Interface Tracking Results

VOF PLIC using the Youngs' Finite Difference. Interface advection using the out-of-cell explicit linear mapping method.

T=2 and t=1

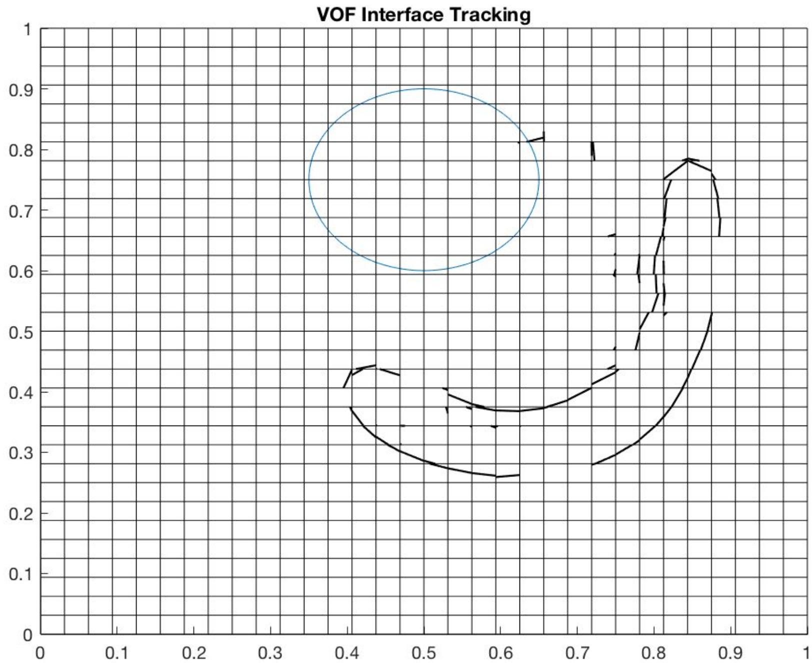


Figure 1: Vortex-in-a-box test for a 33^2 grid and 80 time steps, where T=2, t=1.

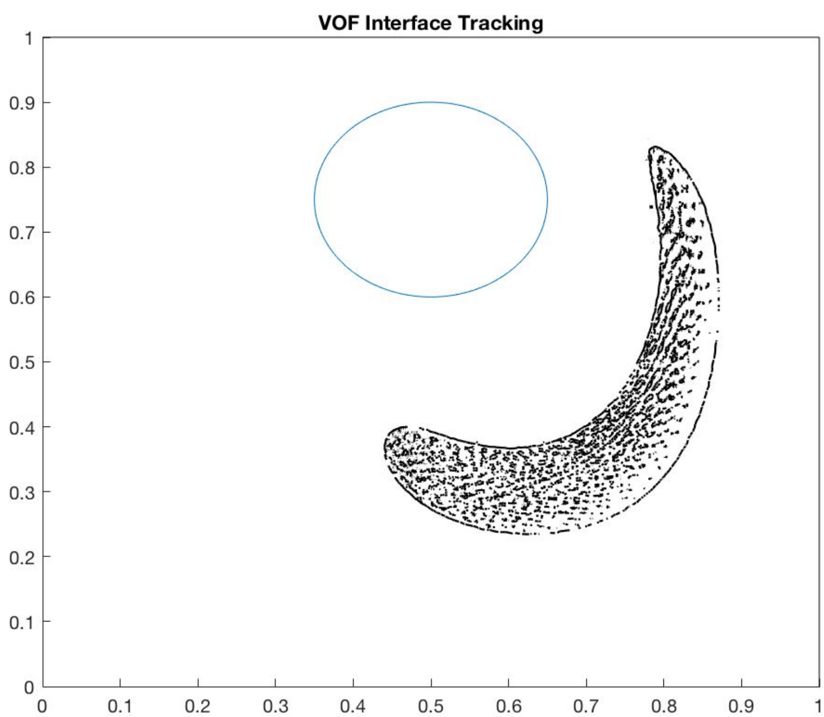


Figure 2: Vortex-in-a-box test for a 333^2 grid and 10 time steps, where T=2, t=1.

