Fundamental Concepts in Computational and Applied Mathematics

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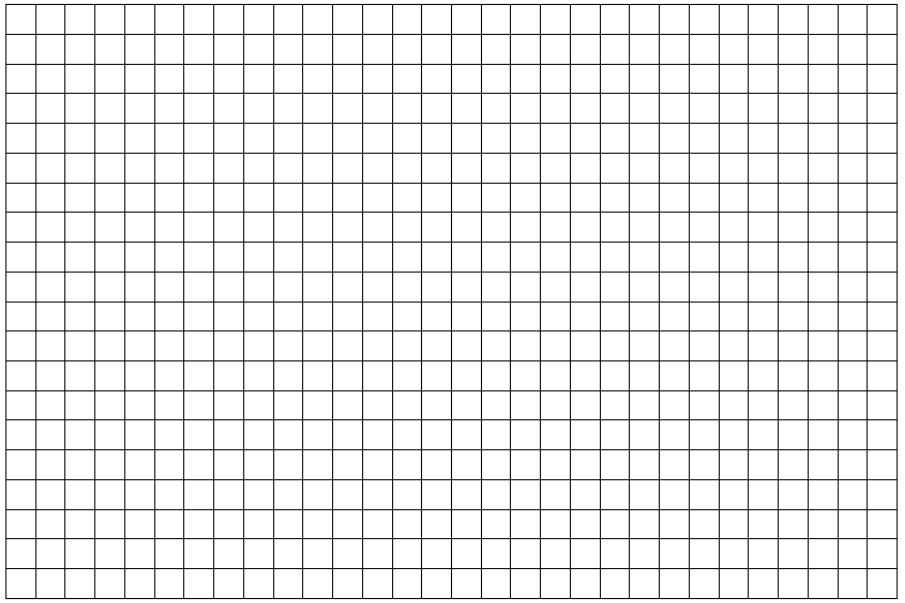
Structured Grids

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

Structured Grid Examples

Uniform Grid

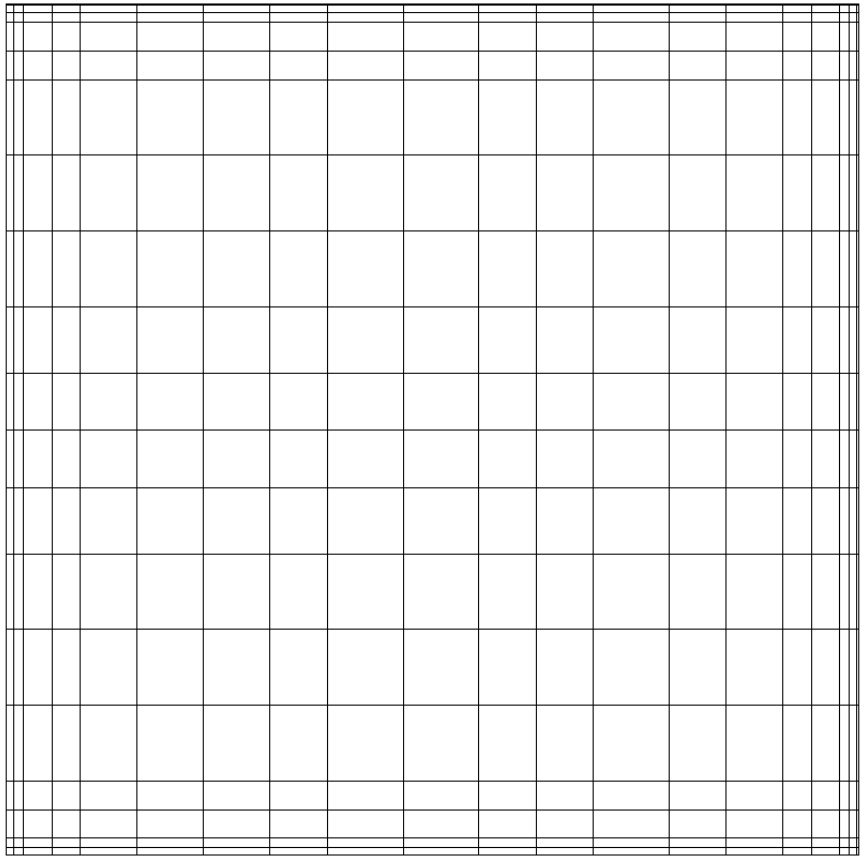
- Simplest of all structured grids, (i, j, k) indexing
- Easy formula determining location of all nodes
- What are the advantages/disadvantages?



