The second method for predicting the behavior of a collection of a large number of interacting particles is the Monte-Carlo Method. In principle, Monte-Carlo method relies on random sampling of the particles in the system, and, after calculating the state for each of the selected particles, a new particle is randomly selected. It is then said that the more random samples we preform, the closer approximation of the actual system we get. However, in our project we only considered a square 10X10 lattice of atoms, so the selection of particles could be done iteratively. The selection was done 5000 time to ensure a good convergence of results.

Another crucial difference from the Mean Field Approximation also lied in the fact that we considered the probability for the spin of each particle to flip from the probabilistic point of view. We calculated the average energy state of the four neighboring spins to the selected particle (diagonal neighbors excluded). Then if flipping the spin of the selected particle led to the lowering of the energy state of the five spins, the spin of the selected particle was flipped to align the particle with the majority spin of its neighbors. Otherwise, we calculated the probability of the selected spin to flip using the Boltzmann distribution. If the Boltzmann factor was less then 0.5 the spin was flipped to align with the spin of the majority, otherwise the spin remained the same.

We then preformed this simulation for five different temperatures given in terms of Energy over the Boltzmann constant. W can see that as the temperature is increased, the average magnetization tends to oscillate, asymptotically falling to zero as the temperature increases. This can be seen in the final graph, where the average magnetization was plotted against a range of temperatures from 1 to 200 given in terms of energy over the Boltzmann factor.

In the final graph the two methods were plotted side by side for comparison. We can see that the Monte-Carlo method predicts a quicker decay of the spin average, however the Mean Field method still offers good quantitative results.