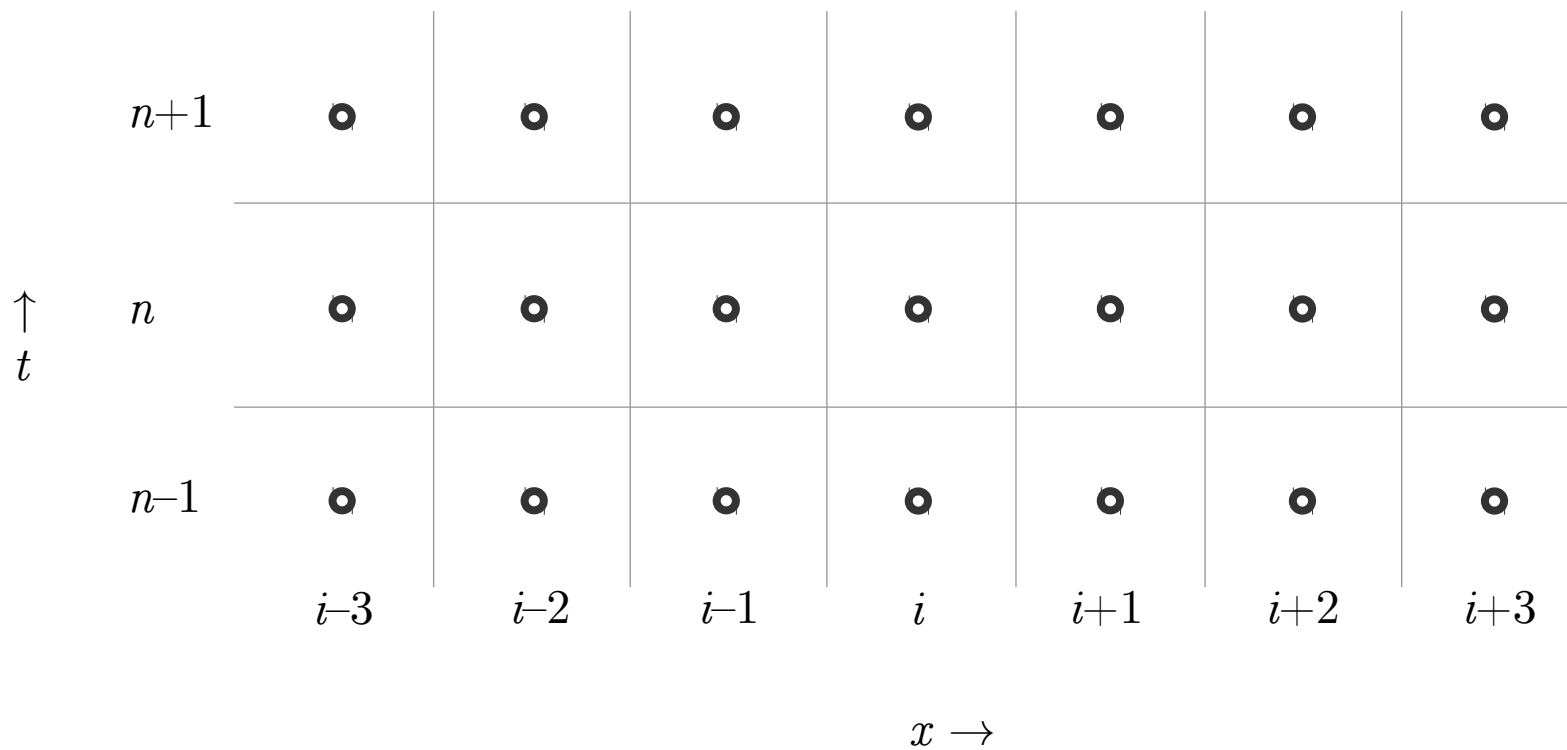
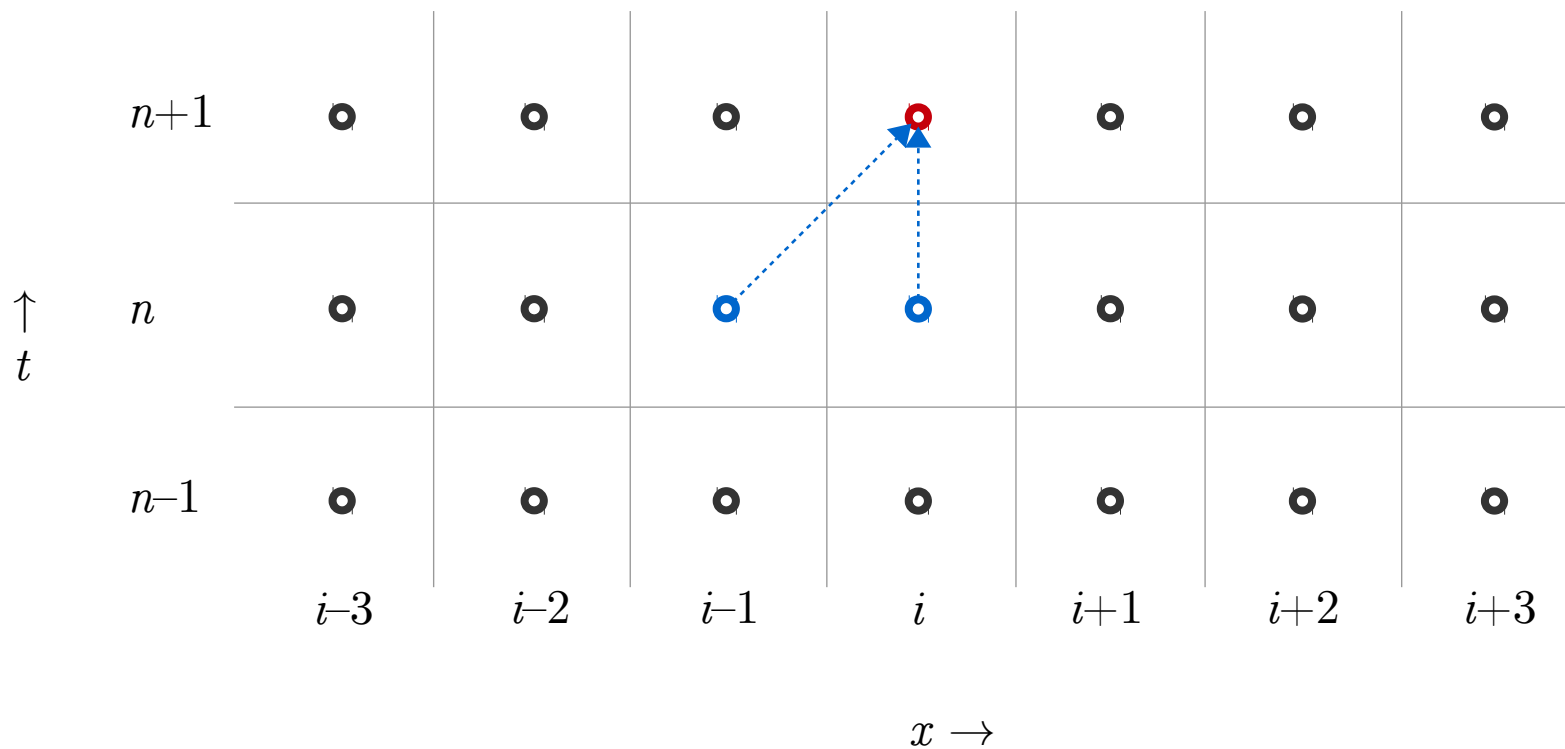


