Monte Carlo simulation of the Ising magnet

We will use a Java applet simulating an Ising magnet in two dimensions. You should be able to access it on the Globex website (Ising.jar).

(a) Familiarize yourself with the simulator. Find how to change the temperature (T), the external magnetic field (H), and the lattice width (L).

Sweep from low to high temperatures and observe the behavior of the energy E and magnetization M. During a simulation, the Monte Carlo configurations are generated and averaged to give <E> and <M>. As the simulations goes on, the averages get more precise.

The transition temperature between magnetic and non-magnetic is $T_c =$ 2.269. Start by writing down the averaged magnetization for L=16, and 10 temperatures between T=0.1 and T=4. Write in Excel the results and plot it. Repeat the same for L=64.

(b) Then set the temperature to T=3 and the size to L=100. Change the temperature to T=0. Let the system evolve for a little bit. What do you observe? Are all the domains pointing in the same direction? What do you think is happening? Remember that in the Metropolis algorithm, we generate configurations by changing one domain at a time (we select one domain, and make a change). All domains like to align in the same direction, so try to think if this algorithm is “limited” in any ways when they are islands of domains already pointing in the same direction

(c) For L=32, set the temperature to T=1, and start applying an external magnetic field H, by calculating <M> for 10 values of H, between 0 and 5. What do you observe? How can you explain this result?

(d) For L=64, set H=0, and calculate the average energy for 10 temperatures between T=0 and T=3. From the average energy, can you calculate the specific heat? If you don’t remember your thermodynamic course, have a look in the literature. Plot the specific heat. What you observe near T=2.2?