

Exercise 2 – Finite differences

1. Last week you wrote a Fortran program that calculates the mean and standard deviation of a series of real numbers. Now edit the program to calculate these properties for an array. The program should:

- Ask for the number of numbers
- If the number entered is negative, ask repeatedly for a positive number
- Allocate the array
- Read the values into the array
- Calculate the mean and standard deviation of the array
- Display the result

Use as many whole array operations and as few loops as possible.

2. Write a Fortran program that uses the [sieve of Eratosthenes](#) to find all prime numbers less than or equal to a given number.
3. Write a Fortran program that computes the **second derivative of a 1D array** using the finite difference method for a given number of grid points (n) and grid spacing (h):

$$\left(\frac{\partial^2 y}{\partial x^2} \right)_i \approx \frac{y_{i+1} - 2y_i + y_{i-1}}{h^2} \quad (1)$$

- The second derivative is calculated at the points $i = 2 \dots n-1$
- At the boundaries ($i=1$ and n) the derivative is set to 0.
- The result is another 1D array.

Test the program for two idealized functions for which you know the result, e.g. $\sin(x)$ or x^2 . Compare the result of your program with the correct result and calculate the error.

Deadline: Please hand in your solutions (.f90 files and the results of the two tests) by **Tuesday, 19 March 2024, 23:59**.