MESH GENERATION

Applied Computational Fluid Dynamics

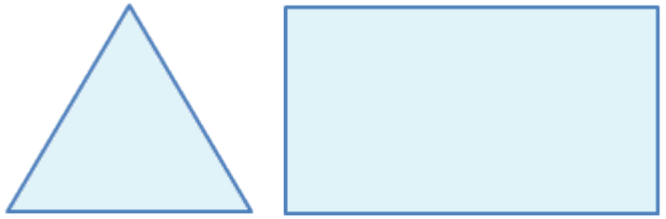
MAE 6220

Outline

- Types of mesh elements
- General refinement settings
- Why is mesh quality important?
- Mesh statistics
- Boundary layer treatment
- Multi-zone mesh

Types of mesh elements

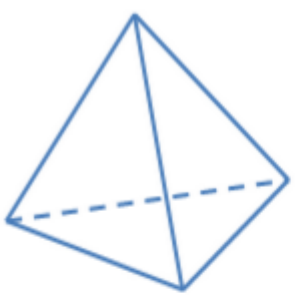
2-D



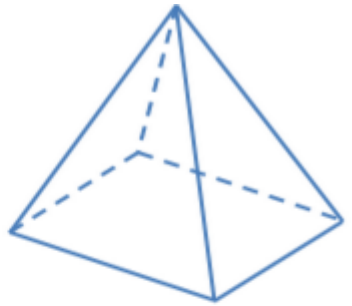
Triangle

Quadrilateral

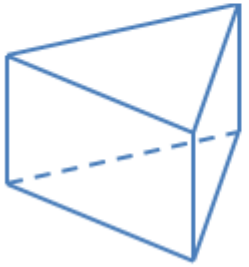
3-D



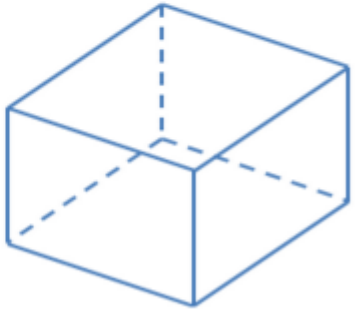
Tetrahedron



Pyramid



Triangular Prism



Hexahedron

Quadrilateral vs. Triangles

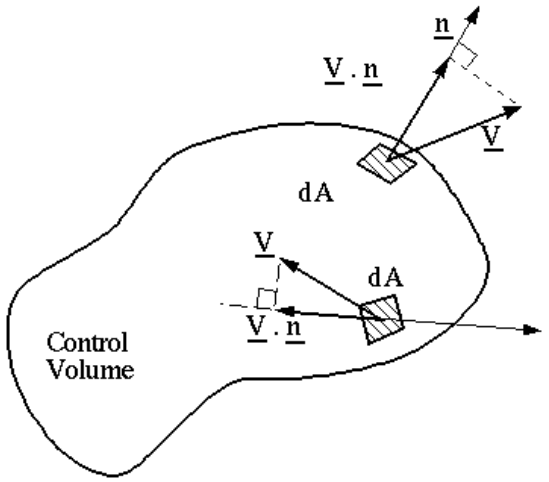
	Pros	Cons
Quadrilateral	• Errors made at opposite cell faces partially cancel • Easier to follow streamlines	• Slower mesh generation • More difficult to handle complex geometries
Triangles	• Fast mesh generation • Can handle any geometry	• Less accurate

Source: J.H Ferziger, M. Peric; *Computational Methods for Fluid Dynamics*; Springer

