Introduction to Computational Fluid Dynamics using OpenFOAM and Octave

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(Session-8)

Instructions: Mon, Wed, Thu (3:30PM-4:30PM IST)
Query session: Sundays 8:30AM-9:00AM IST

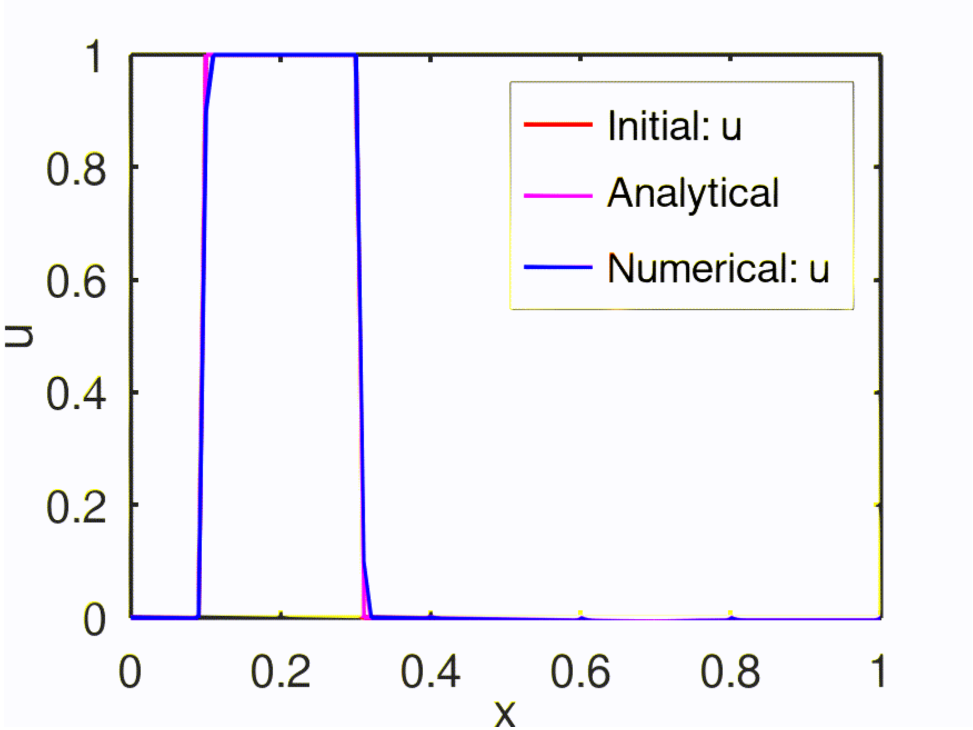
Quick Recap

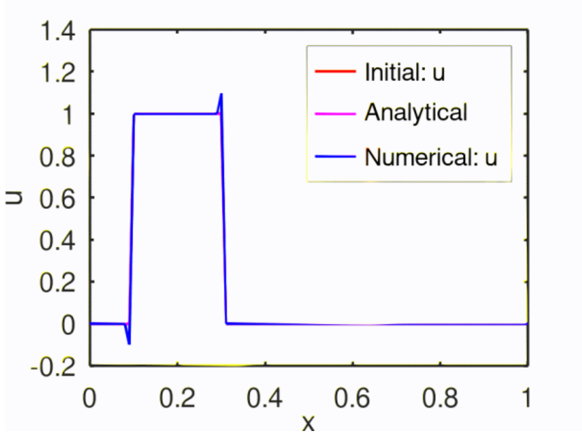
What Did We Discuss?

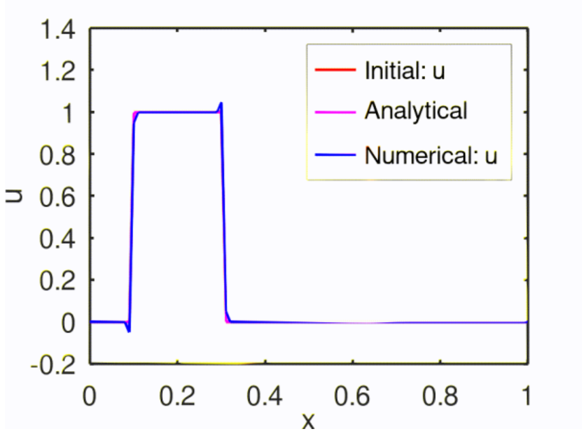
$$\left(\frac{\partial u}{\partial x}\right)_i^n \approx \frac{u_{i+1}^n - u_i^n}{\Delta x_i}$$ Simple forward difference scheme

$$\left(\frac{\partial u}{\partial x}\right)_i^n \approx \frac{u_{i+1}^n - u_{i-1}^n}{2\Delta x_i}$$ Central difference

$$u_i^{n+1} = u_i^n - c\Delta t\left(\frac{\partial u}{\partial x}\right)_i^n \longrightarrow \left(\frac{\partial u}{\partial x}\right)_i^n \approx \frac{u_i^n - u_{i-1}^n}{\Delta x_i}$$ Upwind





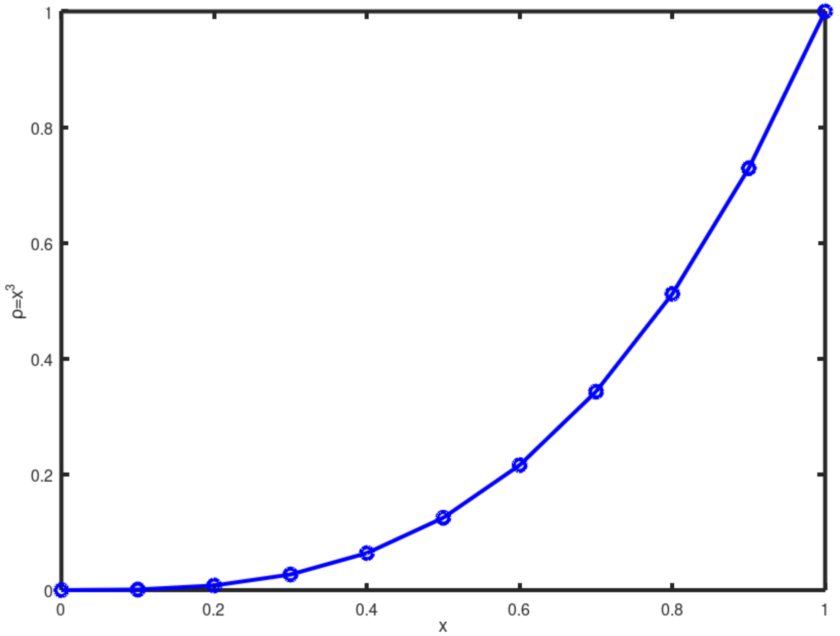


Current Session

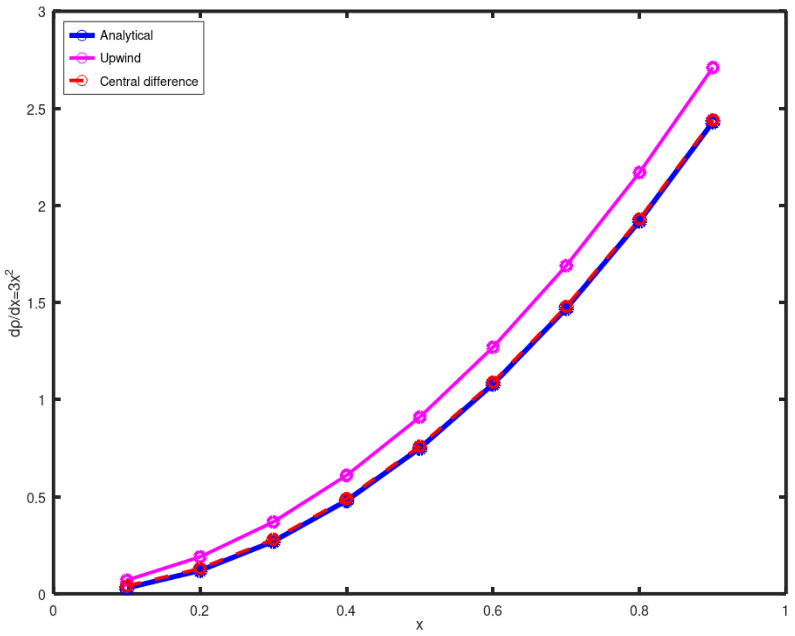
Overview

- Rate of convergence
- Introduction to C++ for OpenFOAM

Rate of Convergence

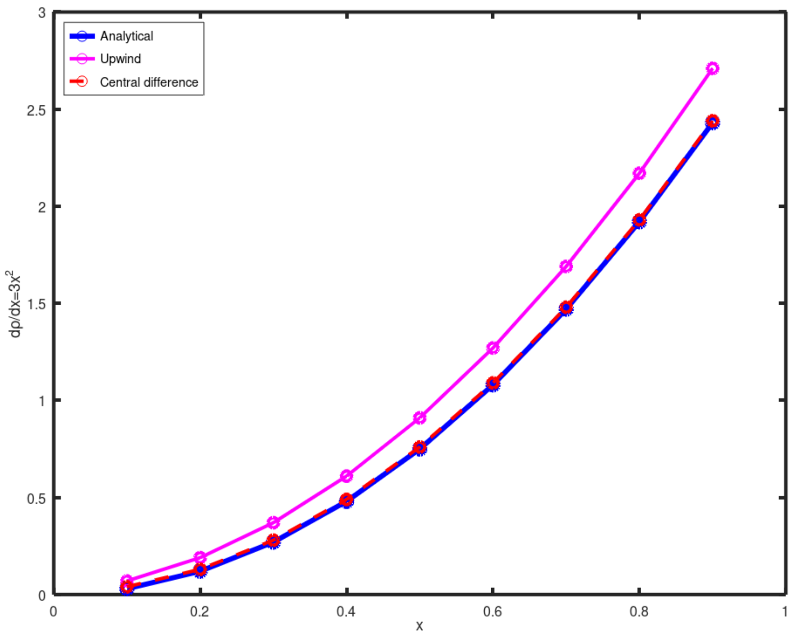


$$\rho = x^3$$



$$\frac{\partial \rho}{\partial x} = 3x^2$$

Rate of Convergence



$$\frac{\partial \rho}{\partial x} = 3x^2$$

First order forward difference approximation

$$\left(\frac{d\rho}{dx}\right)_i \approx \frac{\rho(x_{i+1}) - \rho(x_i)}{\Delta x_i} + O(\Delta x_i)$$

Second order central difference approximation

$$\left(\frac{d\rho}{dx}\right)_i = \frac{\rho(x_{i+1}) - \rho(x_{i-1})}{2\Delta x_i} + O(\Delta x_i^2)$$

Rate of Convergence

$$\left(\frac{d\rho}{dx}\right)_i \approx \frac{\rho(x_{i+1}) - \rho(x_i)}{\Delta x_i} + O(\Delta x_i)$$

Δx	Error	Rate of convergence
0.1	0.16	-
0.05	0.0775	1.04
0.025	0.038125	1.02

$$\left(\frac{d\rho}{dx}\right)_i = \frac{\rho(x_{i+1}) - \rho(x_{i-1})}{2\Delta x_i} + O\left(\Delta x_i^2\right)$$

Δx	Error	Rate of convergence
0.1	0.01	-
0.05	0.0025	2
0.025	0.000625	2

Rate of Convergence

$$\left(\frac{d\rho}{dx}\right)_i \approx \frac{\rho(x_{i+1}) - \rho(x_i)}{\Delta x_i} + O(\Delta x_i)$$

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Δx	Error	Rate of convergence
0.1	0.01	-
0.05	0.0025	2
0.025	0.000625	2

Introduction to C++ for OpenFOAM

b8_functions_classes.cpp

Next Session

- Finite difference method to solve diffusion equation
- Introduction to C++ for OpenFOAM

Thank you