

## Homework 1: Nonlinear Equation Solution

(1) Use the bisection method to find the solution to  $x^3 + 4x^2 - 10 = 0$  when  $x$  lies between 0 and 2. Plot the error (log scale) as a function of the iteration number. What do you notice?

(2) Use the bisection method to find the solution to  $\tan(x) = 0$  when  $x$  is between 1 and 2.

Is the answer correct? What is going on?

(3) Find the solution to  $x^3 - 3x + 2 = 0$  using the bisection (initial values of -2.4 and 0.0), Newton-Raphson (initial value of -2.4) and Secant (initial values of -2.4 and 0.0) methods. Plot the error for all three methods on the same graph. What do you see?

(4) Repeat (3) using the initial guess of 1.2 Newton-Raphson and (1.2 and 0.0) for bisection and the Secant method. What do you see now? You might need to look at the answer as well as the error as it changes with each iteration.

(5) Find the solution to  $x^3 - x + 3 = 0$  using the Newton-Raphson method (starting from 0.0) and Secant method (starting from 2.0 and 1.0). Plot the  $\log(\text{error})$  for both methods on the same graph. What do you see?

(6) Solve  $xe^{-x} = 0$  with a starting guess of 1.5 and 2.0 using the Secant method. Look at the solution vs iterations. Is this right? Draw a picture of what is going on. What would the Newton-Raphson method give you (starting from 2.0).

(7) Solve  $\arctan(x) = \tan^{-1}(x) = 0$  starting from 1.4 and using Newton-Raphson. What happens? Why? Draw me a picture.

(8) Now solve  $\arctan(x) = \tan^{-1}(x) = 0$  starting from 1.5 and 1.6 and using Secant method. What happens now?

(9) What are the advantages and disadvantages of these three solution methods?

(10) The book derives the Newton-Raphson method for 2 nonlinear equations and 2 unknowns. Write a matrix equation (similar to 6.20) for a general  $N$  nonlinear equations and  $N$  unknowns.

(11) Bonus: What does the secant method look like for a system of  $N$  nonlinear equations?