Assignment 3

Description

This assignment will cover chapters 5 and 6. Heads up, this requires tons of programming. During chapters 5 and 6, we will be covering elimination methods and dive into matrix properties and operations.

The purpose of this chapter is to give an introduction to the numerical methods needed to solve differential equations, and to explain how solution accuracy can be controlled and how stability can be ensured by selecting the appropriate methods.

For full credit on this assignment, the following is required:

- Create expected structure
- ensure there's a readme with instructions on how to compile
- every output for each question is correct

Constraints

Standard Structure

For this assignment, you will need the following structure:

```
Top Level
|-- src/
|   |-- main/
|   |   |-- __init__.py
|   |   |--assignment_3.py
|   |-- test/
|   |   |-- __init__.py
|   |   |-- test_ assignment_3.py
|-- requirements.txt
|-- README.md
```

Please ensure your repository is named “cot-4500-as3”.

Compilation Instructions

Keeping true to adding industry likeness to each assignment, it is required that you need to include a README per repository. A README is a file used to describe a repo’s purpose, include

compilation purposes, or both. A proper README.md is typically filled out with sections, akin to an essay.

For this assignment, a README needs to be included and filled out. The amount of info you put into the README is up to you, but you will need the following at least:

- Mention of requirements.txt
  - No need to include this UNLESS you plan on using a library other than NumPy
- Mention of running python
  - Since we require instructions on to run, you will need to include the command to run the script from command line.

RESTRICTIONS

Please avoid using the scipy library for this assignment. You will need to be able to do the decomposition without the use of this external library.

Questions

1. Euler Method with the following details
   a. Function: $t - y^2$
   b. Range: $0 < t < 2$
   c. Iterations: 10
   d. Initial Point: $f(0) = 1$
2. Runge-Kutta with the following details:
   a. Function: $t - y^2$
   b. Range: $0 < t < 2$
   c. Iterations: 10
   d. Initial Point: $f(0) = 1$
3. Use Gaussian elimination and backward substitution solve the following linear system of equations written in augmented matrix format.

$$\left[\begin{array}{ccc|c} 2 & -1 & 1 & 6 \\ 1 & 3 & 1 & 0 \\ -1 & 5 & 4 & -3 \end{array}\right]$$

4. Implement LU Factorization for the following matrix and do the following:

$$\begin{matrix} 1 & 1 & 0 & 3 \\ 2 & 1 & -1 & 1 \\ 3 & -1 & -1 & 2 \\ -1 & 2 & 3 & -1 \end{matrix}$$

   a. Print out the matrix determinant.
   b. Print out the L matrix.
   c. Print out the U matrix.

5. Determine if the following matrix is diagonally dominate.

$$\begin{matrix} 9 & 0 & 5 & 2 & 1 \\ 3 & 9 & 1 & 2 & 1 \\ 0 & 1 & 7 & 2 & 3 \\ 4 & 2 & 3 & 12 & 2 \\ 3 & 2 & 4 & 0 & 8 \end{matrix}$$

6. Determine if the matrix is a positive definite.

$$\begin{matrix} 2 & 2 & 1 \\ 2 & 3 & 0 \\ 1 & 0 & 2 \end{matrix}$$

Expected Output

```
1.2446380979332121

1.251316587879806

[ 2 -1  1]

38.99999999999999

[[ 1.  0.  0.  0.]
 [ 2.  1.  0.  0.]
 [ 3.  4.  1.  0.]
 [-1. -3.  0.  1.]]
```

```
[[  1.   1.   0.   3.]
 [  0.  -1.  -1.  -5.]
 [  0.   0.   3.  13.]
 [  0.   0.   0. -13.]]

False

True
```