# Solvers and Discretization Schemes



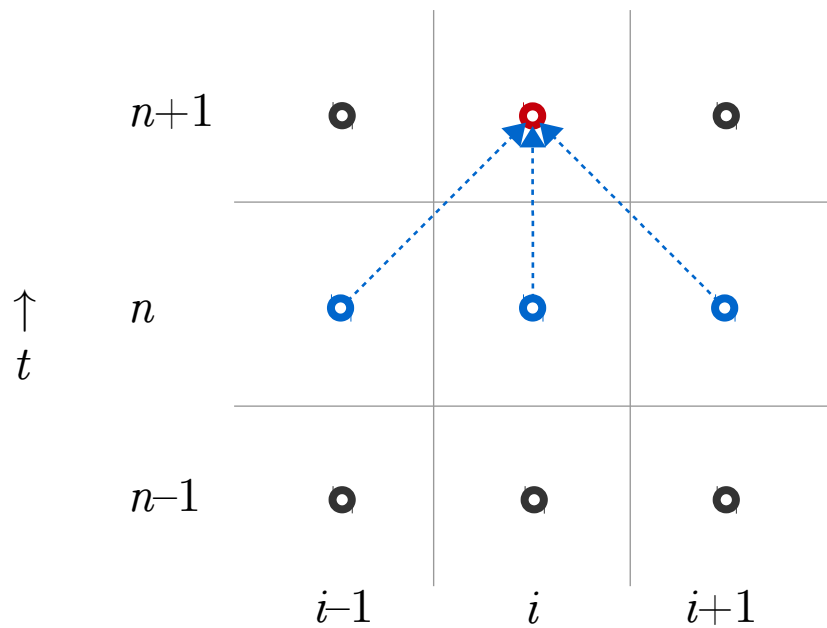
$$\frac{\partial u}{\partial t} = -a \frac{\partial u}{\partial x}$$

