

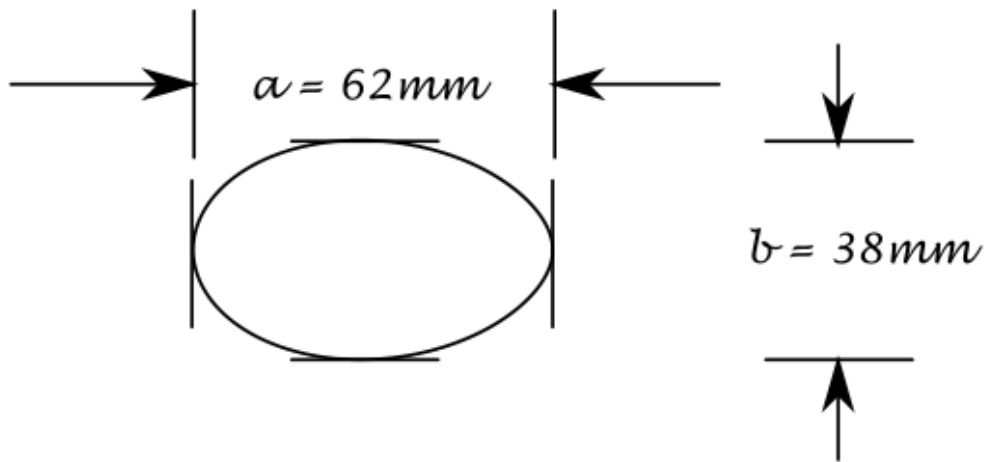
A step by step guide to setting up the Eggbot for minimum plotting errors.

This is a brief explanation on how to measure and set up the Eggbot by using Inkscape to:

1. Draw an actual egg by using parametric plot.
2. Construct a circle going through three points on the egg surface plane.
3. Take measurements in Inkscape.
4. Set up the Eggbot according to the measurements.

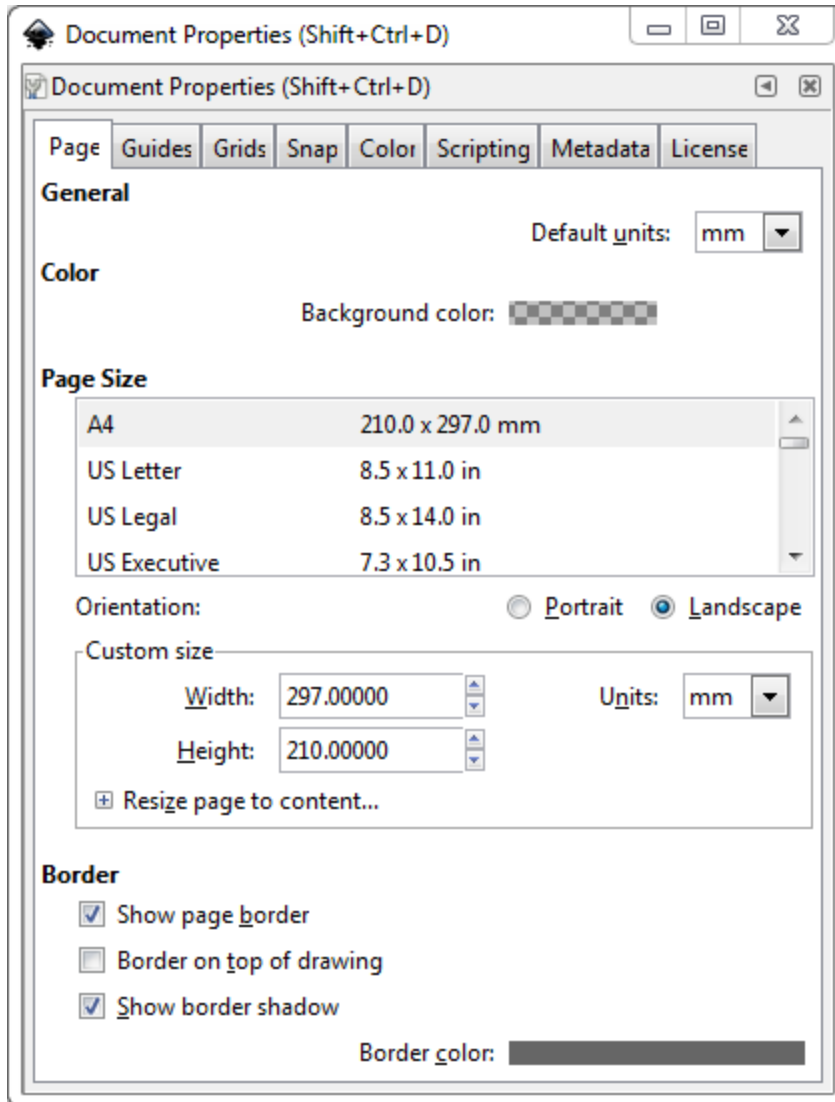
This guide is intended for a novice Inkscape user – like myself - and most steps are explained in detail.

