

Question 6.5: Instructions for using the `ising_2d_sweep` Matlab function

These instructions are only for students who are not proficient in any programming language other than Matlab. If you can solve problem 6.5 by programming in another language (C, Fortran, Java, etc.), please do so. Reminder: question 6.5 is a bonus question. If you don't want to do it you don't have to.

If you decide to solve the question and to use Matlab as your programming language, you are required to write a Matlab code for the Metropolis simulation and use it to solve the question and estimate the magnetization for a system of size $L = 5$ (i.e., a 5×5 system). Then, you should repeat the exercise for larger systems using the provided `ising_2d_sweep` Matlab function (you should be able to reach systems of size $L \approx 100 \sim 200$ within reasonable running times).

After extracting the archive which contains the file you are now reading, you should have a file called `ising_2d_sweep.mexw64`, and a directory called `source_files` which contains two files `mt19937ar.h` and `ising_2d_sweep.c`.

The program, written in C++, is compiled for use in 64 bit machines running Microsoft Windows 7. If you are working on a different machine, it will probably not work and you will need to compile the function yourself. Instructions on how to compile it are presented below, followed by instructions on how to use it.

How to compile the Matlab function

Note: if you are using a 64 bit machines running Microsoft Windows 7 you might be able to skip this step.

1. Change the Matlab working directory to the source files directory.
2. Enter `mex ising_2d_sweep.c`. You might be prompted to choose a compiler from a list. If you have Visual C installed on your computer choose it, otherwise choose any other option from the list.
3. Hopefully, this compilation will be successful. If not, please contact me.

How to use the function

After compilation, you should have a mex file, i.e., a file with the extension `.mexw32`, `.mexw64`, or something similar. This is the file used by Matlab when calling the function. Make sure that your Matlab working directory contains this file.

The function `ising_2d_sweep` runs the requested number of sweeps of the Metropolis algorithm. It is used as follows

```
[lattice_out, m] = ising_2d_sweep(lattice_in,  
                                T_over_J, n_sweeps)
```

The input parameters are:

1. `lattice_in` is the initial configuration of the lattice. It should be an $L \times L$ matrix with values of ± 1 only, representing the values of the different spins.
2. `T_over_J` is the temperature, measured in units of the coupling constant J . It should be a non-negative real number.
3. `n_sweeps` is the number of Metropolis sweeps the function will run. It should be a non-negative integer.

The output parameters are:

1. `lattice_out` is the state of the lattice at the end of the Monte Carlo simulation. It is an $L \times L$ matrix with values ± 1 .
2. `m` is the time-series of the measured magnetization *per spin*. The magnetization is measured at the end of each sweep, and therefore `m` is a vector of length `n_sweeps`.

For example, assume that the $L \times L$ matrix `lat` represents some configuration of the lattice, and you wish to run a single Monte Carlo sweep at temperature $T = 2J$, and to store the result back in the matrix `lat`. To do this, enter `[lat, m] = ising_2d_sweep(lat, 2, 1)`.

Remark: Matlab is especially slow when running `for` loops. To keep the running time reasonable, try to avoid them as much as possible. Can you estimate how much is the C program faster compared with the Matlab code which you have written?

In case there are problems, please contact me.

Good luck!

Ori.