Project 2 Report

Numerical Methods Used

Finding the centre of mass

For this method I used the formula:

$$Centre\ of\ Mass\ x\ coordinate = \frac{\sum_{i=1}^{N} x_i}{N} \qquad Centre\ of\ Mass\ y\ coordinate = \frac{\sum_{i=1}^{N} y_i}{N}$$

Where $x_1, x_2, x_3, \ldots, x_N$ and $y_1, y_2, y_3, \ldots, y_N$ are the x and y coordinates of the aggregate and N is the total number of aggregate particles

Finding gradient of mean line of scatter graph (calculating fractal dimension)

For this I tried to use a method where I took gradient of line going through each 2 points and then took an average of this data but it was inefficient for large grid/particle numbers and also inaccurate so I used the following formula instead as it provides a much better approximation, is more efficient and when tested against GNUPlot output, the results were extremely close so it confirmed that it was accurate.

$$gradient = \frac{N \sum_{i=1}^{N} x_i y_i - (\sum_{i=1}^{N} x_i)(\sum_{i=1}^{N} y_i)}{N \sum_{i=1}^{N} x_i^2 - (\sum_{i=1}^{N} x_i)^2}$$

Where $x_1, x_2, x_3, \ldots, x_N$ and $y_1, y_2, y_3, \ldots, y_N$ are the x and y coordinates of the aggregate and N is the total number of aggregate particles

Results of Program (1008533_proj2.c)

Lattice Size	Released Particle Number	Random Seed Number	Fractal Dimension Outputted
40	500	1324147790	1.656438
50	600	1324147830	1.711004
60	800	1324148041	1.678906
100	1000	1324148608	1.683905
100	1800	1324148727	1.609809
120	1600	1324149178	1.628407
130	3000	1324156247	1.666304

Average Fractal Dimension: 1.66

As you can see from the above results the fractal dimension for all different lattice sizes and released particle numbers varied very little and all results are around 1.6-1.8 . This shows that fractal dimension is fairly constant.

Its also worth noting that fractal dimension is not around this mark when too many particles are used as the lattice becomes full and the aggregate can't grow completely randomly due to it hitting a boundary, this also happens with a small amount of particles as there isn't enough data produced to be able to accurately calculate the fractal dimension.

Experimentation of Code
The main experimentation I did in the code was which points to include in the fractal dimension calculation. I tried taking the middle ½ and ¼ of the data to eliminate the end points that don't conform to the trend, I also tried taking all points with particle number not equal to 0 or total particle number and a mixture of the two. In the end the best figures arose from just taking all points with particle number not equal to 0 or total particle number.
I also changed the method of finding number of particles within a distance of a point from checking distance of every point on lattice to a method where all points within a square of 2*distance centred at point have there distance calculated. This greatly reduces computation time for large lattices so makes the program more efficient.

Extension of Project
A small extension I made to the code was to allow the user to output a representation of the lattice to the commandline where a 1 represents a aggregate particle and 0 does not.
My main extension of the project was to take the 2D lattice and change it into a 3D lattice and have particles do a random walk in 3D, creating a 3D aggregate, therefore allowing calculation of fractal dimension of 3D diffusion limited aggregation.

Results from Extension (1008533_proj2_Extension.c)

Lattice Size	Released Particle Number	Random Seed Number	Fractal Dimension Outputted
20	2000	1324478366	2.566727
25	4000	1324478412	2.432389
10	400	1324478544	2.575399
5	65	1324478635	2.385772
35	10000	1324478678	2.540070
50	20000	1324478763	2.544835

Average Fractal Dimension: 2.51
Again fractal dimension is fairly constant at 2.4 to 2.6 . Showing again that even in 3D, fractal dimension of diffusion limited aggregation is fairly constant.