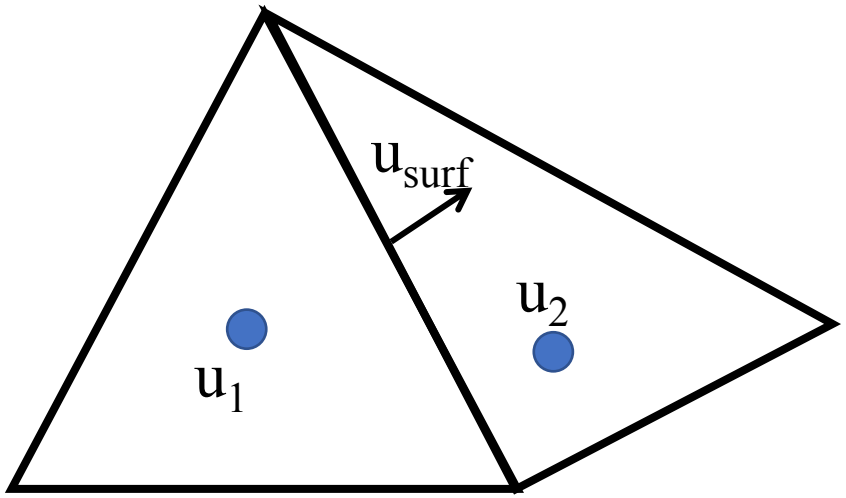
Why is mesh quality imortant?

- Finite volume approach

$$\dot{\phi} = \frac{d}{dt}\left(\int_{CV} \phi\rho d\forall\right) + \int_{CS} \phi\rho(V.n)dA$$

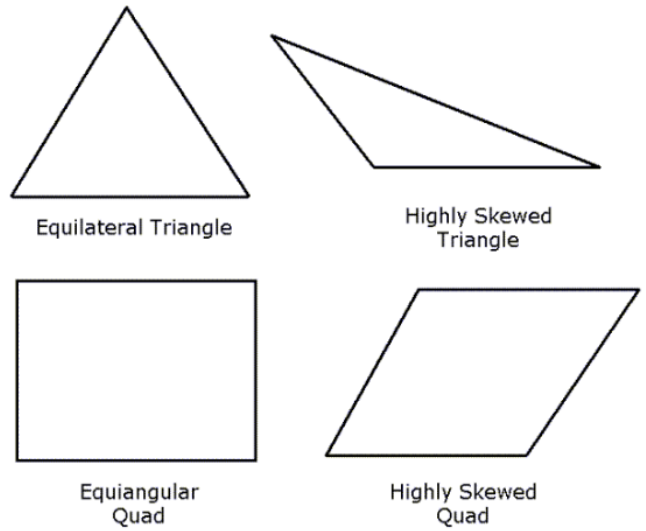


- Velocity at the surface has to be interpolated



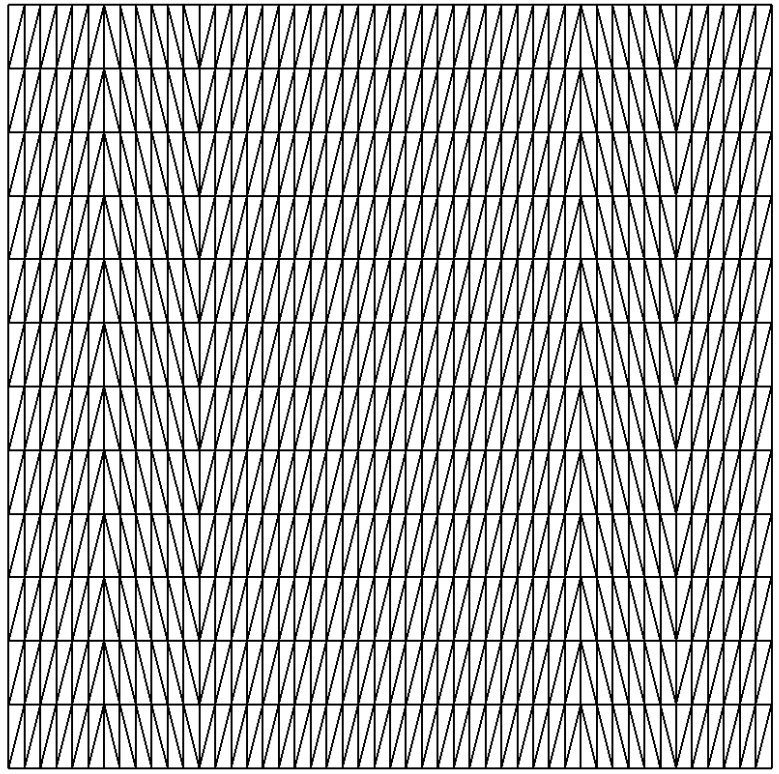
Mesh statistics

- Element quality
  - 1 — Perfect cube
  - 0 — Zero or negative volume
- Skewness
  - 1 — Degenerate
  - 0 — Equilateral or equiangular element

