Multiphase Flows – WS 2022/23
Problem Session 6: Interface Tracking (2/3)

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Agenda

- Problem Session 5: Interface Tracking (1/3)
- Problem Session 6: Interface Tracking (2/3)
- Problem Session 7: Interface Tracking (3/3)

Problem Session 6: Interface Tracking (2/3)

Motivation

- Last Problem Session: implicit " capturing" of interface by means of density field advection
  - ➢ Interface smears out, unphysical density gradients over large distances

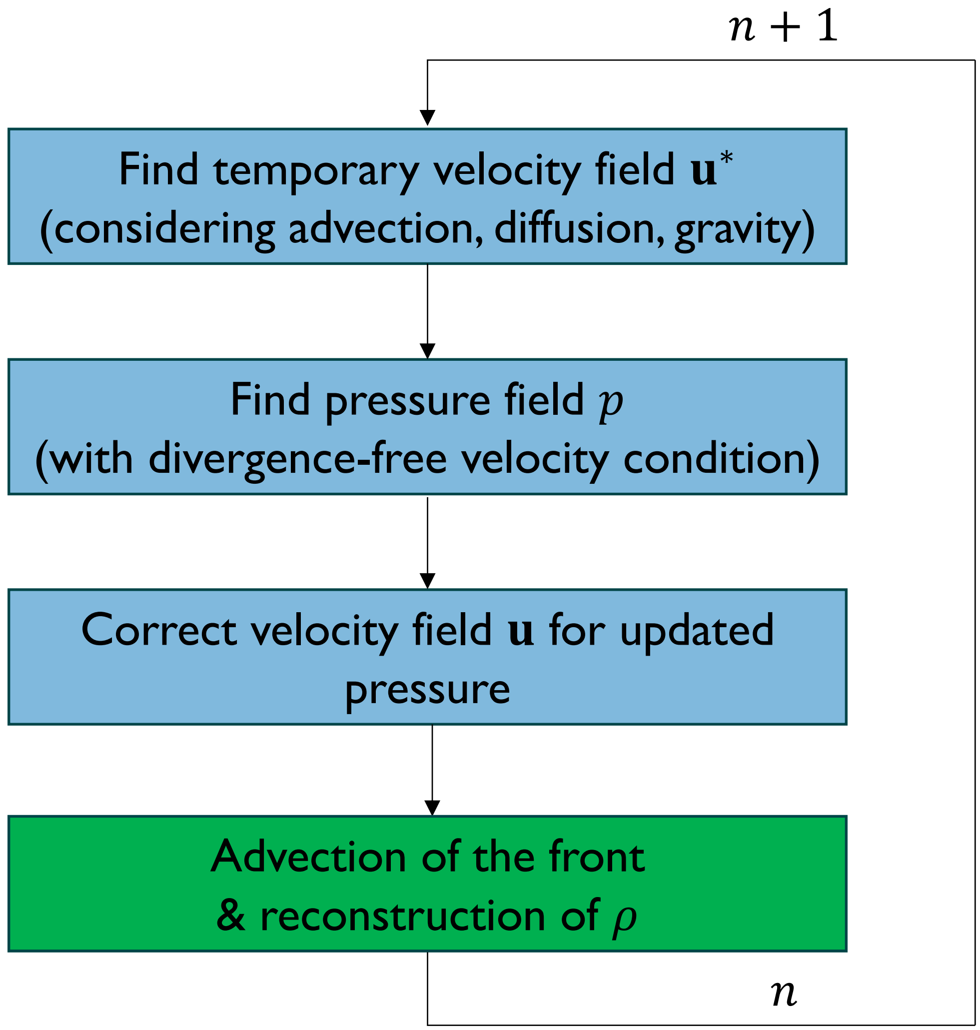
➢ Today: front tracking

- ➢ Advection of density replaced by explicit tracking of the interface and subsequent reconstruction of the density field
- ➢ Still assumed: equal viscosities for both phases, no surface tension, no phase change

Problem Session 6: Interface Tracking (2/3)

