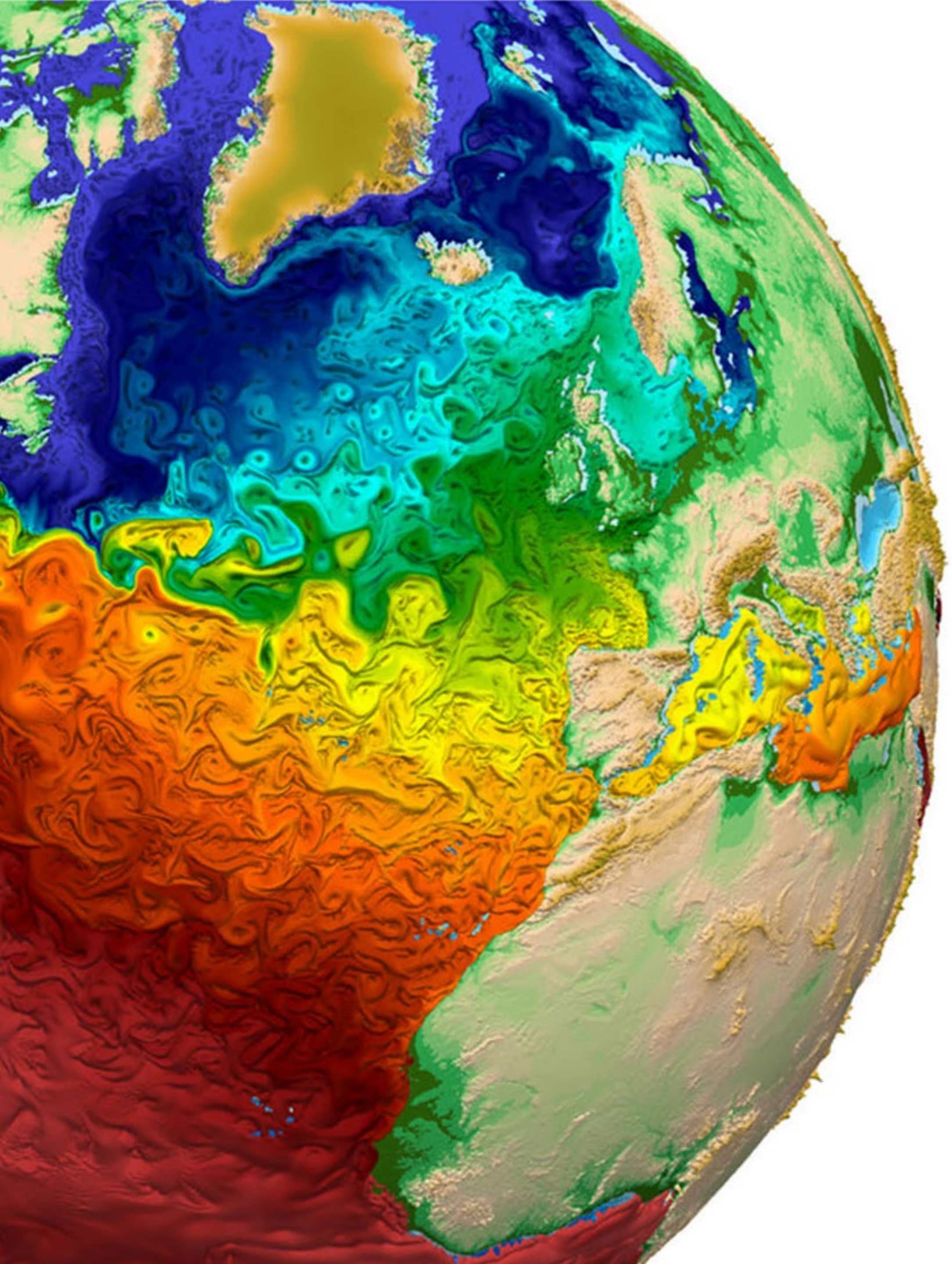


Contouring

Dual Marching Squares

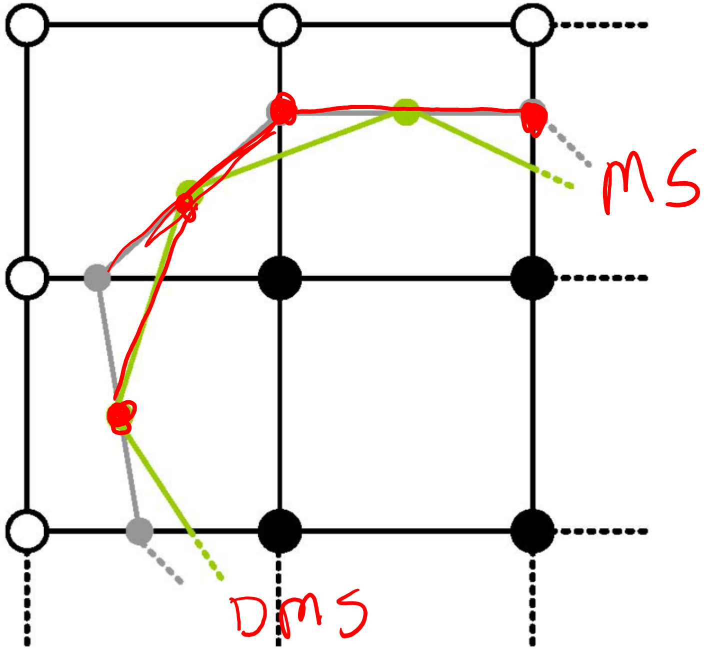
Scientific Visualization

Professor Eric Shaffer

ILLINOIS

Dual Methods

- Dual contouring places isosurface vertices inside mesh elements
- Isosurface vertices in adjacent elements are with edges
  - In 3D these edges connect to form facets (faces of a mesh)



MS DMS

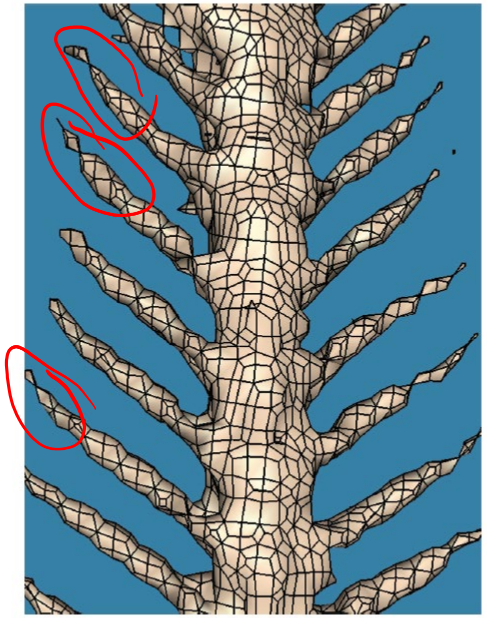
Edge ⟷ Vertex

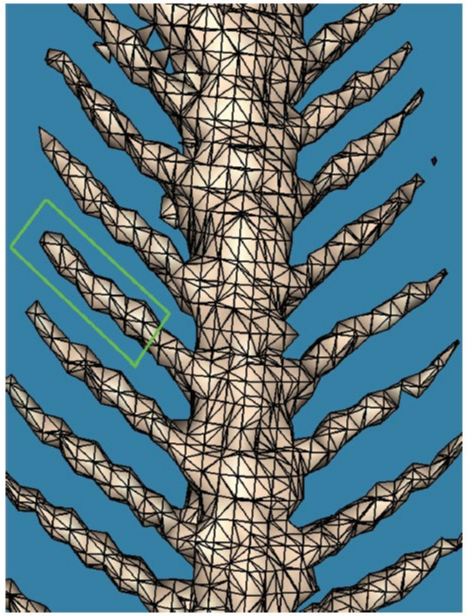
Dual Marching Cubes and Dual Marching Squares

- Allow more than one vertex per cube (squares)
- Dual MC generates quadrilaterals instead of triangles
  - …obviously you can triangulate the quadrilaterals

