12 pixel diameter. Set c to 10 in the formula above.

   Here are a few hints to get you started:

   - **This does not need to be a complicated program.** A complete solution will easily fit into a 25–30 line sketch. The main challenge is to translate the mathematical formulas above into Processing code. You'll need a single `for` loop to draw 500 dots.

   - Even though you're drawing a design that doesn't change, create a full `draw()` function that clears the screen and then draws the design. You'll unnecessarily redraw the design every frame, but it'll make the next part of the question easier.

- Don't forget that the formula above gives the locations of the dots in polar coordinates! If you need a refresher on the necessary trigonometry, I recommend this Processing-based tutorial: `http://imaginary-institute.com/resources/TechNote02/TechNote02.html` (see especially "Polar Coordinates"). The first Lab will also help.

- I recommend defining a helper function that draws a disc, given the location of the disc's centre in polar coordinates. That function can be responsible for converting from polar to Cartesian.

- Remember to use global variables to hold constants, instead of embedding their values everywhere that they're used.

c. Now add one very simple feature to the visualization above: have the design rotate slowly around the centre of the window. Completing a revolution in about 30 seconds is a good speed to shoot for. This addition requires only about two or three lines of code: calculate a rotation amount each frame, and add it to every dot's angle $2\pi\phi n$ above.

d. **Optional:** If you're feeling adventurous, there are many ways to spice up this simple visualization. Experiment with different ways to colour or style the dots. Adjust the spacing of the dots by changing c or choosing a different constant instead of ϕ. Find a good way to set the sizes of the dots. Better yet, use the mouse position to dynamically vary some of these values, so that you can explore a large space of possible designs interactively.

Because this is the very first assignment, this creative exploration is completely optional. But if you do come up with something interesting, submit it and we'll see if we can get it up on the display wall in Stratford.

What to submit: On LEARN, you should submit a single ZIP file containing a sketch folder entitled A00, which provides a solution for Part c above. You *do not* need to submit a separate solution for Part b. If you manage to develop some creative extensions to the sketch, you should *still* submit the solution to Part c, which we can evaluate in its pure form; submit a *separate* sketch entitled A00ext in a separate ZIP file. Put a comment at the top of the sketch that explains what new features you added.

Postscript: The Golden Ratio has many beautiful mathematical properties. Unfortunately, it also seems to attract a high proportion of pseuscientific junk: attempts to find mystical significance in the number, or to uncover its hidden uses in art and architecture. The good news is that there's a reasonable argument for why plants might have naturally evolved to space their seeds and leaves according to the Golden Ratio. You may enjoy these Vi Hart videos (the second talks specifically about this question).

- Part 1: `https://www.youtube.com/watch?v=ahXIMUkSXX0`

- Part 2: `https://www.youtube.com/watch?v=lOIP_Z_-OHs`

- Part 3: `https://www.youtube.com/watch?v=14-NdQwKz9w`