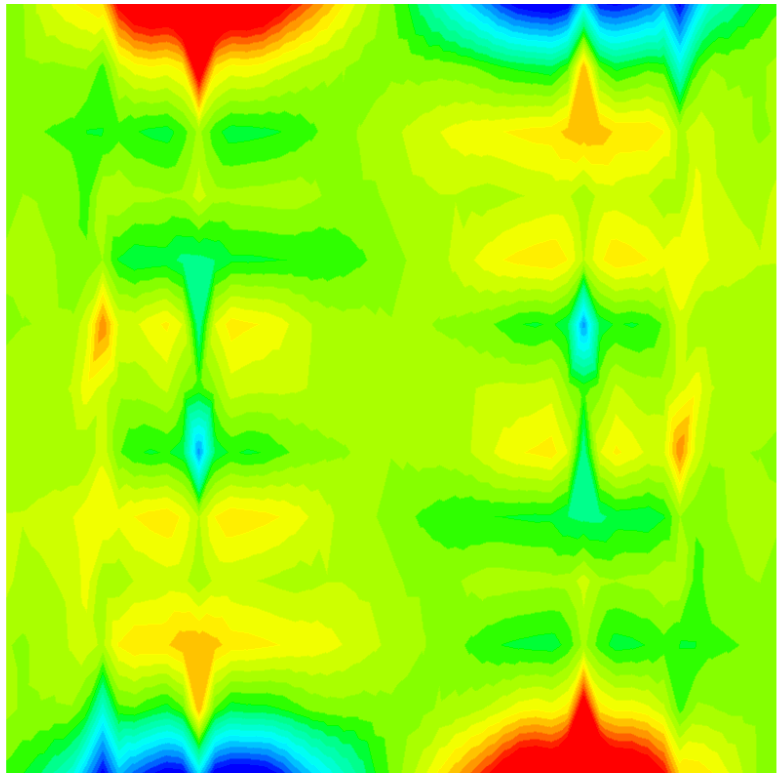


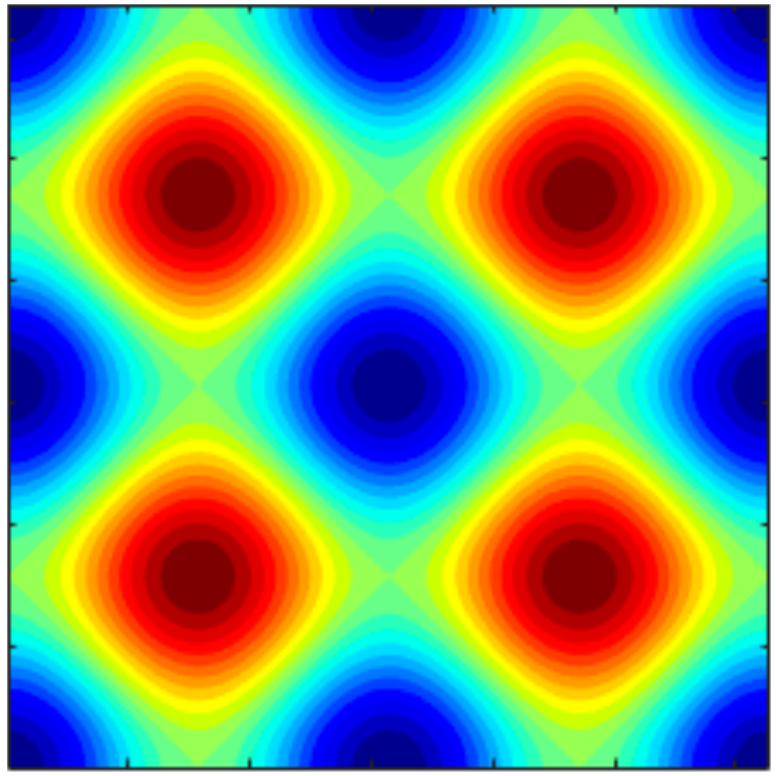
Mesh statistics

- 1152 elements (~32 x 32)
- Highly skewed



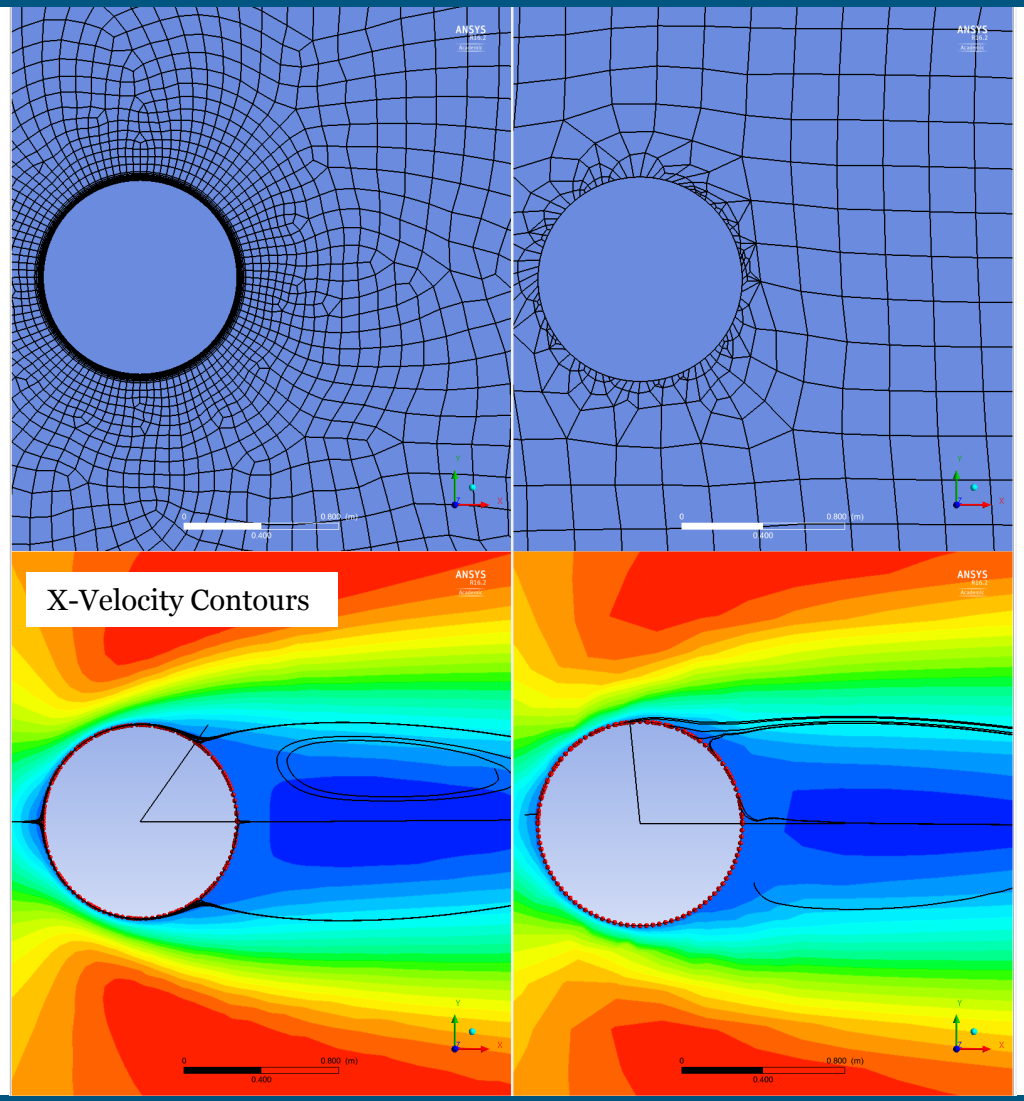
Pressure





Boundary layer treatment

- 100 nodes on the cylinder in both cases
- Asymmetric grid that does not follow streamlines cannot predict the separation point correctly.



Multi-zone mesh