Table of Contents


```
clc;
close all;
clear;
```

Declare simulation parameters

```
dx = 2/1000;
x_vals = (-1+dx):dx:(1-dx);
eps_arr = [0.1, 0.01, 0.001];
dt = dx/100;

u_plots = zeros(size(eps_arr));
res_plots = u_plots;
labels = {};
```

Initial Values and Boundary conditions

```
for i = 1:length(eps_arr)

    eps = eps_arr(i);
    labels{i} = ['eps = ' num2str(eps)];
    u_vals = repmat(-1.*x_vals, 3,1);
    uu_1 = 1;
    uu_n = -1;

    tol = 1e-5;
```

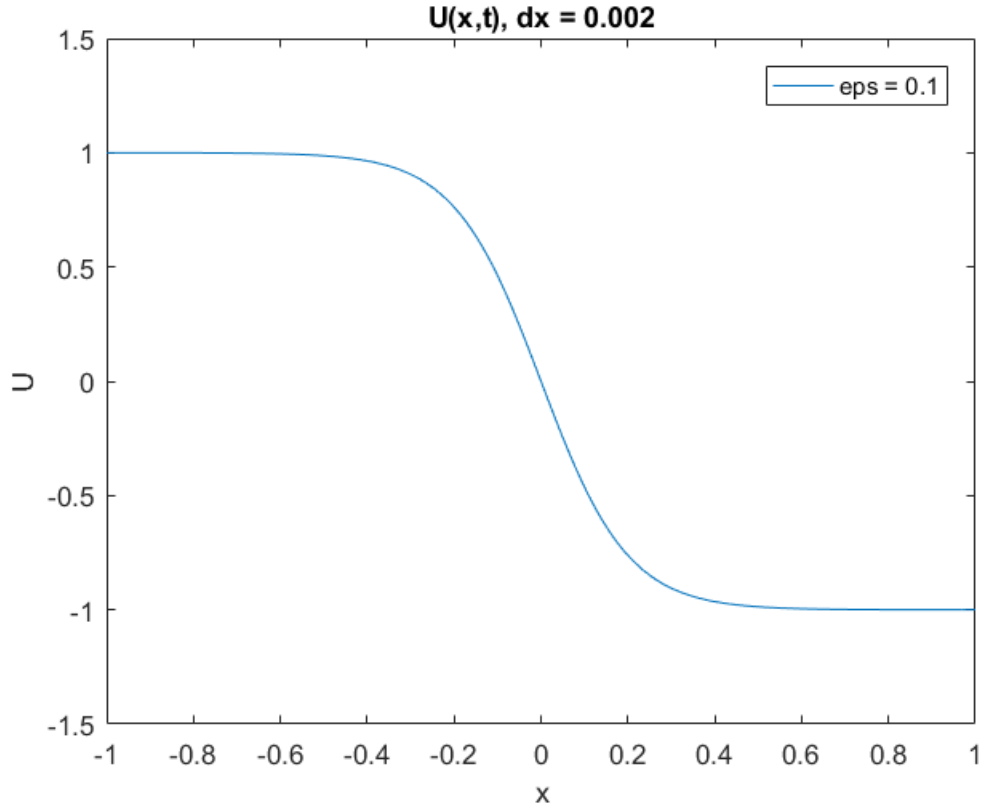
Iterate

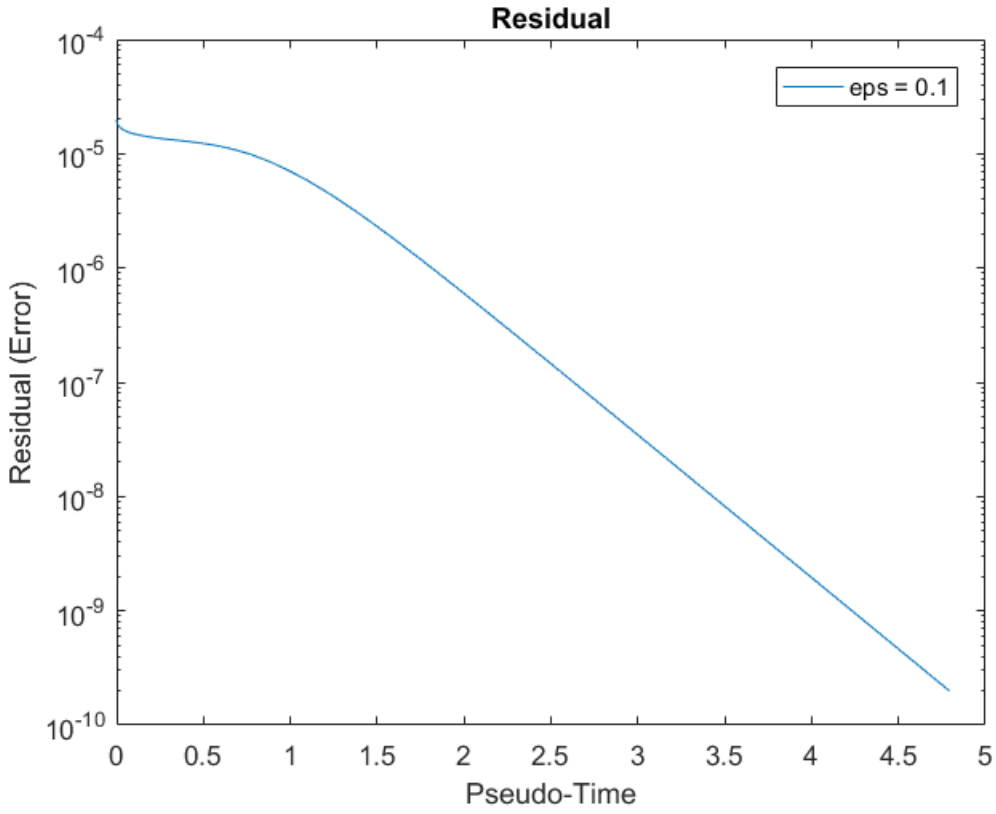
```
    res = [0];
    while (res(end) > tol*max(res)) ||  (length(res) < 1e4)
        u_vals(1:2,:) = u_vals(2:3,:);

        CFL_i = dt.*max(abs(u_vals(2,:))./(dx);

        if CFL_i >= 1.0
           fprintf('CFL condition not met!\n');
           fprintf('Decreasing time steps!\n');
           dt = dt / CFL_i;
```

