CSE 6730: Jet Engine Flow Simulation

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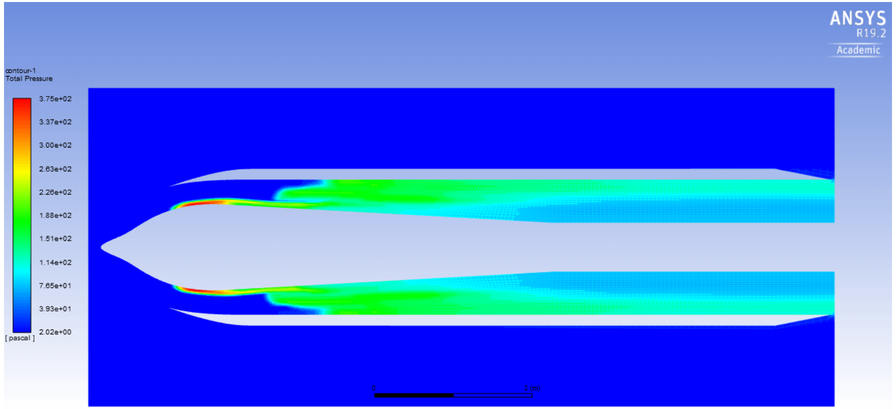
Background and Objectives

- Challenges in using Computational Fluid Dynamics (CFD) modeling supersonic jet engine inlet flows due to **shockwaves altering pressure and temperature**.

- Want to replicate the results from CFD software using an **adaptive first-order Finite-Volume Method(FVM)** to calculate the pressure recovery



