Project Report
CS421 SU21
UIUC
Fractals Using Functional Programming

Submitted by:

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Overview

In this project, we work on how to create Fractal geometry using the techniques in a Functional Programming Language – Haskell. Fractals are simple mathematical structures which are self-similar at different scales. Snowflake is popular real-life structure which is a fractal. Th intricate geometry repeats itself at successive magnifications. These elegant patterns can be generated using seemingly easy recursion functions.

Our fascination with Fractals started a few years back when we were doing a research internship at Washington University in St. Louis and then again in a Non-Linear Dynamics and Chaos course in the 4th year of our Undergraduate program.

Mandelbrot Sets and Julia Sets are two examples of fractals which we generate using Haskell concepts such as higher order functions, recursion and laziness.

Implementation

This section lists various components of the code at a higher level.

The most basic components of a visual object are Points and Images (groups of points). These can be represented on a 2D Euclidian space using a Tuple of Floating-point numbers and 2D list of Points respectively.

Core logic to implement the replicating logic. For example, Mandelbrot Set can be defined by set of points c for which the iteration of the function (quadratic map) remains *bounded* (Wikipedia).

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

Here z_n is a point in the Euclidean space with (0,0) as the starting point.
It is initiated by a seed which is a point other than the origin (0,0). It is slightly displaced from the origin. All the subsequent points are generated from this Seed point.

2D Array of Points is converted to an image using a character palette.

This project does what was proposed in the initial project proposal. It is mainly focused on implementing a connection between physics and functional programming. We explore different kinds of fractal geometries and share the results here.

Tests and Results

In this section, we post some of the results of this experiments. Figure1 and 2 are examples of Mandelbrot sets and Julia Sets.

Figure 1 Example of a Mandelbrot Set

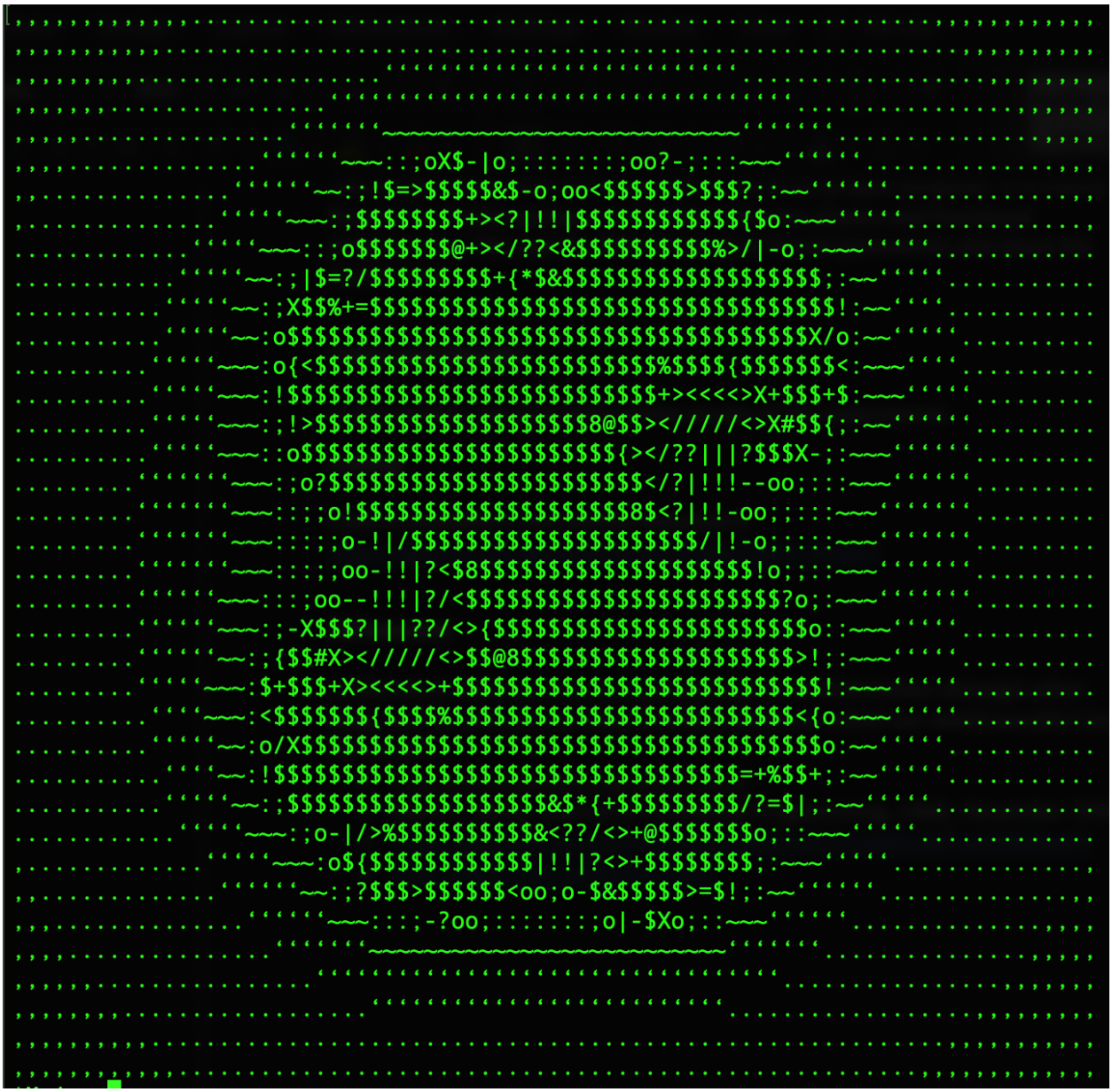

Figure 2 Example of a Julia Set

Listing

Code is available in this GitHub Repository.
https://github.com/gowthamkuntumalla/CS421-Project

References

I referred to these sources as a general source of information amongst other blogs and forums such as *Stack Overflow* (without which our world wouldn't be the same!)

- http://en.wikipedia.org/wiki/Fractal
- Mark P. Jones, Journal of Functional Programming, 14(6), November 2004.
- https://gist.github.com/mbrc12/c3a40215022ea8efcddf7ad39993e4f3
- http://learn.hfm.io/fractals.html