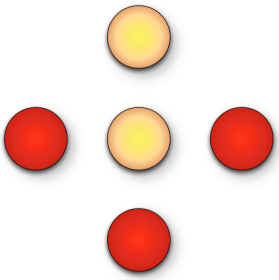
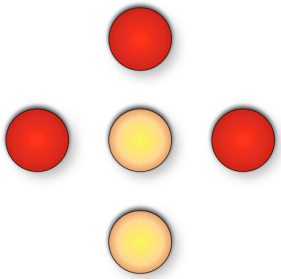


MacIsing 1.1



User Guide

Introduction

MacIsing is an interactive simulator of the 2D Ising model on a square lattice. A regular grid of classical spins (either pointing up or down) are coupled via nearest-neighbour (NN) and next-to-NN (NNN) interactions. Spins are randomly flipped by thermal agitation and a uniform external magnetic field can be applied. The simulation is performed applying a Metropolis Montecarlo algorithm. For more details about the physics of the Ising model and the Montecarlo method, see the section "References" at the bottom of this document.

Installation

To install MacIsing, open the MacIsing.dmg disk image and drag the MacIsing icon on the "Applications" folder alias.

Generalities

At the startup, MacIsing will show a screen similar to the one below

The main part of the window is occupied by a grid representing the spin lattice. Two views are available: either the spin direction (represented in two different colours which can be selected by the user) or the energy per spin. It is possible to toggle between the two views by pressing the "Energy" spin (in energy view mode, the button displays "Spin").

At the bottom of the window, a bar and a display show the magnetization of the system

By default, the simulation runs on a 200 x 200 grid. The user can select the size of the grid by choosing "Grid" on the main menu bar.

The simulation can be paused by pressing the "Pause" button. While paused, the user can "strobe" can force the flipping of one spin at a time by pressing the "S" button.

The speed of the simulation can be controlled via the "Speed" menu on the main menu bar. Note that higher speeds correspond to higher CPU loads.

Controls

The four sliders on the right part of the window control the system temperature (T), the NN coupling strength (J), the magnetic field (B) and the NNN coupling intensity (Jnn). These parameters can be quickly reset to the default values by clicking on the square buttons abuove the sliders.

Four types of simulations are possible, according to the drop-down menu:

1. *Homogeneous*: the coupling constants are equal on every spin-spin bond;
2. *Random J*; a random coupling is present on each spin-spin bond;
3. *Interface*: the central stripe of the lattice has opposite coupling strength w.r.t. the outer parts;
4. *Wedge*: the coupling strength increases from zero at the borders to its maximum at the center.

The grid can be initialized by means of the four square buttons below the drop down menu: *random* (R), *all spins up* (U), *all spins down* (D) and in a *checkerboard* pattern (C).

License

responsible. However, the author believes that this software is not to cause any damage to your hardware.

MacIsing is a "work in progress" project. I use it as an excuse to learn Cocoa and Objective-C. I would really appreciate any feedback, comment and criticism, by sending an e-mail to macising@gmail.com.

Credits

I would like to thank Umberto De Giovannini for providing the inspiration to start and play with Cocoa on the Iphone. MacIsing really started as "iSing", a little app for the iPhone.

I would like to thank Steve Jobs and the guys at Apple: thanks to their absurd policy of not letting a developer to test *his* code on *his* device (unless an extra ninety-something dollars per year is paid), i quickly dropped the iPhone platform and converted to Mac. This also means that you will never be able to enjoy iSing on your iPhones - I bet most people will be able to cope with that anyway :)

I am indebted to Robert Mills and the guys at cocoaforum.com for their friendly help.

This software is dedicated to my daughter Viola: although she's only six months old, she just goes crazy when all those spins dance on the screen!

References

An online introduction to the Ising model is provided by Wikipedia: http://en.wikipedia.org/wiki/Ising_model.

The model is discussed on virtually any textbook on statistical mechanics. A particularly nice discussion can be found on "Statistical Mechanics" by R. P. Feynman.

Among the several review articles on the subject, I have enjoied "An introduction to the Ising model" by B. A. Cipra on *The American Mathematical Monthly* **94**, 937 (1987) and "Instabilities and phase transitions in the Ising model. A Review." on the (rather obscure) *Rivista del Nuovo Cimento* **2,** 133 (1972).

Wikipedia also provides a nice introduction to the Montecarlo method (http://en.wikipedia.org/wiki/Monte_Carlo_method) and to the Metropolis-Hastings algorithm which is employed in this simulation (http://en.wikipedia.org/wiki/Metropolis-Hastings_algorithm).