Nicholas Livingstone HW #5 MATH-375 2/25/16

2 b/c)

```
A = [3, 1, 2; 6, 3 ,4; 3, 1, 5];
B = [0; 1; 3];
[L, U, p] = lu(A, "vector");


%Part C
%convert p to a normal matrix
P = zeros(3);
P(1, p(1)) = 1;
P(2, p(2)) = 1;
P(3, p(3)) = 1;


PB = P*B;

%Complete Forward-Sub on Ly = B
Y = [0;0;0];

for i = 1:3
    Y(i) = PB(i)/L(i, i);
    for j = i : 3
        PB(j) = PB(j) - L(j, i) * Y(i);
    end
end

%Back Substitution Ux = Y
X = [0;0;0];
for i = 3 :-1:1
    for j = i + 1 : 3
        Y(i) = Y(i) - U(i, j) * X(j);
    end
    X(i) = Y(i)/U(i, i);
end

X
```

```
X = 3×1
    -1
     1
     1
```

3. Heat Distribution

a)

```
x = linspace(0,1,10);
h = (10 + 1).^(-1);
f = @(x) max(0, 1-((x - x(5)).^2)./0.5^2);
```

```
a = 0.5;

B = (a * (h^2) .* f(x))';

%Example Solving a system i = 10
trisolve1(B)
```

```
ans = 10×1
    0.0136
    0.0263
    0.0368
    0.0439
    0.0471
    0.0462
    0.0413
    0.0332
    0.0227
    0.0113
```

B)

```
%Bi-diagonal matricies
[L U] = lu(tri_matrix(10))
```

```
L = 10×10
    1.0000         0         0         0         0         0         0         0         0
   -0.5000    1.0000         0         0         0         0         0         0         0
         0   -0.6667    1.0000         0         0         0         0         0         0
         0         0   -0.7500    1.0000         0         0         0         0         0
         0         0         0   -0.8000    1.0000         0         0         0         0
         0         0         0         0   -0.8333    1.0000         0         0         0
         0         0         0         0         0   -0.8571    1.0000         0         0
         0         0         0         0         0         0   -0.8750    1.0000         0
         0         0         0         0         0         0         0   -0.8889    1.0000
         0         0         0         0         0         0         0         0   -0.9000    1.00
U = 10×10
    2.0000   -1.0000         0         0         0         0         0         0         0
         0    1.5000   -1.0000         0         0         0         0         0         0
         0         0    1.3333   -1.0000         0         0         0         0         0
         0         0         0    1.2500   -1.0000         0         0         0         0
         0         0         0         0    1.2000   -1.0000         0         0         0
         0         0         0         0         0    1.1667   -1.0000         0         0
         0         0         0         0         0         0    1.1429   -1.0000         0
         0         0         0         0         0         0         0    1.1250   -1.0000
         0         0         0         0         0         0         0         0    1.1111   -1.00
         0         0         0         0         0         0         0         0         0    1.10
```

```
%no permations/permutation matrix required to reproduce T.
L * U
```

```
ans = 10×10
```

```
     2    -1     0     0     0     0     0     0     0     0
    -1     2    -1     0     0     0     0     0     0     0
     0    -1     2    -1     0     0     0     0     0     0
     0     0    -1     2    -1     0     0     0     0     0
     0     0     0    -1     2    -1     0     0     0     0
     0     0     0     0    -1     2    -1     0     0     0
     0     0     0     0     0    -1     2    -1     0     0
     0     0     0     0     0     0    -1     2    -1     0
     0     0     0     0     0     0     0    -1     2    -1
     0     0     0     0     0     0     0     0    -1     2
```

```
trisolve2(B)
```

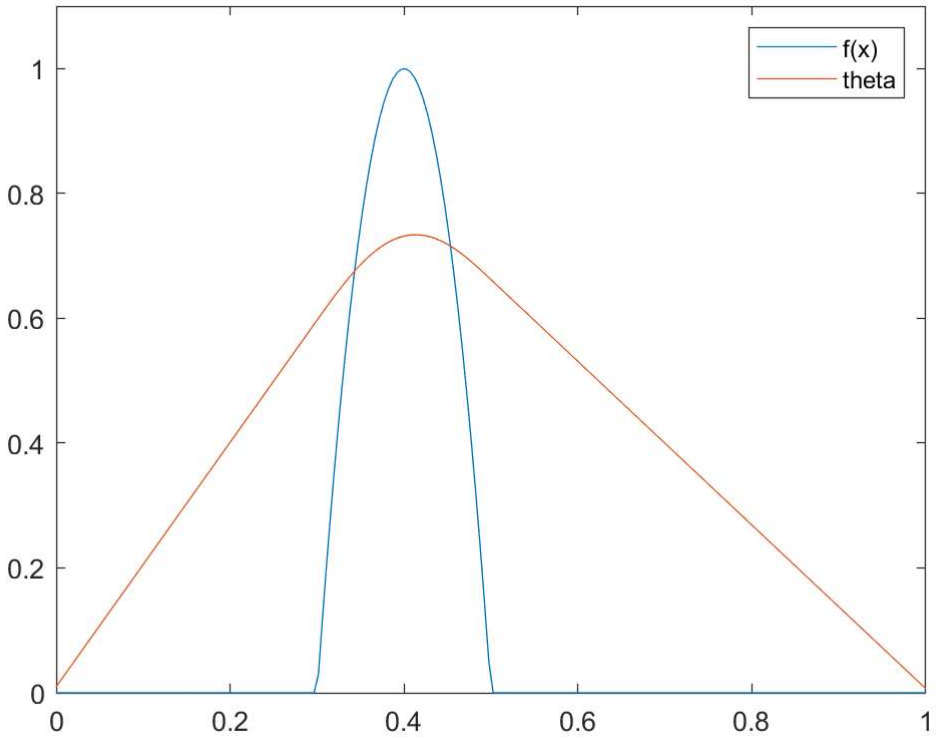
```
ans = 10^1
    0.0136
    0.0263
    0.0368
    0.0439
    0.0471
    0.0462
    0.0413
    0.0332
    0.0227
    0.0113
```

