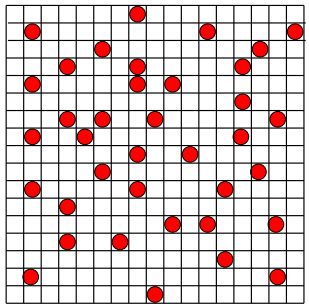
Stochastic processes project: Vicious walkers

Objective

Many processes requires molecules, persons, or other objects to meet and react. How long does this take? In this project the aim is to, as a model for chemical reactions, simulate random walkers in a box which kill each other (vicious walkers) whenever they meet (this is a "reaction" of type $A + A \to 0$). How will the density of particles decay with time in such a system? You will perform simulation of such vicious walkers systems in two dimensions and compare the density decay to analytic expression for long times.



For realistic chemical reactions, not every encounter results in a reaction. You may therefore want consider a finite probability for an encounter to result in death. Or, perhaps there are different types of particles (A, B, C etc)? For instance, presently there is much interest in spreading of disease: A may thus represent a healthy person, whereas B may be an infected person. If two such persons meet A may be infected by B (a reaction of type $A + B \to B$) with some probability (one may also imagine B dying, $B \to 0$, with some rate). How does the density of A decay in such a system? Will the result depend on the number of dimensions? Feel free to explore different scenarios.

Numerical considerations

A simple method for dealing with vicious walker type dynamics will be discused during the lectures. It may be a good idea to investigate your result with respect to number of simulation runs, system volume $V = L^d$ (L is the system's length and d the number of dimensions) and number of particles N. In particular, most analytic results are obtained for the thermodynamic limit: $N \to \infty$, $V \to \infty$ with

the initial concentration N/V kept fixed. How large a system is needed to get results in agreement with the thermodynamic limit?

The report

The report should contain:

- Description of the problem you have chosen to study.
- Describe briefly the algorithm you used. What tests did you perform in order to convince yourself that your simulations gave correct results?
- Simulation results and discussions.
- Conclusions
- Appendix: include a listing of your program. Also, send you code to tobias@thep.lu.se.