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FFYS7068 Classical Simulation Methods in Physics

Assignment 2 (Diffusion limited aggregation)

Python 3.8.2 was used in this assignment. Requested picture of the cluster and plot used for determining the fractal dimension are presented in figures 1 and 2.

So, why the cluster looks the way it is? (and not just a clump as one could easily expect.) It's because of how it's created. First there's a center point and new particles are placed near it. The random placement pops new particle up somewhere around the current cluster radius + small marginal. Then the particle is set on a random walk and if it bumps to the cluster it's attached to it. Cluster radius is also updated.

When first new particles attach they create points which are on the edges of the cluster. As new particles are created they are little more likely to wander and attach to these points that are farther from the center as particles movement is random, but starts from the radius of cluster + small marginal. That's why tree like arms emerge and start to grow outwards from the center. Clumping doesn't happen because particles are more likely to hit already existing branches on the way than reach the center.

The fit to determine fractal dimension was performed on $\ln N$ as a function of $\ln R$ plot using the linear part. Linear part was chosen just by looking at the plot. Suitable values were then assigned for calling the *scipy.optimize.curve_fit* function. Fractal dimension could then be determined from the slope of the fit which was readily obtained as a return value from the function. Program output:

Estimated value for the fractal dimension: 1.562208277956173

Our cluster has a non-integer fractal dimension of approximately 1.6. It means that the logarithm of the number of particles contained is linearly grown by a function of the logarithm of the radius with a slope equal to the dimensionality of the object. This relation holds is true for object of any dimension.

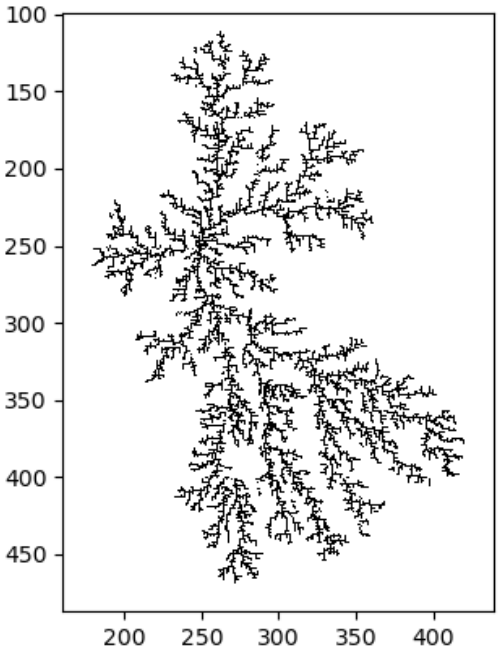

Figure 1: Picture of the cluster generated using 10 000 particles.

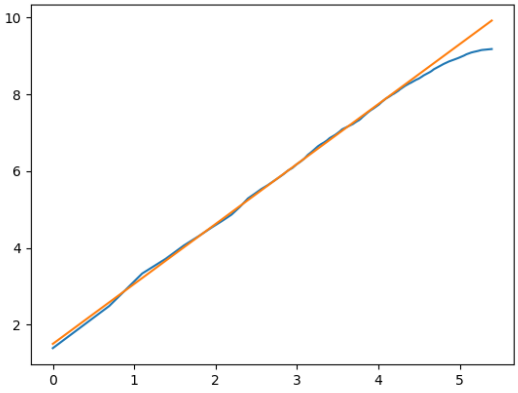

Figure 2: $\ln N$ as a function of $\ln R$ with linear fit used for determining the fractal dimension.