T=2 and t=2

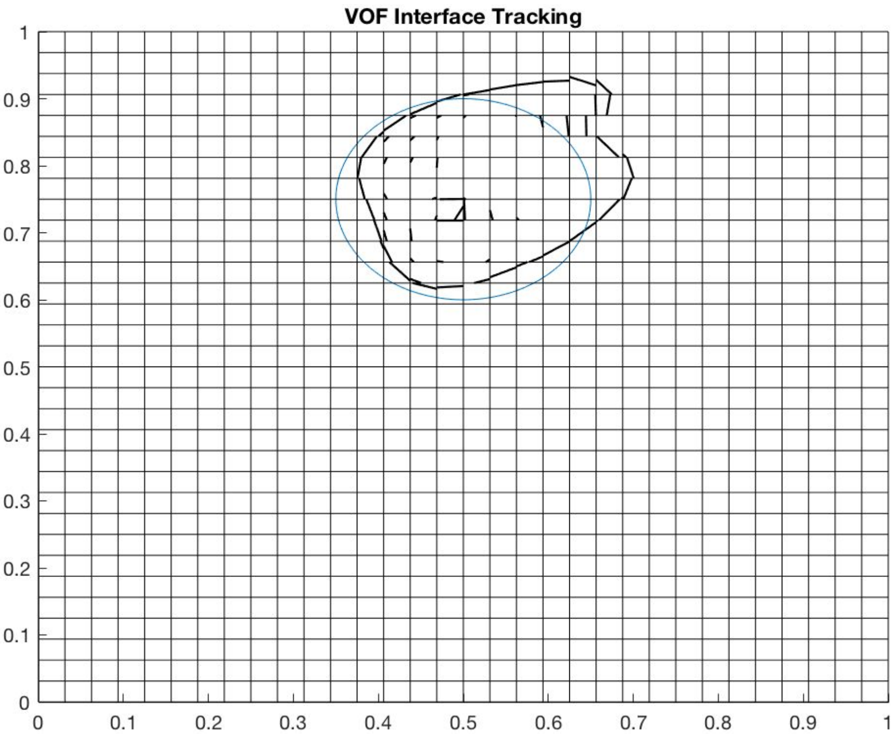


Figure 3: Vortex-in-a-box test for a 33^2 grid and 80 time steps, where T=2, t=2.

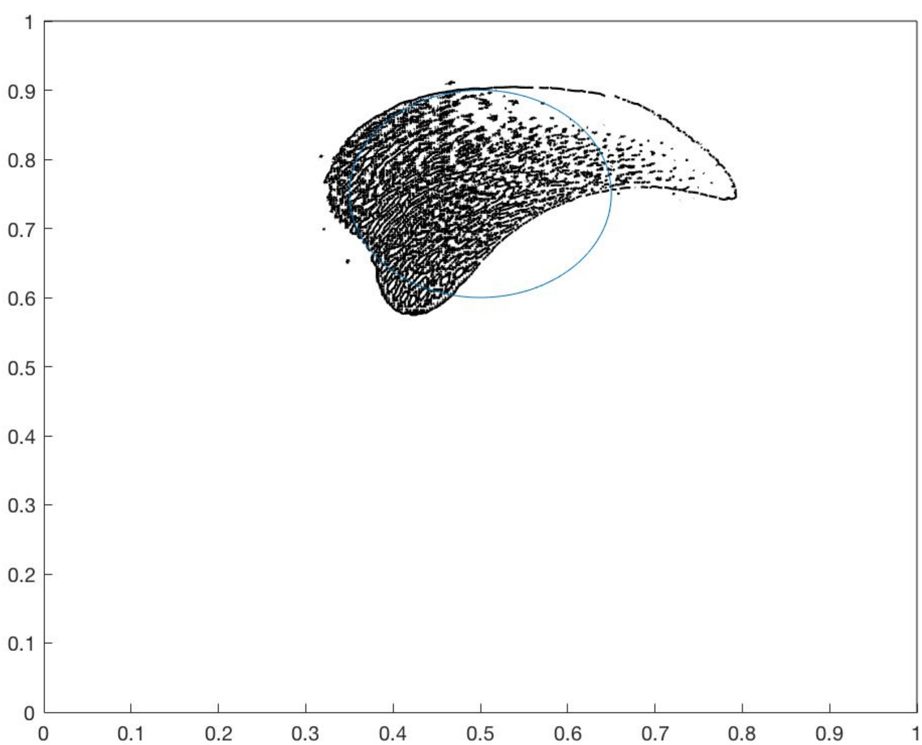
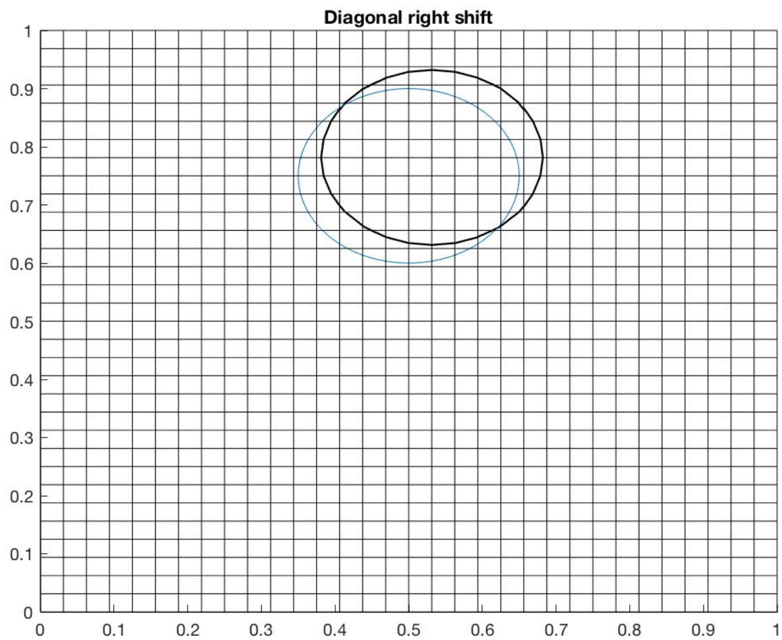
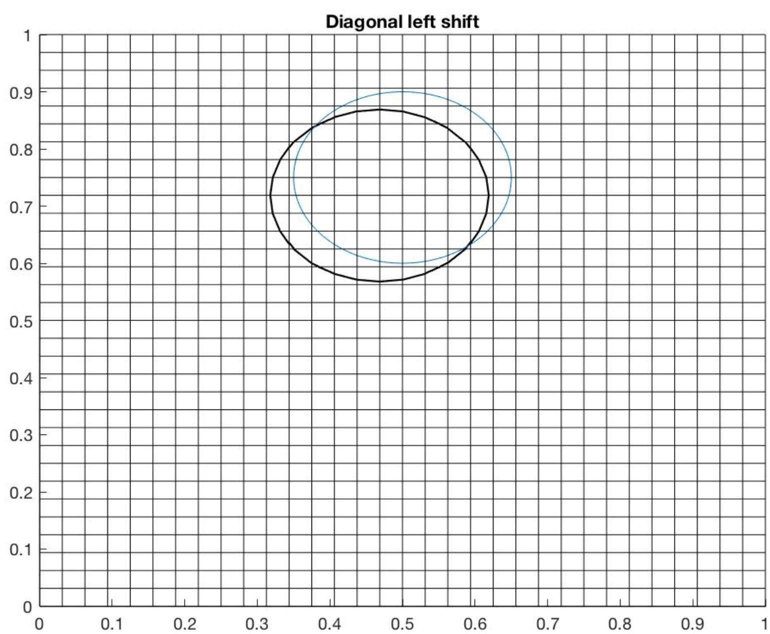


