FRACTAL SETS

In this practice, we will generate two fractal sets named Julia and Mandelbrot sets respectively. Both are based on the same complex iteration:

$$z_{n+1} = z_n^2 + c,$$

where z and c are complex numbers.

(a) Mandelbrot's set:

We define the succesion of values z_n starting always at value $z_0 = 0$ but changing the value $c = \big(real(c), img(c)\big)$ taken in each case. Then, we are considering the set of all possible c's from the rang on the figure.

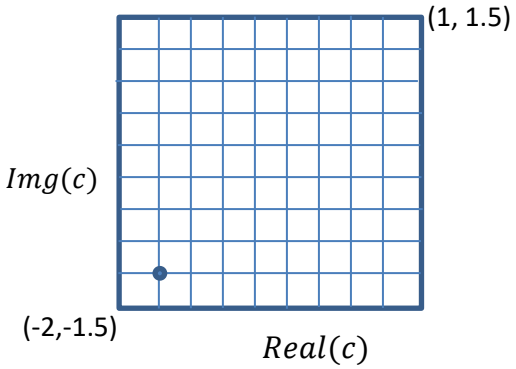

Fig 1. Table of values of c analyzed

For each value of $c = \big(real(c), img(c)\big)$ we do the following:

1. Divide the study window (Fig.1) in 500x500 parts $real(c) = xmin{:}\, hx{:}\, xmax$ with $hx = \frac{(xmax - xmin)}{500}$ and analogously for $img(c)$.
2. Take $z_0 = 0$ and compute the iterates $z_{n+1} = z_n^2 + c$ until a $maxiter = 100$, as long as $|z_n| < 10$.
3. If during the iterates $|z_n| > 10$ we do not draw this point c. If $maxiter$ is reached we will draw this c value, so we will keep this value using $x_p = \big[x_p; real(c)\big]$, $y_p = [y_p; img(c)]$)
4. When all values of c are analized, the we draw the respective points using $plot(xp, yp, '.', \text{"markersize"}, 1)$

   (**Hint.** Do preliminary tests using only a 100 divisions)

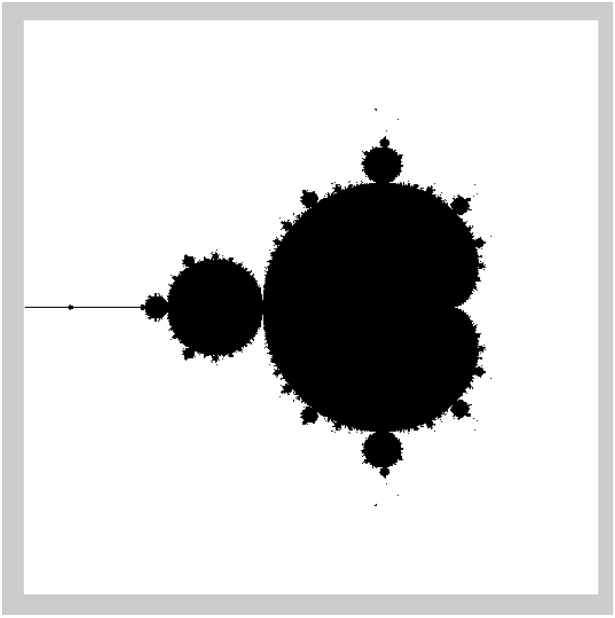

Fig. 2. Mandelbrot's set.

(b) Julia's set:

Analogously, but changing now the roles of c and z_0:

We fix a $c = 0.3 + i \cdot 0.5$ and we will take different values for z_0 in each case using now the same previous window but now for the values of z_0

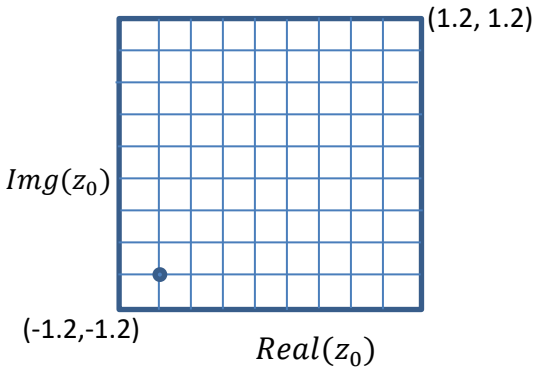

Fig 3. Value table for z_0 using in the iterations

For each value of $z_0 = \big(real(z_0), img(z_0)\big)$ we do the following:

1. Divide the window in 500x500 parts $real(z_0) = -1.2 : h : 1.2$ with $h = \frac{2.4}{500}$ and the same for $img(z_0)$.

2. Take c fixed and with the corresponding initial value $z_0 = (real(z_0), img(z_0))$ and compute the iterates $z_{n+1} = z_n^2 + c$ until $maxiter = 100$, as long as $|z_n| < 10$.
3. If in during the iterations $|z_n| > 10$ then we do not plot z_0. On the contrary, we will keep the z_0 value like in the previous case.
4. When we finished of studying all z_0 $values$, we plot them.

(**Hint.** Do preliminary tests using only a 100 divisions)

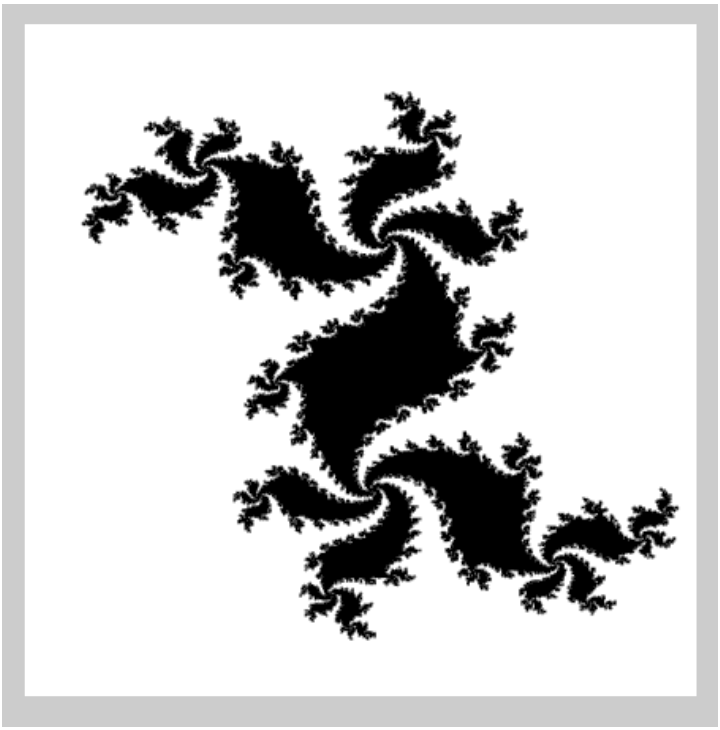

Fig. 4. Julia's set.