Assignment 2

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This is a template file for the first assignment to get started with running and publishing code in Matlab. Each problem has its own section (delineated by %%) and can be run in isolation by clicking into the particular section and pressing `Ctrl` + `Enter` (evaluate current section).

To generate a pdf for submission in your current directory, use the following three lines of code at the command window:

```
>> options.format = 'pdf'; options.outputDir = pwd; publish('assignment3.m', options)
```

Problem 3

```
format long
A = [4 3 2 1; 8 8 5 2; 16 12 10 5; 32 24 20 11];
[L,U,P] = pivotedOuterProductLU(A);
display(L);
display(U);
display(P);
```

Problem 6

```
[X,Y] = meshgrid((0:2000)/2000);
A = exp(-sqrt((X-Y).^2));
L = outerProductCholesky(A);
disp(norm(L*L'-A, 'fro'));
```

Problem 3 (continued)

```
function [L,U,P] = pivotedOuterProductLU(A)
    dimensions = size(A);
    n = dimensions(1);

    p = 1:n;
    L = zeros(n);
    U = zeros(n);

    for i = 1:n
        values = A(:,i);
```

```
        values(values == 0) = -Inf;
        [~, p_k] = max(values);
        k = find(p == p_k);

        if k == -Inf
            disp("Matrix is singular");
            L = [];
            U = [];
            P = [];
            return
        end

        p(k) = p(i);
        p(i) = p_k;

        L(:,i) = A(:,i) / A(p(i),i);
        U(i,:) = A(p(i),:);
        A = A - L(:,i) * U(i,:);
    end

    I = eye(n);
    P = zeros(n);
    for i = 1:n
        P(:,i) = I(:,p(i));
    end
    P = transpose(P);
    L = P * L;
end
```

```
L =

  Columns 1 through 3

   1.000000000000000                   0                   0
   0.250000000000000   1.000000000000000                   0
   0.125000000000000                   0   1.000000000000000
   0.500000000000000                   0                   0

  Column 4

                   0
                   0
                   0
   1.000000000000000


U =

  Columns 1 through 3

  32.000000000000000  24.000000000000000  20.000000000000000
                   0   2.000000000000000                   0
                   0                   0  -0.500000000000000
```

```
                    0                    0                    0

  Column 4

  11.000000000000000
  -0.750000000000000
  -0.375000000000000
  -0.500000000000000


P =

     0     0     0     1
     0     1     0     0
     1     0     0     0
     0     0     1     0
```

Problem 6 (continued)

```
function [L] = outerProductCholesky(A)
    if ~all(eig(A) >= 0)
        disp("matrix is not positive definite");
        L = [];
        return;
    end
    dimensions = size(A);
    n = dimensions(1);
    L = zeros(n);

    for i = 1:n
        L(:, i) = A(:, i) / sqrt(A(i,i));
        A = A - L(:, i) * transpose(L(:, i));
    end
end
```

```
     1.017943787626267e-12
```

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