Introduction to Computational Fluid Dynamics using OpenFOAM and Octave

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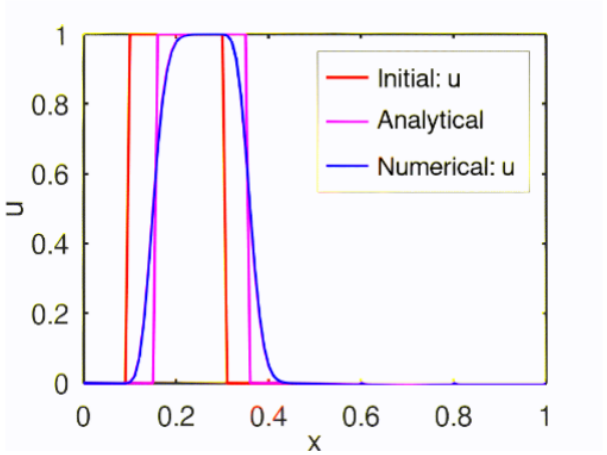
(Session-12)

Instructions: Wed, Fri (4:30-5:30PM IST), Sat (4PM-5PM IST)
Query sessions: Sundays 9:00AM-9:30AM IST

Quick Recap

What Did We Discuss?

Numerical Solution to Convection Equation



$c = 0.1; \Delta x = 0.01; \Delta t = 0.01 \qquad CFL: \frac{c\Delta t}{\Delta x} = 0.1$

$$u_i^{n+1} = u_i^n - c\Delta t \left(\frac{\partial u}{\partial x}\right)_i^n$$

$$\left(\frac{\partial u}{\partial x}\right)_i^n \approx \frac{u_i^n - u_{i-1}^n}{\Delta x_i} \quad \text{Upwind}$$

```cpp
#include <iostream>
#include <vector>
#include <cmath>

std::vector<float> compute_rate_of_convergence(std::vector<float> errors, std::vector<float> dx) {
    std::vector<float> roc;

    for (int i = 0; i < errors.size()-1; ++i)  {
        float r = log(errors[i]/errors[i+1])/log(dx[i]/dx[i+1]);

        roc.push_back(r);
    }

    return roc;
}

int main()
{
    std::vector<float> errors({0.16, 0.0775, 0.038125});
    std::vector<float> dx({0.1, 0.05, 0.025});

    std::vector<float> roc = compute_rate_of_convergence(errors, dx);

    for (int i = 0; i < roc.size(); ++i) {
        std::cout << roc[i] << std::endl;
    }

    return 0;
}
```

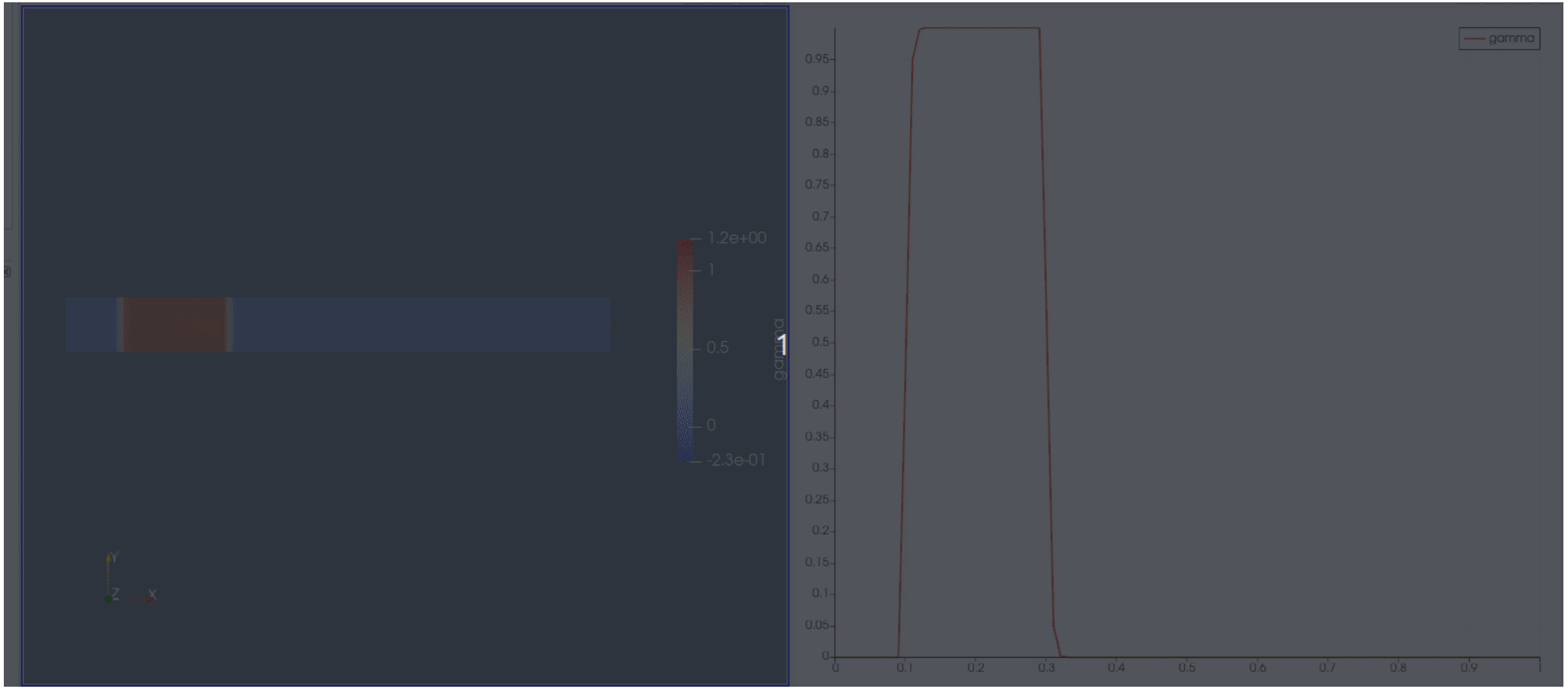
Current Session

Overview

- **OpenFOAM**: Numerical Solution to convection Equation
- Introduction to C++ for OpenFOAM (contd.)

Numerical Solution to Convection Equation

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



Numerical Solution to Convection Equation

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

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

$$\frac{\partial \gamma}{\partial t} + \nabla \cdot (c\gamma) = 0$$

Introduction to C++ for OpenFOAM

a12_roc.cpp

Next Session

- Finite volume method to solve convection-diffusion equation in OpenFOAM
- Introduction to C++ for OpenFOAM (Contd.)

Thank you