Structured Grid Examples

Rectilinear Grid

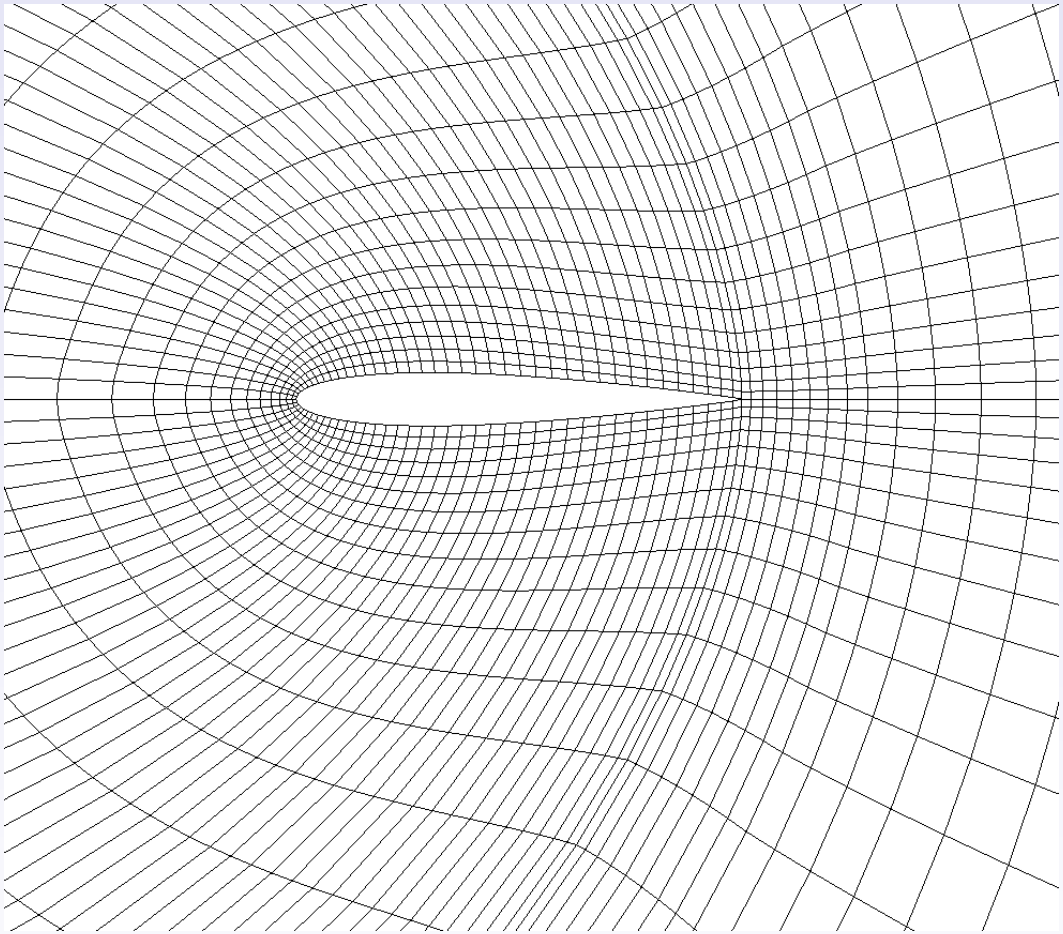
- Similar to uniform grid
- What is the main advantage here?
- What are the disadvantages?



