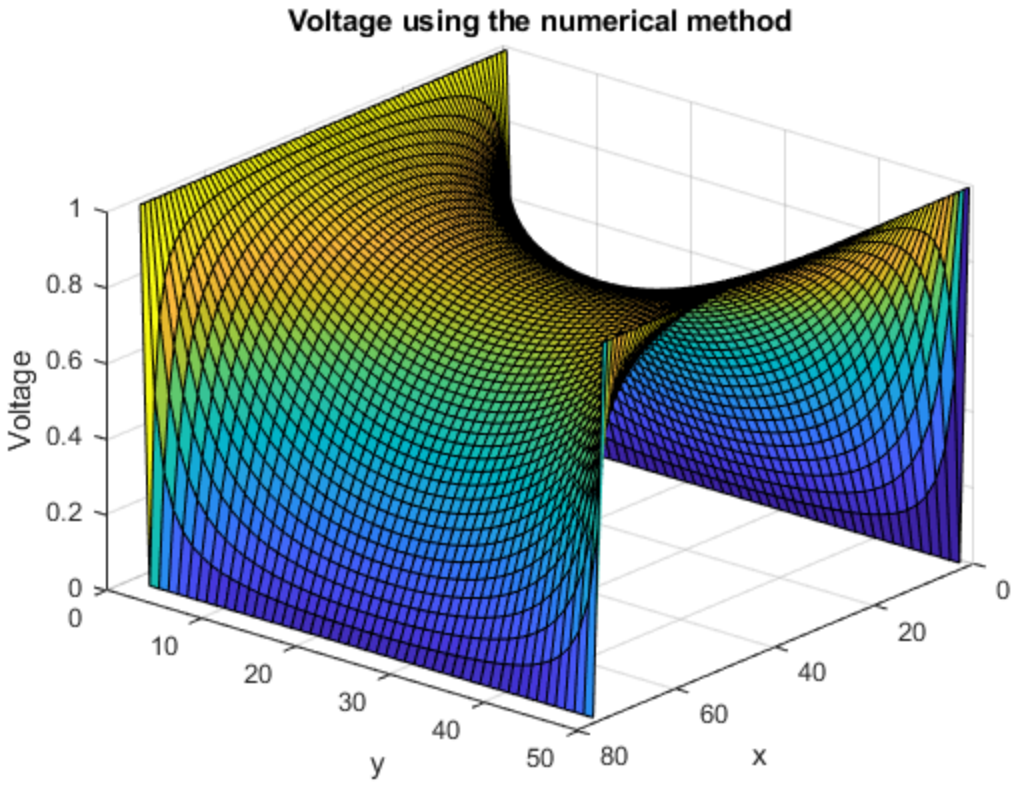
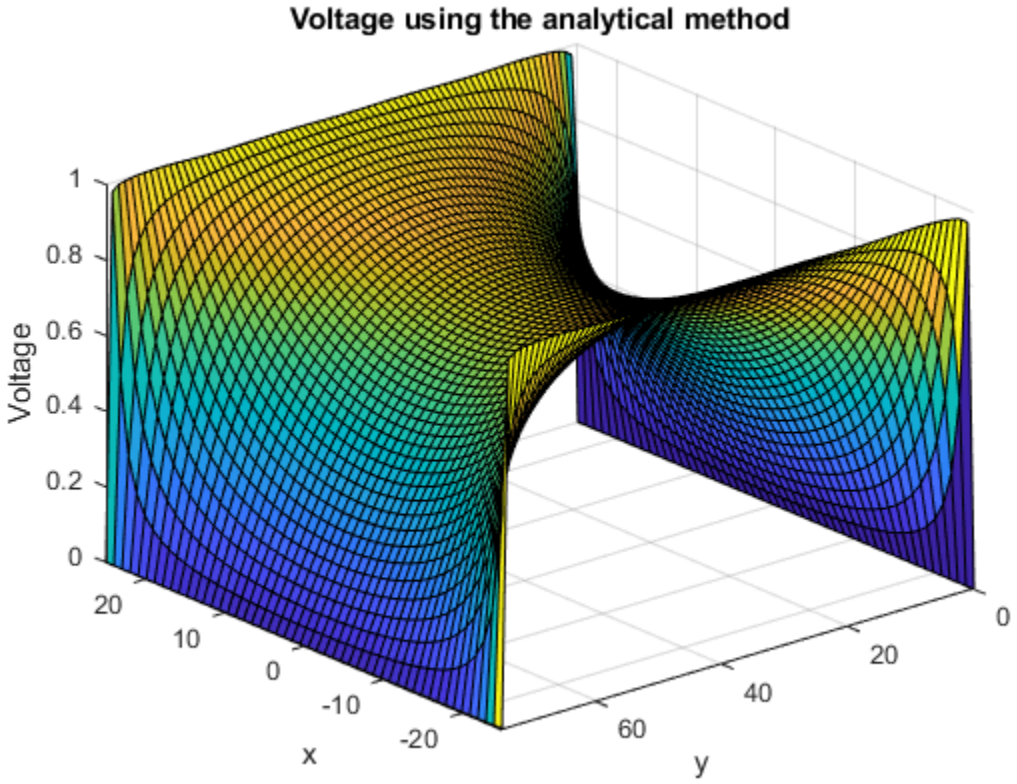
Part 2 b

