NSM CFD Workshop 2023, IITH

Day-1

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Hands-on Session

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1. The available C++ code provides a framework for solving a one-dimensional advection equation for the advection of a sine wave or a Heaviside function

$$\frac{\partial u}{\partial t} + c\frac{\partial u}{\partial x} = 0$$

Implement any 3 different advection algorithms (for e.g.: FTCS, FTBS, Lax-Wendroff, Beam-warning, MacCormack etc.) for solving this problem. Check the stability and performance of the different schemes at a suitable time-step.

2. Convert this code for solving the 1-D Non-linear Convection (Inviscid Burger's) equation:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} = 0$$

for an initial input of a Heaviside function using one the following approaches:

(i) Richtmyer

(ii) MacCormack

(iii) Beam-Warming (implicit)

3. Convert this code for solving the 1-D Non-linear Convection-Diffusion (Burger's) equation:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} = \nu\frac{\partial^2 u}{\partial x^2}$$

for an initial input of a Heaviside function using one the following approaches:

(i) Richtmyer

(ii) MacCormack

4. You are provided with a basic 2-D C++ framework for solving 2-D Non-linear Convection-Diffusion (Burger's) equation:

$$\frac{\partial u}{\partial t} + (u.\nabla)u = \nu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial x^2}\right)$$

For an initial input of a sine or Heaviside step function, solve this using one of the following approaches:

(i) Richtmyer

(ii) MacCormack

5. Implement of FTBS algorithm for linear convection for parallel computations.