Exercise 1: Site percolation on the square lattice

In this first exercise, we want to numerically investigate site percolation on the two-dimensional square lattice. In order to get you started, we have prepared a simple reference code (in C++), which sets up the data structures for this problem and provides a routine to occupy sites with a given probability p.

You can download this code from the course website:
http://www.thp.uni-koeln.de/trebst/Lectures/2012-CompManyBody.html

Note: If you feel more comfortable writing your own code from scratch, you are welcome to do this.

Starting from this reference code (or your own creation), we want to calculate some characteristic properties for this 2D percolation problem.

1. Implement a **cluster labeling algorithm**, e.g. the *Hoshen-Kopelman* algorithm described in the lecture.

2. Plot the probability to find a **percolating cluster** as a function of the occupation probability p for different system sizes $L = 8, 16, 32, 64, 128$.

3. Plot the **strength of the percolating cluster** P as a function of the occupation probability p, i.e. the probability that an arbitrary site is on the percolating cluster. Again combine data for different system sizes, e.g. $L = 8, 16, 32, 64, 128$, in one plot.

4. Plot the **average cluster size** S as a function of the occupation probability p. Again combine data for different system sizes, e.g. $L = 8, 16, 32, 64, 128$, in one plot.

   Note: Keep in mind to *not* include the percolating cluster in this count.

5. From the two results plotted above can you reproduce the estimate of the **percolation threshold** $p_c \approx 0.592746\ldots$ for the square lattice?

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