

Proposal for semester project in Introductory Computational Physics Course

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1 Aim

Simulation of Ising Model(1D, 2D, 3D) and its implementation on 'neural network in brain' by using Monte Carlo Method.

2 Introduction

Ising model consist of a large number of simple units (spins) which are connected together in a very simple manner. Likewise the human brain consist of an extremely large (10^{12}) of basic units called 'neurons', each of which is connected to many other neurons in relatively simple manner. We will model a neuron as a Ising spin. Likewise spin a neuron also has only two possible states:'firing' and 'not firing'(Neurons communicate with each other by emitting electrical pulses, called firing).

The effective energy of the neuron network is,

$$E = - \sum J_{ij} s_i s_j \quad (1)$$

where $s_i = \pm 1$ corresponding to firing rate of i^{th} neuron and $s_j = \pm 1$ corresponding to firing rate of j^{th} neuron. J_{ij} are related to the strength of the synaptic connections.

3 Plan

In this project I want to simulate the 1D, 2D, 3D Ising model by using Monte Carlo simulation and apply this technique in the study of neuron system.

The simulation of neutral network memory involves the following steps-

1. Choosing desire $N*N$ grid pattern.
2. Storing the spin values in 2D array(m,n).
3. The stored pattern can be described by using the labeling scheme in terms of the number i and $s_i(p)$ denoting the value of the i^{th} spin for the p^{th} stored pattern.
- 4.The Monte Carlo method is used to calculate the spin direction of the future time. Given a collection of the pattern we store J_{th} .
5. The network operates as a content addressable memory.The lattice of neurons is initialized with a configuration that resembles the recalling pattern.

4 Techniques used

At the first glance I can say that I'll use Monte Carlo method. If time permits then I can go for Image processing ,handwriting recognition ,learning and fading of the old memory.

Instead of all these, I'll also make sure about the numerical instability and accuracy of the computation.