

Project: Zooming into Mandelbrot Set

The aim of the project is to visualize the Mandelbrot Set.

1.1 Implementation Details

The absolute value of Z , which is the escape radius, is set to 2, since it is easily calculated bound that makes it “never blow up”. The short answer is from this question on stackoverflow (<http://stackoverflow.com/questions/10690224/why-mandelbrots-boundary-is-2>).

By checking if $|Z|$ reaches the escape radius during iteration, we can check if a particular point will reach infinity and therefore decide if it belongs to Mandelbrot set. It also gives color to these points that are out of the set, by giving the iteration time it reaches escape radius.

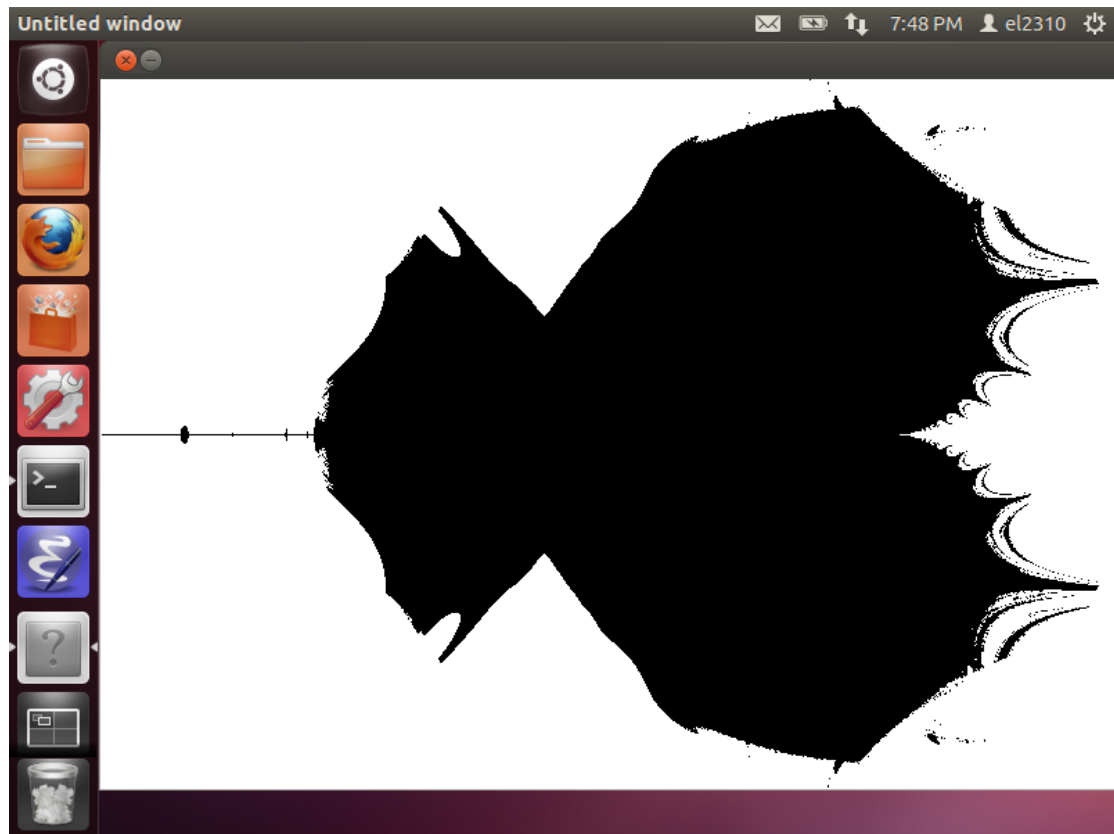
For numerous reasons, the square of escape radius is used to compare.

1.2 How to Move from Complex Numbers to Image Pixels

The mapping between complex numbers and image pixels can be defined as:

$$\text{complex } x = (\text{complex } x \text{ max} + \text{complex } x \text{ min}) / \text{width of pixels} + \text{complex } x \text{ min};$$
$$\text{complex } y = -(\text{complex } y \text{ max} + \text{complex } y \text{ min}) / \text{height of pixels} + \text{complex } y \text{ max};$$

However, when calculated in this way, the result is inaccurate, like this:



By searching and adopting the method used in this program(http://rosettacode.org/wiki/Mandelbrot_set), I found that this bug may be caused by accumulative error.

The mapping steps are therefore calculated and added for each iterations, since increment is more accurate than multiplication.

1.3 Colormap

The iteration time it takes for a point to reach escape radius is used to generate a pseudo-colored image.

Since R, G, B components are 8 bits in computer storage, bit-wise operators are used to assemble the RGB representation.

1.4 How to Zoom into the Set

A focus is pre-defined for better visualization.

The mapping between complex numbers and image pixels are represented as center coordinate and offset along four directions. the offset can be iterated to get a zoom-in effect.

1.5Speedup

By moving calculation of complex x to the outer circle, it should save some unnecessary multiplication.

The timer though, doesn't make much difference between the speedup.

1.6Result

