**ECE 4960 Spring 2018: Computational and Software Engineering**
**Reading 2: Differentiation in Local Analysis**

Deposit a pdf file of the two tables below to your Git directory before 11:59pm of 2/11

**Document your programming environment: Language; development platform; operating system**
Language: C++
Platform: Apple LLVM version 9.0.0
Operating System: MacOS

**Prob. 1. (Quadratic function to observe the tradeoffs between the truncation error and round-off error):** For $f(x) = x^2$, we know the exact $f'(x=1) = 2$.

1.1 Use Eq. (1) below to estimate $f'(x=1)$ varying the value of $h$ from 0.1 to $10^{-18}$ to observe the relative error in calculating $f'(x)$. Tabulate your results with sufficient precision in a table.

1.2 Repeat your calculation with $f(x) = x^2 + 10^8$. Add your results to the same table.

1.3 Repeat the above two procedures by using Eq. (2). Add your results to the same table.

$$f'(x) = \frac{f(x+h) - f(x)}{h} + O(h) \qquad (1)$$

$$f'(x) = \frac{f(x+h) - f(x-h)}{2h} + O(h^2) \qquad (2)$$

| $h$ | Error in $f'(x=1)$ by Eq. (1) where $f(x) = x^2$ | Error in $f'(x=1)$ by Eq. (1) where $f(x) = x^2 + 10^8$ | Error in $f'(x=1)$ by Eq. (2) where $f(x) = x^2$ | Error in $f'(x=1)$ by Eq. (2) where $f(x) = x^2 + 10^8$ |
|---|---|---|---|---|
| $10^{-1}$ | 0.1 | -0.00001 | 0 | 0 |
| $10^{-2}$ | 0.01 | -0.00004 | 0 | -0.00005 |
| $10^{-3}$ | 0.001 | -0.00019 | | -0.00014 |
| … | | | | |
| $10^{-18}$ | 2 | 2 | 2 | 2 |