Structured Grid Examples

Curvilinear Grid

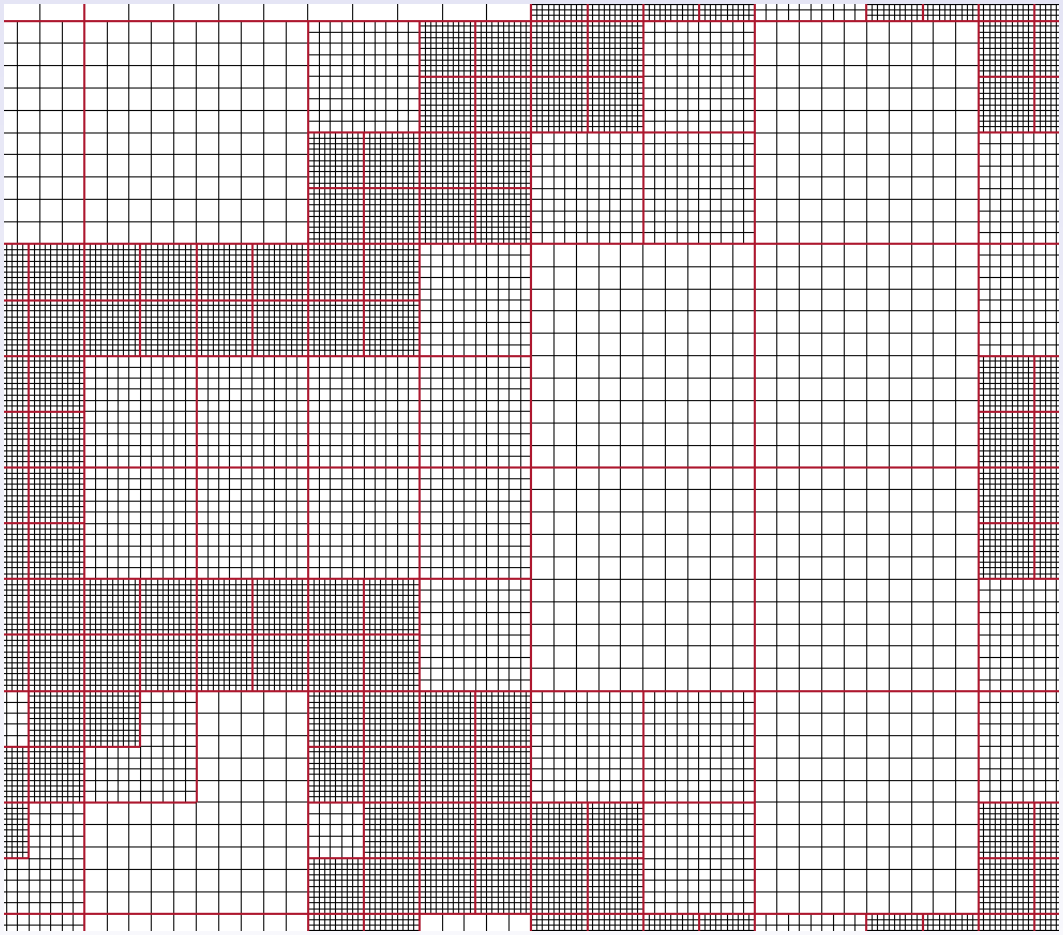
- Note that each node still has the same number of neighbors
- What is the main advantage here?
- What are the disadvantages?



