Assignment 3

Part 1

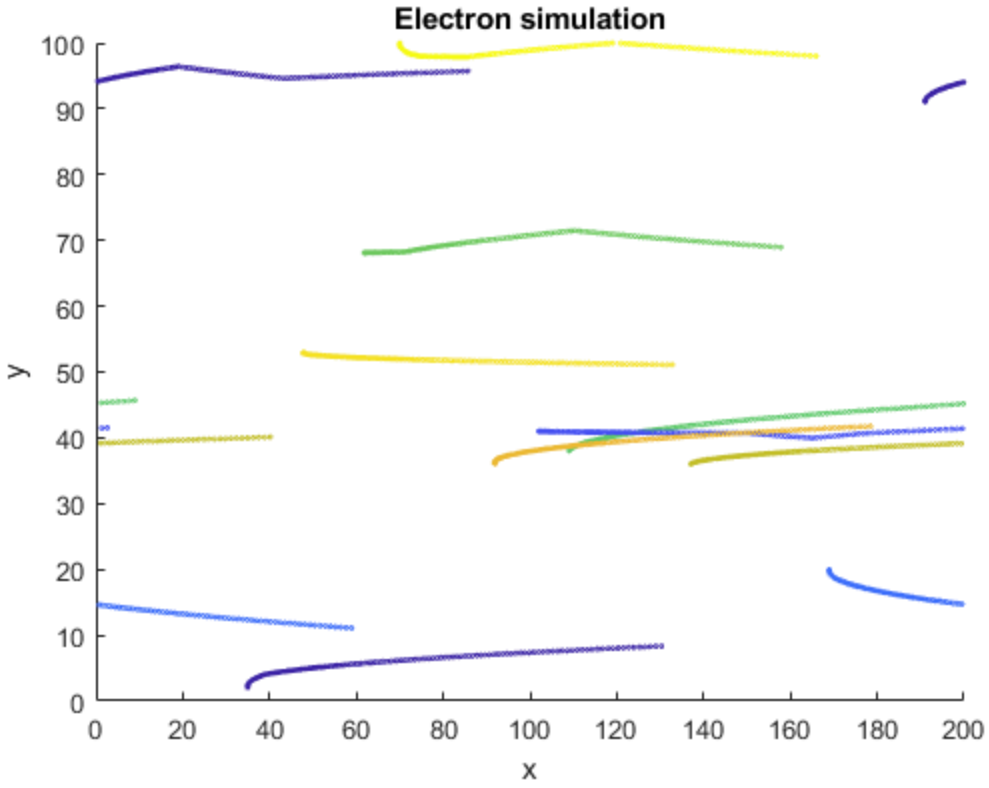
For Part 1 , we have simulating the electrons in an electric field. This field will create a constant force on each electron and thus accelerate.

