Approximating Material Interfaces during Data Simplification

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Outline

- Motivation
- Multi-resolution Framework
- Material Interfaces
- Discontinuous Field Representations
- Error Metrics
- Pictures

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Motivation

- Too much data and not enough processing power. Therefore some of the data must disappear.
- Computational Datasets operate on a large variety of meshes. Rectilinear Curvilinear, and unstructured.
- Datasets often contain discontinuities or small features that must be preserved when the data is simplified.

Our algorithm

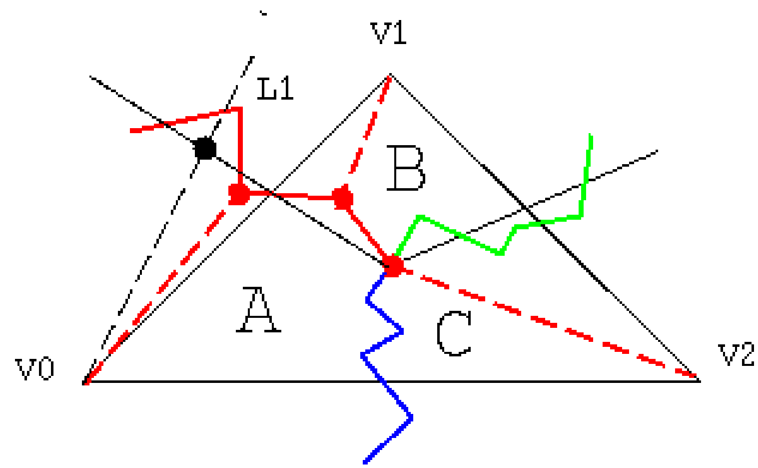
- Simplify dataset by resampling rather than decimating the original mesh.
- Recursive tetrahedral mesh presented by Kaufman et. al. provides the basis for our *Multi-Resolution Framework*.
- Represent discontinuities explicitly within each cell. (Polygon Mesh)
- Separate field representations for either side of a discontinuity.

Multi-resolution Framework

- Interactive level of detail transition between pre-computed levels of detail.
- Strict L^{infinity} error bounds.
- Local and adaptive mesh refinement and local error computations.
- Adaptability to different input meshes.
- Explicit representation of discontinuities.

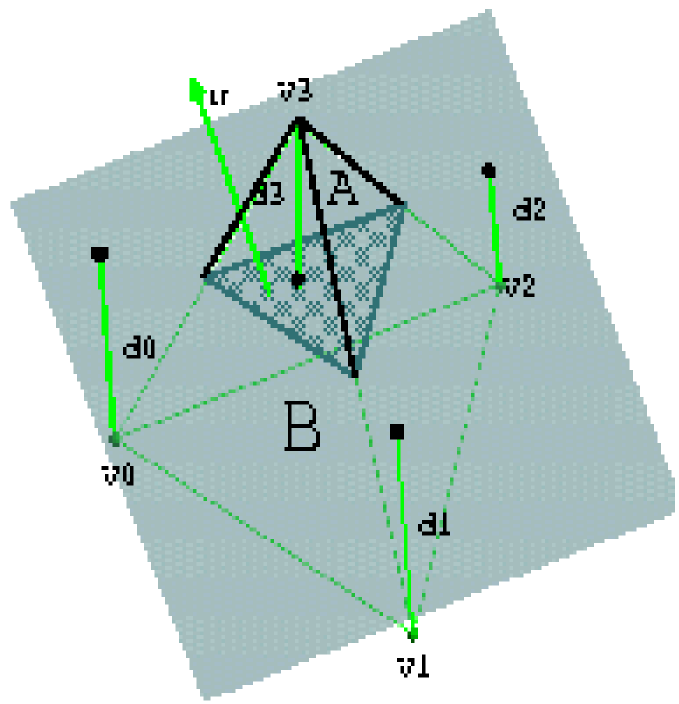
Material Interfaces

- Discontinuity between two distinct materials.
- Example: A missile impacting armor.
- During simplification cells that contain these discontinuities can have large amount of error.
- Example: the difference of density field between oil and water.



