Math 3P40 Assignment 3: ballistic deposition model

Due date : March 13, 2017 at the beginning of class.

Problem 1

Write a program simulating the Ballistic Deposition Model. You do not need to simulate dropping of individual particles, just implement time evolution of $h(i,t)$, using the equation given in class, starting from flat surface and using periodic boundary conditions.

Your program should output two columns: time t and the interface width $w(L,t)$.

Once your program is working, run it for lattice size $L = 10^5$ and number of iterations $N = 10^7$. **In order to increase efficiency, compute the width and output it only when the iteration number is divisible by L - this way you will get 100 data points.**

Plot the data in gnuplot and find the exponent β by fitting the line $f(x) = ax^b$, which is written in gnuplot as $f(x) = a \star (x \star \star b)$. Does the obtained value of β agree (at least approximately) with what was given in class?

Attach printout of your program and graph of the data together with fitted line (used to estimate the exponent β).

Problem 2

We will now estimate the exponent α. The suggested method is as follows.

First, we will need to run the simulation for different values of L (lattice size) and N (number of iterations, or particles deposited).

Instead of compiling it and running many times, we will modify program of Problem 1 by adding arguments to main function. Suppose that your program for problem 1 has the following beginning:

```
#include <iostream>
#include <algorithm>
#include "rand.c"
using namespace std;
int main()
{
  int L=100; //number of space sites
  int N=1000; //number of iterations
  ...
```

Change it to this:

```
#include <iostream>
#include <algorithm>
#include "rand.c"
using namespace std;
int main(int argc, char *argv[])
{
  int L=atoi(argv[1]); //number of space sites
```

```
  int N=atoi(argv[2]); //number of iterations
  ...
```

Now compile the program the usual way. You can run it as this:

```
./a.exe 100 10000
```

This will execute your program with $L = 200$ and $N = 1000$. You can of course save the output to a file,

```
./a.exe 100 10000 > myfile.dat
```

Now run your program for $L = 50$ and $N = 50000$ and save the output to file bd50.dat. Then double L and triple N, and save the data in bd100.dat. Repeat this as many times as you can, each time doubling L and tripling N while saving the output in different file. You should be able to get 7 or 8 files (if you are willing to wait, you can even do more).

Plot each of these data files with gnuplot. They will have huge fluctuations, but we will still try to estimate the saturation width for each of them. We will do it by fitting function $f(x) = a$, that is, horizontal line to the second half of data, using

```
f(x)=a
fit [500:] f(x) "bd50.dat" via a
```

The argument [500:] tells gnuplot to use only values for which $x > 500$, and this should be roughly half of the entire data set.

Using this, find the values of saturation width for all L values, and then try to estimate exponent α. Write a brief report explaining in detail what you did and results obtained. Compare your result with known value. What could be done to improve the result?

Problem 3

Using scaling relations, compute the value of the exponent z. How would estimate uncertainty of the result?