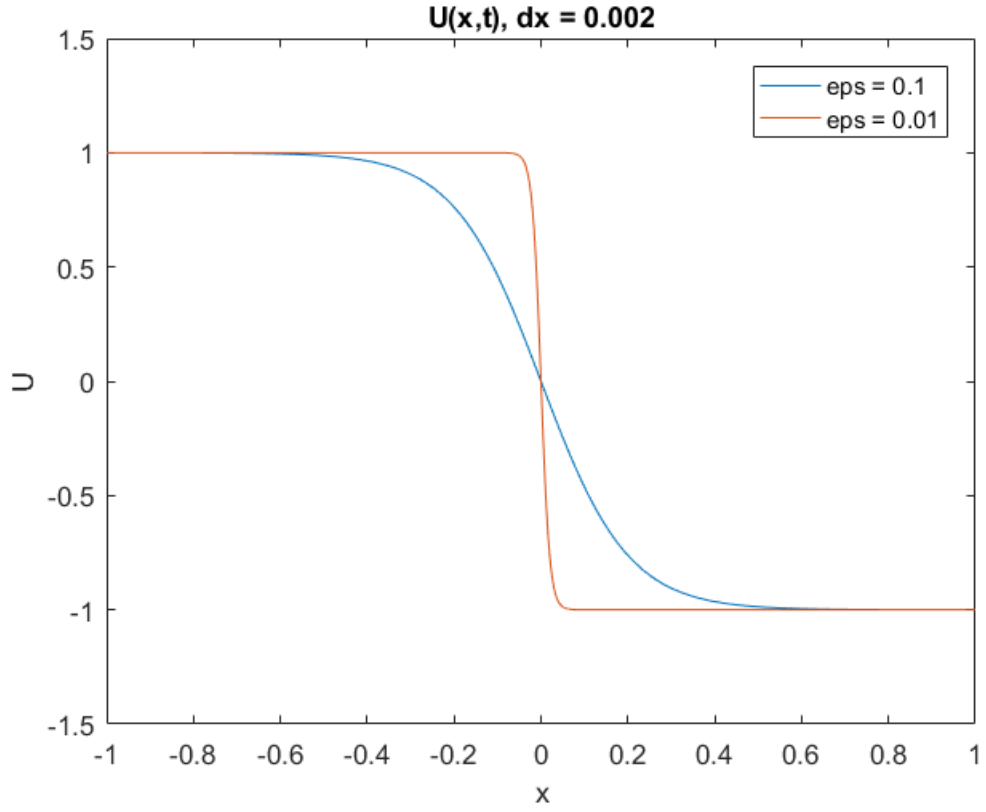
```
            fprintf('New time step:%0.5f\n', dt);
        end

        % laplacian
        u_f = [u_vals(2,2:end), uu_n];
        u_b = [uu_1, u_vals(2,1:end-1)];
        laplace = (u_f + u_b)./dx^2;

        % spacial acceleration
        u2_xf = 0.5.*[diff(u_vals(2,:).^2, 1,2), uu_n.^2 -
 u_vals(2,end).^2]./dx;
        u2_xb = 0.5.*[u_vals(2,1).^2 - uu_1.^2, diff(u_vals(2,:).^2,
 1,2)]./dx;
        u2_x = 0.5.*(u2_xf + u2_xb);

        u_vals(3,:) = ( eps.*laplace + u_vals(1,:).*(1./(2*dt) - eps/
(dx^2)) - u2_x )./(1./(2*dt) + eps./(dx^2));

        if (size(res,1) == 1) && all(res(end,:) == 0)
            res(end) = max(u_vals(3,:) - u_vals(2,:));
        else
            res(end+1) = max(u_vals(3,:) - u_vals(2,:));
        end

    end
```