linear  
advection



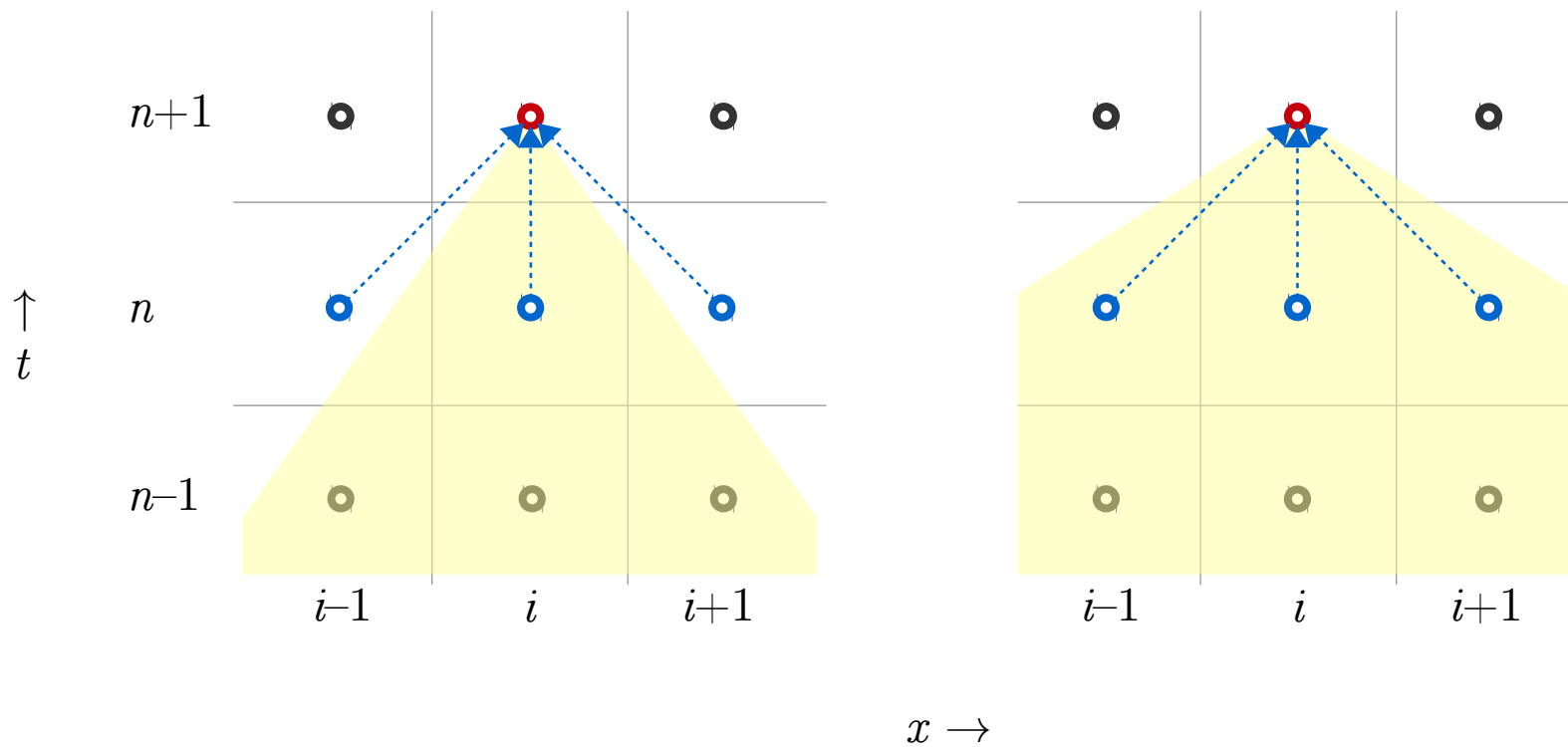
$$\frac{u_i^{n+1} - u_i^n}{\Delta t} = -a \frac{u_i^n - u_{i-1}^n}{\Delta x}$$

first-order  
upwind



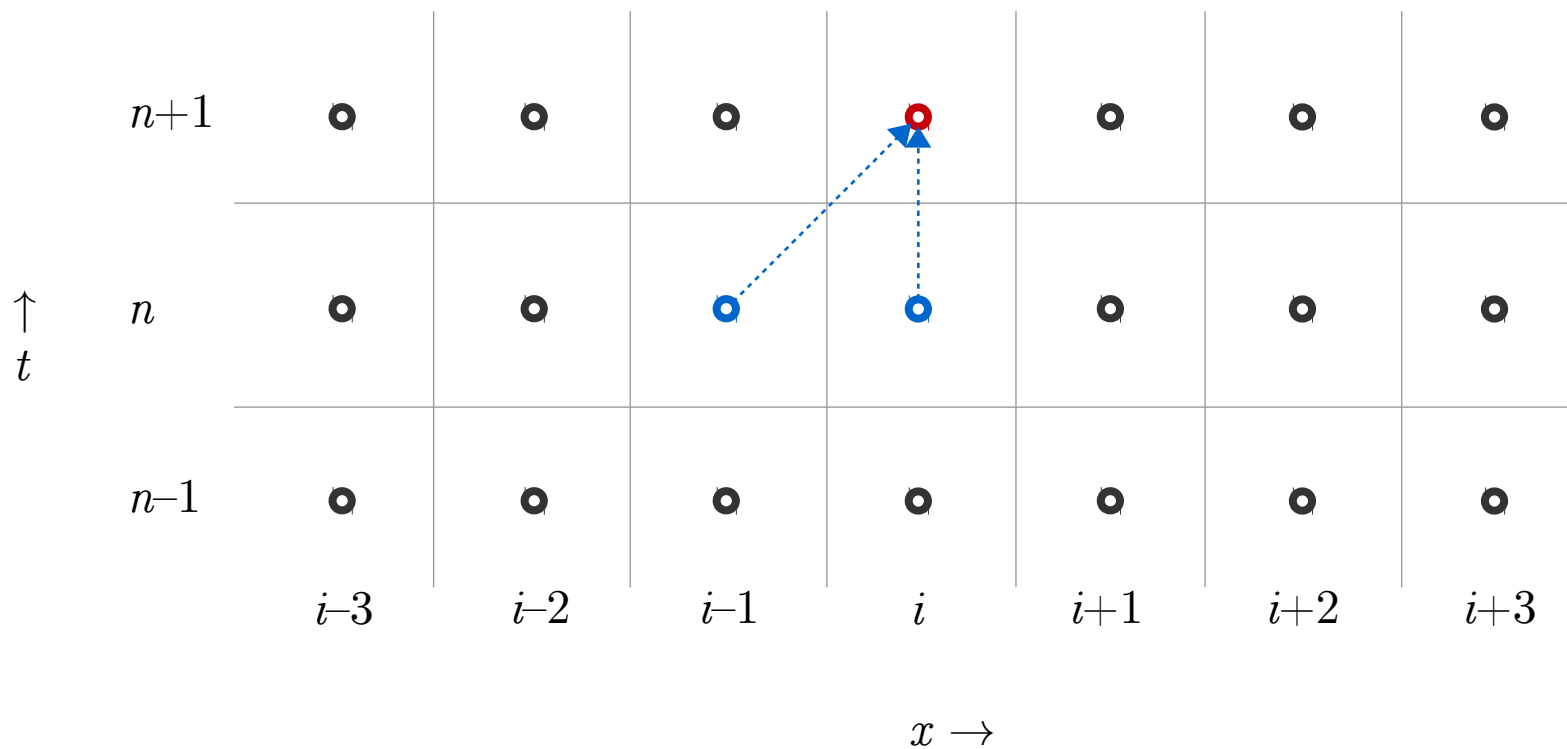
$$c = \left| \frac{a \Delta t}{\Delta x} \right| \leq 1$$

