Numerical Simulation of 2D Ising Model

After our arduous journey through the theoretical landscape of the 2D Ising model, we now relax and see how numerical simulations relate to the theory. We will use the Metropolis algorithm to simulate the 2D Ising model on a square lattice and compute various thermodynamic quantities.

Metropolis Algorithm

Evolution of the Lattice

Here we will see how the lattice evolves with time at different temperatures. We will observe the formation of domains and how they grow as the system approaches equilibrium. Before we need to define what our time scale is. We will define one Monte Carlo Step (MCS) as one complete sweep through the lattice, where each spin has been considered for a possible flip once. So one MCS consists of L^2 spin flip attempts for a lattice of size $L \times L$.

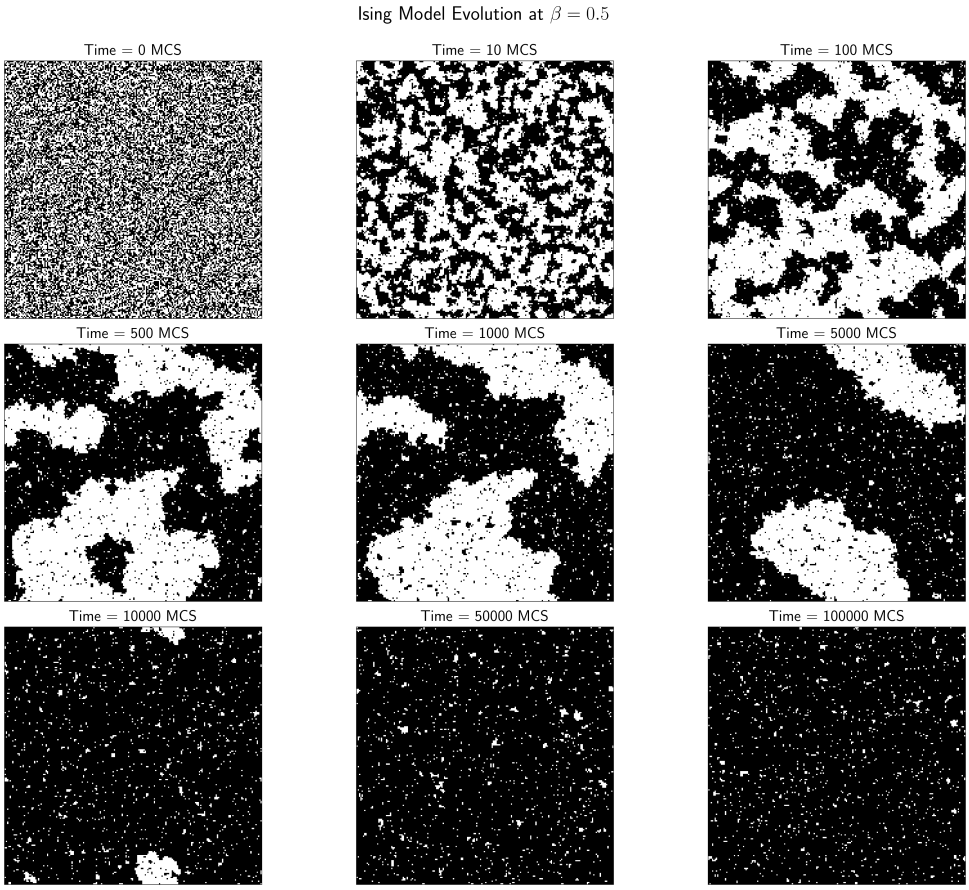

Figure 1: The evolution of the Ising Model at different times(in units of MCS) at $T = 2$.

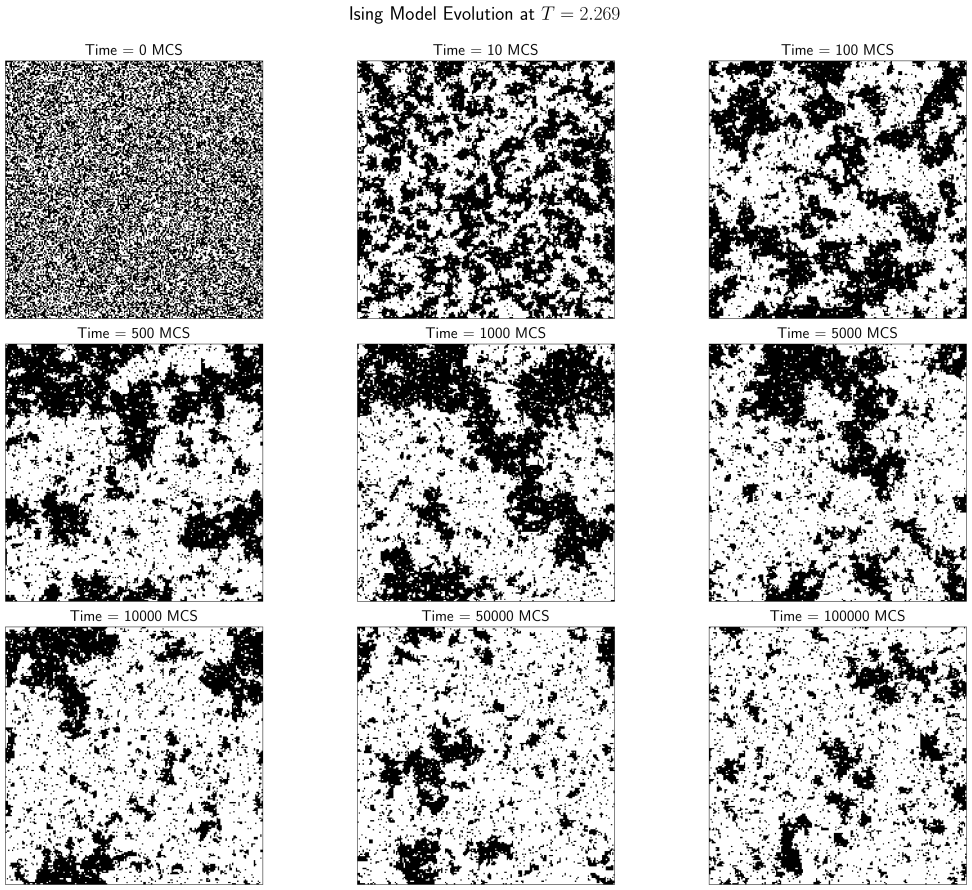

Figure 2: The evolution of the Ising Model at different times(in units of MCS) at $T \approx 2.269$.

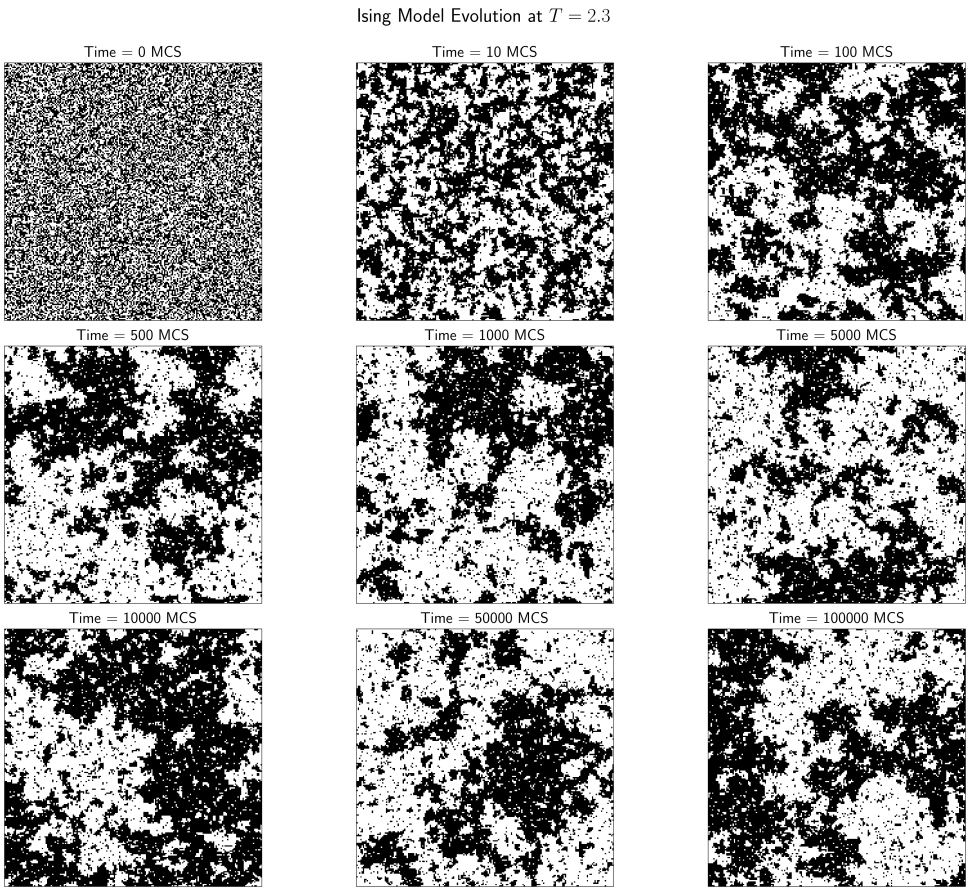

Figure 3: The evolution of the Ising Model at different times(in units of MCS) at $T = 2.3$.

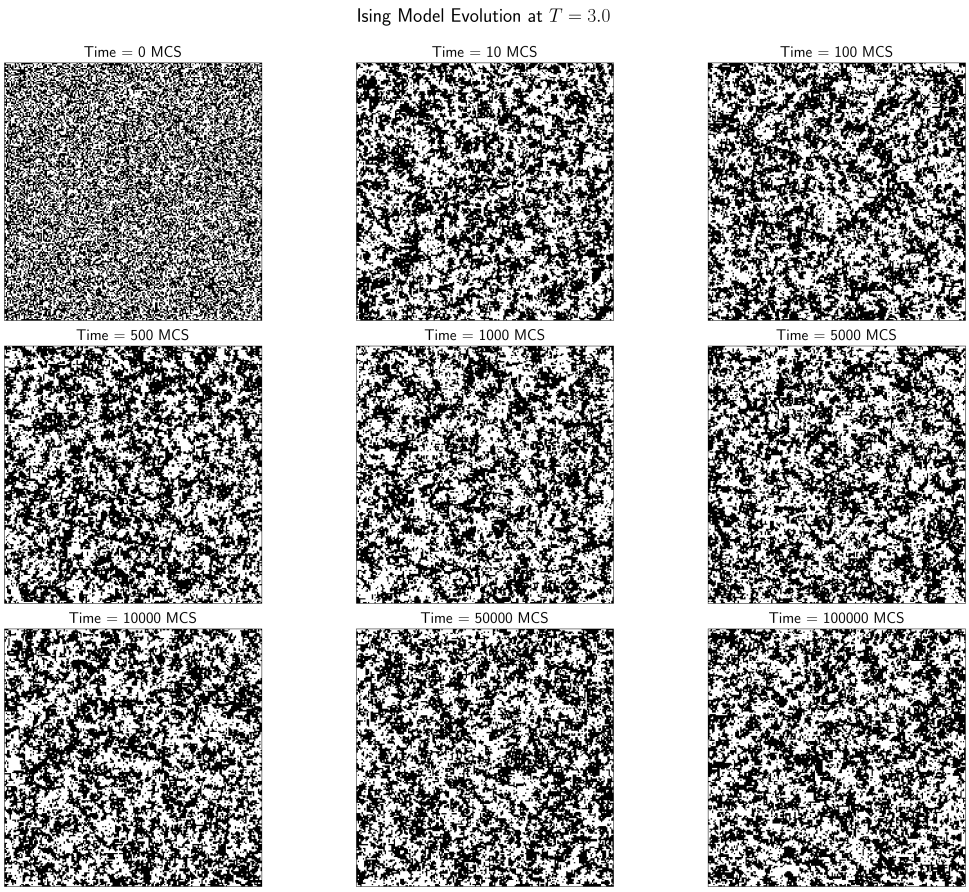

Figure 4: The evolution of the Ising Model at different times(in units of MCS) at $T = 30$.

Thermodynamic Quantities

Time Delayed Autocorrelation function

Critical Slowing Down

The Wolff Algorithm

The Ising model simulation done using the Metropolis algorithm

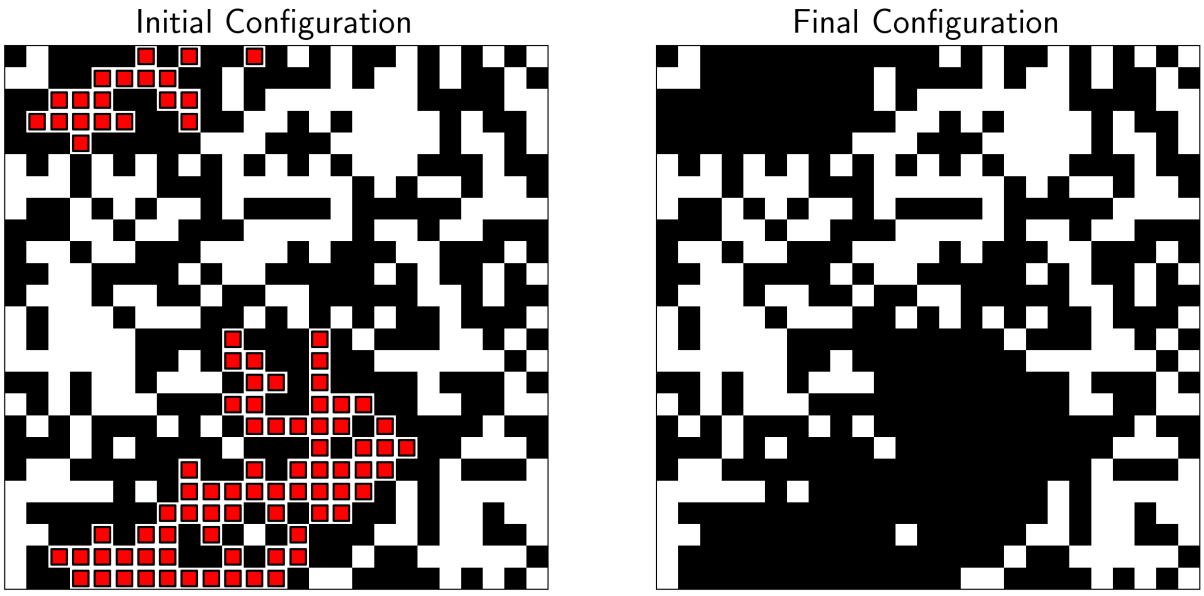

Figure 5: Flipping a Cluster of spins using the Wolff algorithm.

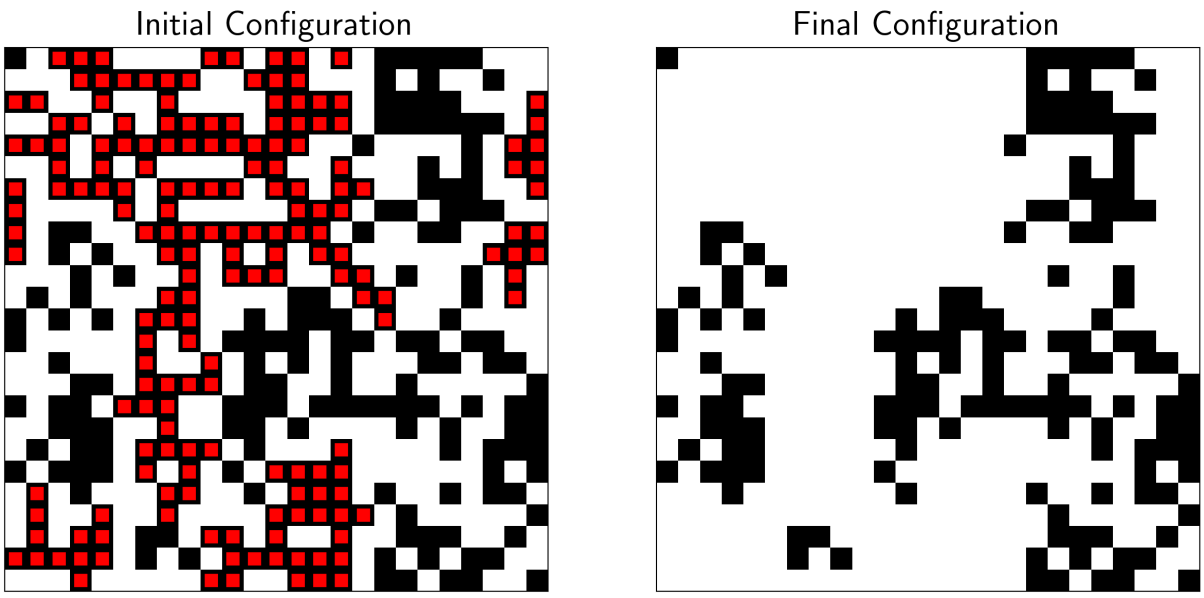

Figure 6: Flipping a Cluster of spins using the Wolff algorithm.