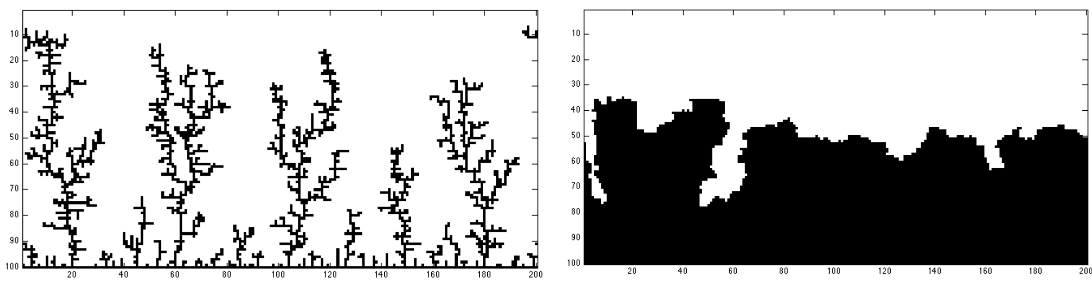
Computer Lab Assignment 5

Diffusion Limited Aggregation

In this lab, you will edit a code that simulated the 2D diffusion of particles and their aggregation. Each particle performs a random walk until it gets stuck on the substrate, or on one of the forming dendrites. You should understand why different growth mechanisms lead to two so different pictures shown here:



(1) Please download the Matlab file `diffusion_limited_aggregation2D_lab01.m` from bSpace and familiarize yourself with every section of it. Please pay attention to the 2D array A(x,y) and understand what the ranges *maxX* and *maxY* mean.

(2) Please insert the diffusion step at lines marked with %%%. Depending on the random value, *r*, please go left, right, up, or down with 25% probability each. Add 7 to 10 lines of code.

```
r = rand();
%%% Determine the direction of motion using the random nubmer 'r'
%%% Update 'x' and 'y' with the following probabilities
%%% 25% go LEFT
%%% 25% go RIGHT
%%% 25% go UP
%%% 25% go DOWN
%%% --> need to enter about 10 lines of code
```

(3) Right below in the file apply periodic boundary conditions in *x* direction. If the particle has left the simulation cell on the left, let it reappear on the right, and vice versa.

(4) Below, we need to check whether the 4 neighboring fields are filled. The variables *xLEFT, xRIGHT, yUP, yDOWN* are defined for simplicity. Again apply periodic boundary conditions to *xLEFT* and *xRIGHT.* Why do not we worry about periodic boundary conditions in the Y direction?

(5) Run the code and see what happens.

(6) The code will stop earlier because there is not enough space to accommodate 10000 particles. Please increase *maxX* and *maxY* until there is sufficient space for all of them. This completes part I.

Part II: Imagine a stream of particles through a pipe with a sticky lower surface. To simulate a flow in a very simple way, I suggest altering the diffusion probability in the *X* directions so that the particle moves to the right with 40% probability, with only 10% probability to the left. Leave the probability for the vertical motion at unchanged at 25%. Run the code again and determine whether the dendrites grow with the stream (like stalactites) or against it (like stalagmites). Explain your answer!

Part III: Finally we want to see if we can adapt the program to make more compact structures. The main problem in the existing code is that new particles get stuck too early before they can diffuse further to fill any gaps. This will now be changed.

Main correction: A particle will not necessarily get stuck the first time it gets close to others. We introduce a sticking probability 'p'. If the diffusing particle hits other then its sticks only with probability 'p' and keeps moving on otherwise. In part I, the particle would always stick, which is equivalent to p=1.

Now introduce another *if* statement around the existing *if* statement

```
if (A(xR,y) > 0 || A(xL,y) > 0 || A(x,yU) > 0 || A(x,yD) > 0)
```

so that the particle sticks only with probability p=0.01. Use another random variable using the *rand()* function. Finally study the effect of running the DLA simulation with different values of *p*.