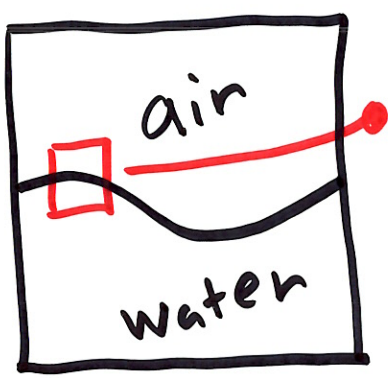
Lecture 16 — 10/19

Proj 2 two-phase flow / flow w/ interface
multi-phase

VOF (Volume of Fluid)

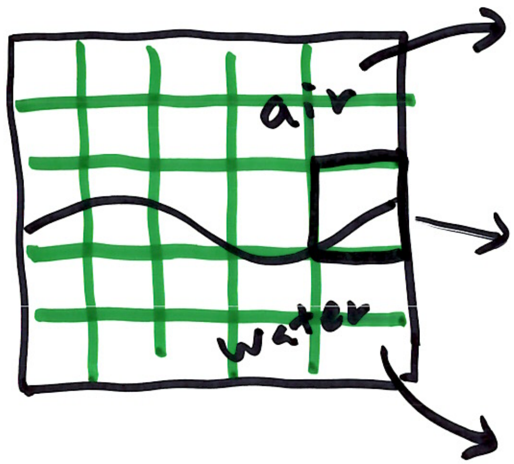
Recap (Lec 15)



very high gradient of ρ, μ, κ — Numerical problems w/ single-fluid equations

$\nabla \rho$ $\nabla \mu$ etc.

instead, compute **VF** (volume fraction) of individual fluids



$VF_1 = 1$
$VF_2 = 0$

$VF_1 = 0.6$
$VF_2 = 0.4$

$VF_1 = 0$
$VF_2 = 1$

air : phase 1

$C_1 \equiv VF_1$

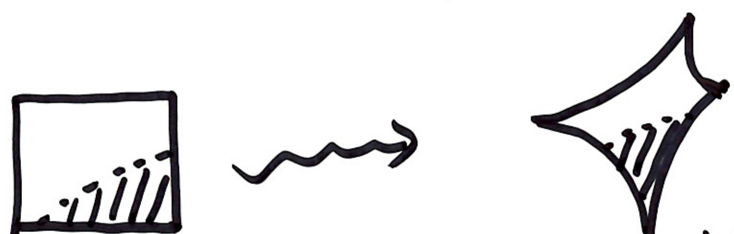
water : phase 2

$C_2 \equiv VF_2$

$VF_1 + VF_2 = 1$
for each element

key:
If $\rho_1 = const$, $\rho_2 = const$

$\Rightarrow$



$VF_1 = 0.6$
$VF_2 = 0.4$

$VF_1 = 0.6$
$VF_2 = 0.4$

key: $\frac{dC_2}{dt} = 0$

$\Downarrow$

$$\frac{\partial C_2}{\partial t} = -\vec{V} \cdot \nabla C_2$$

$0 \le C_2 \le 1$

2 phases C_1 C_2

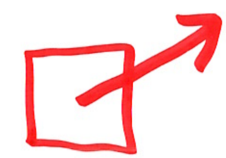
(VF_1) (VF_2)

Need to compute C_2

$(C_1 = 1 - C_2)$

✓ momentum eq. for mixture ✓

$$\frac{\partial \vec{v}}{\partial t} = -\vec{v} \cdot \nabla \vec{v} - \frac{1}{\rho} \nabla p + \nu \nabla^2 \vec{v}$$