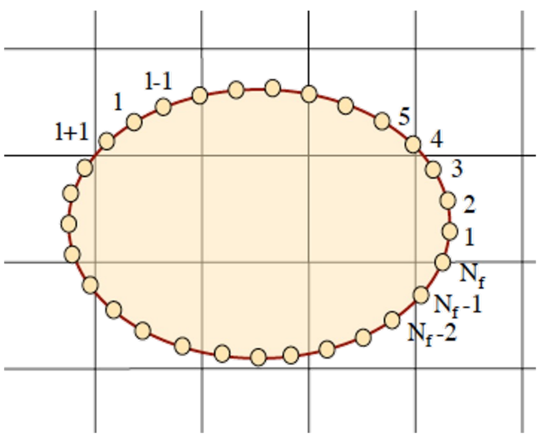
Numerical Solver

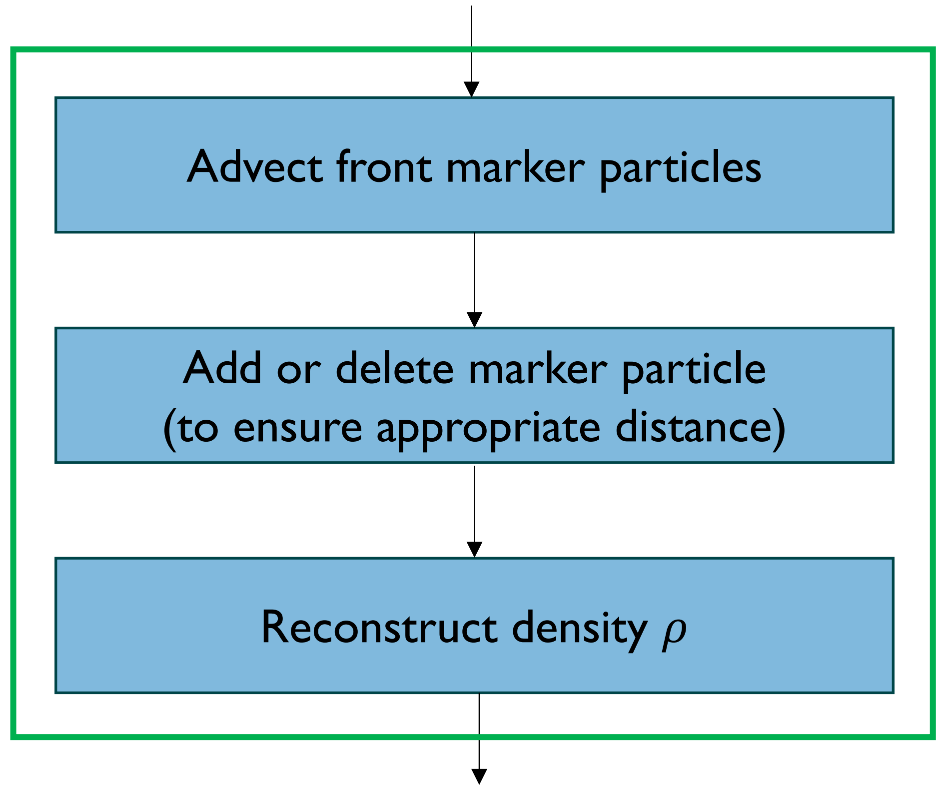
- Solver unchanged for velocity and pressure
- Density advection replaced by front advection with density reconstruction



Numerical Solver: Front Tracking

- Front represented by marker particles
- Advection of particles to represent front motion
- Reconstruction of density field based on new front location



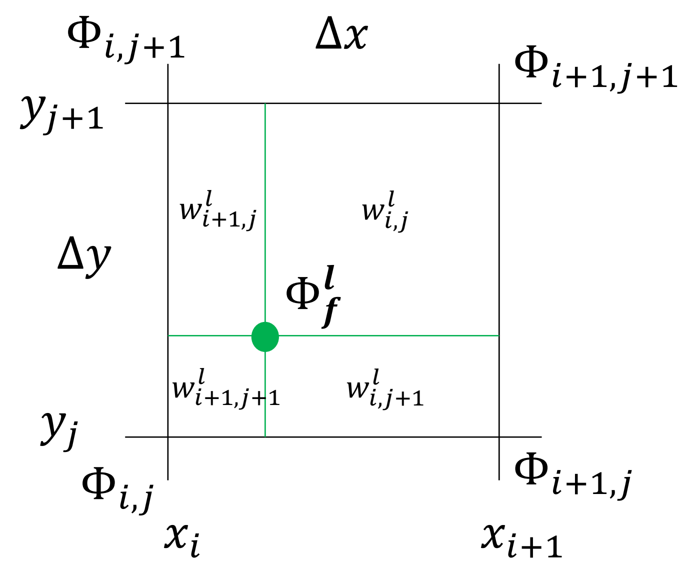


Problem 1: Advecting the Front

a) *Derive an expression for bilinear interpolation of a front marker quantity* Φ_f^l *from the nearest values of that quantity on the fixed grid.*

b) *In the given code template, implement the determination of the front velocity components* u_f^l *and* v_f^l *from the fixed grid velocities. (in MATLAB)*

