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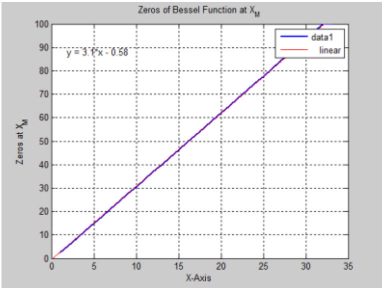
MACM 316 - Assignment 4 Report

Part 1: Justification for the values of *a*, *b*, *TOL*, and *M* you chose in terms of three key concepts of the course: *accuracy*, *efficiency* and *robustness*.

In my MATLAB code, *Bessel.m*, it first computes the Bessel function $J_0(x)$ for *c* iterations, which I have set to 100. Through the use of the bisection method, values for *a* and *b* are chosen automatically, starting at *a = 1* and *b = 2*. My code will then determine when *a* and *b* are opposite signs, when they are, it will find the zero via the Bisection Method. *Bessel.m* is coded to not just only search for the first zero, but all the zeros within the range of *c*, smaller or equal to 100.



By using this method, it ensures *efficiency* by searching for zeros in shorter lines of code through the use of *for loops*. As a result of my lack of skills in MATLAB's language, my code sometimes stores the same zeros in the vector, thus I have implemented temporary fix to the issue and copied the values of *M* when *f(M) = 0*, removing the duplicates. I chose *TOL* to be 1e-15, which is near *Machine Epsilon*, to ensure *accuracy*. The value of *M* is determined by the amount of zeros within range *c* (M=33 in this case). The above results in *robustness* with the chosen values.

Part 2: Values of $\alpha + \beta$ you computed, and an explanation of as to how you found them.

We have the equation $f(M) = 3.1M - 0.58$ calculated from MATLAB which describes the linear relationship of the zeros computed through the use of the Bisection Method on the Bessel Function.

$$X_M = \alpha(M + \beta) + O\left(\frac{1}{M}\right), \qquad M \to \infty$$

Then we plug in $f(M) = 3.1M - 0.58$ into the equation above to get:

$$3.1(M) - 0.58 = \alpha(M + \beta), \qquad M \to \infty$$

Since $\frac{1}{M}\ as\ M \to \infty = 0$. Then we expand to get the following:

$$3.1(\lim_{M\to\infty} M) - 0.58 = \alpha(\lim_{M\to\infty} M) + \alpha\beta$$

As we can see from the above equation, both sides are clearly equivalent. We get the following from the above:

$$\alpha = 3.1$$
$$\alpha\beta = -0.58$$

Solve for β then $\boldsymbol{\beta = -0.187096774}$ and $\boldsymbol{\alpha = 3.1}$

Part 3: A hypothesis, based on the values you computed, as to the exact values of α and β.

The linear equation was found via *Basic Fitting* in the *tools* menu, with the use of 2 significant digits. The values I have computed for α and β, however, should be as accurate as it could be as the TOL I have chosen is near *Machine Epsilon* <u>With only 2 significant digits used in the linear equation, there will be rounding errors in the Mathematical computations that could lead to slight inaccuracies when comparing the computed values versus the exact values of α and β.</u>