In order to get all the parameters we need we have to measure the size of the eggs to use, a caliper is the best tool here but a quite accurate measurement can be made by laying the egg down on a piece of paper and using a square (book, card etc.) to get one end marked on the paper, then without moving the egg use the same procedure for the other end of the egg and measure the distance between marks. Use the same procedure to find the max diameter of the egg. The more accurate these measurements are the better. One of the eggs used in the Inkscape drawing got the following measurements:



This egg will be called “the black egg” and placed on it’s own layer in the drawing.

Start up Inkscape and set page size to A4 (File – Document properties or Shift+Ctrl+D) to A4 – Landscape orientation or - if you live in the in the US to Letter – Landscape). Select the default units as millimeter – mm.



Maximize the page size in the window by pressing the number 5 on the keypad or click this icon on the



Then it's on to plotting the egg shape, several equations for this exists but the one I found to give a result which is true to the shape of "my" eggs is from a Japanese web page, (http://www16.ocn.ne.jp/~akiko-y/Egg/index_egg_E.html).

First calculate the eggs "aspect ratio" : b / a , in the example I used :

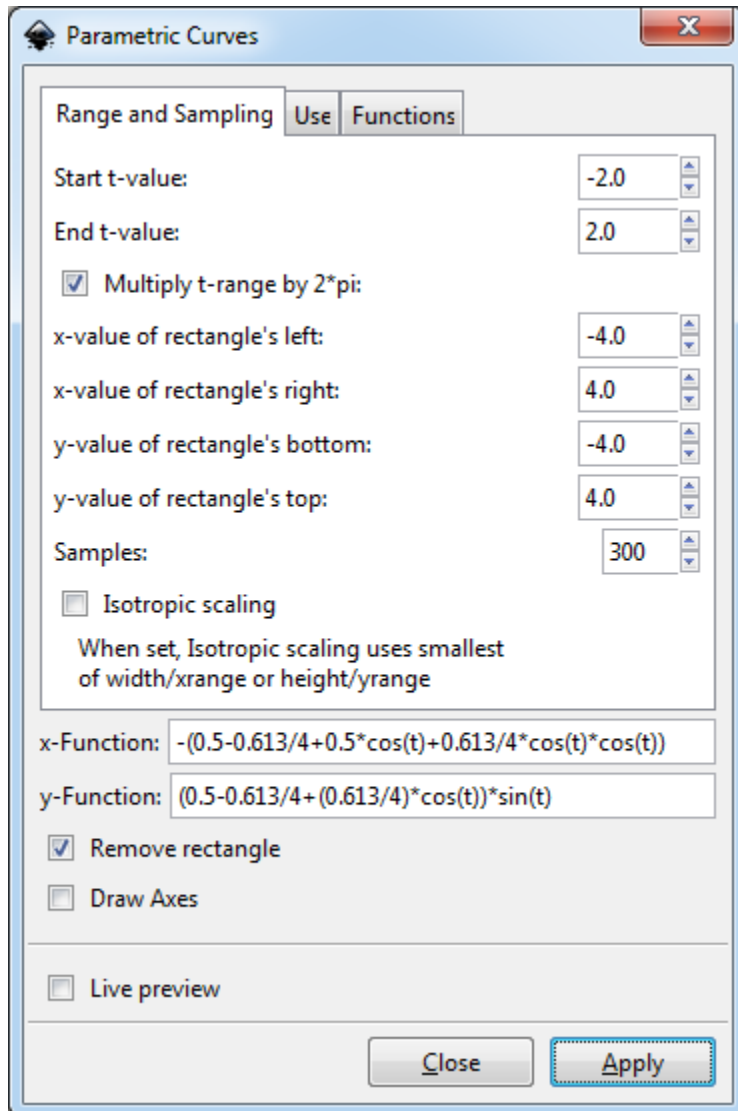
$$\frac{b}{a} = \frac{38}{62} = 0.613$$

This number will be used for the plot.



First draw a rectangle in Inkscape by pressing F4 or clicking on the tools toolbar. The size of the rectangle does not matter. Keep the rectangle selected and open the “Parametric Curves” tool in Extensions – Render – Parametric curves.