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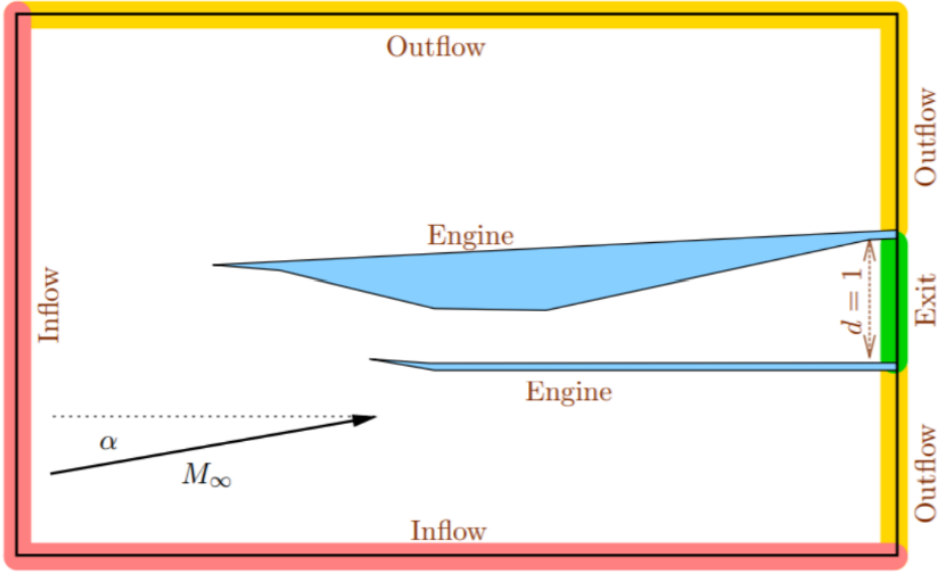
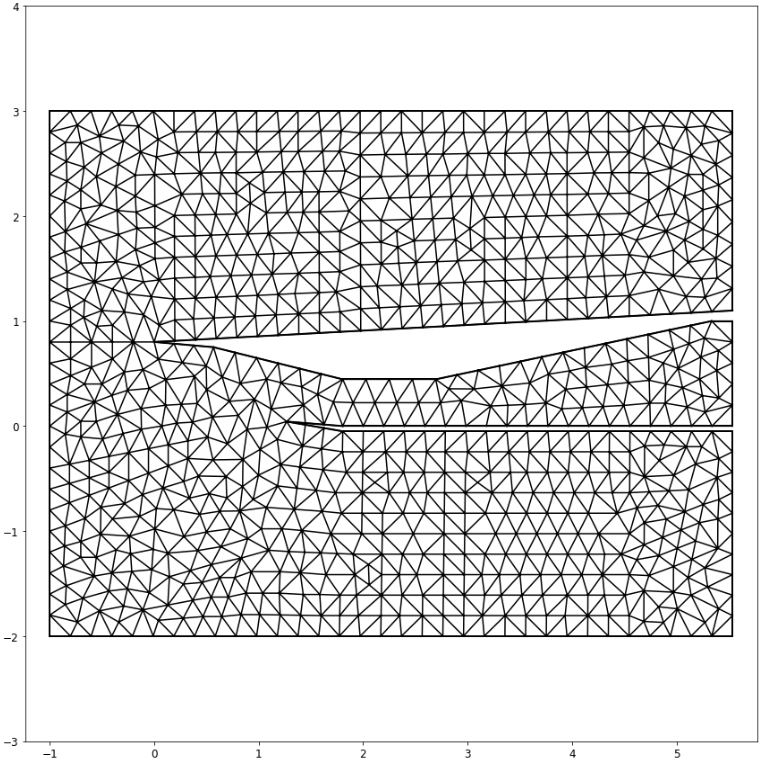
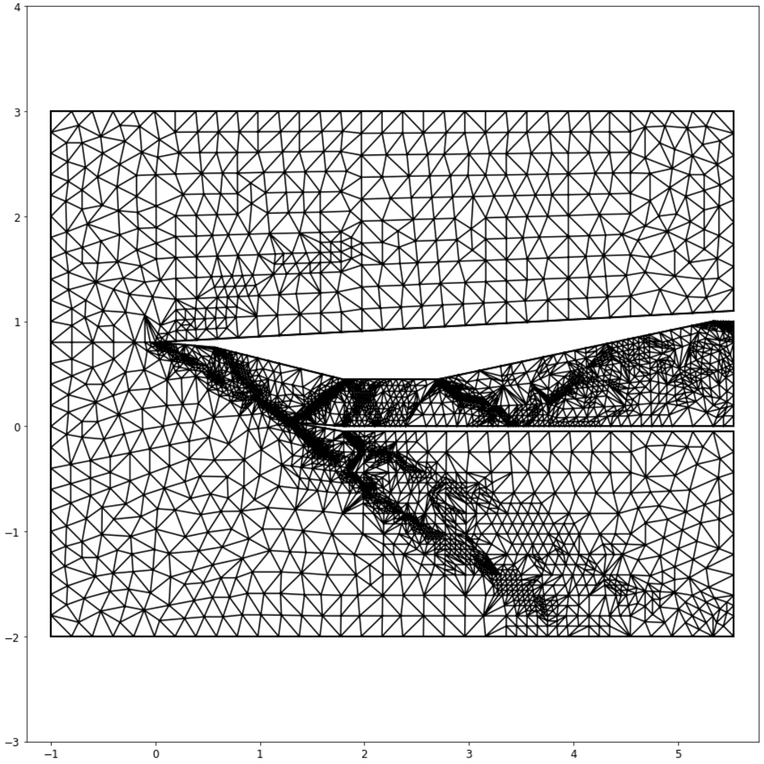
Conceptual Model



- The system under research consists of the scramjet engine inlet and the incoming supersonic airflow.
- The mathematical model is the **Euler Equations** simplified from N-S Equation

Simulation Model - Coarse Mesh & Fine Mesh





Simulation Model - 2D FVM Implementation

- Import the Mesh
- Initialization
- FVM Iterations
  - Residual matrix and CFL helper matrix initialization.
  - Loop over all the edges and elements
  - Call the Roe Flux function
  - Update the helper matrix
  - Calculate the Average Total Pressure Recovery (ATPR).