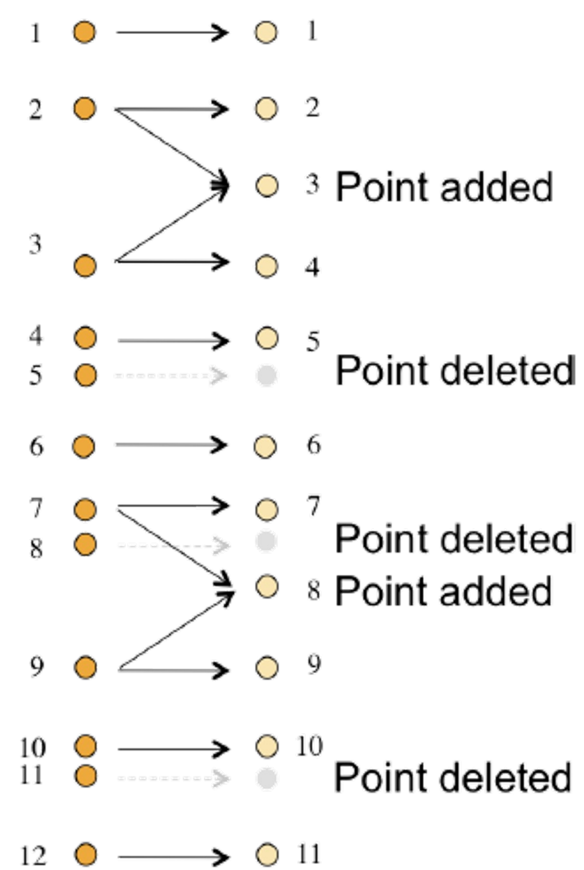
c) *Determine the new location* $\left(x_\mathrm{f}^l, y_\mathrm{f}^l\right)$ *of the front marker particles by advecting them with the velocity components* u_f^l *and* v_f^l*. Use a simple explicit first-order time integration. (in MATLAB)*



Problem 2: Front Restructuring

a) *Determine an expression for the normalized distance between two front marker particles based on the known marker coordinates $\left(x_\mathrm{f}^l, y_\mathrm{f}^l\right)$. Use Δx and Δy for normalization.*

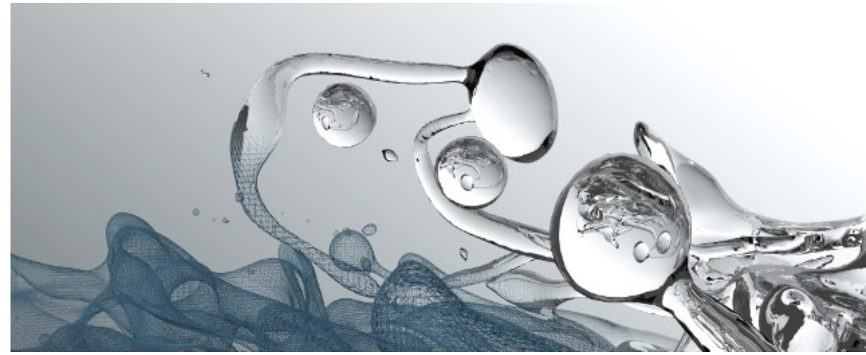
b) *Assemble the new arrays of marker particle coordinates $\left(x_\mathrm{f}^l, y_\mathrm{f}^l\right)$ based on the old coordinates. Ensure that particle distances are within a desired range. If the distance between two particles is too large, add an additional particle by linear interpolation between the locations of those particles. If the distance between two particles is too short, delete one of them. (in MATLAB)*



Problem 3: Simulation of Falling Drop (in MATLAB)

a) *Use your implementation to simulate the falling drop. Evaluate how well the interface motion is captured compared to the case where the front is not explicitly tracked.*

b) *Is the predicted drop motion realistic? Which effects are still missing?*



Thank you for your attention

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