primal
Marching □s

dual

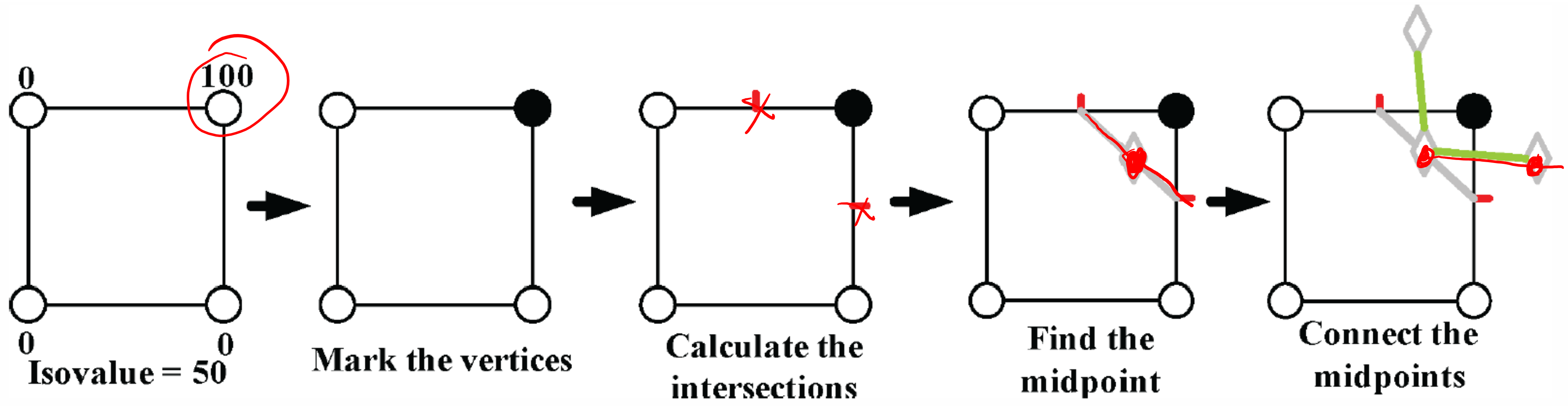




MC surface will be manifold

DMC surface unlikely to be manifold

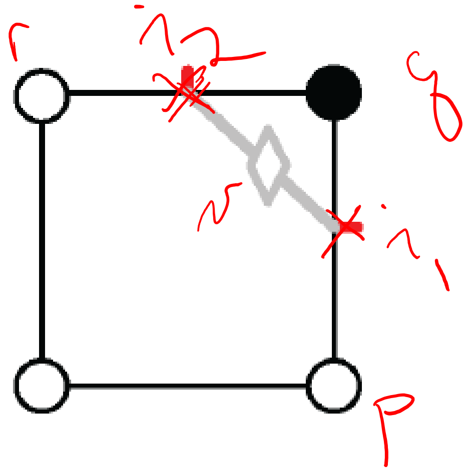
Dual Marching Squares: Algorithm



Positioning Vertices

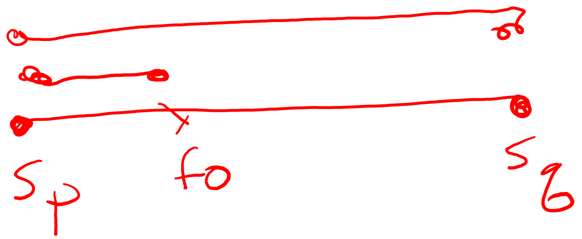
- Compute an intersection point along each bipolar edge
  - Use linear interpolation to estimate where isoline crosses the edge
- Find the midpoint between the intersection points
