Computational Science 2

http://www.tu-chemnitz.de/physik/THUS/de/lehre/CSM_SS20.php
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Seminar
Exercises

Exercise 2 (28.4.2020):

Invasion percolation

from ***An Introduction to Computer Simulation Methods***,
Chapter 13, Problem 13.7

a) Use class `Invasion` to generate an invasion percolation cluster on a 20×40 lattice and describe the qualitative nature of the cluster.

b) Compute $M(L)$, the number of sites occupied by the invader in the central $L \times L$ region of the $L \times 2L$ lattice when the invader first reaches the right edge. Average over at least twenty configurations. Assume that $M(L) \sim L^D$ and estimate D from a plot of $\ln M$ versus $\ln L$. Compare your estimate for D with the fractal dimension of site percolation clusters at $p = p_c$.

c) Determine the probability $P(r)\Delta r$ that a site with a random number between r and $r + \Delta r$ is occupied. Choose $\Delta r = 0.01$. Plot $P(r)$ versus r for $L = 20$ and for values of L up to about $L \geq 50$. Is there a value of r near which $P(r)$ changes rapidly? How does this value of r compare to the value of p_c for site percolation on the square lattice? On the basis of your numerical estimate for the exponent D found in part (b) and the qualitative behavior of $P(r)$, make an hypothesis about the relation between the nature of the geometrical properties of the invasion percolation cluster and the spanning percolation cluster at $p = p_c$.

d) Explain the nature of the two search algorithms given in class `Invasion`. Which method yields the fastest results on a 30×60 lattice? Verify that the CPU time for a linear and binary search is proportional to n and $\log(n)$ respectively, where n is the number of items in the list to be searched.