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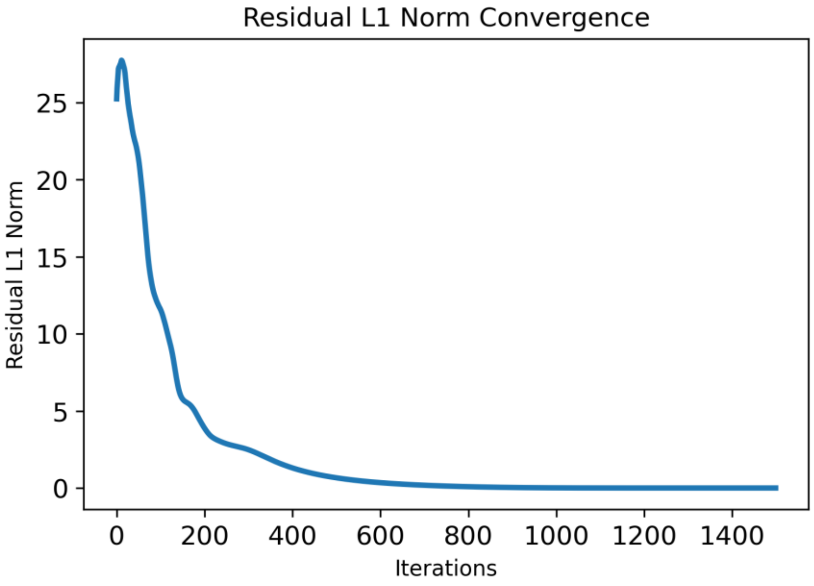
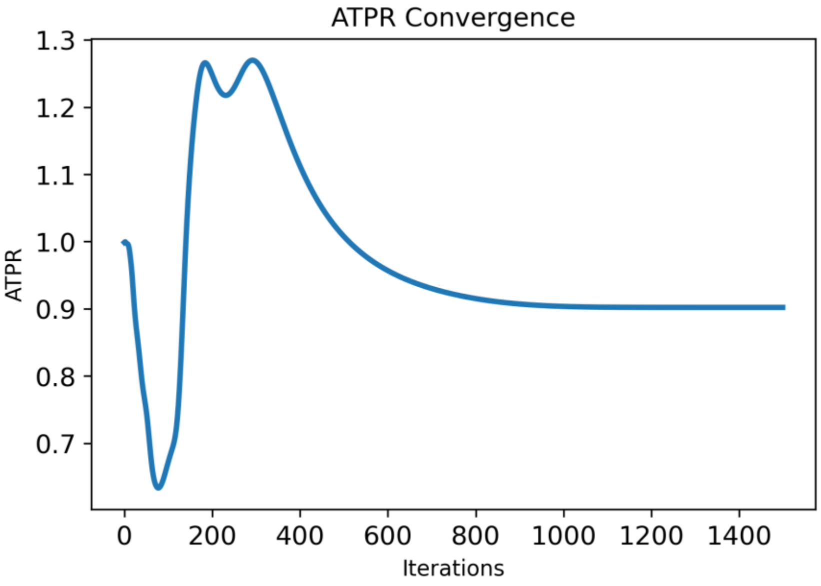
Results Discussion - Convergence Analysis