- Position vertex for isoline at the midpoint

$$\boxed{v = \frac{i_1 + i_2}{2}}$$



For mesh edge $[p, q]$ with $f(p) = s_p$ and $f(q) = s_q$ and isovalue f_0

Place intersection point at $\boxed{(1-t)p + tq}$ where $\boxed{t = \frac{(f_0 - s_p)}{(s_q - s_p)}}$ $\in [0, 1]$



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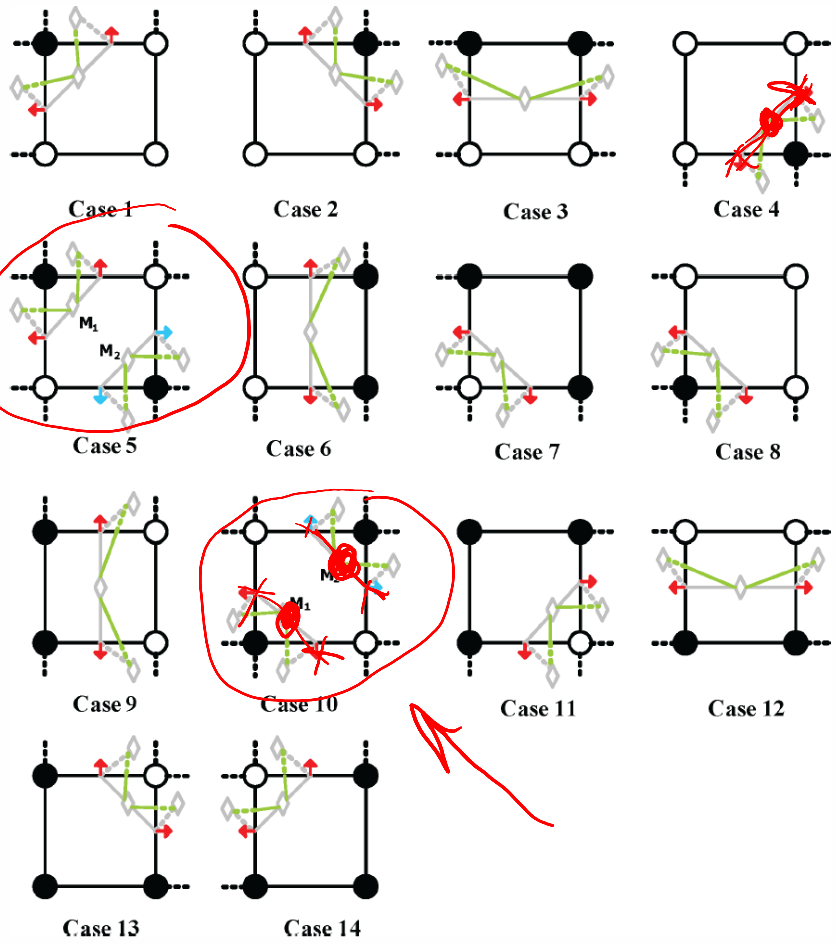
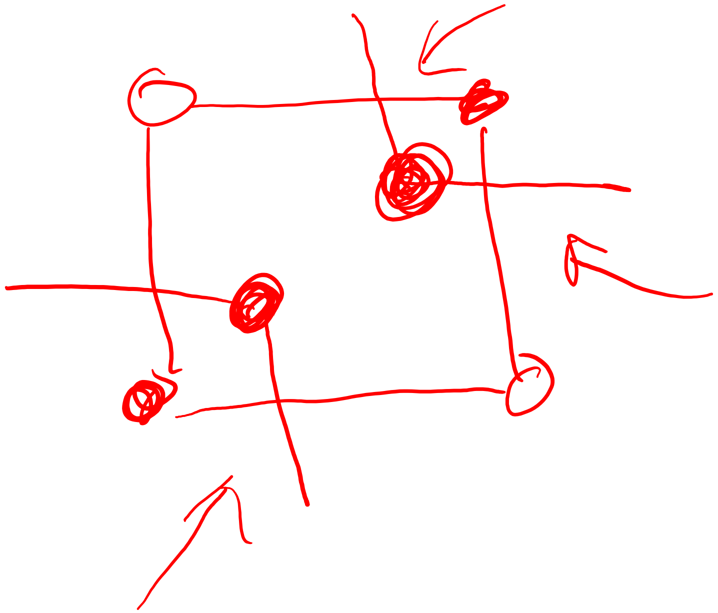
Cell Configurations



