Finite-Volume Method for Gradient

Homework 4

Handed out: October 22
Due in: October 31

You are given two unstructured grids to complete this homework. They are labeled 20x20, and 40x40. You can use the `checkMesh` utility, or paraview, to find the total number of cells in the domain. This is useful for finding the equivalent cell size.

(1) Use the two unstructured grids that are provided to compute the gradient of a scalar field. The quarter-sine profile is sometimes used to approximate a boundary-layer profile:

$$T(y) = \sin(\frac{\pi}{2}y) \text{ for } x \in [0:1]$$

Initialize the field with this function, and compute the gradient in the y direction using both the Gauss theorem and the least-squares procedure. This can be done by modifying the `system/fvSchemes` file.

(2) Plot the results from each method and grid compared to the analytic solution, at $x = 0.5$. You may use the `sample` utility that is provided by OpenFOAM. This utility requires a command file: `system/sampleDict`. Alternatively, you may use paraview to sample the solution. In either case, be aware that the you may commit additional numerical errors when you post-process your data.

(3) Find the observed order-of-accuracy of each method. Recall that discretization error is a *local* quantity, so when you what to find the observed order, you can use just a single point. You might think about computing the observed order of accuracy at many points.

(4) Plot your approximation to the gradient on the fine mesh, with each scheme, and with error bars. Use the ASME procedure, and also plot the analytic solution.