Report for Exercise 06

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1 Task 1

For the supervised learning task I first created a training and a validation set. The training set consists of 20000 sampled grid configurations of a 2d-Ising model of size $L = 30$. Where I sampled 1000 grids for 20 equidistant inverse temperatures β in $[0.2, 0.8]$. The validation set consists of 25000 samples where I sampled 1000 grids for 25 equidistant inverse temperatures β in $[0.2, 0.8]$. I constructed the validation set for slightly different temperatures such when testing the model using the validation set we get more meaning-full results.

I used the training data to train a fully connected neural network with one input layer, one hidden layer with 100 neurons and an output layer. Note that I excluded all grid configurations which where created for $\beta \in [0.42, 0.46]$ in order to avoid the random behaviour near the critical temperature. The input layer contains 900 nodes each taking on node of the $30x30$ grid. The output layer contains 2 nodes where as $(1, 0)$ is the output for a ordered grid and $(0, 1)$ the output for a disordered grid. I used sigmoid neurons, binary cross entropy cost function and trained the model using the Adam method for stochastic optimization. Also I used 150 epochs of batch size 10.

Using the validation set for testing the the model I achieved 99.84% accuracy. Also, I used the model to predict the states of the grids in the validation set and counted the number of ordered states for each temperature. In Figure 1 one can see the plotted the percentage of ordered states over the inverse temperature β obtained from this prediction.

Overall I think the model works good as it has high accuracy and also the fit of the percentage of ordered state looks like a step function at the critical inverse temperature $\beta \approx 0.44$ as we would expect. To further improve the accuracy one could experiment with different network architectures or the training set.

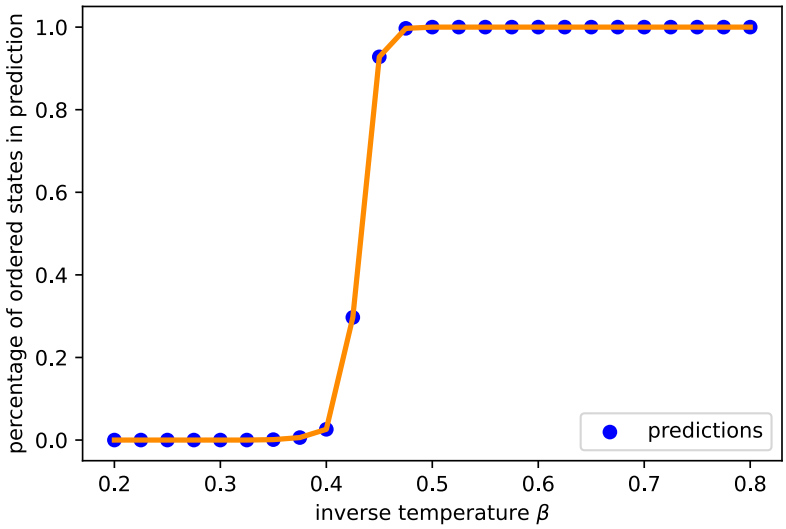

Figure 1: Plot of the percentage of ordered states over the inverse temperature temperature β.