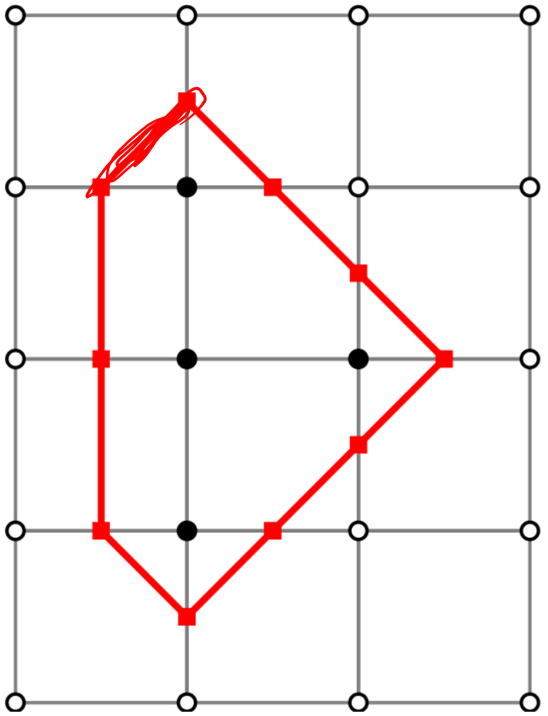


So Why Do This?

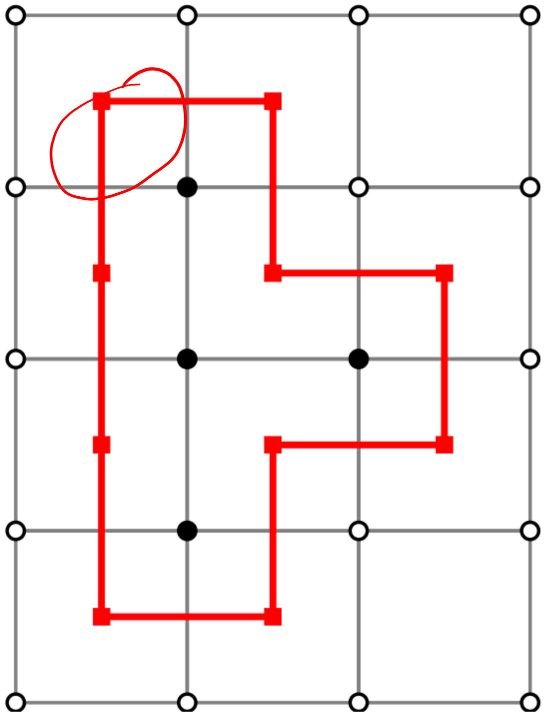
So…why do this when MS already exists?

Empirical evidence that DMS generates better approximations to curved isolines.

- Better at reproducing sharp features
- Simpler to implement



primal



dual