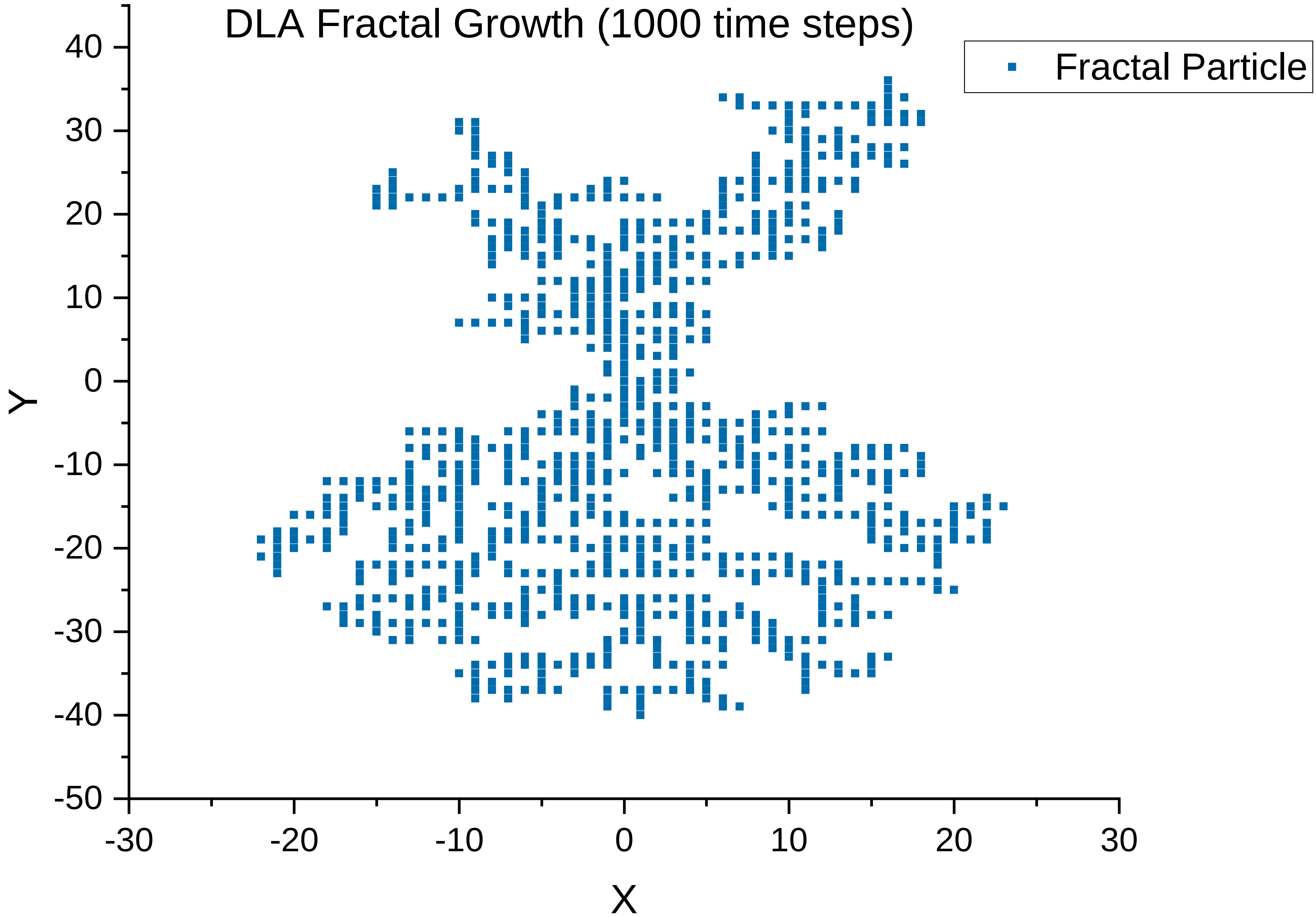