ONE velocity

ONE pressure

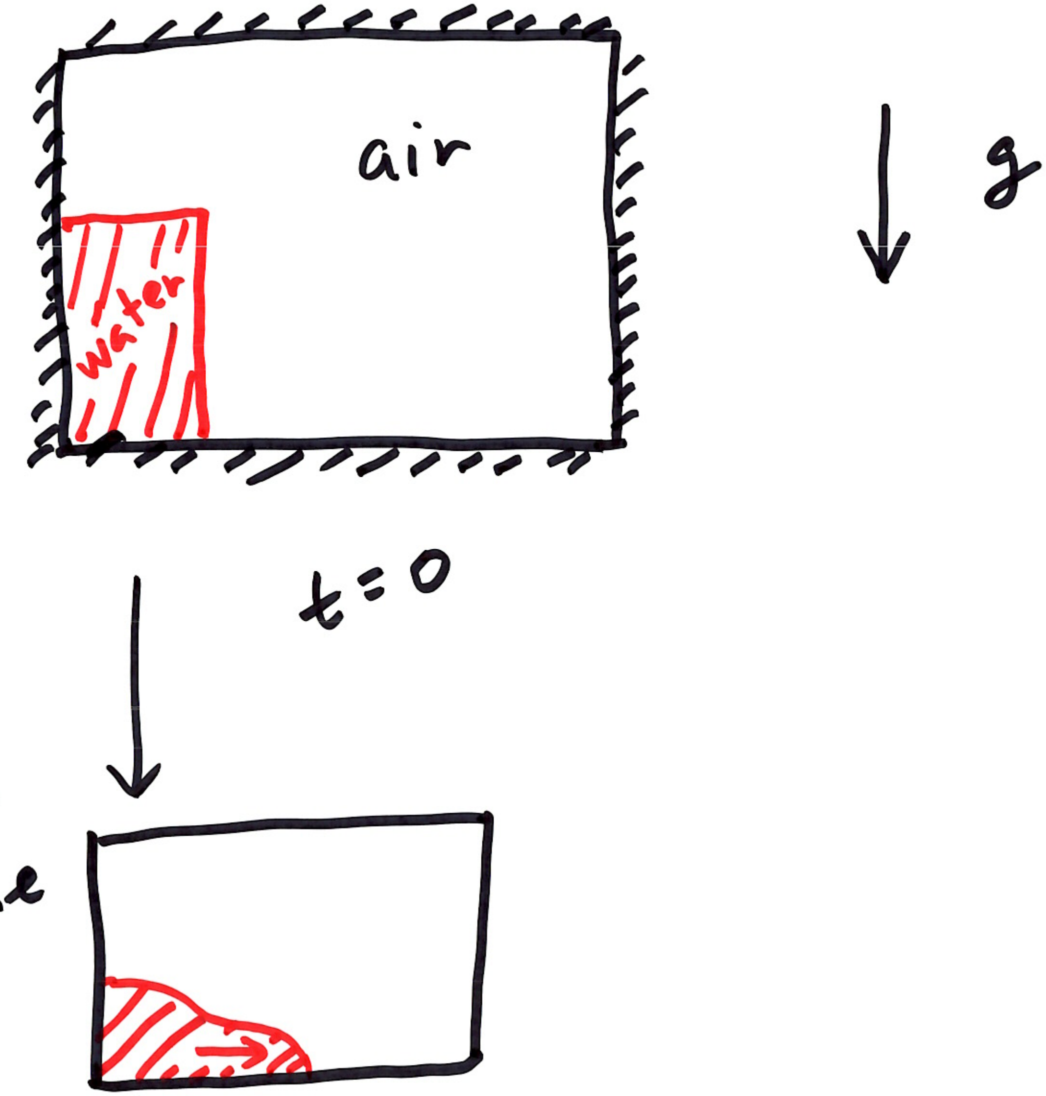
density of mixture : $\rho = \underline{C_1} \rho_1 + \underline{C_2} \rho_2$

field variables just like u, v, w, T, p

Demo

2-D closed domain

<u>transient</u>



later time

- [ ] Explicit → Explicit OK, too.
  ↖ But be careful about numerical stability
- [x] Implicit

- [x] Implicit body force
  ↖ if gravity is ON

"Operating Density Method"

* minimum-phase averaged — for some tasks in Proj 2

vs.

* mixture averaged — for a task?