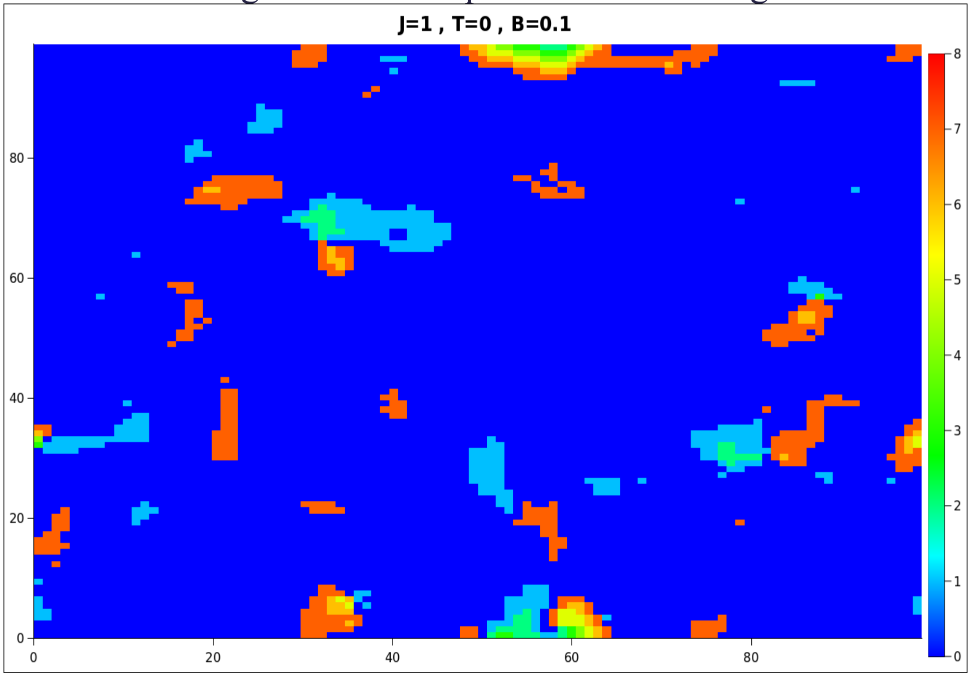
Simulation of the 2D Ising Model in a square lattice with eight-directional Spin



```
#include <fstream>

#include <cmath>

#include <stdlib.h>

#include <ctime>

using namespace std;


const int N = 100;

const float J = 1.0, T = 2.0, h =5.0; // h Ù…ÛŒØ¯Ø§Ù† Ø®Ø§Ø±Ø¬ÛŒ

const int directions = 8; // ØªØ¹Ø¯Ø§Ø¯ Ø¬Ù‡Ø§Øª Ù…Ù…Ú©Ù† Ø¨Ø±Ø§ÛŒ Ø§Ø³Ù¾ÛŒÙ†â€ŒÙ‡Ø§


int main(){

   srand(time(NULL));

   int S[N][N];

   float Ei,Ef,deltaE;

   float r;
```

```
    int i,j;

    int ii,jj;

    float Smeanx,Smeany,Emean;

    float angle[directions]={0,M_PI/4,M_PI/2,3*M_PI/4,M_PI,5*M_PI/4,3*M_PI/2,7*M_PI/4}; //
Ø²Ø§Ù^ÛŒÙ‡â€ŒÙ‡Ø§ Ø¨Ø± ØØ³Ø¨ Ø±Ø§Ø¯ÛŒØ§Ù†


    // Ù…Ù‚Ø¯Ø§Ø±Ø¯Ù‡ÛŒ ØªØµØ§Ø¯Ù⍰ÛŒ Ø¢Ø±Ø§ÛŒÙ‡

    for(i=0;i<N;i++){

        for(j=0;j<N;j++){

            S[i][j]=rand()%directions;

        }

    }


    ofstream outs("sdata(t=2,h=5).txt");

    ofstream outc("sconfig(t=2,h=5).txt");


    for(int n=0;n<1000000;n++){

        Ei=0.0;

        for(i=0;i<N;i++){

            for(j=0;j<N;j++){

                Ei+=-J*0.5*cos(angle[S[i][j]]-angle[S[(i+1)%N][j]])-J*0.5*cos(angle[S[i][j]]-angle[S[i][(j+1)%N]])-
J*0.5*cos(angle[S[i][j]]-angle[S[(i-1+N)%N][j]])-J*0.5*cos(angle[S[i][j]]-angle[S[i][(j-1+N)%N]])-
h*cos(angle[S[i][j]]); // Ø§Ù†Ø±Ú˜ÛŒ Ø¨Ø±Ù‡Ù…â€ŒÚ©Ù†Ø´ÛŒ

            }

        }


        ii=rand()%N;

        jj=rand()%N;

        int old_S=S[ii][jj];
        S[ii][jj]=rand()%directions; // ØªØºÛŒÛŒØ± Ø¬Ù‡Øª Ø§Ø³Ù¾ÛŒÙ† Ø¨Ù‡ ØµÙˆØ±Øª ØªØµØ§Ø¯Ù⍰ÛŒ
        Ef=0.0;
        for(i=0;i<N;i++){
            for(j=0;j<N;j++){
                Ef+=-J*0.5*cos(angle[S[i][j]]-angle[S[(i+1)%N][j]])-J*0.5*cos(angle[S[i][j]]-angle[S[i][(j+1)%N]])-J*0.5*cos(angle[S[i][j]]-angle[S[(i-1+N)%N][j]])-J*0.5*cos(angle[S[i][j]]-angle[S[i][(j-1+N)%N]])-h*cos(angle[S[i][j]]); // Ø§Ù†Ø±Ú˜ÛŒ Ø¨Ø±Ù‡Ù…â€ŒÚ©Ù†Ø´ÛŒ
            }
        }
        deltaE=Ef-Ei;
        if(deltaE>0){
            r=rand()/(RAND_MAX+1.0);
            if(r>exp(-deltaE/T)){
                S[ii][jj]=old_S; // Ø¨Ø§Ø²Ú¯Ø´Øª Ø¨Ù‡ ØØ§Ù„Øª Ù‚Ø¨Ù„ÛŒ
                Emean=Ei/(N*N);
            }else{
                Emean=Ef/(N*N);
            }
        }else{
            Emean=Ef/(N*N); // Ù…ØªÙˆØ³Ø· Ø§Ù†Ø±Ú˜ÛŒ Ø¨Ù‡ Ø§Ø²Ø§ÛŒ Ù‡Ø± Ø§Ø³Ù¾ÛŒÙ†
        }

        Smeanx=0.0;
        Smeany=0.0;
        for(i=0;i<N;i++){
            for(j=0;j<N;j++){
                Smeanx+=cos(angle[S[i][j]]);
                 Smeany+=sin(angle[S[i][j]]);
            }
        }
        Smeanx/=(N*N);
        Smeany/=(N*N);
        outs<<n<<'\t'<<Emean<<'\t'<<Smeanx<<'\t'<<Smeany<<'\n';
    }

    outs.close();

    for(i=0;i<N;i++){
        for(j=0;j<N;j++){
            outc<<i<<'\t'<<j<<'\t'<<S[i][j]<<'\n';
        }
    }

    outc.close();

    return 0;
}
```