C)

```
%Set parameters for example
a = 25;
d = 0.1;
x_c = 0.4;
n = 200;
x = linspace(0, 1, n);
h = (n+1).^(-1);
f = @(x) max(0, 1-((x - x_c).^2)./d^2);


B = (a * (h^2) .* f(x))';
theta = trisolve2(B);

plot(x, f(x));
hold on;
plot(x, theta);
legend('f(x)', 'theta');
ylim([0 1.1]);
hold off;
```

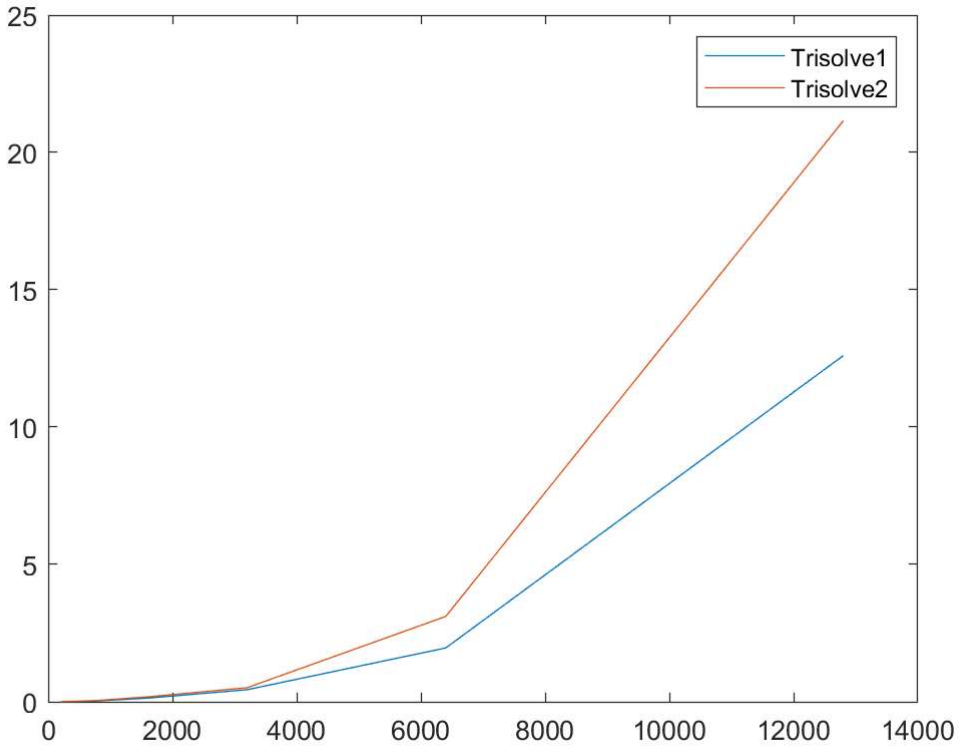



```
n = [200, 400, 800, 1600, 3200, 6400, 12800];
time1 = [];
time2 = [];
for i = 1:7
    x = linspace(0, 1, n(i));
    h = (n(i)+1).^(-1);
    B = (a * (h^2) .* f(x))';

    tic;
    trisolve1(B);
    time1(i) = toc;

    tic;
    trisolve2(B);
    time2(i) = toc;
end

plot(n, time1);
hold on
plot(n, time2);
hold off
legend('Trisolve1', 'Trisolve2');
```




```
h = (n+1).^(-1);
f = @(x) max(0, 1-((x - x_c).^2)./d^2);
```

N	Trisolve1 (s)	Trisolve2 (s)
200	0.0130773	0.0076609
400	0.0126418	0.0216859
800	0.0352504	0.0486253
1600	0.1435187	0.1617854
3200	0.5209446	0.5537689
6400	1.9375459	2.976873
12800	17.7227424	29.2279651

```
function theta= trisolve1(b)
    n = length(b);

    %acquire T matrix
    T = tri_matrix(n);

    theta = T\b;
end

function theta = trisolve2(b)
    %Solve using LU Decomposition
    n = length(b);
    T = tri_matrix(n);
    [L U] = lu(T);
```

```
    %Solve Ly = B
    Y = zeros(n, 1);
    Y(1) = b(1);
    for i = 2:n
        Y(i) = b(i) - L(i, i-1) * Y(i - 1);
    end

    %solve U*theta = Y
    theta = zeros(n, 1);
    theta(n) = Y(n)/U(n,n);
    for i = (n-1):-1:1
        theta(i) = (Y(i) + theta(i + 1))/U(i, i);
    end

end



function T = tri_matrix(n)
%creates an nxn trigiagonal matrix of Poisson equation
    T = zeros(n);
    for i = 1:n
            T(i, i) = 2;
            if i ~= 1
                T(i, i-1) = -1;
            end
            if i ~= n
                T(i, i+1) = -1;
            end
    end
end
```