Mathematical Skills for Data Scientists
Lab Exercises 3 – 4 Marks (Due: 24/10/22, 11 am)

Gibin Powathil

g.g.powathil@swansea.ac.uk

Submit all Matlab files (`.m`), any log files from the command windows (`.txt` or .pdf) and any commentary and interpretation (`.txt` or `.pdf`).

Exercise 1 (Numerical Differentiation)**.** Write Matlab code (you may write the code as a function) to approximate the derivatives of these functions at 0 to an accuracy of 0.01:

1. $\frac{\mathrm{d}}{\mathrm{d}x}5$
2. $\frac{\mathrm{d}}{\mathrm{d}x}x^2 - x$
3. $\frac{\mathrm{d}}{\mathrm{d}x}e^{2x}$
4. $\frac{\mathrm{d}}{\mathrm{d}x}|x|$

For each function, draw a graph (or just look at a graph online) and ask yourself if you are happy with the approximation. If you are not, do you see a fix? (2 marks)

Exercise 2 (Machine epsilon)**.** Look at the following Matlab code and speculate what would happen. Then run it, and interpret what happens:

```
num = 0; myeps = 1;
while (1+myeps) > 1
   myeps = myeps/2;
   num = num + 1;
end
num
```

(0.5 marks)

Exercise 3 (Numerical Differentiation)**.** Write Matlab code to approximate the derivative of $\sin(x)$ at $x = 0.5$. Begin at $h = 1$ and divide h by 10 at each step until you have computed twenty approximations. Print all twenty answers to the screen and interpret what has happened. (0.5 marks)

Exercise 4 (Symbolic Differentiation)**.** Use Matlab to compute the derivatives of $x \mapsto \frac{1}{x}$, $x \mapsto \frac{x^2}{\cos x}$ and $x \mapsto (\cos x)^2 + (\sin x)^2$. (1 marks)

Useful link: `https://uk.mathworks.com/help/symbolic/differentiation.html`