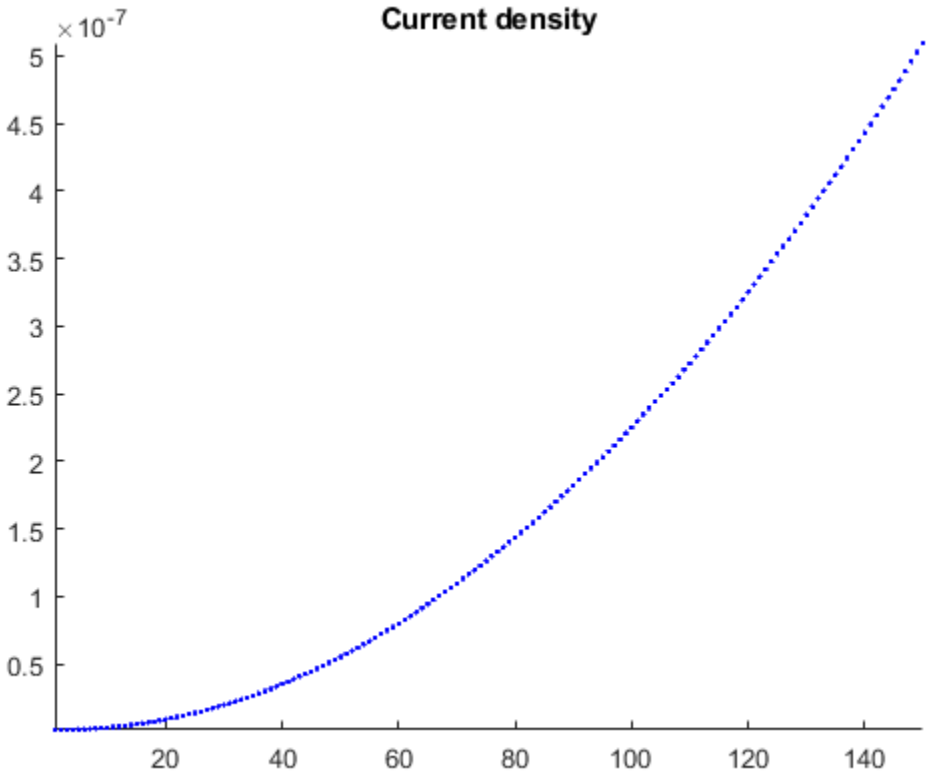
```
clc
clear

global C



C.q_0 = 1.60217653e-19;             % electron charge
C.hb = 1.054571596e-34;             % Dirac constant
C.h = C.hb * 2 * pi;                    % Planck constant
C.m_0 = 9.10938215e-31;             % electron mass
C.kb = 1.3806504e-23;               % Boltzmann constant
C.eps_0 = 8.854187817e-12;          % vacuum permittivity
C.mu_0 = 1.2566370614e-6;           % vacuum permeability
C.c = 299792458;                    % speed of light
C.g = 9.80665; %metres (32.1740 ft) per sÂ²

%              ELECTRIC FIELD
% Voltage of 0.l V across x dimension
% Using V = E * d ,
%   We get E = 0.1 / 200 = 500 uV/m
eField = 0.1 / (200);

%                      FORCE  & ACCELERATION
% E = F / q , we know the q = C.q_0
force = eField * C.q_0;
eAcceleration = force / (C.m_0 * 0.26);




nSim = 150;
noe = 1000;
r2 = randi(360,noe,1);
xbound = 200;
ybound = 100;
x = randi(200,noe,1);
y = randi(100,noe,1);
vth = sqrt((C.kb * 300)/(C.m_0 * 0.26));
vx = vth * cos(r2) ;
vy = vth * sin(r2);

nPlot = 10;
colourArray= rand(nPlot,1);
```