Enter the parameters as follows substituting the 0.613 with the number calculated for your egg.



To avoid typing errors for the x and y function cut (CTRL-C) and paste (CTRL-V) from the following two lines:

$-(0.5-0.613/4+0.5*\cos(t)+0.613/4*\cos(t)*\cos(t))$

$(0.5-0.613/4+(0.613/4)*\cos(t))*\sin(t)$

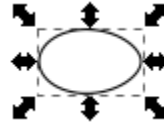
In math notation:

$$\text{x-Function} = -\left(0.5 - \frac{0.613}{4} + 0.5 * \cos(t) + \frac{0.613}{4} * \cos(t) * \cos(t)\right)$$

$$\text{y-Function} = \left(0.5 - \frac{0.613}{4} + \left(\frac{0.613}{4}\right) * \cos(t)\right) * \sin(t)$$

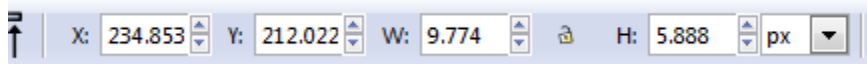
Replace the 0.613 term with the number calculated for your egg. (The minus sign in front of the x-Function is used to “orient” the egg with the “butt side” on the left as it would be in the Eggbot - seen from the front)

Next we have to scale the eggplot to the correct size:

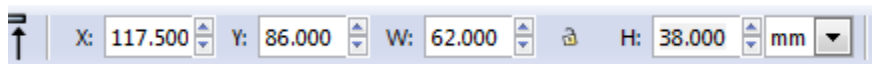


Select the eggplot by left clicking on the object.

On the toolbar will be the position and size of the object:



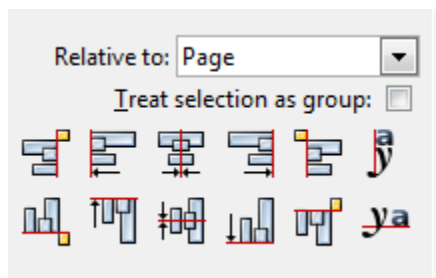
Change the width W: and height H: to the dimensions of your egg: Make sure you change the units to millimeters - mm.



Your “egg” will now have the correct size.




Center the “egg” on the page by using the alignment tool:

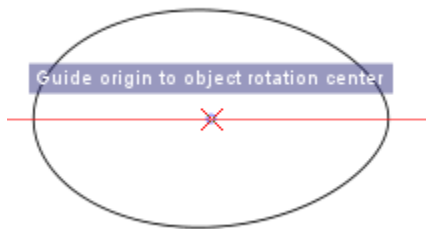


(Click on the third icon – from left - in the first and second row)