CFL stability  
criterion



$$c = \left| \frac{a\Delta t}{\Delta x} \right| \leq 1$$

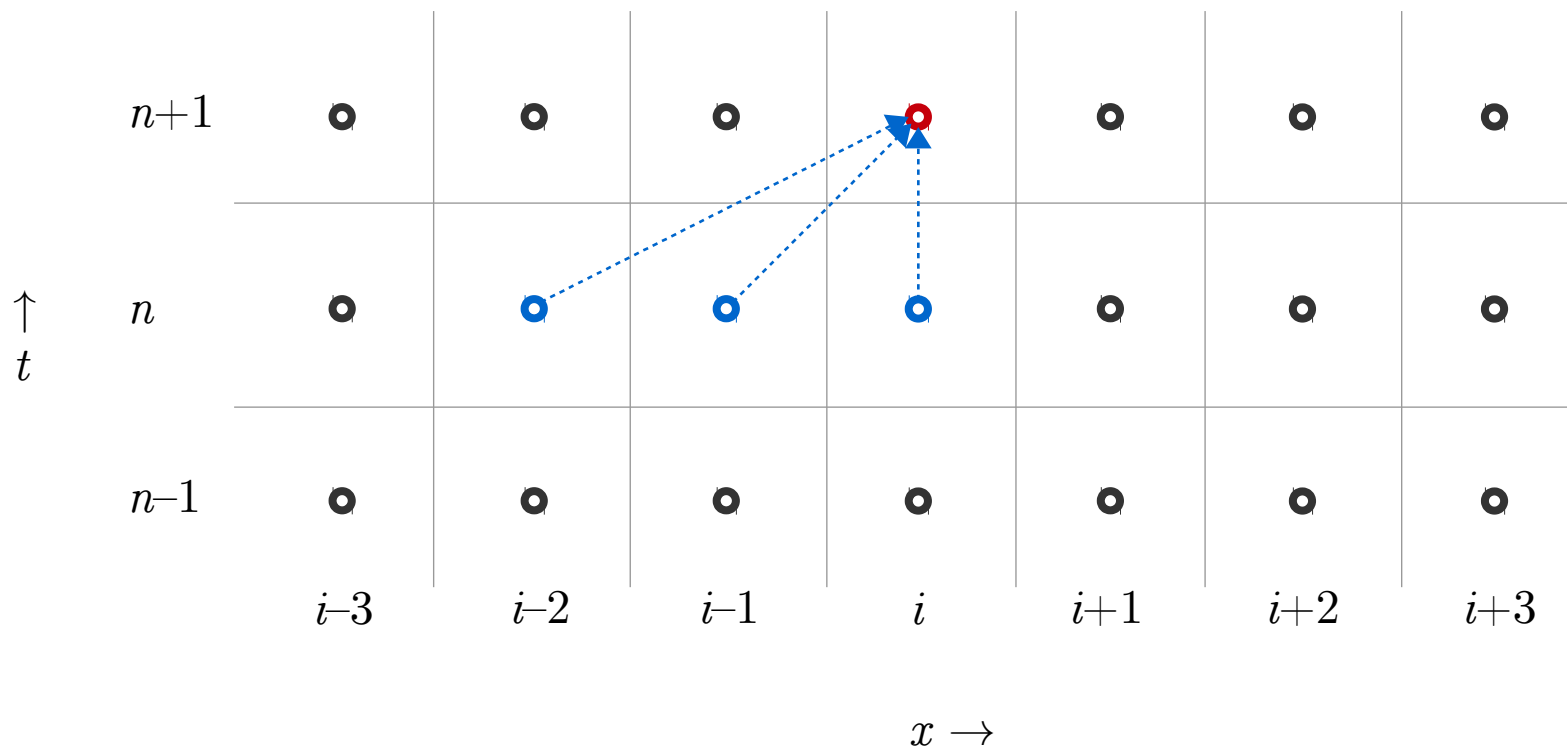
CFL stability  
criterion



$$\frac{\partial u}{\partial t} = -a \frac{\partial u}{\partial x}$$

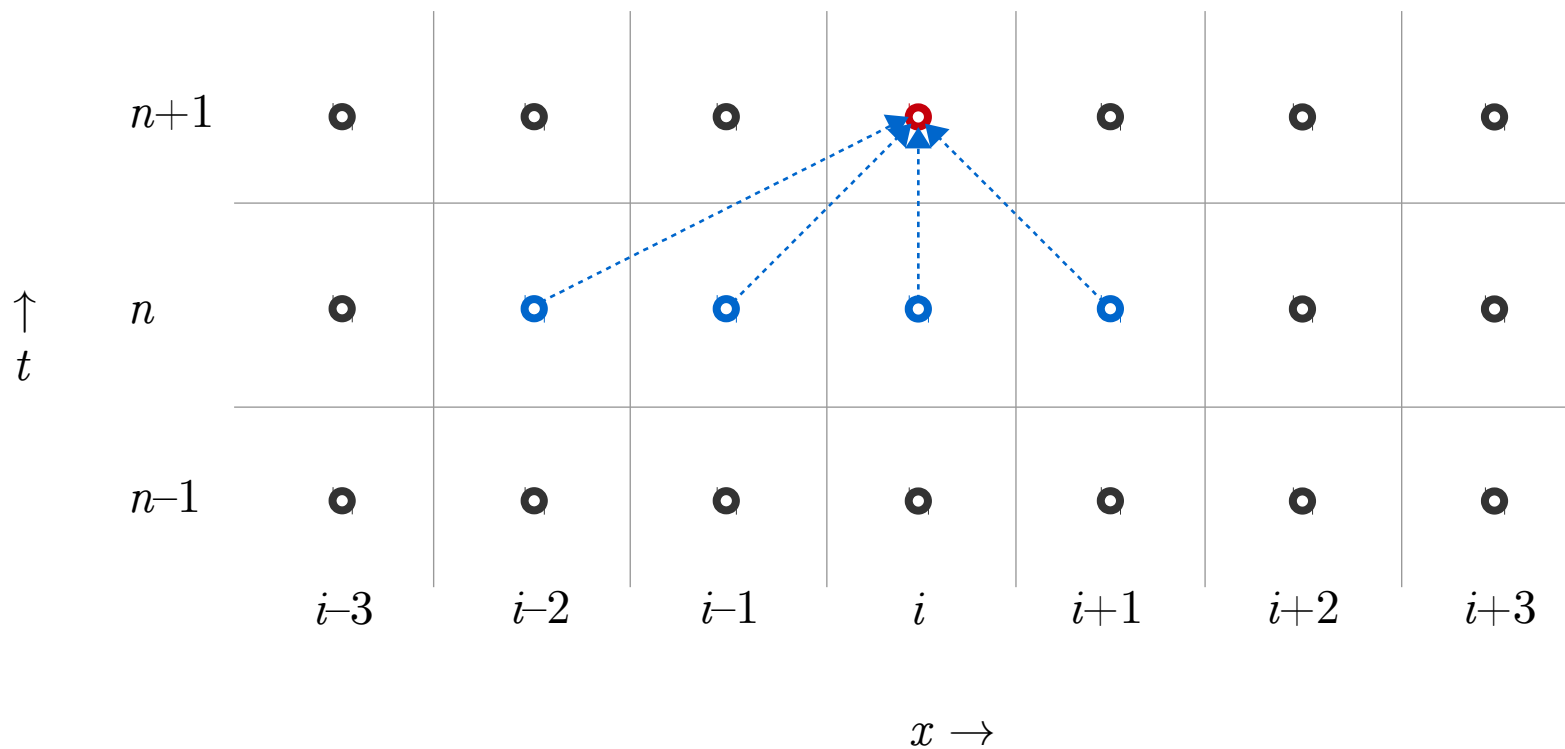
$$\frac{\partial u}{\partial t} = -a \frac{\partial u}{\partial x} + \left( \frac{\partial^2 u}{\partial t^2} \frac{\Delta t}{2} - a \frac{\partial^2 u}{\partial x^2} \frac{\Delta x}{2} \right) + \text{HOT}$$

first-order  
upwind  
modified  
equation



$$\frac{u_i^{n+1} - u_i^n}{\Delta t} = -a \frac{3u_i^n - 4u_{i-1}^n + u_{i-2}^n}{2\Delta x}$$

