Applied Engineering Problem Solving (CHEN.3170)

Homework Assignment #6b -- Fall 2017

Some More Practice with Systems of Nonlinear Equations

Problem #1:

Our goal with this last HW problem of the semester is to gain some additional hands-on experience solving nonlinear equations. In particular, consider the simple 2×2 system of nonlinear equations:

$$x_1^2 - 2x_1 - x_2 = -0.5$$
$$x_1^2 + 4x_2^2 = 4.0$$

We will solve this system using both Matlab's ***fsolve*** function and by implementing Newton's method.

One of the first steps in finding a solution to a nonlinear system is to identify one or more appropriate initial guesses for the solution algorithm. However, since the system described above is purely arbitrary (does not represent a physical system), we have no idea how many solutions there are (if any) and where they are located. Thus, our first task is to learn a little about the potential solution space.

In particular, for a 2×2 system, one can often solve the problem algebraically or simply plot the two nonlinear equations to visually identify the number and approximate location of the solutions. In particular, we will take the graphical approach here, which simply involves plotting the two equations as x_2 vs. x_1, and looking for the x_1,x_2 combinations where the two curves intersect (be sure to put both curve on the same plot!!!) -- any such locations represent the approximate real roots or solutions to the original equations (note that this simple graphical approach is not practical for high-order systems).

With the above brief introduction, you should perform the following tasks/analyses:

a. Use the graphical technique described above to find a complete set of reasonable starting guesses within the domain defined by $-3 \le x_1 \le 3$.

b. With appropriate guesses from the graphical analysis in Part a, use Matlab's ***fsolve*** command to find all the solutions to the original nonlinear equations within the domain defined in Part a (**Note:** See the example given in the **nldemo3_lesson6.m** file from the Lesson 6 Lecture Notes).

c. Now, based on the description and **nldemo2_lesson6.m** file (also from the Lesson 6 Lecture Notes), implement Newton's method into Matlab for solution of this problem. Using the same initial guesses as in Part b, compare your solutions using Newton's method with those obtained using Matlab's ***fsolve*** command.

Comment on your overall experience here -- that is, do you now have a better understanding and appreciation for solving nonlinear systems? Also, as part of your overall solution, be sure to include the development of the Jacobian matrix needed for implementation of Newton's method…

Documentation

Documentation for this assignment should include any hand calculations/derivations (i.e. be sure to show the development of any equations programmed into Matlab), answers to any specific questions given, a listing of the Matlab script and function files generated, the resultant Matlab plots, and a brief description of the data and results of your analysis for each problem. An overall professional job is expected!

See HW#1 for a description of the expected format -- every HW in this course should follow these basic instructions…