HW2: Fortran exercises

<u>A.</u> If you are unfamiliar with Fortran, work your way through the tutorials on the Canvas > All Pages > Lecture notes webpage.

<u>B.</u> Build and test Fortran programs that do the following:

1. trap.f90

Integrates a simple function f(x) between two limits using the Trapezoidal rule (see next page):

Your code will need to:

- Have a Fortran function routine that you can hardwire the desired f(x) into
- Have a main routine that:
 - ✓ Requests the upper and lower limits of integration from the user
 - ✓ Requests the number of intervals N in the quadrature required from the user
 - ✓ Perform the integration using a DO loop
 - ✓ Output the result
- Test your program on $\int_{0}^{2} x^{2} dx$ and $\int_{0}^{\pi} \sin(x) dx$

Q1: What are the right answers? Q2: How many intervals do you have to use to get a decent answer?

2. ones.f90

Dynamically creates a square array of a size input by the user at runtime

Assigns certain of the values in the array to be 1's and the rest 0's (by some method = random, input by user, etc)

Calculates another array that contains a 1 at any location if exactly 3 of the 8 surrounding neighbouring locations in the original array contain 1's.

The trapezoidal rule

$$\int_a^b f(x)\,dx pprox \sum_{k=1}^N rac{f(x_{k-1})+f(x_k)}{2} \Delta x_k$$

$$a = x_0 < x_1 < \dots < x_{N-1} < x_N = b$$

$$\Delta x_k = x_k - x_{k-1}$$

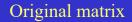
Uniform grid version:

$$\int_a^b f(x)\,dx pprox rac{\Delta x}{2} \sum_{k=1}^N \left(f(x_{k-1}) + f(x_k)
ight) \qquad \Delta x_k = \Delta x = rac{b-a}{N}$$

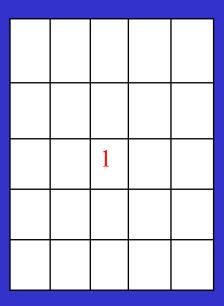
$$\Delta x_k = \Delta x = rac{b-a}{N}$$

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Example of how to update one point (the red point):



New matrix containing updated values



At cell(i,j)

If (sum_of_neighbors = 3) then updated_value = 1 else 0

HW submission

Submit to Canvas a tar file that contains:

- 1. Your source code
- 2. A text file that contains the commands necessary to compile and run your code
- 3. Sample output of your code tests
 - the answers to the integrals for various numbers of intervals N, showing convergence towards the answer (answering Q1 and Q2)
 - -- an array of assigned 1,0's and the subsequent calculated array determined by the neighbours

Note: To create a tar file called "your_username.tar" containing <file list> files, you can use the Linux command: tar cvf your_username.tar <file list>