

Math 298  
Fundamental Concepts in  
Computational and Applied Mathematics  
Lecture 4

Juan Meza  
School of Natural Sciences  
University of California, Merced

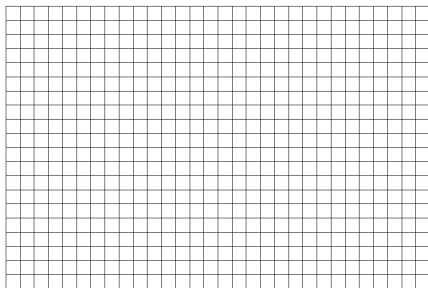
# Structured Grids

- Some terminology
  - cells, elements; triangles, quads, tetrahedrons, hex
  - node, vertex
  - edge, face
- Properties
  - quality of mesh
  - degeneracy
  - dof

# Structured Grid Examples

## Uniform Grid

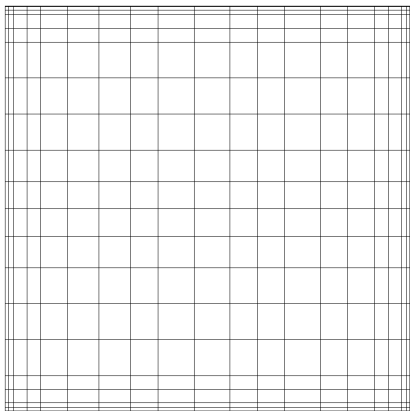
- Simplest of all structured grids,  $(i, j, k)$  indexing
- Easy formula determining location of all nodes
- What are the advantages/disadvantages?



# Structured Grid Examples

## Rectilinear Grid

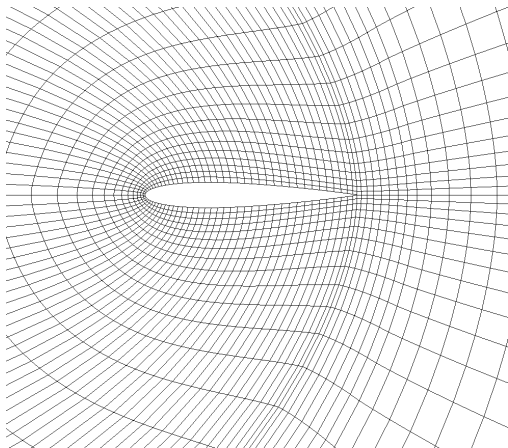
- Similar to uniform grid
- What is the main advantage here?
- What are the disadvantages?



# Structured Grid Examples

## Curvilinear Grid

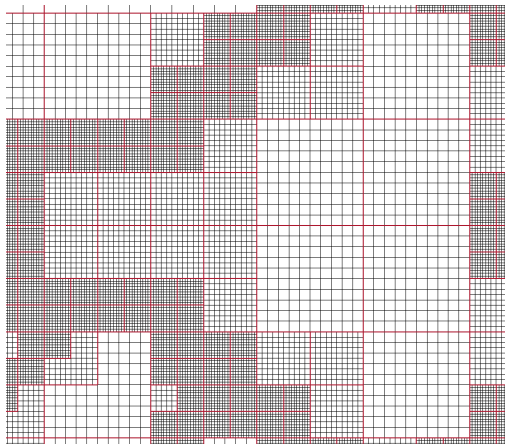
- Note that each node still has the same number of neighbors
- What is the main advantage here?
- What are the disadvantages?



# Structured Grid Examples

## Adaptive Mesh Refinement Grid

- Block structured
- Solves problem of having too much resolution in places that you don't need it
- Software is more complicated
- Error analysis more difficult



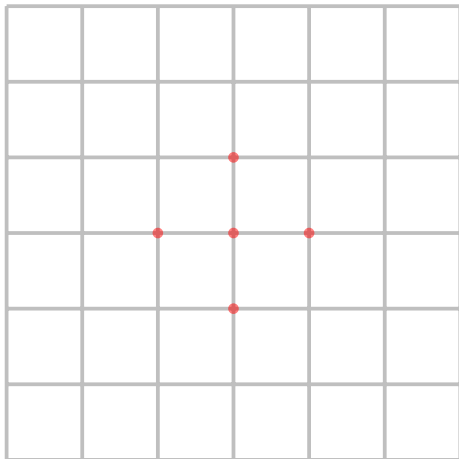
## Properties of Structured Grids

- Number of adjacent mesh elements is always the same
- Generally more accurate per dof
- Convergence of algorithms (linear solvers) usually faster
- Better data layout, which is good for computation

## 5-Point Stencil

### 5-point stencil

- Simplest 2-D case
- Leads directly to a sparse (penta-diagonal) matrix
- Easy to solve with iterative methods



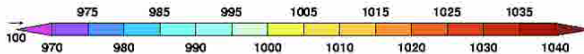
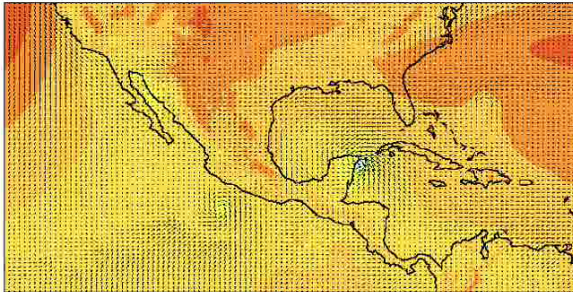


# Structured Grid Applications: Climate Modeling

AdGif - UNREGISTERED

Maximum surface wind speed = 76.703981490904894 mph

Minimum sea level pressure = 993.58273437499997 mb



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## Summary

- Structured grids exist in many shapes and forms
- Well developed and well understood methods available
- Work extremely well on parallel and other high performance computing environments