second-order  
upwind



$$\frac{u_i^{n+1} - u_i^n}{\Delta t} = -a \frac{2u_{i+1}^n + 3u_i^n - 6u_{i-1}^n + u_{i-2}^n}{6\Delta x} \text{ third-order upwind}$$



$$\frac{u_i^{n+1} - u_i^n}{\Delta t} = F(u^n)$$

explicit  
(cond. stable)  
*density-based*

$$\frac{u_i^{n+1} - u_i^n}{\Delta t} = F(u^{n+1})$$

implicit  
(stable)  
*pressure-,  
density-based*

$$u^{n+1/2} = u_n + \frac{1}{2}\beta_{n+1/2} (u^n - u^{n-1})$$

$$u^{n-1/2} = u_{n-1} + \frac{1}{2}\beta_{n-1/2} (u^{n-1} - u^{n-2})$$

second-order  
implicit  
(stable)  
*pressure-based*

# Solvers

- Pressure-based
  - Segregated—converges slowly, saves memory
    - SIMPLE, SIMPLEC, PISO
  - Coupled - converges fast but costs memory
    - Coupled
- Density-based

The image shows a 'General' settings dialog box for a solver. It is divided into two main sections: 'Mesh' and 'Solver'. The 'Mesh' section contains four buttons: 'Scale...', 'Check', 'Report Quality', and 'Display...'. The 'Solver' section contains several radio button options. The 'Type' section has 'Pressure-Based' selected (indicated by a blue dot) and 'Density-Based' unselected. The 'Velocity Formulation' section has 'Absolute' selected and 'Relative' unselected. The 'Time' section has 'Steady' selected and 'Transient' unselected. The '2D Space' section has 'Axisymmetric' selected and 'Axisymmetric Swirl' unselected. At the bottom of the 'Solver' section, there is a checkbox for 'Gravity' which is currently unchecked, and a 'Units...' button. A 'Help' button is located at the very bottom of the dialog box.

**General**

Mesh

Scale... Check Report Quality Display...