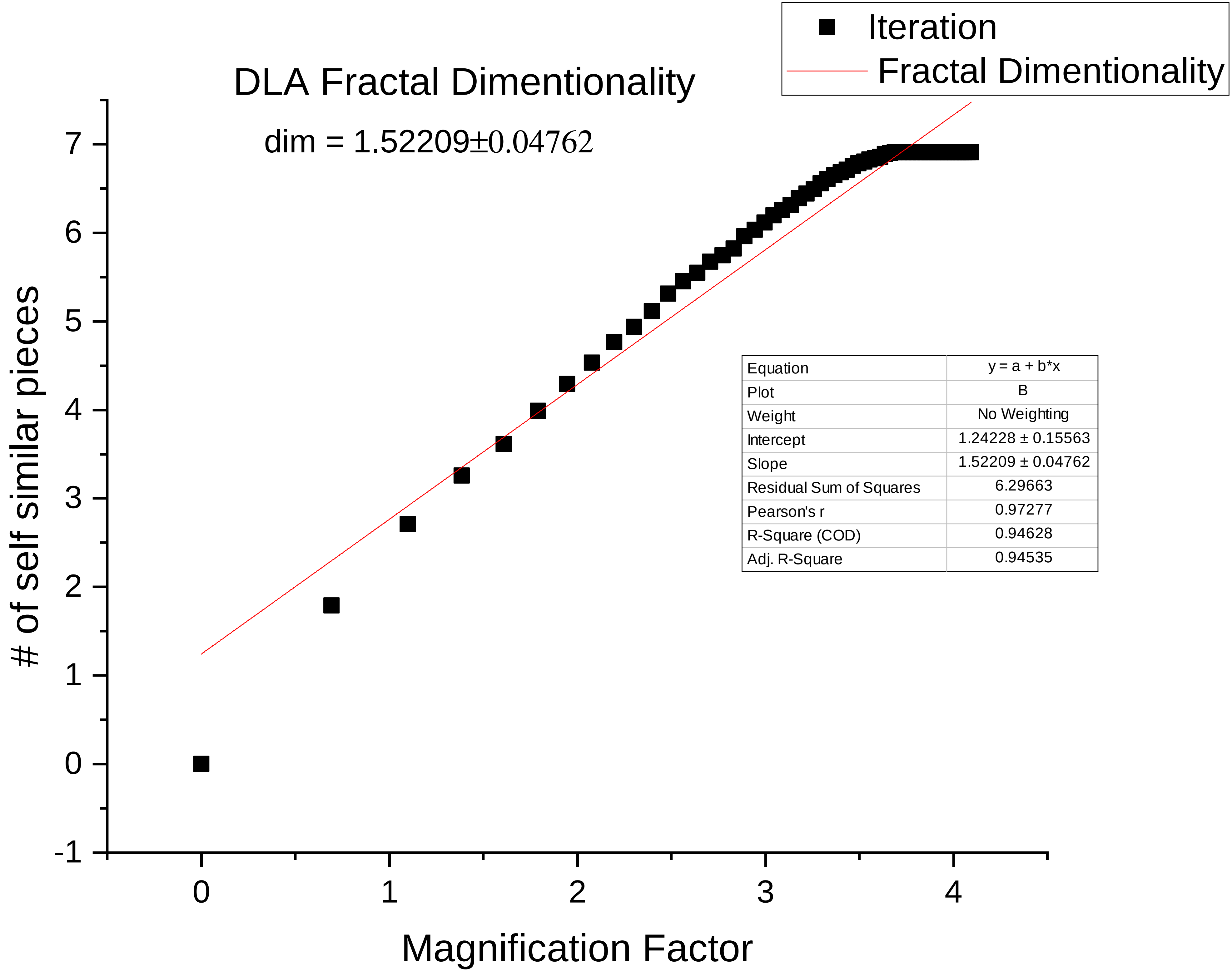