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



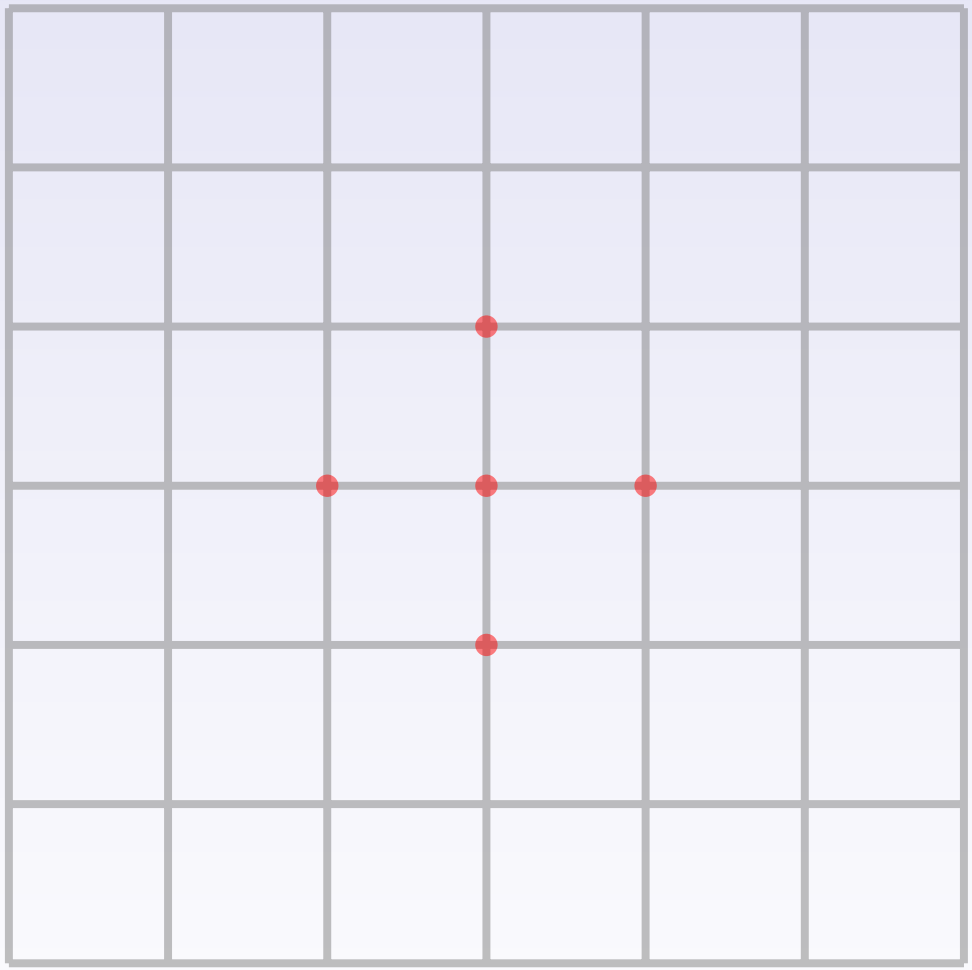
Properties of Structured Grids

- 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

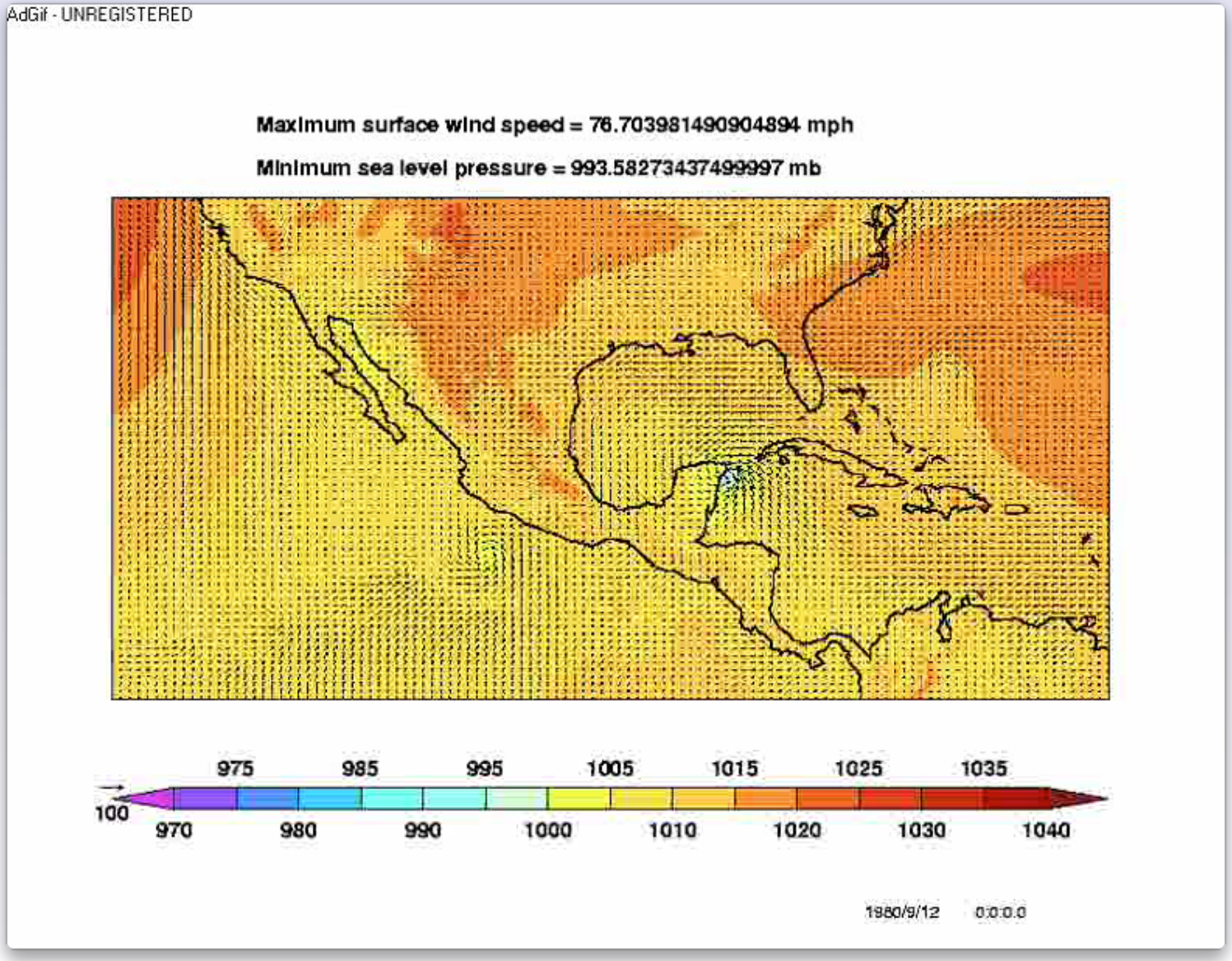
5-Point Stencil

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



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