Data Analysis and Machine Learning
Project 2

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Abstract

1 Introduction

Data science is one of the most rapidly developing parts of information technologies nowadays. The increase of computer power allow us to analyze huge amounts of data and this require some specific methods and techniques to be studied. Some of them have been already under consideration in the previous project, for example simple regression methods - linear, Ridge and Lasso. In this project we aim to tackle a classification problem using logistics regression. After that our goal is to move towards the neural network. The problem we are going to use as a test bed is Ising model.

Structure of the report. The first part is a theoretical description of the 1D and 2D Ising model. Second part is a brief description of the methods. After this we move toe the results and discussion part.

2 Problem description

This project is mostly based on the work of Metha et al. (REF!!!) and that's why we are using the problem formulation provided in this article. However, Ising model is a well known model in physics and one may find many studies devoted to the model. For example, it's one of the natural choices to study Monte Carlo simulations, as it have been done here (REF to project 4).
Generally speaking the Ising model provides us a simple approach to model the phase transitions of a ferromagnet. In the project we will study 1D and 2D Ising models.

2.1 1D Ising model

The Hamiltonian for the classical 1D Ising model is given by

$$H = -J \sum_{i}^{N} S_i S_{i+1}, \qquad S_i \in \{\pm 1\}, \tag{1}$$

where N is number of particles in the system, and S_i is a spin pointing up or down.

$$H = -J \sum_{\langle ij \rangle}^{N} S_i S_j, \qquad S_j \in \{\pm 1\}, \tag{2}$$

where the lattice site indices i,j run over all nearest neighbors of a 2D square lattice, and J is some arbitrary interaction energy scale. We adopt periodic boundary conditions. Onsager proved that this model undergoes a thermal phase transition in the thermodynamic limit from an ordered ferromagnet with all spins aligned to a disordered phase at the critical temperature $T_c/J = 2/\log(1+\sqrt{2}) \approx 2.26$.

2.2 Logistic Regression

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3 Results and discussion

4 Conclusion

5 Further work