

# Mandelbrot Zoom

CS293 Project  
Data Structures and Algorithms Lab

Mandelbrot set is a set of points which diverges according to the following equation  $z = z^2 + c$  where  $c$  is a point in a complex plane. Mathematically we get that if we start from  $z=0$  as initial value then it always diverges at infinity if at some point the value of  $z$  reaches out of the range  $[-2,2]$ .

Hence, any point which diverges depends only on ' $c$ ' (initial value). Now, if we map a RGB color value to the number of iterations it took to diverge then we get a beautiful pattern on this complex plane. Zooming into this creates an amazing animation known as Mandelbrot zoom.

In this project I have implemented a program to show the Mandelbrot zoom using SDL Graphics library in C++. We first calculated the number of iterations the equation  $z = z^2 + c$  to reach infinity. The code has its own defined infinity. If this infinity is reached by the iterator without exceeding the range  $[-2,2]$ , we take it inside our mandelbrot set, otherwise we map it to a RGB function to color that particular pixel.

To zoom into our mandelbrot set we reduce the range for which the mandelbrot set was plotted and map it to the width and height of our window which provides a zoomed view. This activity is done by the program continuously which makes it look zoomed continuously.

## Project Description

Directory Structure:

Mandelbrot\_Zoom

```
|— main.cpp
|— mandelbrot.h
|— helper.h
|— Makefile
|— mandelbrot      (BINARY)
```

Programming Language : C++

Graphics Library : Simple DirectMedia Library (SDL)

Environment Required :

Install SDL in ubuntu and then use the Makefile. Command 'make mandelbrot' will create a binary 'mandelbrot' and then run it. This command will also create images in images directory which we can use to see faster zoom to the Mandelbrot set.

## Other Features

### Zoom it as you like

I have extended the zoom feature in the Mandelbrot set so that we can zoom inside it to any point as we wish. To make this possible keyboard events were used in the program. While zooming in we can use the arrow keys in our keyboard to to shift the zoom up, down, right or left according to our wish to explore a particular point.

This idea was implemented by using the zoom factor. The Mandelbrot set was zoomed by different factors on four sides creating a balance to observe the effect required.

### Spiral Zoom

Taking motivation from the previous feature the idea of zooming by different factors was extended to create a spiral zoom. An algorithm was executed to achieve a balance between the zoom on four sides. This algorithm was such that it was close to a circular path followed by the zoom while moving into the mandelbrot set. Any arrow key should not be used while the execution of the program otherwise it would disturb the spiral path.

### Link to demo Video

<https://drive.google.com/file/d/1pRwN66RXYhnmFcCC95yv-Wz4a0Q8v3Xh/view?usp=sharing>

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