Week Seven PHY-480

Lewis

October 7, 2025

1. Ground state using a greedy strategy

Start with a random set of spins ($S_i = \pm 1$). Go through each spin one at a time and flip it only if doing so lowers the total energy. Repeat this process until no single flip can reduce the energy any further. The result is a locally minimal energy state.

2. Ground state using simulated annealing

Start with a random spin configuration and a high temperature then randomly flip spins and calculate the change in energy ΔE.

- If $\Delta E < 0$, accept the flip.
- If $\Delta E > 0$, accept it with probability $e^{-\Delta E/T}$.

Lower the temperature so the system becomes less likely to accept higher energy states and when the temperature is near zero, the system settles near the ground state.

3. Simulated annealing psedocode

1. Start with a random spin configuration.
2. Set an initial high temperature.
3. Repeat:
   (a) Pick a random spin and flip it.
   (b) Calculate the energy change.
   (c) Accept the flip if it lowers energy, or sometimes accept it if it raises energy (based on temperature).
   (d) Slowly decrease the temperature.
4. Stop when the temperature is near zero or energy stops changing.
5. The final configuration is the approximate ground state.

4. Showing that at $T = 0$, Metropolis MC is greedy

In the Metropolis Monte Carlo method, flips that raise energy are accepted with probability $e^{-\Delta E/T}$. When $T = 0$, this probability becomes zero, meaning only energy-lowering flips are accepted.S o $T = 0$, the algorithm behaves as a greedy algorithm.