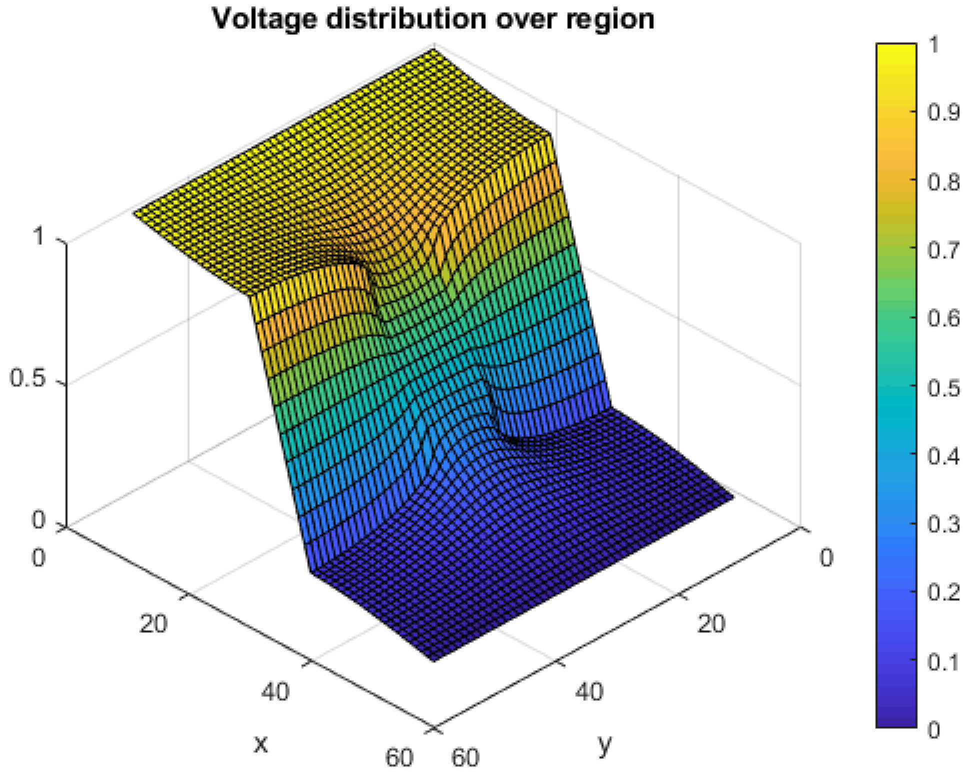
Assignment 3 Part 2 - Andrew Paul

This section of the assignmnet is taken from assignment 2 and plots the potnetial and electric field of the bottle-neck using the finite differences method

```
clear

nx = 50;
ny = 50;

% Create sparse G matrix
G = sparse(nx*ny,nx*ny);

% Conductivity outside box
sigma1 = 1;
% Conductivity inside box
sigma2 = 10^-2;

% Generate F matrix to set boundary conditions
F = zeros(nx*ny,1);

% Change for difference in bottle neck width
Lb = 0.4;
Wb = 0.6;

% Create matrix for mapping the conductivity and loop through to
 assign
% conductivity values for the given conditions
condMap = zeros(nx,ny);

for i = 1:nx
    for j = 1:ny
        if (i>=Lb*nx && i<=Wb*nx && j<=Lb*ny) || (i>=Lb*nx && i<=Wb*nx
 && j>=Wb*ny)
            condMap(i,j) = sigma2;
        else
            condMap(i,j) = sigma1;
        end
    end
end

% Loop through to set boundary conditions

for i = 1:nx
    for j = 1:ny
        n = j + (i-1)*ny;

        if i == 1
            G(n,:) = 0;
            G(n,n) = 1;
            F(n) = 1;
```