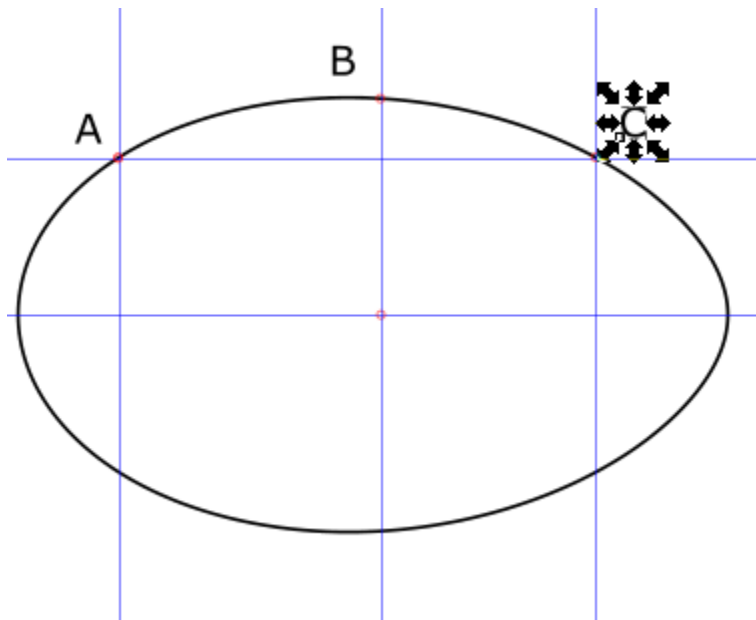
Now we will need some guide lines in Inkscape, first set the following snap options; Enable snapping (%), Snap nodes, Snap to paths, Snap to intersections, Snap other points, Snap rotation centers and finally Snap to guides.

Then zoom in to the “egg” by selecting the egg and “Zoom to object” (3) on the number key along top – not on the numpad.) or by clicking; 

To get a guide line click on the ruler along the top or side of your drawing and while keeping the mousebutton pressed drag onto the page, when getting close to the center of the egg the line will snap to the center. Release mouse button. The “Center of the guide will be marked by a small red circle.



Do the same for a vertical guide by pulling in from the vertical ruler. Make sure these two guides are snapped to the center of the “egg”. Add another four guides as follows:




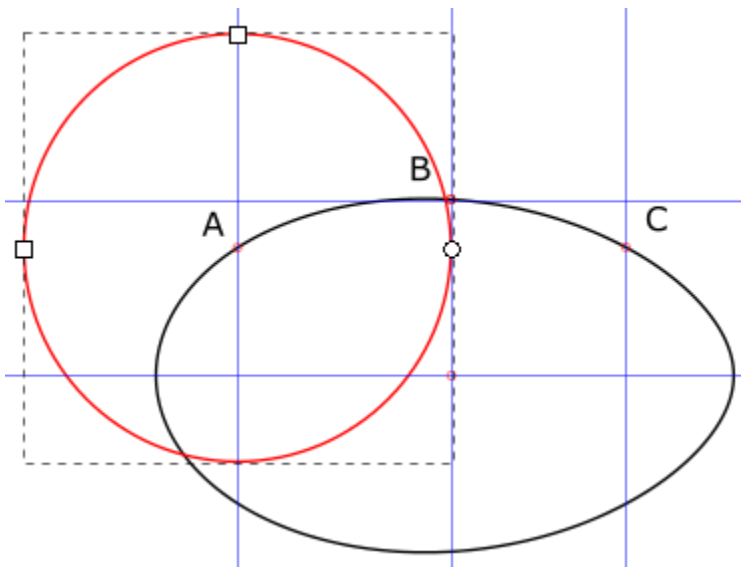
Make sure the center of the last four guides are snapped to the path of the egg.

Then the fun begins, we will now “construct” a circle which circumference passes through the three points along the egg shell.