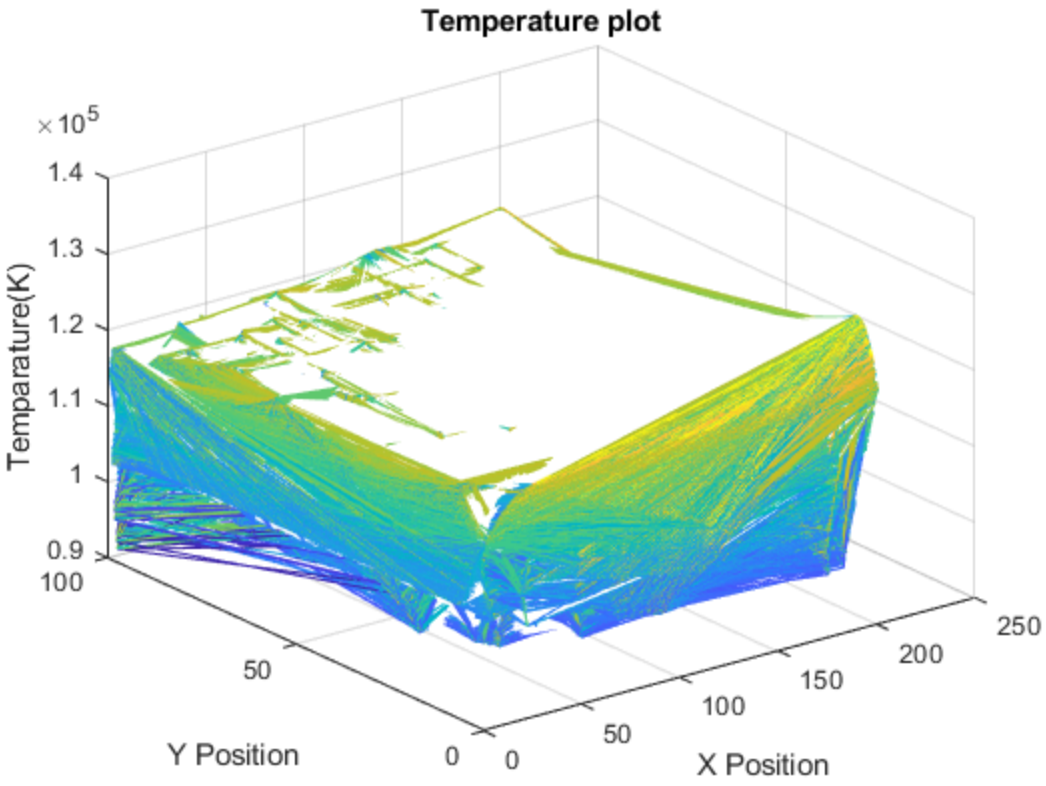
```
MFP = vth * 0.2 * 10^-12;

pScat = 1 - exp((-35 * 10^-16)/(0.2 * 10^-12));

tMatrix = zeros (noe);


for t = 1:nSim
    vxc = vx; % create copy of vx
    vyc = vy; % create copy of vy
    [n,m] = size(vx);
    [n1,m1] = size(vy);

    %%randomly permutation of positions in vx and vy%%%
    idx = randperm(n);
    randomvx = vx;
    randomvx(idx,1)= vx (:,1) ;

    idy = randperm(n1);
    randomvy = vy;
    randomvy(idy,1) = vy(:,1);


    %Modelling scattering%%%%%%
    rScatter= rand(noe,1);

    % this gives 1s and 0s. 1 means it scatters
    tempScatter = rScatter < pScat;
    randomvx = tempScatter .* randomvx; % not scattered are 0s
    randomvy = tempScatter .* randomvy ; % not scattered are 0s

    %not scattered
    notScatter = rScatter >= pScat;
    %%%%%%%%%%%%%%%%%%%%%%%%%

    vx = vx .* notScatter; % the scattered vx are now 0
    vy = vy .* notScatter; % scattered vy = 0

    vx = vx + randomvx;
    vy = vy + randomvy;



    %%%%%%%%%%%%%
    xc = x; % x copy
    yc = y; % y copy


    %Reflecting for y bounds%
    temp = y >= ybound ;
    temp1 = y < ybound ;
```

