

IN-CLASS WORK: RANDOM WALK

1. Random Walk in Two Dimensions

Our goal is for today to write a program for a random walk. We focus here on the random walk in two dimensions (instead of one dimension), because the random walk in two dimensions will be part of the fractal growth model, which we will program in the following classes.

1a. Flow Chart

Work in groups of two and draw a flow chart for a program of a random walk in two dimensions for N timesteps, which prints out at each time step t, x, y . Be as detailed as possible.

1b. Program

Write a program for a random walk in two dimensions for $N = 50000$ timesteps. As a start copy into your working directory the random number generator sample program

```
~kvollmay/sunhome/classes.dir/capstone_s2008.dir/traffic.dir/float_rand0-1.cc
```

Change the program such that it print on screen for each time step t, x and y , so you want to end up with three columns and 50000 lines. Have a look at $x(t)$ and $y(t)$ with

```
executable | xgraph -m          and
executable | gawk '{print $1,$3}' | xgraph -m
```

1c. Movie

Next let's make a movie of your random walk. Define a lattice of size 100x100 and initialize it with all sites equal to zero. Put your initial walker at $x = 50$ and $y = 50$. For each timestep print the lattice such that you can pipe your output into DynamicLattice, that means that for each time step you print on screen the whole lattice (100x100) and one empty line in between whole lattices. Set the current lattice site (x, y) equal to 2 and all sites which were visited in the past equal to 1. You should obtain a white polymer with a red tail and blue background. Run your program for about 300 timesteps. To look at the movie you use

```
executable.out | DynamicLattice -nx 100 -ny 100 -matrix
```

2. Random Walk in One Dimension (Advanced)

Next we will do important analysis on the random walk. To simplify the task (and yet being able to get the main concept) let us use the random walk in one dimension. Before you start with 2a, please get me. I would like to discuss the following analysis with you.

2a. Program the random walk in one dimension, initialize with $x(0) = 0$ and plot $x(t)$. Use $N_{STEPS} = 5000$ time steps.

2b. The next step is a preparation for 2c. Instead of printing every time step, print only once after $N = N_{STEPS}$ time steps the resulting $x(N)$ and $(x(N))^2$.

2c. Now add a loop over simulation runs to your program from 2b. Each simulation run gives you an x and an x^2 . Take the average over $N_{SIMRUNS} = 10000$ simulation runs of x and an x^2 and print out the resulting averages $\langle x \rangle$ and $\langle x^2 \rangle$.

2d. Next no longer use the number of steps N_{STEPS} as constant but instead add a loop over $N = N_{STEPS}$ to your program of 2c. For each N_{STEP} print out $N = N_{STEPS}$ and $\langle x^2 \rangle$. Look at the resulting $\langle x^2(N) \rangle$.