Figure 4: Vortex-in-a-box test for a 333^2 grid and 20 time steps, where T=2, t=2

Instead of CFL analysis, we determined the appropriate number of time steps based on the convergence of the interface. The small interfaces are constructed due to the error of the colorfunction resulting in values not quite equal to 1 inside the interface and 0 outside the interface. This comes with a very low CFL, which is present in the 333^2 grid. The gaps in the interface are due to the adjacent cell holding values larger than 1. Compared to the example in page 126 of Tryggvason et. al, our results for t=1 are reasonable. However, the final circle at t=2 is seemingly warped despite the fact that it should form the original circle (shown in blue). To show the range of our advection algorithm, the following additional plots were created:





Particle Tracking Results

The particle tracking code uses a one way coupling approach in order to update particle positions at each time step. The positions can be initialized as uniformly distributed particles **(particles or parcels?),** or as randomly distributed particles on a continuous unit square. The driving force behind particle movement in the drag force. The drag force model used in this work was found in "[Lagrangian-Eulerian Methods for Multiphase Flows]". The change in particle position is calculated by integrating the following force balance equation.

$$\frac{dV}{dt} = \frac{3}{8}\frac{\rho_f}{\rho_d}\frac{|<U_f>+u_f'-V|}{R_p}(<U_f>+u_f'-V)C_D+g$$

Where

$$C_D = \frac{24}{Re_p}\left(1+\frac{Re_p^{\frac{2}{3}}}{6}\right) \quad Re_p \leq 1000$$

$$C_D = 0.424 \qquad Re_p > 1000$$

$$Re_p = \frac{2\rho_f|<U_f>+u_f'-V|R_p}{\mu_f}$$

Where **g** is gravity which is acting into the page, and therefore doesn't affect the particle velocity. The change in position calculated is then added to the original position.

