

# MACM 316 – Computing Assignment 1

- Read the *Guidelines for Assignments* first.
- Submit a one-page PDF report to Canvas and upload your Matlab scripts (as m-files). Do not use any other file formats.
- Keep in mind that Canvas discussions are open forums.
- You must acknowledge any collaborations/assistance from colleagues, TAs, instructors etc.

## Floating Point Arithmetic

Your goal in this assignment is to study the effect of round-off error in evaluating the function

$$f(x) = \begin{cases} (\exp(x) - 1)/x & x \neq 0 \\ 1 & x = 0 \end{cases}.$$

The most obvious way to do this is via the following algorithm:

```
1 % Algorithm 1
2 if x == 0
3     y = 1;
4 else
5     y = (exp(x)-1)/x;
6 end
```

However, an alternative approach is the following:

```
1 % Algorithm 2
2 z = exp(x);
3 if z == 1
4     y = 1;
5 else
6     y = (z-1)/log(z);
7 end
```

In exact arithmetic, both algorithms obviously give the same output, namely  $f(x)$ . However, the results in finite precision may be quite different. Your aim is to investigate these differences. Implement both algorithms in Matlab and compare their output for different values of  $x$ , paying particular attention to the case where  $x \approx 0$ .

Your conclusions should be explained in a one-page report. Your report **must** include the following:

- (a) Outputs of the results of each algorithm for a **suitable** range of values of  $x$ . It is up to you to decide which values of  $x$  to use and how best to display your results (e.g. a figure or table of values). If using a figure, make sure you use good scales on your axes.
- (b) A discussion of behaviour of each algorithm for different values of  $x$ .
- (c) Brief explanations of the results you have obtained. Use tools from the course to do this.

Note: for part (c), you may assume that  $\exp(x)$  and  $\log(x)$  are computed in floating point arithmetic with a bounded *relative* error (i.e. the same as the standard floating point operations  $+$ ,  $-$ ,  $\times$ ,  $\div$ ).