Creating a shared library

Below is an example of the terminal commands you may use to create a C library

```
% ls
smacups.c   dmaceps.c

% gcc -c -c smaceps.c
% gcc -c -c dmaceps.c

% ls
smacups.c   dmaceps.c   smacups.o   dmaceps.o

% ar crv mylib.a *.o

% ranlib mylib.a //alias for ar

% gcc -o test test.c mylib.a
```

Expectations for software written in this class

- Every piece of code needs to be documented
  - A markdown file has been provided that needs to be filled with the following information for every function, method, etc:
    - Author
    - Date
    - Description of functionality
    - Usage Example
  - documentation should contain a table of contents

Gausian Elimination

gaus.c

```
float[][] gaus_elim(float[][] a, float[] b){

    int sum;

    for(int k = 0; k < (n-1); k++)
    {
        for(int i = k + 1; i < n; i++)
        {
            //multiplier for reduction on the i-th row
            double factor = a[i][k] / a[k][k];

            for(int j = k + 1; j < n; j++)
            {
                a[i][j] = a[i][j] - (factor * a[k][j]);
            }
            b[i] = b[i] - (factor * b[k]);
        }
    }
    return a, b; //bad syntax; need to return as an array of arrays
}

float[] back_sub(float[][] a, float[] b){
    float[] x; //need to allocate this array

    //back substitution routine
    x[n - 1] = b[n - 1] / a[n - 1][n - 1];
    for(int i = n - 2; i >= 0; i--){
        sum = 0.0;
        for(int j = i+ 1; j < n; j++)
        {
            sum = a[i][j] * x[j];
        }
        x[i] = (b[i] - sum) / a[i][i];
    }

    return x;
}
```

Suppose we need to solve:

$$Ax^{(k)} = b^{(k)}$$

We want to consider `LU-factorization`:

$$A = L * U$$

where `L` is a lower triangular maxtrix and `U` is an upper triangular matrix. If `A = L * U`, then

$$Ax = b \rightarrow L * Ux = b \ \rightarrow Ly = b \rightarrow Ux = y$$

Example:

$$A = \begin{pmatrix} a_{11} & a_{12} & a_{13} \, a_{21} & a_{22} & a_{23} \, a_{31} & a_{32} & a_{33} \end{pmatrix} = \begin{pmatrix} l_{11} & 0 & 0 \, l_{21} & l_{22} & 0 \, l_{31} & l_{32} & l_{33} \end{pmatrix} * \begin{pmatrix} u_{11} & u_{12} & u_{13} \, 0 & a_{22} & u_{23} \, 0 & 0 & u_{33} \end{pmatrix}$$

hence,

$$\a_{11} = l_{11} u_{11}$$

finding the components of upper & lower matrix

$$u_{11} = a_{11}\ u_{12} = a_{12}\ u_{13} = a_{13}\ l_{21}u_{11} + 0 + 0 = a_{21}\ l_{21} = \frac{a_{21}}{u_{11}}\ l_{31} = \frac{a_{31}}{u_{11}}\ l_{21} u_{12} + u_{22} = a_{22} \rightarrow u_{22} = a_{22} - l_{21}u_{12}\ l_{31} u_{13} + u_{21} = a_{23} \rightarrow u_{32} = a_{23} - l_{32}u_{13}$$