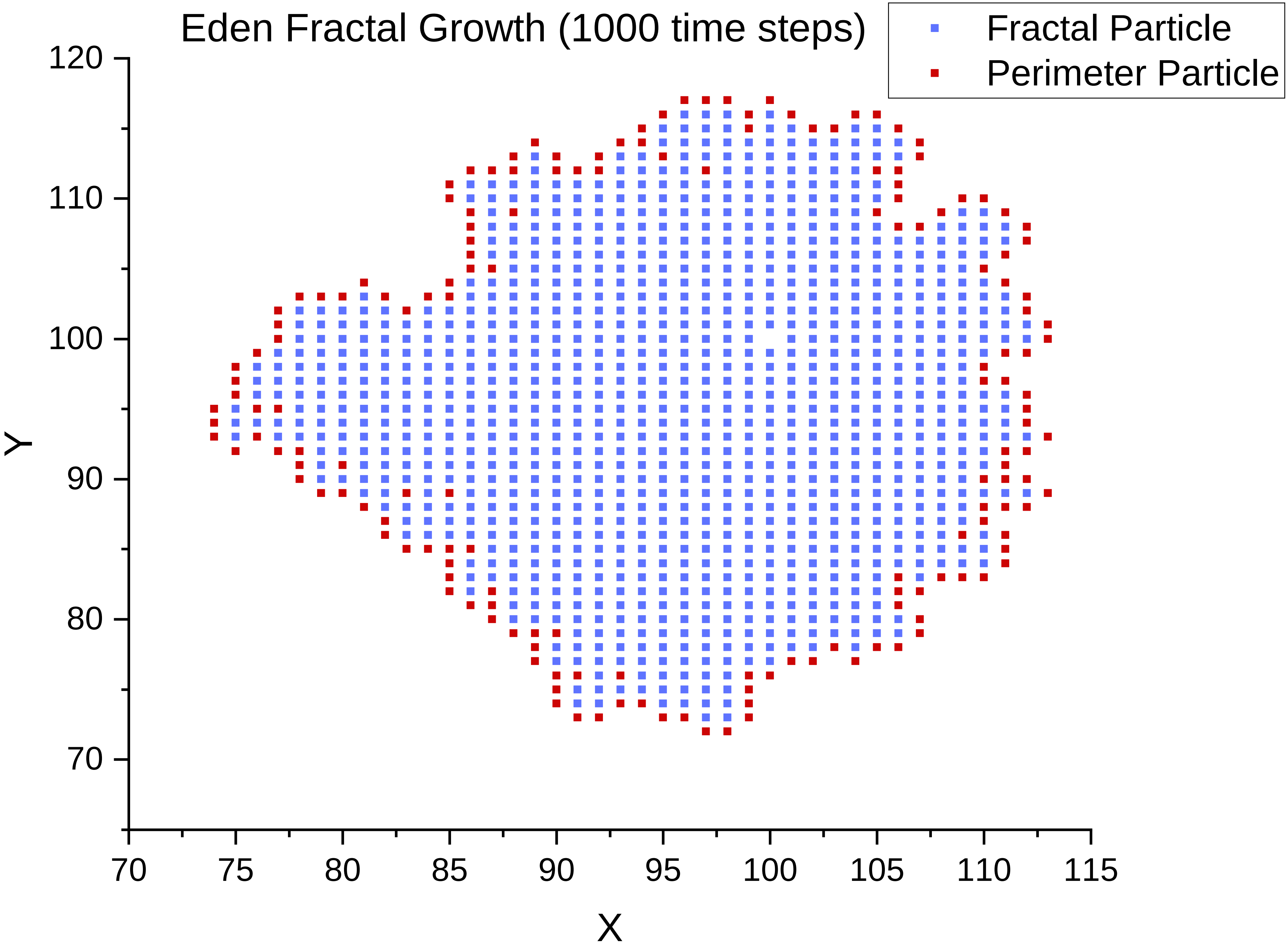
