Bond percolation on a square lattice

Problem 13.3 of Gould-Tobochnik II ed

OR

Problem 12.3 in the III edition

http://www.opensourcephysics.org/items/detail.cfm?ID=7375

In *bond* percolation each lattice site is occupied, and only a fraction of the sites have connections or bonds between them and their nearest neighbor sites (see Fig. 13.6). Each bond either is occupied with probability p or not occupied with probability $1 - p$. A cluster is a group of sites connected by occupied bonds. The wire mesh described in Section 13.1 is an example of bond percolation if we imagine cutting the bonds between the nodes rather than removing the nodes themselves. An application of bond percolation to the description of gelation is discussed in Problem 13.3.

**Problem 13.3.* Bond percolation on a square lattice Suppose that all the lattice sites of a square lattice are occupied by monomers, each with functionality four, i.e., each monomer can react to form a maximum of four bonds. This model is equivalent to bond percolation on a square lattice. Also assume that the presence or absence of a bond between a given pair of monomers is random and is characterized by a probability p. For small p, the system consists of only finite polymers (groups of monomers) and the system is in the *sol* phase. For some threshold value p_c, there will be a single polymer that is infinite in spatial extent. We say that for $p \geq p_c$, the system is in the *gel* phase. How does a bowl of jello, an example of a gel phase, differ from a bowl of broth? Write a program to simulate bond percolation on a square lattice and determine the bond percolation threshold. Are your results consistent with the exact result, $p_c = 1/2$?

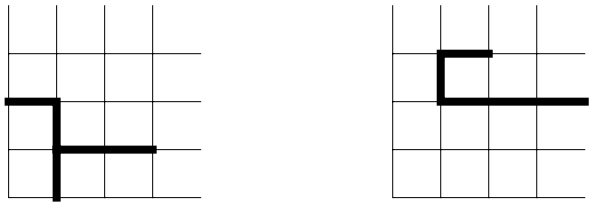

Figure 13.6: Two examples of bond clusters. The occupied bonds are shown as bold lines.