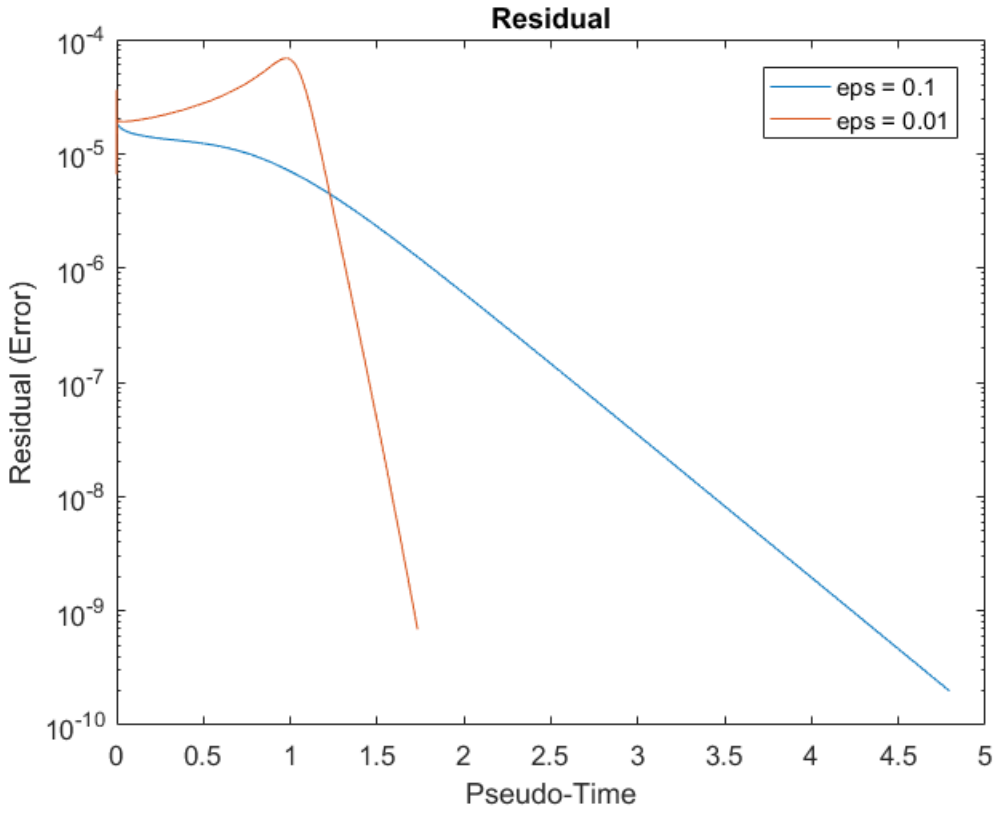
Post Process

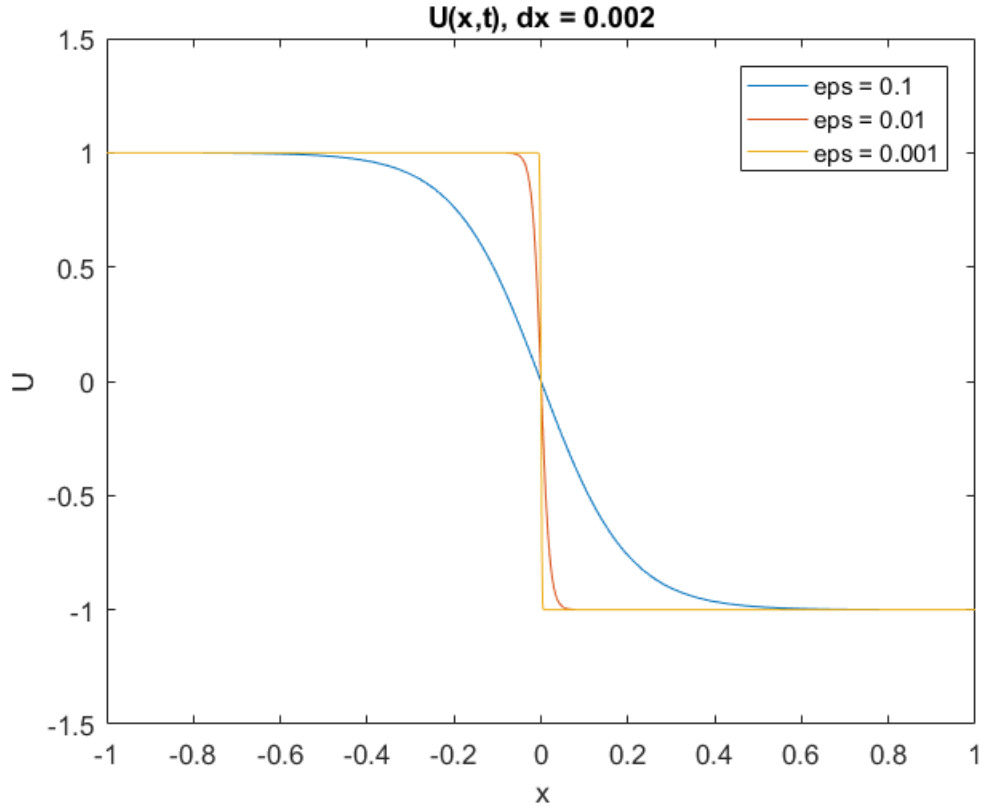
```
    figure(1);
    u_plots(i) = plot([-1, x_vals, 1], [1, u_vals(3,:), -1]);%, 'o-',
 'MarkerIndices', 1:10:length([-1, x_vals, 1]));
    ylim([-1.5, 1.5]);
    title(['U(x,t), dx = ' num2str(dx)]);
    xlabel('x');
    ylabel('U');
    legend(u_plots(1:i), labels(1:i));
    hold on;

    figure(2);
    res_plots(i) = semilogy((1:length(res)) .* dt, res);
    title('Residual');
    xlabel('Pseudo-Time');
    ylabel('Residual (Error)');
    legend(res_plots(1:i), labels(1:i));
    hold on;

    pause(1)
```