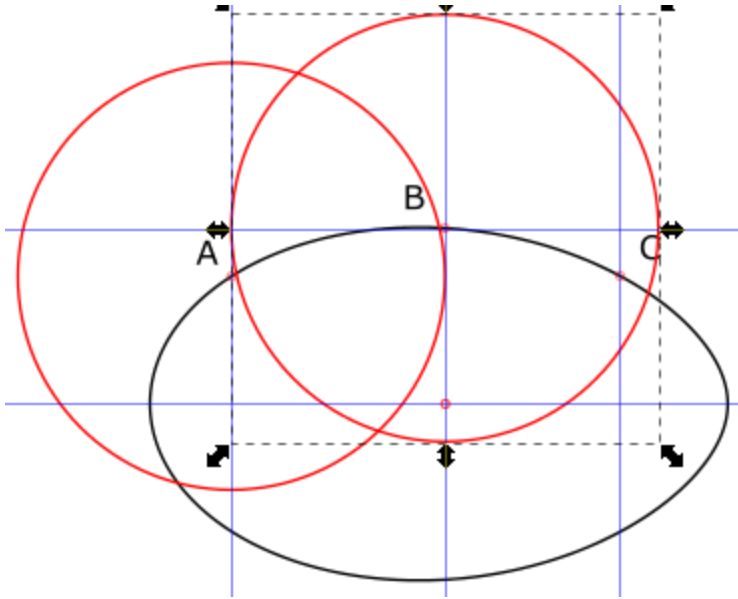
Circle routine:

First draw a red circle with the center located on the guideline cross at point A. First set the stroke to red by getting the mouse pointer over the red color in the Color Palette along the bottom of the Inkscape window, press the right mouse button (RMB) and select "Set stroke", make sure the fill is set to off by selecting the X at the left of the Color Palette, RMB, and select "Set fill".

Select the Circle, Ellipse and Arc tool; , then with the mouse pointer over the guide intersection at point A press the left mouse button, to make the circle go from center and stay round press CTRL and SHIFT on the keyboard and drag the mouse upwards to the right and release as the circle snaps to the guide at B.

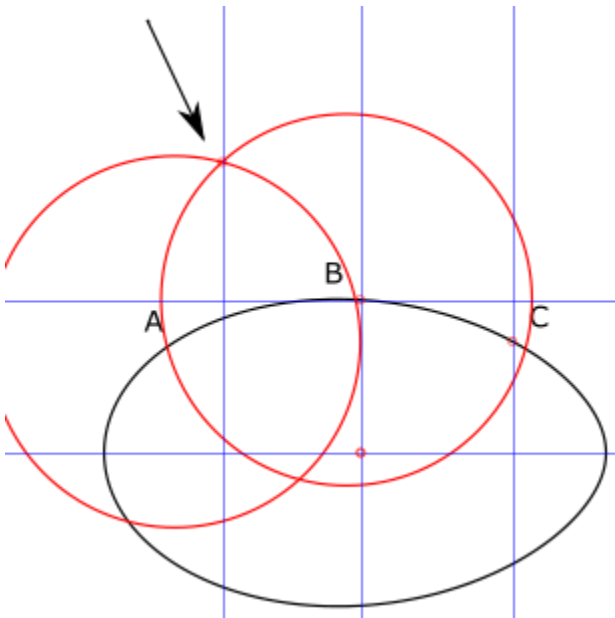


Use the select tool (F1) and select the circle. Make a copy of the circle (CTRL – d) and move it until the center snaps at point B.




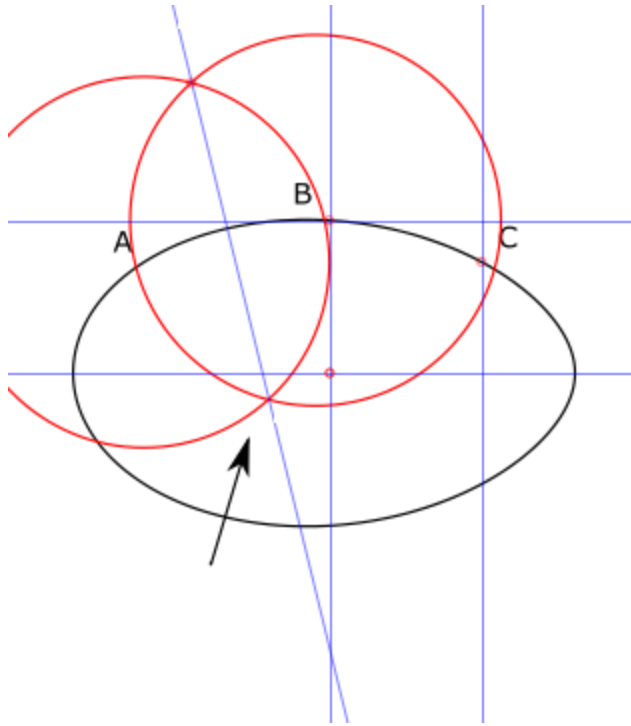
The left vertical guideline can now be moved to the upper intersection of the two circles.