Solver

Type

- ☒ Pressure-Based
- ☐ Density-Based

Velocity Formulation

- ☒ Absolute
- ☐ Relative

Time

- ☒ Steady
- ☐ Transient

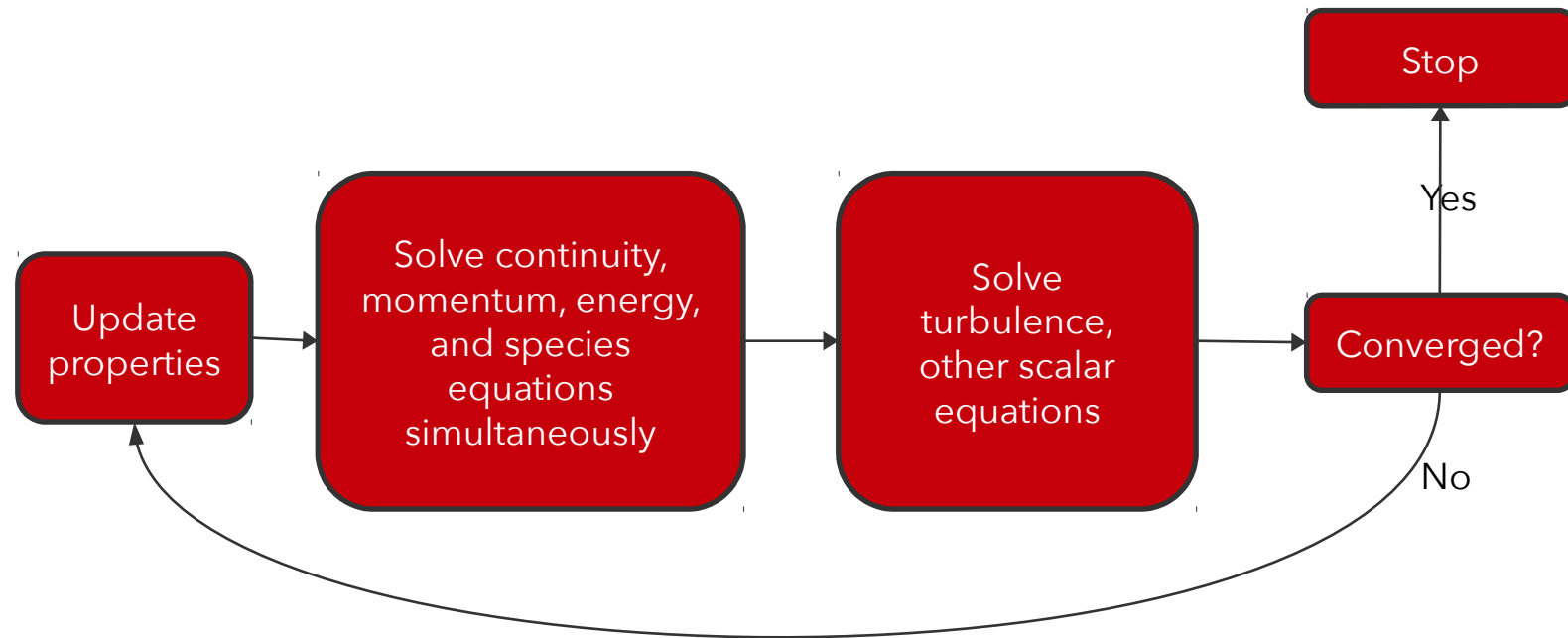
2D Space

- ☐ Planar
- ☒ Axisymmetric
- ☐ Axisymmetric Swirl

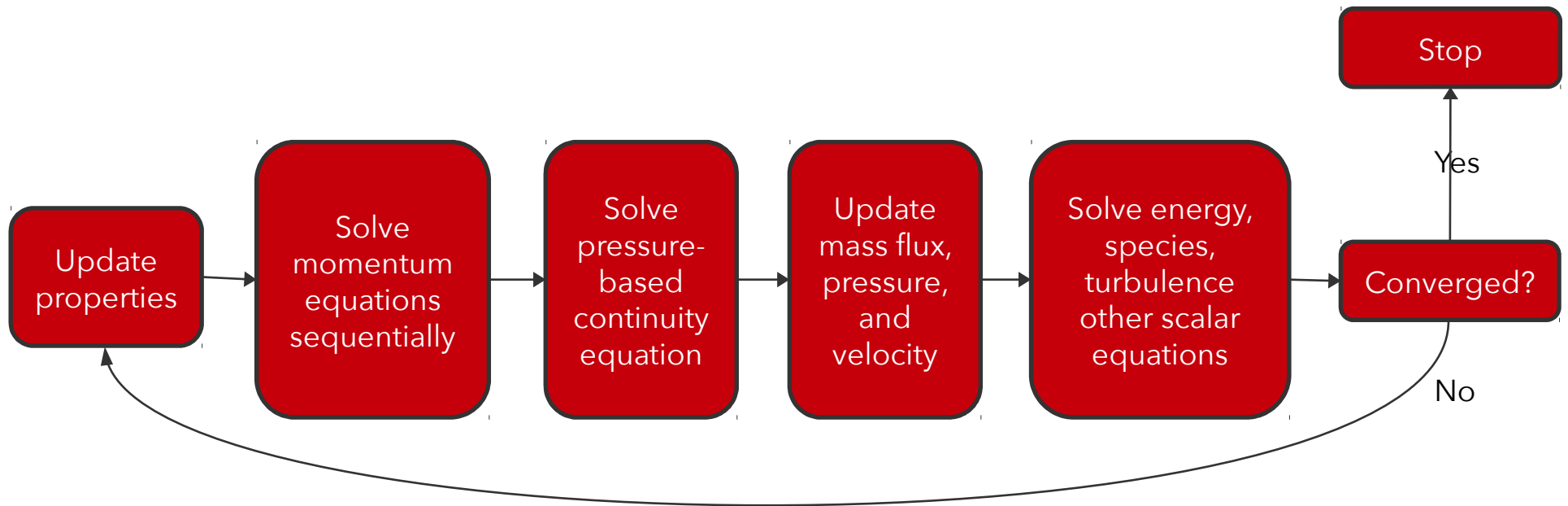
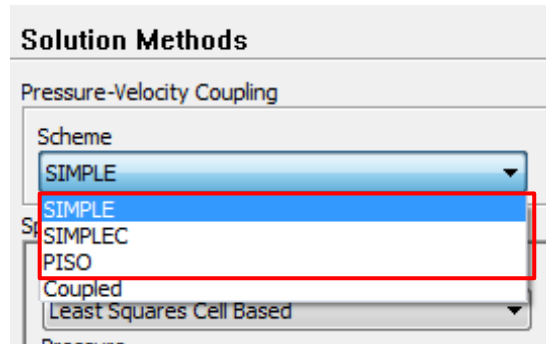
☐ Gravity Units...