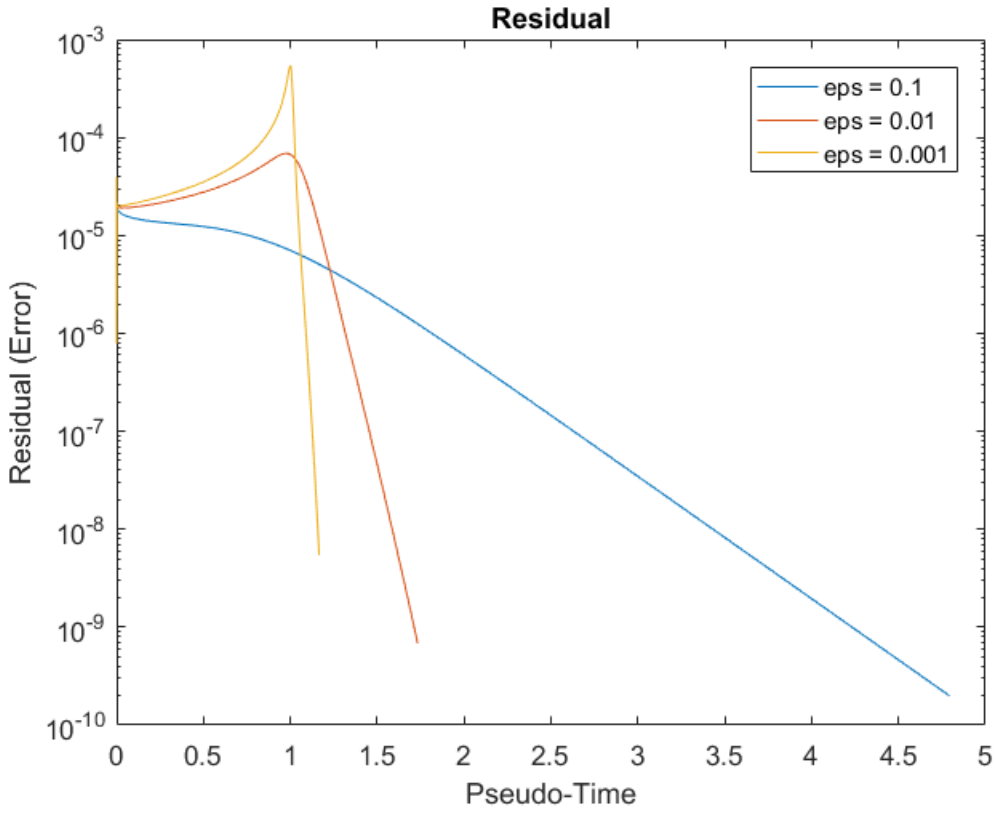

U(x,t), dx = 0.002
eps = 0.1
U
x
1.5
1
0.5
0
-0.5
-1
-1.5
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1


Residual
eps = 0.1
Residual (Error)
Pseudo-Time
10^-4
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5


U(x,t), dx = 0.002
eps = 0.1
eps = 0.01
U
x
1.5
1
0.5
0
-0.5
-1
-1.5
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1


Residual
eps = 0.1
eps = 0.01
Residual (Error)
Pseudo-Time
10^-4
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5


U(x,t), dx = 0.002
eps = 0.1
eps = 0.01
eps = 0.001
U
x
1.5
1
0.5
0
-0.5
-1
-1.5
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1


Residual
eps = 0.1
eps = 0.01
eps = 0.001
Residual (Error)
Pseudo-Time
10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

```
end
```

Published with MATLAB® R2016b