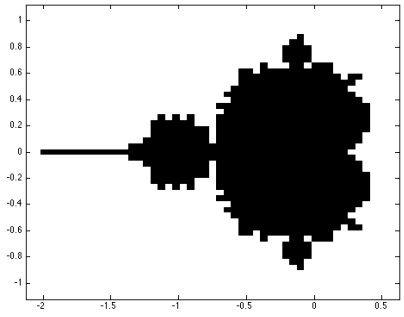
Computer Lab Assignment 4

Mandelbrot Set

This lab is focused on the Mandelbrot set that was discussed in the lecture. The goal is to produce this image and to understand the algorithm for its generation:



(1) Please download the file “mandelbrot.m” from bCourses, open it in the editor, and read through it.

Each point in the (x,y) plane corresponds to a complex number c=x + *I* y that is entered into the iteration formula $z_{n+1} = (z_n)^2 + c$. Please add two lines of code to map the indices ‘i’ and ‘j’ onto x and y intervals:

```
%%%% map the index 'i' onto the interval [xmin,xmax]
%%%% i=1       must yield 'xmin'
%%%% i=nPoints must yield 'xmax'
x(i) = % add line here

%%%% map the index 'j' onto the interval [ymin,ymax]
%%%% j=1       must yield 'ymin'
%%%% j=nPoints must yield 'ymax'
y(j) = % add line here
```

Scroll down, see how complex number are entered into Matlab, and look at the actual iteration over *n*. Enter the iteration formula after “z=”.

```
it_max = 50;            % no more than 50 iterations please
for n = 1:it_max
    %%%% add the iteration formula for the Mandelbrot set
    z = ...
end
```

(3) Run the script and see what kind of image you get. Increase the resolution, *nPoints,* step by step until you are satisfied with the image quality.

(4) Currently the code sets blue dot, *ZZ(j,i)=0,* if the series has not exceeded the limit *zmax* within *it_max* iterations and a red dot, *ZZ(j,i)=1,* if it did. We want to modify the color scheme of the red area. Instead of setting it always to 1, we want to set it to the number of iterations that it took to exceed *zmax* for the first time. The easiest way to do so is to terminate the *for* over *n* using a *break* statement if *z* became too large. Then set *ZZ(j,i)=n,* in order to record how many iterations it took for each pixel. Does the resulting image look more appealing now?

(5) Zoom into the interval -0.8<x<-0.7 and 0.05<y<0.15 and run the code again. Now increase the number of iteration *it_max* first to 75 and later to 100. What change do you see in the resulting image?

(6) Now zoom in further step by step until the size of the x and y intervals are only 0.001 or less. Adjust *it_max* as needed. Get lost in the neverworld of fractals. Save the image file and the parameters for the most beautiful image you obtained!

(7) Append the following *magic* commands to the end of your file

```
m = max(max(ZZ));
for i=1:1000
    ZZ = mod(ZZ+1,m);
    imagesc(x,y,ZZ);
    set(gca,'YDir','normal');
    pause(0.2);
end
```

and restart. What do you get?