Help

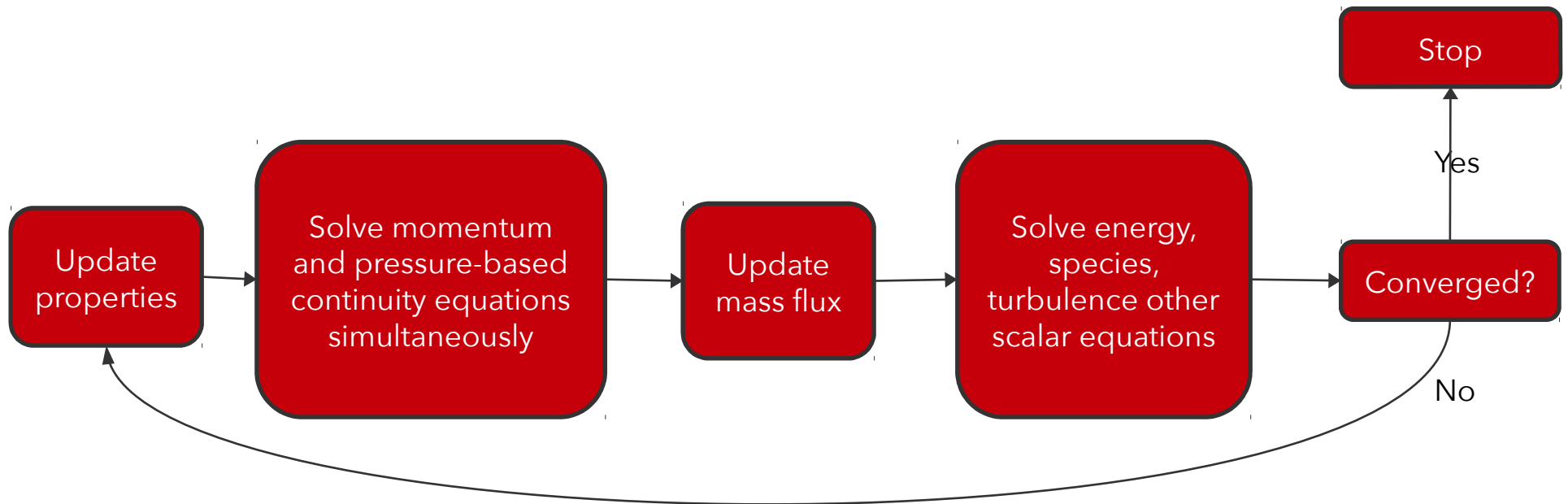
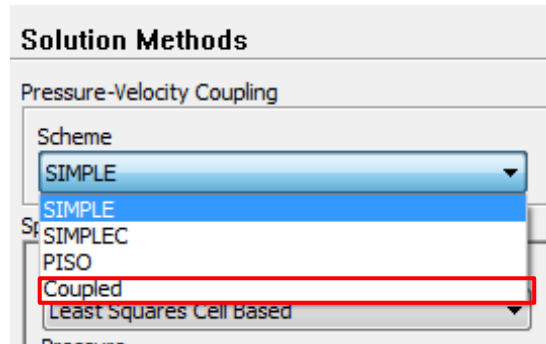
# Density-based solver



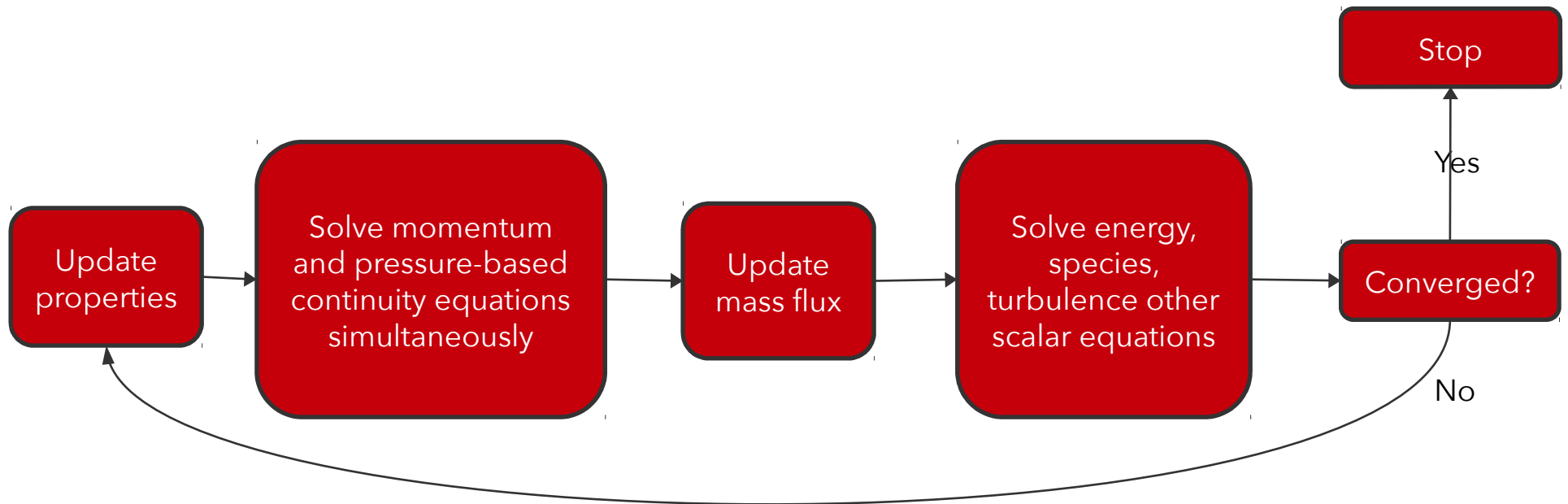
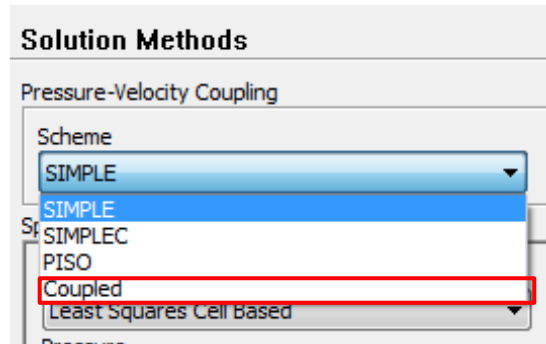
# Segregated pressure-based solver



# Coupled pressure-based solver



# Coupled pressure-based solver



# Density-based solver

