Applied Computational Fluid Dynamics using OpenFOAM

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ExaSlate

- *Mon & Thu : 5 PM to 7 PM*

Overview

- Quick Recap: Installation
- Mesh Generation Example
- Building Custom Solvers and Running Simulations

Installations
(Recap)

Required Applications

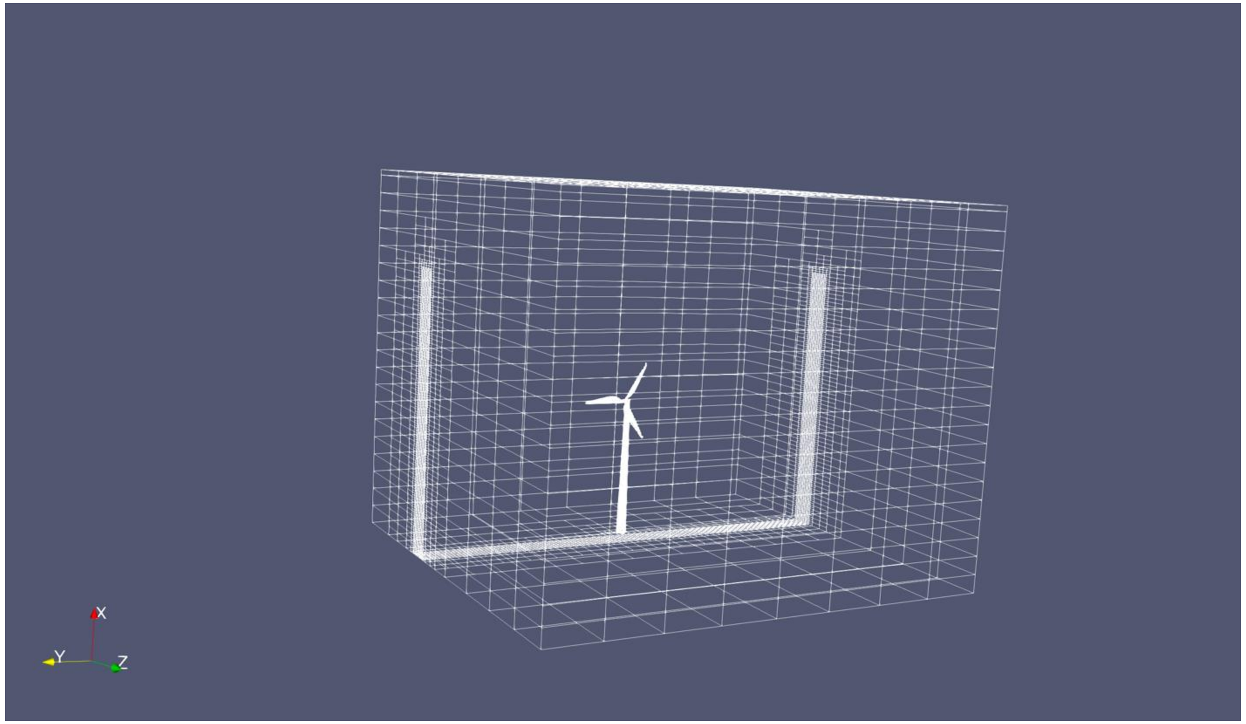
- Preconfiguration packages:
  - https://1drv.ms/f/s!AqT2YEB97-1RgP8MtsMPqoOGsq4ddg?e=IocXv0
- List
  - Virtual Box [to create virtual machines]
  - Ubuntu 22.04 [OS to install OpenFOAM & Octave]
  - AnyDesk [For remote access]
- Emphasizing for the 3rd and hopefully last time

- Exercise-1 [**installation**]
  - https://github.com/exaslate-learn/applied-cfd-using-openfoam-kct-fall2024/discussions

CFD Simulations in OpenFOAM

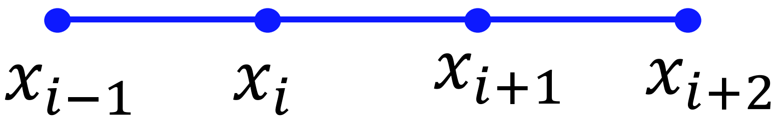
Case #1: Generate Volumetric Mesh

- Test case
  - **demo-wind-turbine-volumetric-mesh**
  - Commands to run
    - `blockMesh`
    - `surfaceFeatureExtract`
    - `snappyHexMesh`

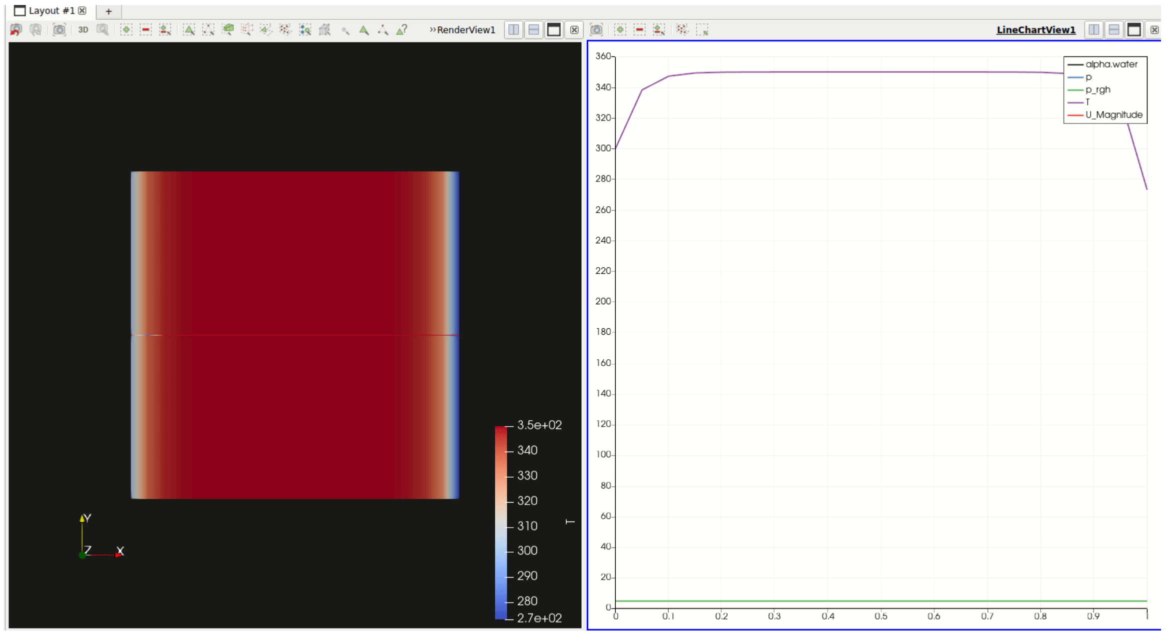


Case #2: Simulate Temperature Diffusion

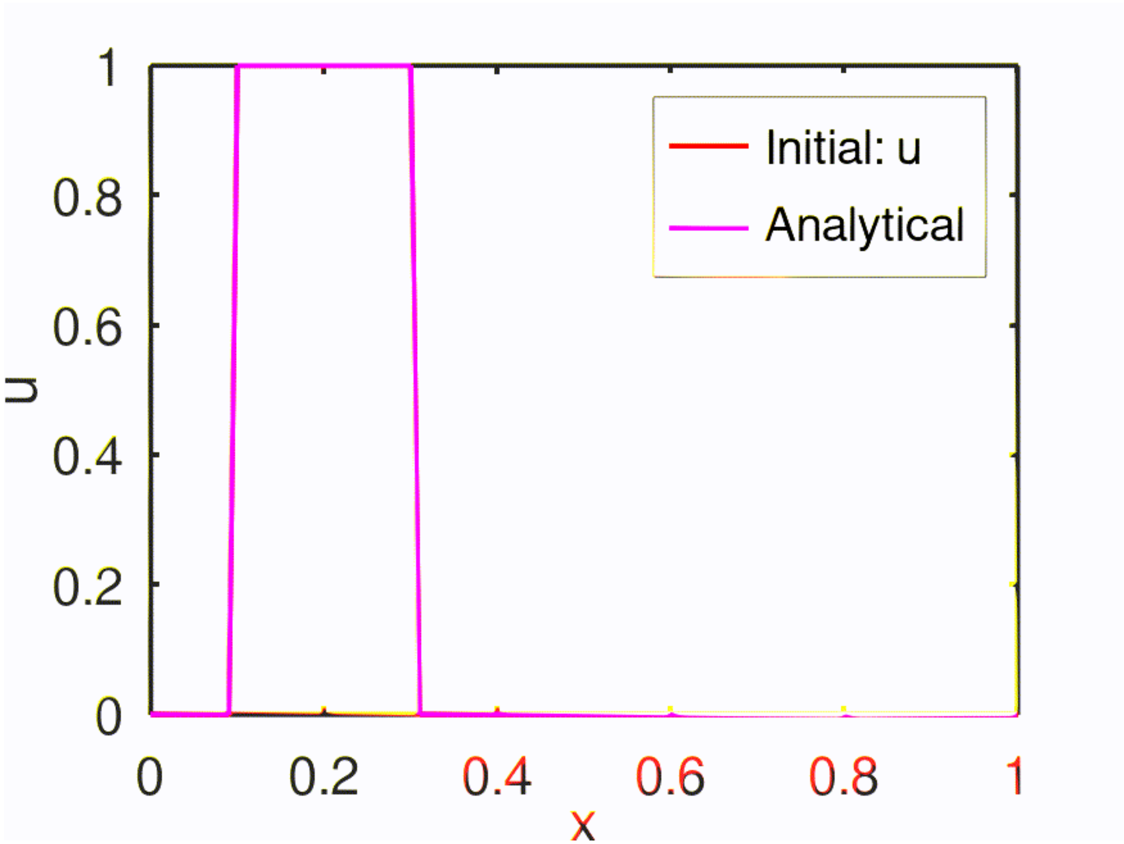
$$\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$$



$$\frac{T^{t+\Delta t} - T^{t}}{\Delta t} = \alpha \frac{T_{i+1}^{t+\Delta t} - 2T_{i}^{t+\Delta t} + T_{i-1}^{t+\Delta t}}{\Delta x^2}$$



Case #2: Convection



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

Numerical Solution to Convection Equation

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

$$\frac{u_i^{n+1} - u_i^n}{\Delta t} + c\left(\frac{\partial u}{\partial x}\right)_i^n = 0$$

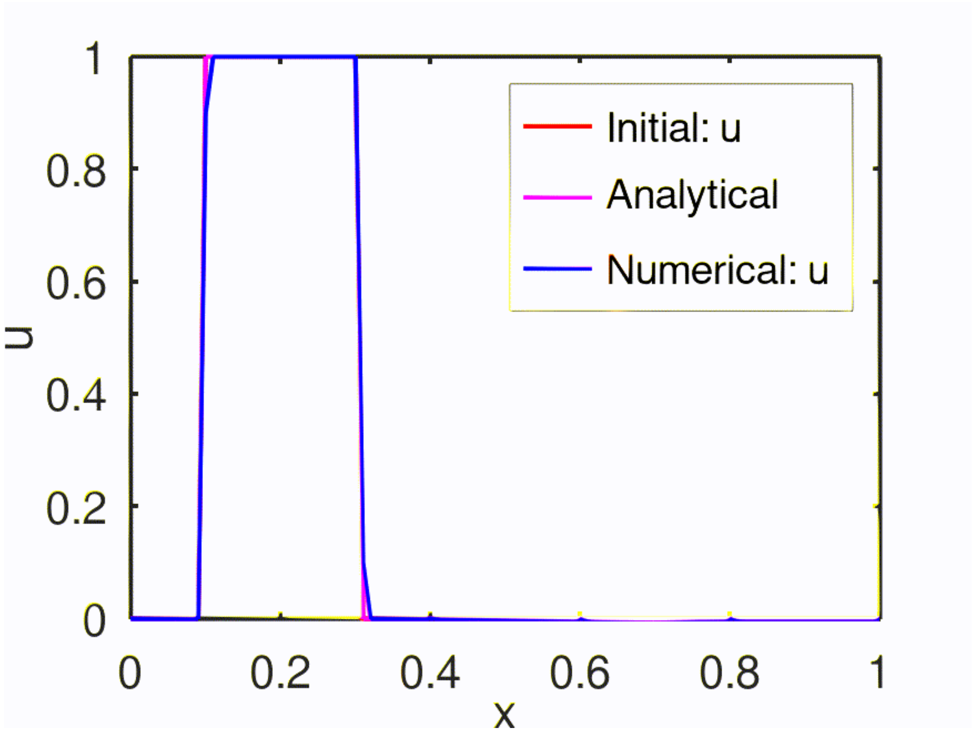
$$u_i^{n+1} = u_i^n - c\Delta t\left(\frac{\partial u}{\partial x}\right)_i^n \longrightarrow \left(\frac{\partial u}{\partial x}\right)_i^n \approx \frac{u_i^n - u_{i-1}^n}{\Delta x_i}$$

Upwind

Numerical Solution to Convection Equation

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

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



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

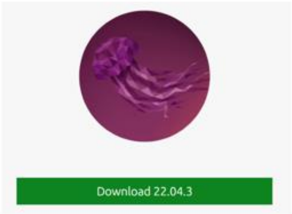
Exercises

Exercise-3

- https://github.com/exaslate-learn/applied-cfd-using-openfoam-kct-fall2024/discussions/4

- *Prerequisites:*
  - Create a github account:
    - https://github.com
    - Discussion forum:
      - https://github.com/exaslate-learn/applied-cfd-using-openfoam-kct-fall2024/discussions

  - Operating System:
    - Ubuntu 22.04



  - Softwares:
    - OpenFOAM v2306

    - Octave

Exercise-4

- https://github.com/exaslate-learn/applied-cfd-using-openfoam-kct-fall2024/discussions/5