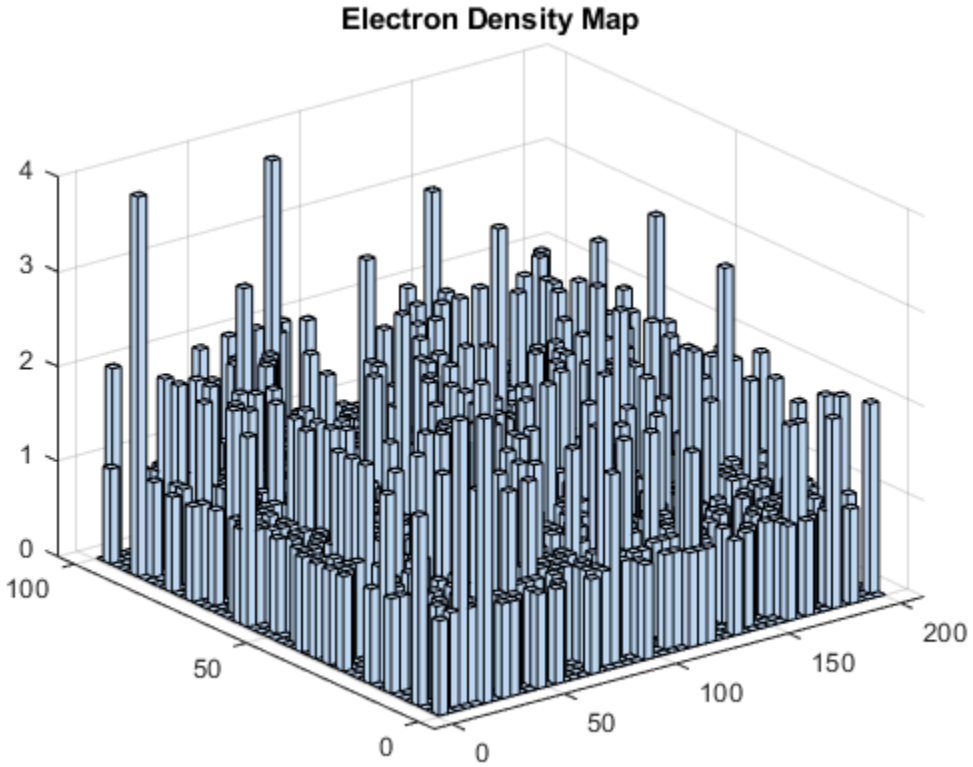
```
temp = temp * -1;

tempHigher = temp + temp1;


temp2 = y <= 0;
temp3 = y > 0;

temp2 = temp2 * -1;
tempLower = temp2 + temp3;

vy = vy .* tempHigher;
vy = vy .* tempLower;

%%%%%%%%%%%%%%%%%%

% when x > 200%%%%%
tempx1 = x <= 200;

x = x .* tempx1;
%%%%%%%%%%%%%%%%%%

%%When x goes less than zero , come from 200 %%%%%

tempx2 = x < -0.1;


tempx2 = tempx2 * 200;
tempxFinal = x + tempx2;

x = tempxFinal;

%%%%%%%%%%%%%%%%%%
dx = vx * (1/2000000);
dy = vy * (1/2000000);

x = x + dx;
y = y + dy;
vsq = (vy).^2 + (vx).^2 ;
average = mean(vsq);

for q = 1:1:nPlot
    plotx(q) = x(q);
    ploty(q) = y(q);

end
tMatrix = ((vsq * 0.26 *  C.m_0)/C.kb);



figure(1)
scatter(plotx,ploty,3,colourArray);
axis([0 200 0 100]);
```

```
    xlabel("x");
    ylabel("y");
    title ("Electron simulation");
    vx =  vx + (eAcceleration * (1/20000));
    pause(0.01);
    hold on

    figure(2)
    I = average *noe * eField * C.q_0;
    scatter(t, I,'b.');
    axis tight;
    title("Current density");
    hold on;

end




[X,Y] = meshgrid (x , y);
f1 = scatteredInterpolant(x,y,tMatrix);
Z = f1(X,Y);
figure (3);
mesh(X,Y,Z);
title('Temperature plot');
xlabel('X Position');
ylabel('Y Position');
zlabel('Temparature(K)');

figure(4)
hist3([x y] , [50 50])
title("Electron Density Map")
```


Electron simulation
y
x
0
10
20
30
40
50
60
70
80
90
100
0
20
40
60
80
100
120
140
160
180
200


Current density
×10^-7
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
20
40
60
80
100
120
140


Temperature plot
×10^5
1.4
1.3
1.2
1.1
1
0.9
Temparature(K)
100
50
0
Y Position
0
50
100
150
200
250
X Position


Electron Density Map
4
3
2
1
0
100
50
0
0
50
100
150
200

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