Make sure it snaps to the intersection.

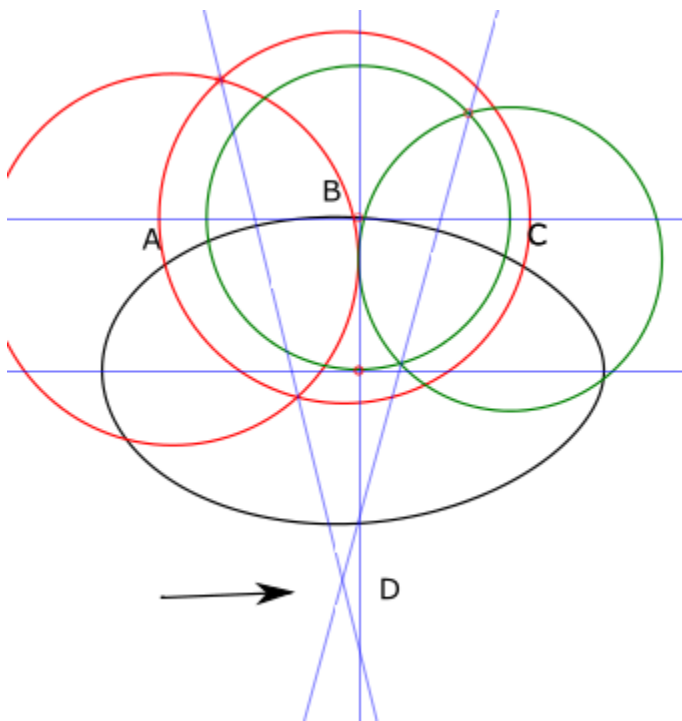


By clicking the guideline and pressing the SHIFT key you will be able to rotate the guideline, the cursor

will change to this:  - rotate it by moving the mouse to the next circle intersection.



Set the stroke to green and do the Circle routine again using point B and C. If all goes well you will end up with something like this:



Point D is ideally where the center of the Eggbot Pen Arm Motor should be. As the motor cannot be moved sideways the eggmotor (and egg) has to be moved to the right until the center of the egg is distance - d - away from the penmotor centerline. To find this distance you can use the measure tool. If you got an older version of Inkscape it still easy to get the distance – Draw a rectangle and snap it to the two guides – read the distance off the Location and Position the top toolbar – or zoom in and read the distance on the top ruler. In this case the distance is 2mm.

The vertical position of the penmotor is ideally (for this egg) 21.1 mm below the egg centerline but the Eggbot design only allows for 19.7mm as the motor hits the bottom of the slot in the chassis. This small error does not introduce too much of a “problem”. With the motor away from the “ideal” a straight line plotted along the egg will be off center at the ends as the pens follow an arc determined by the arm length. For this error to be as small as possible the height of the pen arm and pen (not the motor) should be adjusted to a height where the pen tip is on the centerline of the egg with the arm in the vertical position.

For other eggs where the pen moves up and down as the pen gets closer to the top and bottom of the egg the arm and pen height should be adjusted to a height where the pen is on the centerline when the pen is moved towards the ends of the egg.

When I first started plotting on the eggs I used a pagesize of 3200 x 800 pixels when designing the plots. This turned out to be too much as the pen would hit the Precision Eggcoupler (old style) or the pen arm servo would hit the chassis at the other end. The new max height of the pages was found by trial and error to be around 700 pixels.

When using Inkscape this value can be “read” by plotting the pen arm position as shown on next page:

