Complex Physics Project 1

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1 Plot the order parameter ⟨si⟩ vs. T

In the following plot, the order parameter[1] is plotted for different temperatures and different system sizes. a and b refers to how the different sites react with each other, as descriped in the hand-out.

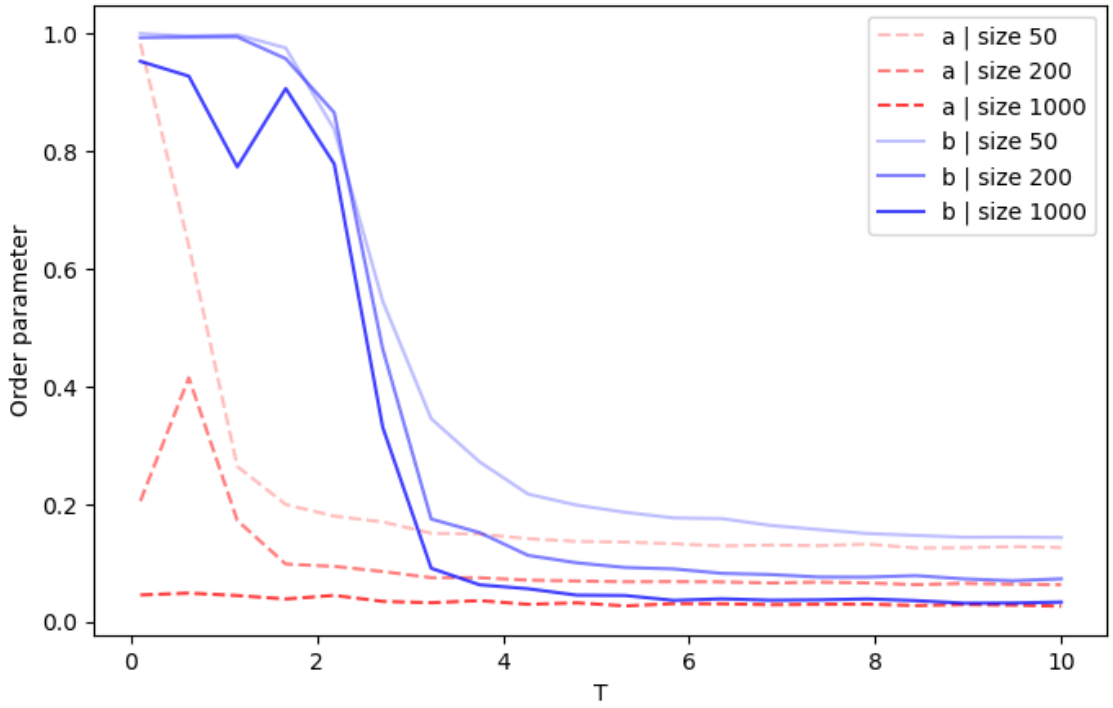

Figure 1: Caption

As can be seen, the order parameter shows a phase transition in the system with b-type-neighbours. While you may be tricked into thinking that the same dynamics are seen in the a-type, this can be an artifact of small system sizes, and the behaviour is not found for bigger systems ($N \to \infty$).

Another thing to note the size-dependence for the b-neighbours. We will look into this in the following section.

[1] the absolute value of the order parameter, that is

2 Explore possible phase transition behavior of each system.

As I have already seen (and as we have learned in the course) there is no phase transition in the simple 1d-model.

On the other hand, we seem to have a phase transition when taking b-neighbours into account. To find the temperature, I have implemented a binary-search and looked at multiple different simulation sizes:

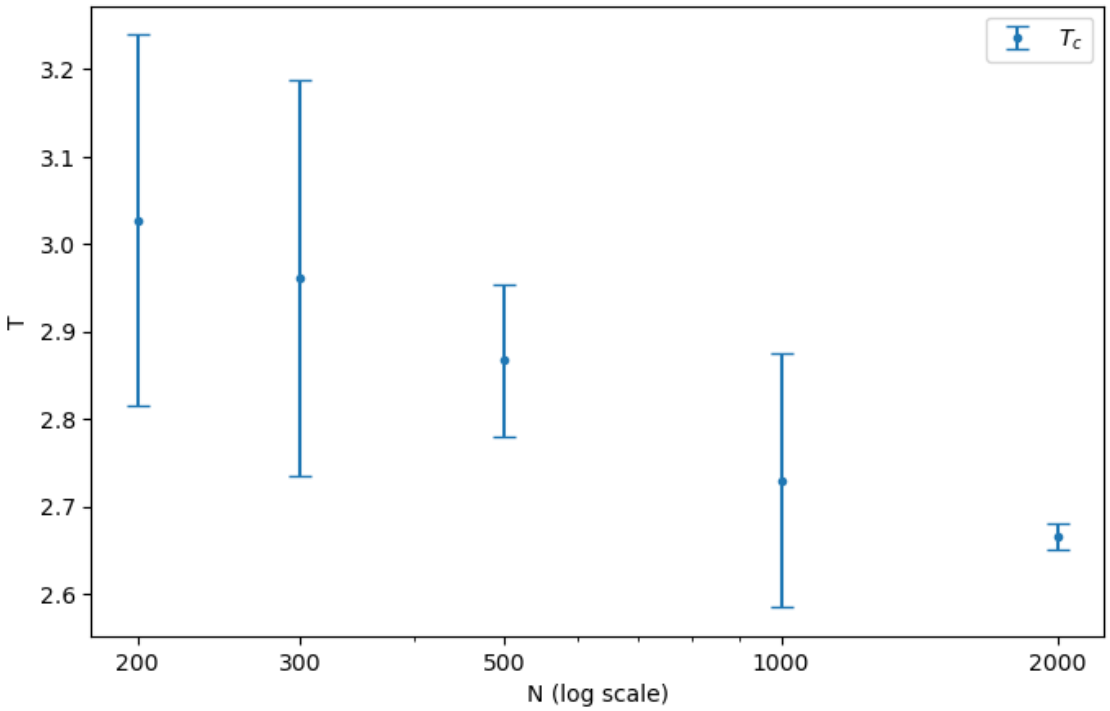

Figure 2: Caption

As both figure 1 and figure 2 seems to imply, the critical temperature is (presumably) asymptotically going towards a T_c for $N \to \infty$.

To find this, I resorted to plotting the temperature as a function of the inverse of the system size:

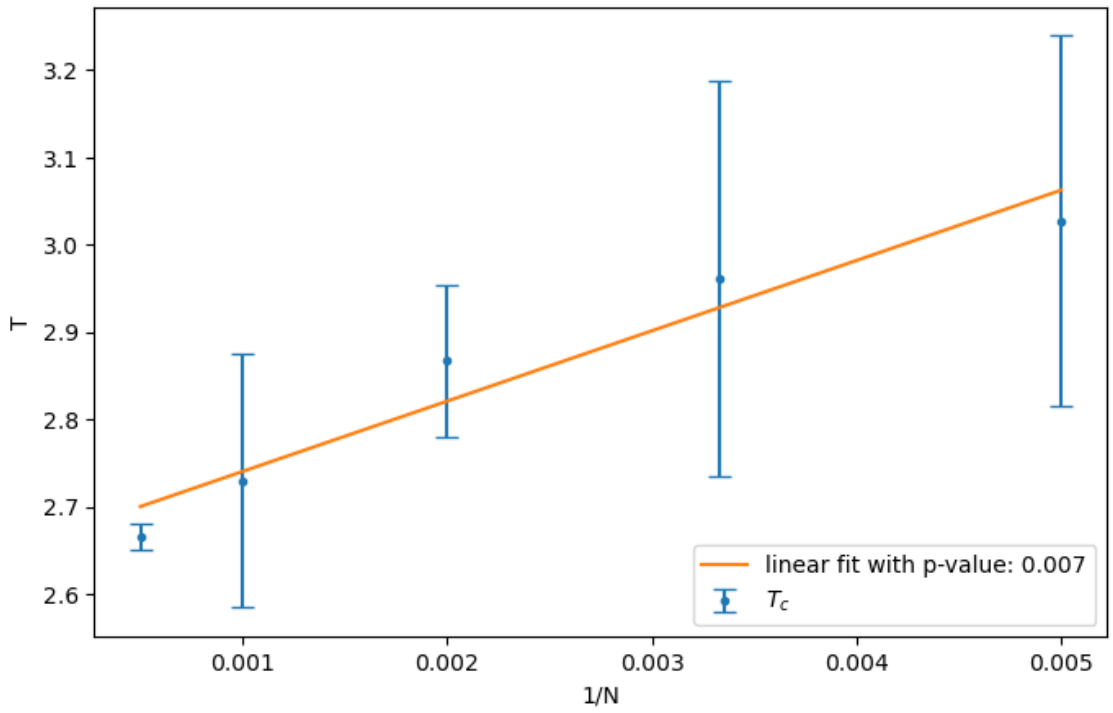

Figure 3: Caption

I get the y-intercept (ie. T_c for $N \to \infty$ as $1/N \to 0$) to be 2.660

3

Since more domain walls means fewer local "groups" of like spins. It makes sense that there is no phase-transition for the simple 1d ising model, as the spin-spin correlation looks as follows (where L is the distance):

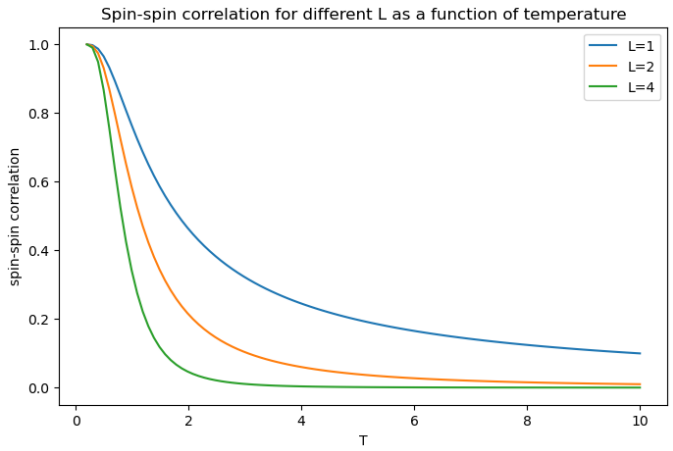

Figure 4: Caption

It is clear to see that for fewer domain walls (ie. a symmetry break) unrealistically low temperatures

is needed. Adding more long-range-neighbour interactions would also help :)