Using SVM to determine the critical temperature

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Abstract

Condensed-matter physics implies dealing with a very large space of states, called the "curse of dimensionality". This is a problem for machine learning algorithms. However, there are techniques for applying machine learning to analyze such complex data sets. In this project, we will use Support Vector Machines (SVM) to find the critical temperature, which is a key parameter of macroscopic physical systems of matter. Its simulation is useful in research related to the superfluid state, Bose-Einstein condensation, superconductors, or magnetism. For this purpose, a complex matter system will be simulated using the Monte Carlo method for the Ising Model. The system will be trained at very low and very high temperatures.

1 Method

In this project we will use Support Vector Machines (SVM) to find the critical temperature. This is a supervised learning method. SVM gives the possibility of using the kernel function, and therefore appropriate mapping of points in the spins table to a new abstract space, where it will be possible to linearly separate the ground states and excited states, and therefore their classification.

2 Intended experiments

We will perform Monte Carlo simulation of the Ising model for very low and very high temperatures in order to obtain spin configurations of the system for different temperatures. Then we will apply the SVM method on these configurations. The machine learning model will be trained in such a way that it can determine the critical temperature based on the spin configuration itself, without the need to calculate the order parameter (in this case, magnetization). This will be done on the basis of the classification of individual points to the low-temperature and high-temperature phase and determination of thermally excited defects (studies of the concentration of excited states among ground states).

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