Convergence of L1 Norm of Residual



Convergence of Total Pressure Recovery Ratio



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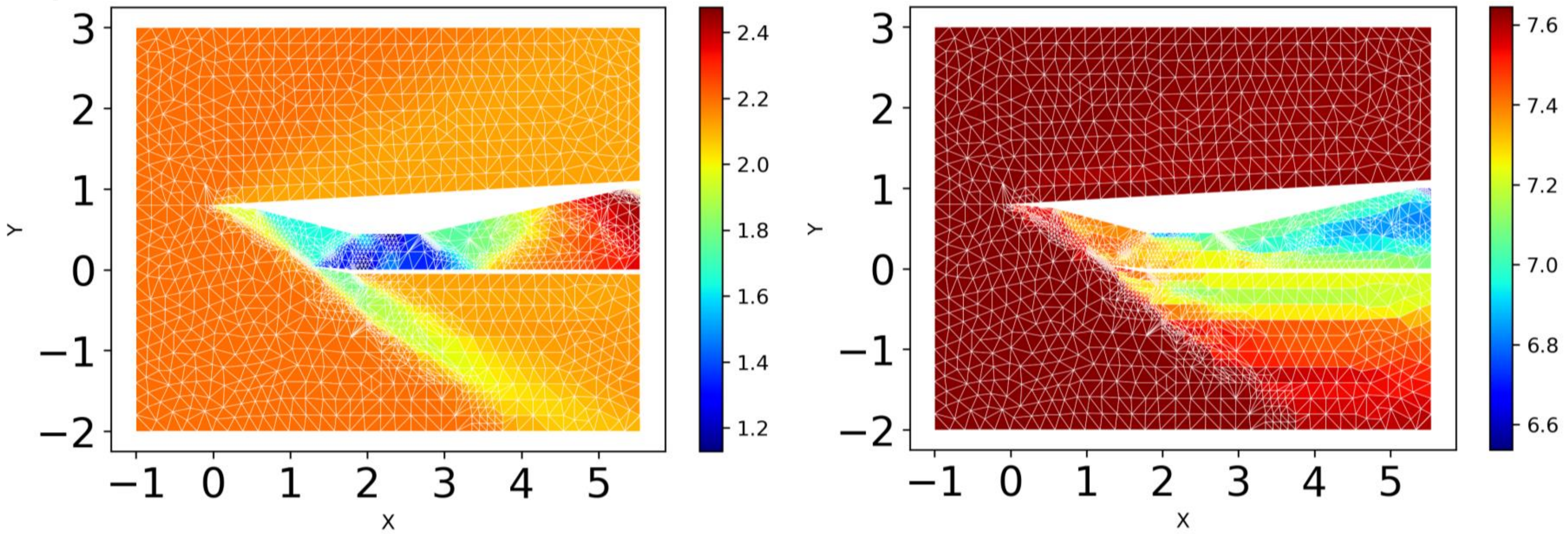
Results Discussion - Contour Plots

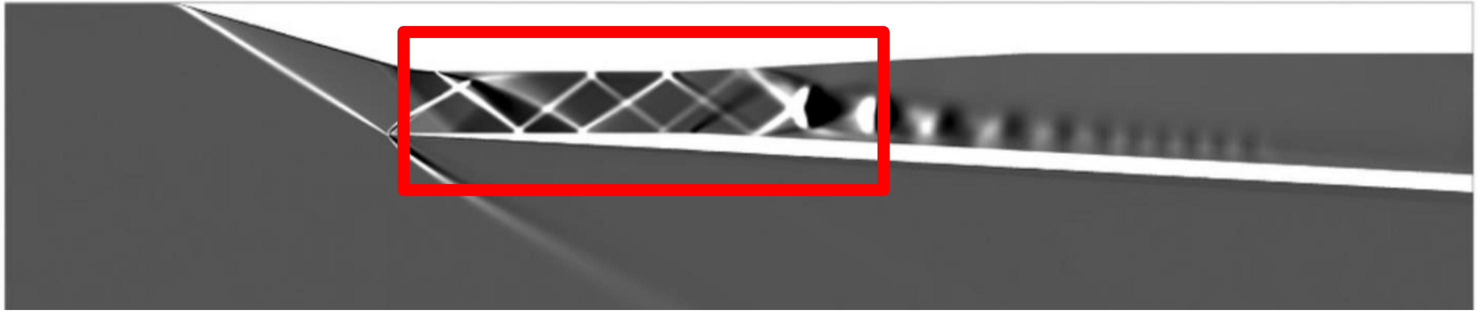
Mach Number Contour Plot

Total Pressure Contour Plot



Validation

- Simulation on the scramjet inlet by Javad and Safa
- The leading shock wave sitting at the entrance
- The complex reflection of the shock waves inside the engine inlet



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Conclusion

- By applying computational methods learned in class, we calculate the supersonic inlet flow pressure recovery and validate our results with publications.

- This project is not only benefical for our CSE field study, but also addresses complex challenges in AE field.

References

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