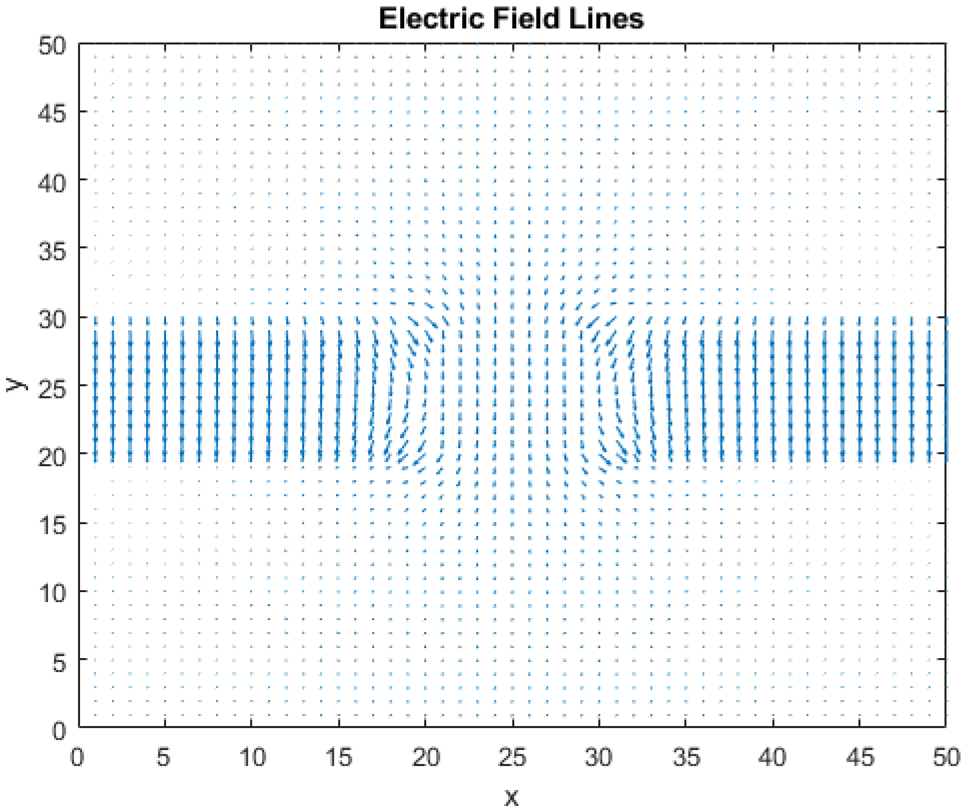
```
        elseif i == nx
            G(n,:) = 0;
            G(n,n) = 1;

        elseif j == 1
            nxm = j+(i-2)*ny;
            nxp = j+(i)*ny;
            nyp = j+1+(i-1)*ny;

            rxm = (condMap(i,j) + condMap(i-1,j))/2;
            rxp = (condMap(i,j) + condMap(i+1,j))/2;
            ryp = (condMap(i,j) + condMap(i,j+1))/2;

            G(n,n) = -(rxm+rxp+ryp);
            G(n,nxm) = rxm;
            G(n,nxp) = rxp;
            G(n,nyp) = ryp;

        elseif j == ny
            nxm = j+(i-2)*ny;
            nxp = j+(i)*ny;
            nym = j-1+(i-1)*ny;

            rxm = (condMap(i,j) + condMap(i-1,j))/2;
            rxp = (condMap(i,j) + condMap(i+1,j))/2;
            rym = (condMap(i,j) + condMap(i,j-1))/2;

            G(n,n) = -(rxm+rxp+rym);
            G(n,nxm) = rxm;
            G(n,nxp) = rxp;
            G(n,nym) = rym;

        else
            nxm = j+(i-2)*ny;
            nxp = j+(i)*ny;
            nym = j-1+(i-1)*ny;
            nyp = j+1+(i-1)*ny;

            rxm = (condMap(i,j) + condMap(i-1,j))/2;
            rxp = (condMap(i,j) + condMap(i+1,j))/2;
            rym = (condMap(i,j) + condMap(i,j-1))/2;
            ryp = (condMap(i,j) + condMap(i,j+1))/2;

            G(n,n) = -(rxm+rxp+ryp+rym);
            G(n,nxm) = rxm;
            G(n,nxp) = rxp;
            G(n,nym) = rym;
            G(n,nyp) = ryp;

        end

    end

end
```

```
% Find voltage values using matrix operations
V = G\F;

% Create matrix to map voltage and loop through matrix to assign
 values
% from calculated voltage matrix
VMap = zeros(nx,ny);

for i = 1:nx
    for j = 1:ny
        n = j + (i-1)*ny;

        VMap(i,j) = V(n);
    end
end

% Plots

% Voltage plot
figure(2)
surf(VMap)
title('Voltage distribution over region')
xlabel('y')
ylabel('x')
colorbar
view(135,45)
```



The voltage plot shown above gives the expected distribution as one side of the region has a voltage of V0 where the other side is set to zero. The barrier in the middle blocks uniform distribution to the other side of the region which is expected. As the conductivity inside the boxes is less than the conductivity outside the barrier boxes.

```
% Gradient used to plot electric field lines
[Ex,Ey] = gradient(VMap);

% Electric field plot
figure(3)
quiver(Ex,Ey)
title ('Electric Field Lines')
xlabel('x')
ylabel('y')
xlim([0 50])
ylim([0 50])
```



The plot above shows that the electric field lines are strongest between the areas which have a lower conductivity. This is execpted as it is similar to the model of a parallel plate capcitor which has two plates of a larger conductivity seperated by a region with a lower conductivity creating a stronger electric field between the two higher conductivity regions.

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