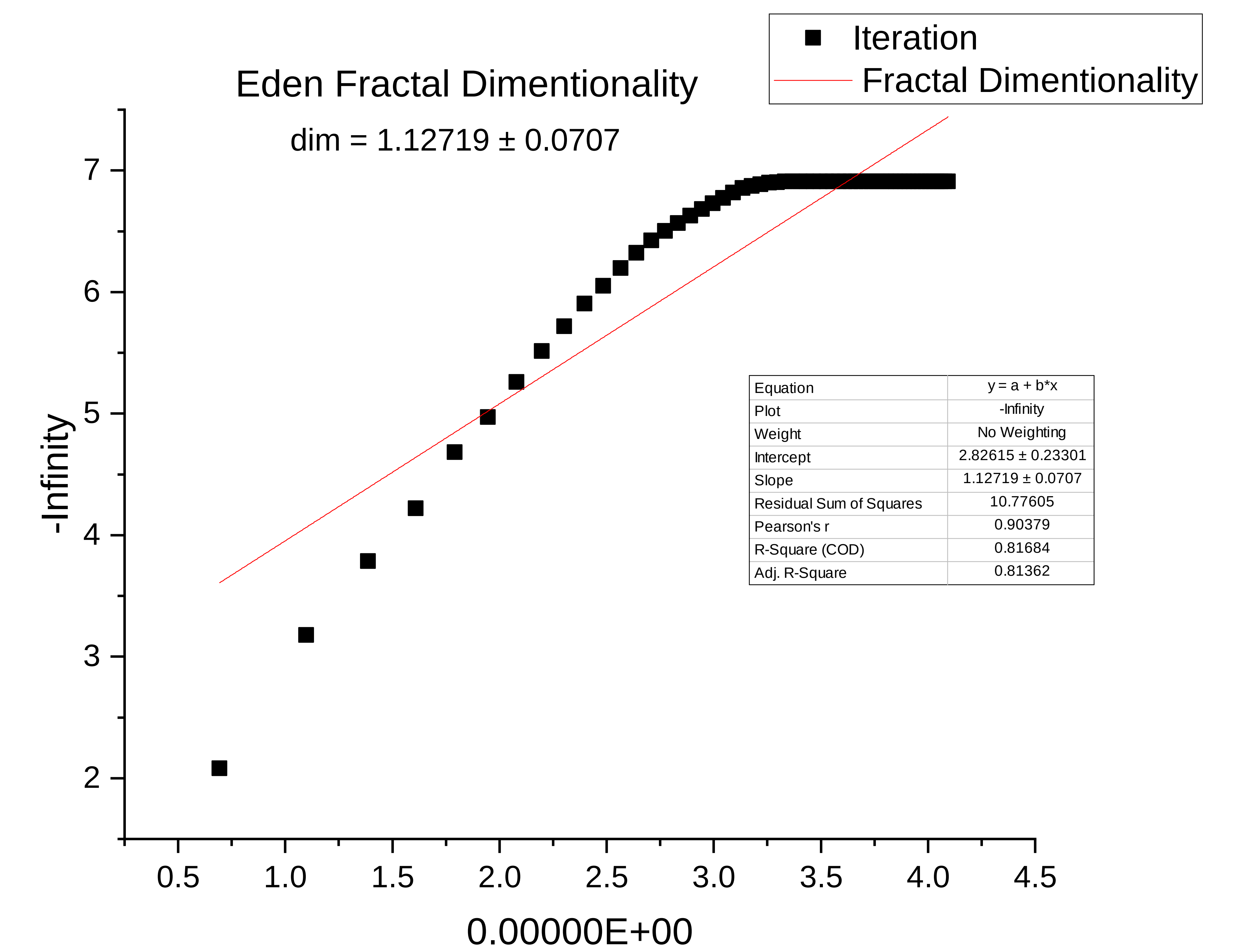

