Monte Carlo simulations 2004. Exercise 4

To be handed in Tue Mar 9, solutions given Thu Mar 11 10:15.

1. (6 p) Write a code which simulates a random walk with equal probability to move in any of the 4 possible directions in an infinite 2-dimensional square lattice. Calculate $< R^2 >=< x^2 + y^2 >$ with good statistics and find the relation between the square side (and step) length l, $< R^2 >$ and the number of steps N, for large N.

2. (6 p) Write a code which simulates a random walk with equal probability to move in any direction in an infinite 2-dimensional continuum. Let each step be of length l. Calculate $< R^2 >=< x^2 + y^2 >$ with good statistics and find the relation between l, $< R^2 >$ and the number of steps N, for large N. Compare with the result in the previous exercise.

3. (12 p). Consider a drunken sailor who leaves a corner pub in a huge city, so large that the sailor will never reach the edge. All blocks in the city are squares. But exactly 10 blocks to the right of the pub where the sailor starts is the quay where the sailor's ship is. The quay is also so long that the sailor can be assumed to never reach its edge, and it is everywhere 10 blocks to the right of the sailors starting position. When the sailor reaches the quay, her fellow sailors will spot her and get her to the boat to sober up. If it always takes the sailor 1 minute to walk from one corner to the next, and she walks completely randomly, what is a) the median, and b) the average time it takes the sailor to reach the quay? Return the code.

If you think this exercise does not belong to a physics course, you are wrong. Exactly the same problem has to be considered for instance for defect migration in the vicinity of a surface. In that case the initial distribution and lattice structure of the walkers are slightly more complicated, but otherwise the problem can be examined with exactly the same approach as in this exercise. (Moreover, this is actually a quite timely problem, as there is an ongoing debate whether surfaces are perfect absorbers of defects or not; see e.g. Colombeau et al, Appl. Phys. Lett. **83** *(2003) p. 1953.)*

4. (18 p) Use the self-avoiding random walk method to determine the exponent in

$$\langle R^2(N) \rangle \propto N^{2\nu}$$

describing the average length of linear polymers in a good solvent. Do a 3D random walk and use at least Rosenbluth-Rosenbluth optimization. Consider polymers with lengths of 50 monomers, and estimate the error of your result. Does your result agree with the experimental value of 0.592?