Homework 01

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1. We consider the example from class for approximating $f'(2)$ for $f(x) = \sin(x)$ using a finite difference approximation. This time, we will be using

$$f'(x_0) \approx \frac{f(x_0 + h) - f(x_0 - h)}{2h}$$

   instead. Show using Taylor's Theorem that you expect the truncation error of this approximation to be $O(h^2)$.

2. Modify the MATLAB example from lecture to use the approximation in 1) and produce a convergence table (include a thid column with the computation of the rate by dividing two consecutive errors, respectively). Finally, show the error plot in log-log scale and include a second line defined by h^2 to confirm the quadratic behavior.

3. On paper, compute the binary representation of the decimal number 0.1 and show that the representation is infinite (that you need an infinite number of binary digits to express 0.1 exactly).
   Are there binary numbers with a finite number of digits that only have an infinite representation in decimal? Why or why not?

4. Write a MATLAB function `function B=tobinary(n)` that converts a positive, whole number n into binary format. Here, B is an array of appropriate length that contains values of 1 and 0. You may use `log2(n)` once to figure out the largest power of two that fits into n. After that, only use simple arithmetic and comparisons (ignore that there are more efficient routines in MATLAB, that could help you here).