This code compares the numerical solution and analytical solution for Laplace's equation

```
nx = 50;
ny = 1.5 * nx; % Since we want the region to be a rectangle

G = sparse(nx*ny, nx*ny); % the equations
B = sparse(1,nx*ny);

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

        if i == 1
            G(n,:) = 0;
            G(n,n) = 1;
            B(n) = 1;
        elseif i==nx
            G(n,:) = 0;
            G(n,n) = 1;
            B(n) = 1;
        elseif j==1 % left side
            G(n,:) =0;
            G(n,n) = 1;

        elseif j==ny % right side
            G(n,:) = 0;
            G(n,n) = 1;

        else
            G(n,n) = -4; % middle value
            G(n,n-1) = 1; % left side
            G(n,n+1) = 1; % right side
            G(n,n-ny) = 1 ;% first value
            G(n,n+ny) = 1 ; % last value
        end


    end

end

V = G\B';

m = zeros(nx,ny,1);


for i = 1:nx
    for j=1:ny
        n = j + (i-1)* ny ;
        m(i,j) = V(n);
```

```
    end
end

figure(1);
surf(m);
title("Voltage using the numerical method");
xlabel("x");
ylabel("y");
zlabel("Voltage");
view(130,30);

% Analytical Solution using infinite series

x1 = linspace(-nx/2,nx/2, 50);
y1 = linspace(0,ny,ny);
[i,j] = meshgrid(x1,y1);

a= ny;
b = nx/2;
voltage = sparse(ny,nx);

for n = 1:2:600
    voltage = (voltage + (cosh(n*pi*i/a).*sin(n*pi*j/a))./
(n*cosh(n*pi*b/a)));
    figure(2);
    surf(x1,y1,(4/pi)*voltage);
    title("Voltage using the analytical method");
    xlabel("x");
    ylabel("y");
    zlabel("Voltage");
    axis tight;
    view(-130,30);
    pause(0.01);

end
```


Voltage using the numerical method
Voltage
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
y
80
60
40
20
0
x


Voltage using the analytical method
Voltage
1
0.8
0.6
0.4
0.2
0
20
10
0
-10
-20
x
60
40
20
0
y

Conclusion

The analytical solution coverges to the numerical solution for a while. After 600 iterations, the analytical solution does not look similar to the numerical solution anymore.

Comparing the analytical and numerical solution:

The analytical solution can be used to calculate a solution quickly. However, sometimes the analytical solution fails to give the correct solution as they are simplistic models

The numerical method can give the approximate answer. However, it uses many resources. Also,you will have to accumulate some error in the final solution.

Published with MATLAB® R2018a