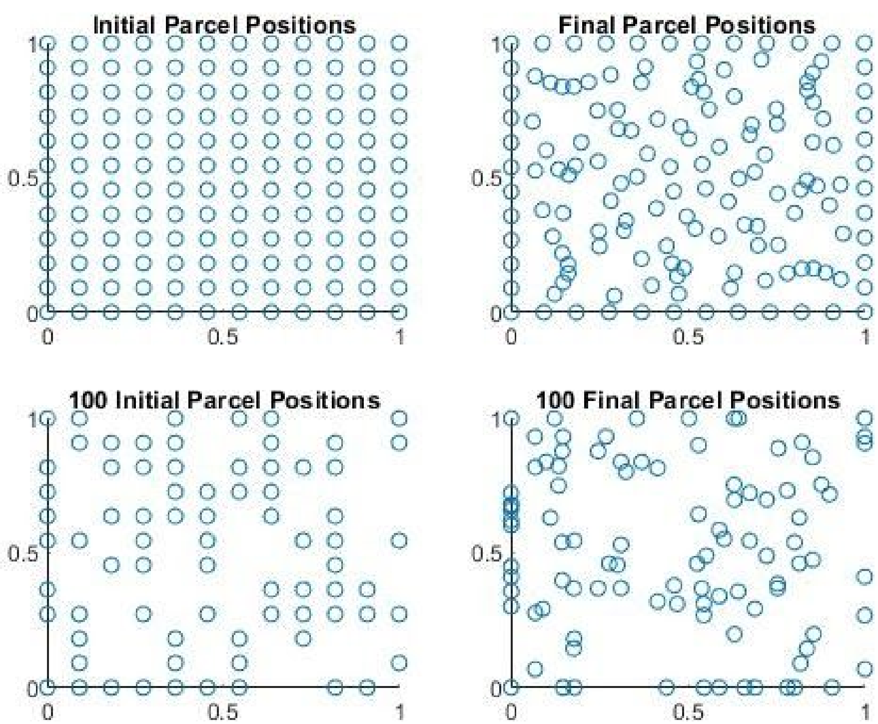


Figure 5: Lagrangian particle tracking test for a 12^2 grid, St=0.2, and 1000 time steps, where T=1, t=10.

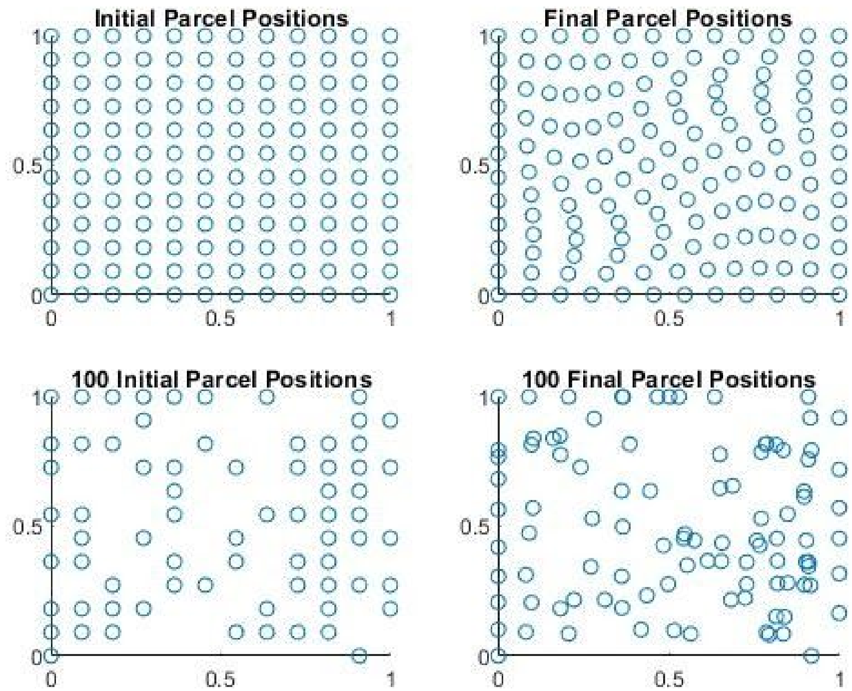


Figure 6: Lagrangian particle tracking test for a 12^2 grid, St=0.8, and 1000 time steps, where T=1, t=10.

