MATH 233: Scientific Computing
Lab 1— Grid2D class
September 2th, 2020

1. Create a new C++ project.

2. In this new project, create a new class named `Grid2D`. It will be used to represent 2-dimensional grids with $N \times M$ points uniformly distributed over $[x_{\min}, x_{\max}] \times [y_{\min}, y_{\max}]$. Nodes will be numbered according to the standard "z-ordering". $\Delta x, \Delta y$ will be the spatial resolutions.

3. In which file should that class be defined? (hint: modularity ......)

4. In the `Grid2D` class, define $N, M, x_{\min}, x_{\max}, y_{\min}, y_{\max}, \Delta x, \Delta y$ as private variables. What types should they be? Why should they be private?

5. Implement a constructor `Grid2D(N, M, x`$_{\min}$`, x`$_{\max}$`, y`$_{\min}$`, y`$_{\max}$`])` that initialize the grid with the prescribed parameters and initialize the resolutions $\Delta x, \Delta y$.

6. Write two public functions `i_from_n(int  n)` and `j_from_n(int  n)` that take the index `n` of a grid point and return its logical coordinates (i, j) on the grid.

7. Write the reverse function `n_from_ij(int  i, int  j)`.

8. Write a function `x_from_n(int  n)`, that take the index of a node and return its position in the direction. Write the same function for the y-direction.

9. Use the `outputVTK.txt` file to implement two functions `initialize_VTK_file` and `print_Quantity_into_VTK_file` that create a vtk file with the grid information and output the values of a given quantity (defined on that grid) in a specified vtk file.

10. Install paraview.

11. Write a main file that

    (a) Create a Grid2D with your choice of parameters

    (b) Create a vector of size $N \times M$ representing the function $\cos(x) \cos(y)$ over the grid.

    (c) Output the grid and the vector into one .vtk file

12. Open your file in paraview. Does it look right?

13. (Further reading) what is the difference between a `class` and a `struct`?