DLA Fractal Growth (1000 time steps)
Fractal Particle
Y
40
30
20
10
0
-10
-20
-30
-40
-50
-30
-20
-10
0
10
20
30
X


DLA Fractal Dimentionality
dim = 1.52209±0.04762
Iteration
Fractal Dimentionality
Equation y = a + b*x
Plot B
Weight No Weighting
Intercept 1.24228 ± 0.15563
Slope 1.52209 ± 0.04762
Residual Sum of Squares 6.29663
Pearson's r 0.97277
R-Square (COD) 0.94628
Adj. R-Square 0.94535
# of self similar pieces
Magnification Factor
-1
0
1
2
3
4
5
6
7
0
1
2
3
4


Eden Fractal Growth (1000 time steps)
Fractal Particle
Perimeter Particle
Y
X
120
110
100
90
80
70
70
75
80
85
90
95
100
105
110
115


Eden Fractal Dimentionality
dim = 1.12719 ± 0.0707
Iteration
Fractal Dimentionality
Equation
y = a + b*x
Plot
-Infinity
Weight
No Weighting
Intercept
2.82615 ± 0.23301
Slope
1.12719 ± 0.0707
Residual Sum of Squares
10.77605
Pearson's r
0.90379
R-Square (COD)
0.81684
Adj. R-Square
0.81362
-Infinity
2
3
4
5
6
7
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
0.00000E+00

During this project we studied cluster growth models which are based on the process of random particle aggregation and therefore require the use of the random walkers – a process we studied in the previous project. The two models primarily differ in their mechanic of how the particles get added to the cluster.

DLA Model

The first model we studied in this class was the Diffusion-Limited Aggregation (DLA). This growth model simulates the growth of clusters by addition of particles from the outside medium in which the cluster grows. Some of the systems that grow according to this model are snowflakes and soot clusters. A formation of a crystal in the oversaturated solution and other crystallization processes can also be modeled by the DLA. The growth of such clusters is greatly affected by how easily new particles can diffuse through the medium towards the forming cluster.

The algorithm that we followed in writing of our program was the following:

1. Place a seed particle at the origin

2. Take a particle and place it at a randomly chosen place on the circle with the center at the seed particle and some fixed radius.

3. Let the particle preform as random walk.

4. If the particle touches any of the particles on the perimeter of our cluster, then add it to the cluster.

5. Increase the radius of the circle so that any point on its circumference is always some distance away from the closest cluster particle.

6. Repeat from step 2 until the cluster has grown to the desired size.

Eden Model

The second model we studied was the Eden model. This model simulates the growth of clusters that grow from within. Contrary to the DLA model, new particles are placed by the algorithm at the randomly selected spot along the perimeter of the cluster. This model simulates some biological cluster growth like cell division and cancel cluster growth.

The algorithm of the Eden cluster growth model is the following:

1. Place a seed particle as the origin of the lattice of points.

2. Create a list of perimeter sites by listing all adjacent sites to the seed particle. (Diagonals don't count)

3. Select one of the perimeter sites at random and place a particle at that site.

4. Update the list of perimeter sites accordingly to include spots created and exclude spots blocked by the new particle. (Diagonals don't count)

5. Repeat from step 3 until the cluster grows to the desired size.

Calculating Dimensionality of Clusters

In our analysis, we extended the definition of dimensionality to include fractional numbers. Our definition lies in the fact of how much of a cluster is encompassed by a circle with the center at the cluster. To find the dimensionality, we search for a relationship of the form $m(r) \sim r^d$ where r is the radius of said circle and m is a measure of how much of the cluster the circle encompasses. In this relationship, d, the exponent, is said to be the dimensionality of the cluster.

Dimensionality for both of the clusters was calculated and it is attached after each of the clusters.