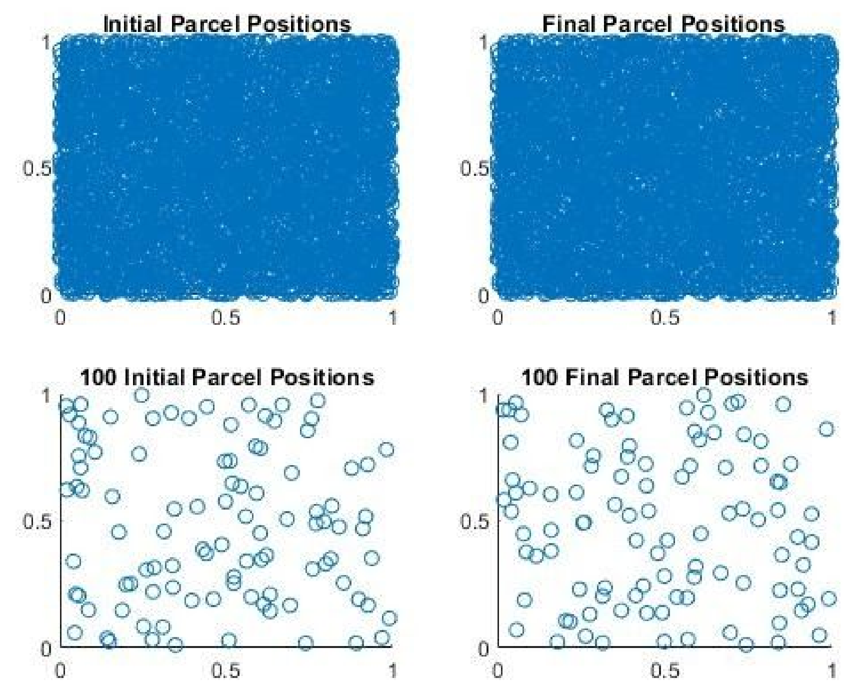


Figure 7: Lagrangian particle tracking test for 5300 particles, St=0.2, and 1000 time steps, where T=1, t=10.

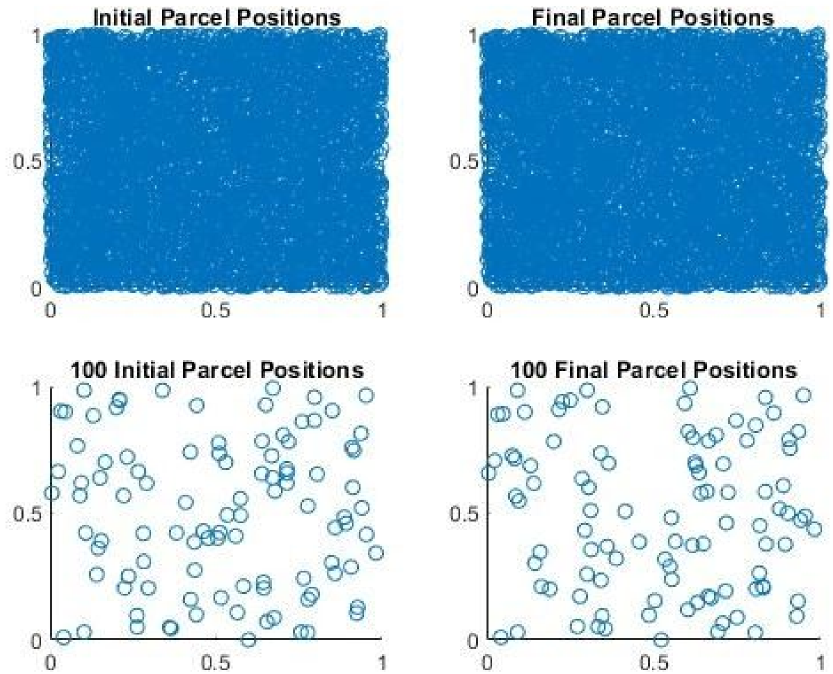


Figure 8: Lagrangian particle tracking test for 5300 particles, St=0.8, and 1000 time steps, where T=1, t=10.

Team Member Contributions:

- Danny Ouk
  - Debugged carrier fluid velocity in Lagrangian Eulerian code
  - Implemented youngsFD.m, reconstruction_test.m, advectionYpos.m.
  - Debugged various geometries in advection schemes
- Joel Strandburg
  - Lagrangian Eulerian Code Base and figures (mainLE.m, InitPosition.m, ParticleVelocity.m)
  - User Interface Creation
  - Contributed to list of advection geometries
- Collin Duffley
  - Interface Tracking Code Base and figures (mainIT.m)
  - Initial circular body of fluid area calculations and initialization (CFDsemiTrapzoid.m, CFDtri1.m, CFDtri2.m
  - Area calculations for reconstruction (areafinder.m)
  - Advection geometries and reflections (advectionXpos.m, advectionXneg.m, advectionYpos.m, advectionYneg.m)