CMPT-439 Numerical Computation
Project 3

---

1. (**40/100**) Using the Newton's method algorithm described in the class notes (Lecture-4) design a function (if you use Matlab or Python, you can make your function robust because there are tools for automatic derivative evaluation there; while it is not required to utilize an automatic evaluation of derivatives, you are encourage to do so) to utilize the Newton's method for solving nonlinear equations.
   This function must use the following calling arguments:

   - initial approximation x_0 ,
   - δ (pre-determined tolerance value),
   - a function utilizing $f(x)$ (and a function utilizing $f'(x)$ if you do not use derivative evaluation in Matlab or Python)).
   - a flag determining a stopping criterion.

   Your function shall give the user 4 options to stop the iterative process and have 3 corresponding branches, accordingly (**an option to be chosen must be an argument** in your function):

   a) An absolute approximate error is used to stop the process. You may predict the number of iterations in advance in such a case.
   b) An absolute relative approximate error is used to stop the process.
   c) Estimation of a true absolute error is used to stop the process.
   d) Conjunction of an absolute approximate error and an estimated true absolute error is used to stop the process.

   You need to comment on every single line of your Bisection function explaining what this line of your code stands for.

2. (**10/100**) Ask a generative AI tool (ChatGPT or Copilot or Meta AI) to create a function in the same language, which you used and utilizing the Newton's method while meeting the same requirements as your function had to meet (in particular, utilizing 4 stopping criteria). Evaluate differences between your code and generative AI code. **Is AI-generated code correct? Does it meet requirements? If this code is not correct, why? (you need to find what is wrong there in this case).**

3. (**30/100**) The equation $2\sin(x) - e^x/4 - 1 = 0$ has one root located in the interval [-7, -5] and another root located in the interval [-5,-3]. Find both roots of the given equation using the Newton's method. Use all four options to stop calculations for each of the roots and then estimate, which root is better (if any) in terms of closeness $2\sin(x) - e^x/4 - 1$ to 0 after a corresponding root was substituted there. Use $\delta = 10^{-6}$ as your tolerance threshold for all three stopping criteria.

4. (**15/100**) Solve the same equation $2\sin(x) - e^x/4 - 1 = 0$ using the function created by generative AI. Use **all four options** to stop calculations for each of the roots and then estimate, which root is better (if any) in terms of closeness $2\sin(x) - e^x/4 - 1$ to 0 after a corresponding root was plugged in. Use $\delta = 10^{-6}$ as your tolerance threshold for all four stopping criteria.

5. (**optional, <u>15 extra credit</u> points**). Find using the Newton's method where the curves of $y = \cos(x)$ and $y = x^3 - 1$ intersect.

6. (**5/100**) Write a brief technical report presenting your solution (all roots found) **in a table** and conclusions about the best stopping criterion or about their equivalence to each other and demonstrating your understanding of this solution. Also include your solutions obtained using the Ai-generated code (if any) and your conclusions about the quality of the Ai code. Also, include your solution for the extra credit Task # 5 (if applicable).

7. Turn in your source code (including a source code for Task # 5 (if applicable)), a screen shot of its test run, and your brief technical report.