# CTA200H - Assignment 3

Louis Branch

May 2022

## 1 Mandelbrot Set

Display a Mandelbrot set by iterating over:

$$f(z) = z^2 + c$$

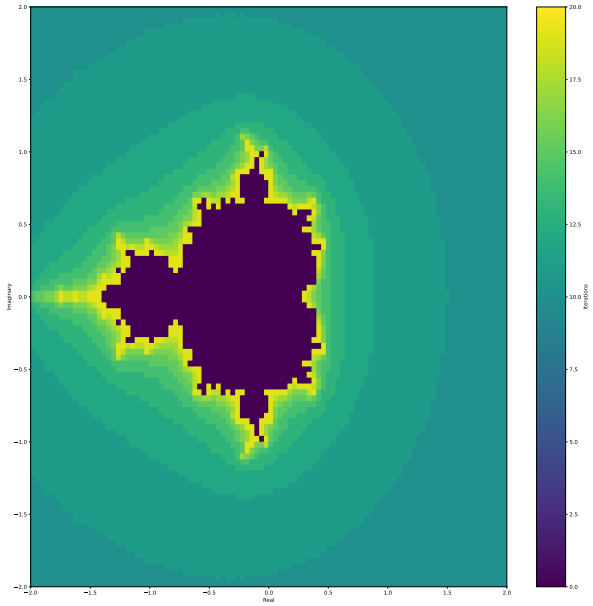
Where c is a complex value in the form of $c = x + yi$.

The `maldenbrot_set` function accepts two inputs: the number of points between -2 and 2, and the maximum number of iterations to test for the boundary conditions. Higher values for both create a sharper image.

The implementation uses `numpy.array` for the computation and masking to plot the complex plane with colors based on the number of iterations.

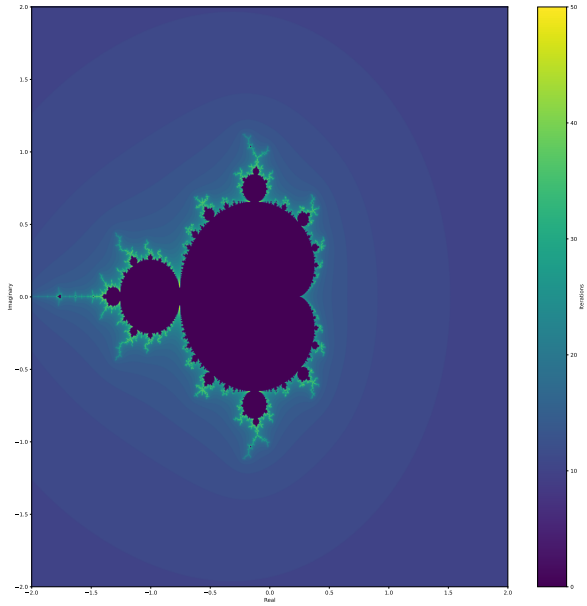
### 1.a Low Resolution

With 100 points, iterating to a maximum of 20 times we get a low resolution image:




## 1.b High Resolution

With 5000 points, iterating to a maximum of 50 times we get a crispier image:



## 2 Lorenz Equations

Solve a system of ordinary differential equations simulating chaotic effect in the atmosphere with initial conditions $W$ in a time frame of 60 seconds.

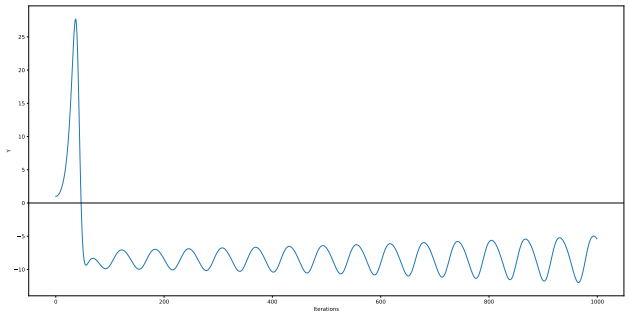
Lorenz used the following constants:

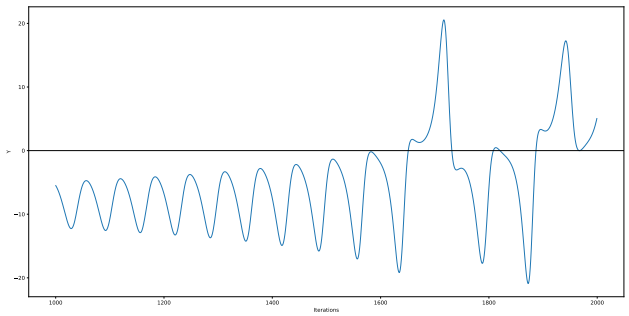
$$\sigma = 10$$
$$\beta = \frac{8}{3}$$
$$\rho = 28$$

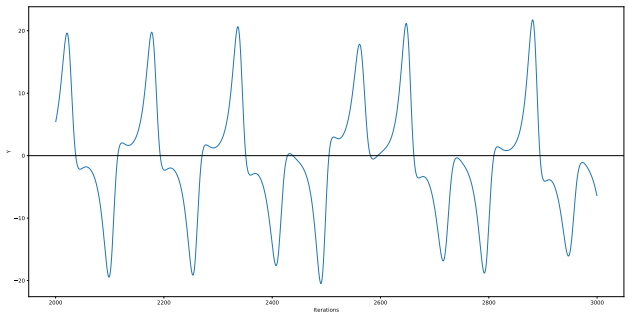
and initial conditions $W = [0, 1, 0]$.

### 2.a Y(t)

Display 3 plots as Y as a function of time for half of the period (30 s). Each plot spans 1000 iterations and an iteration is defined as $\frac{time}{\Delta t}$.

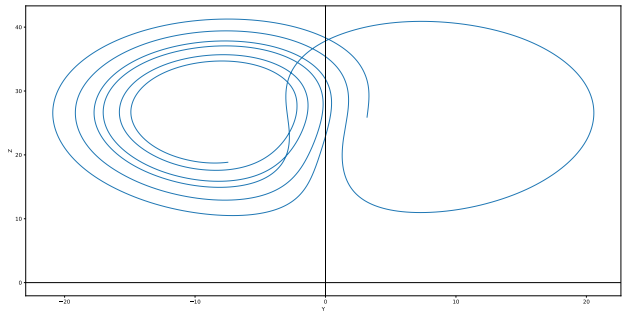


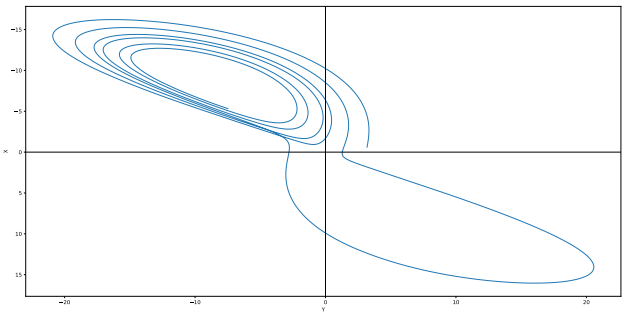




## 2.b Z(Y), X(Y), Z(X)

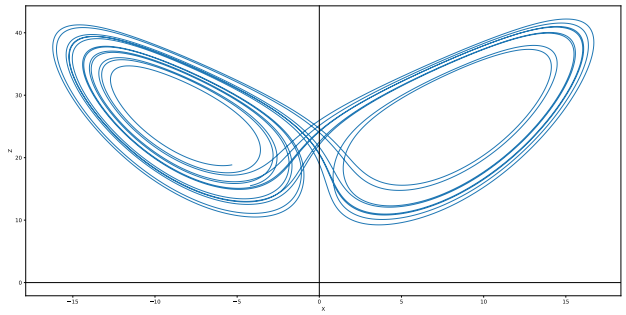
Using a subset of the initial space, display Z as a function of Y:




X as a function of Y, the X-axis is inverted to match the graph on the original paper:




And for the famous "Butterfly Effect", Z as a function of X:



## 2.c Different initial conditions

Using different initial conditions $W' = [0, 1.00000001, 0]$, display a semi-log plot with the absolute distance between $W$ and $W'$ over time.