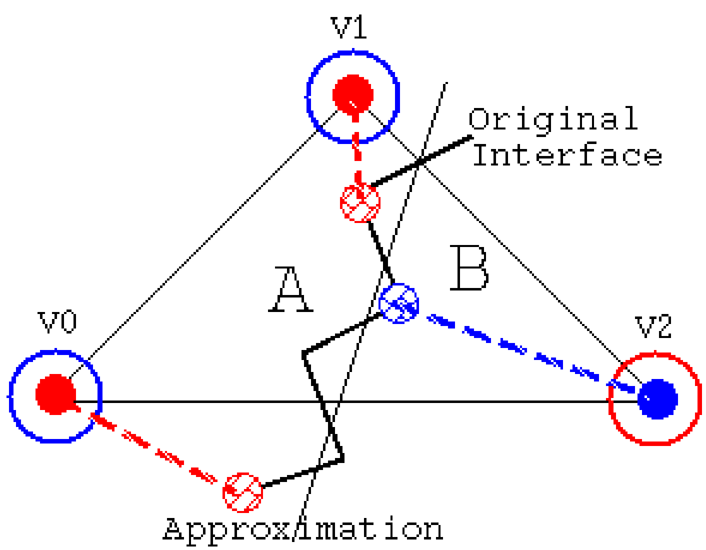
Extraction and Approximation

- Interfaces computed via volume fractions.
- Represented as the zero set of the signed distance function.
- Each vertex has one signed distance value per interface.
- Linear, continuous, and local.



Discontinuous Field Representations

- Field rep needed for each material in cell.
- Each vertex needs a distinct field value for each material.
- Extrapolate *Ghost Field Values* at the vertices for each material that the vertex is not in.

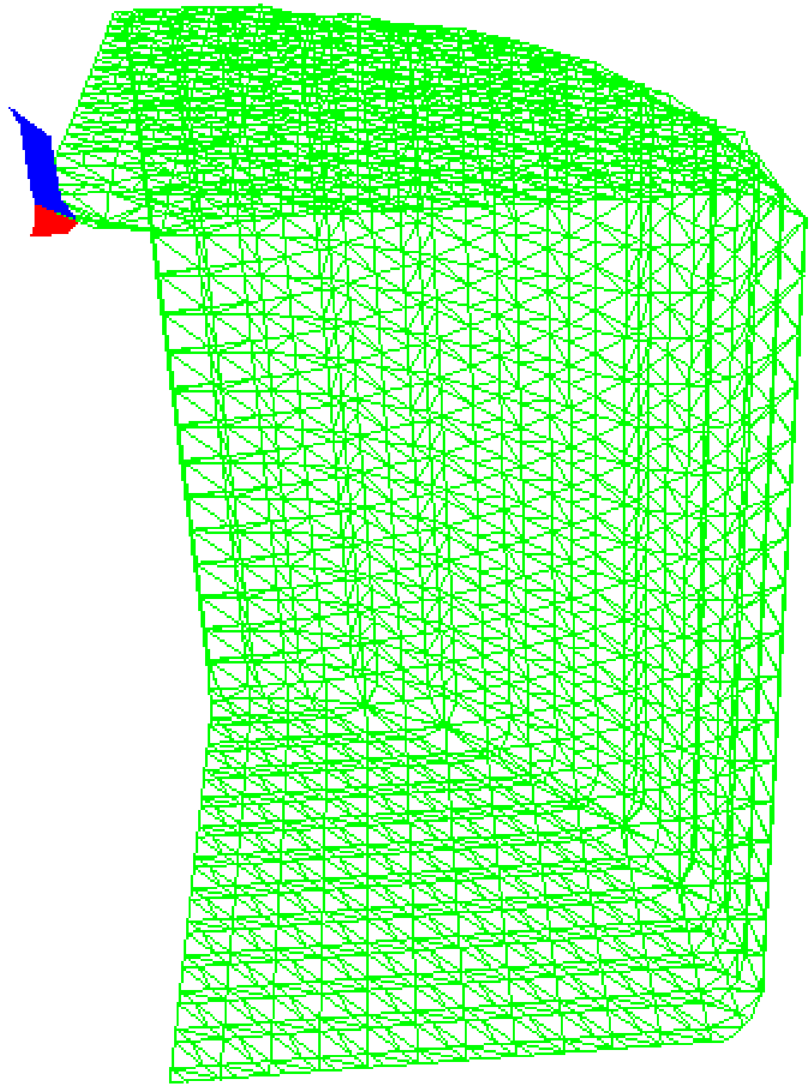


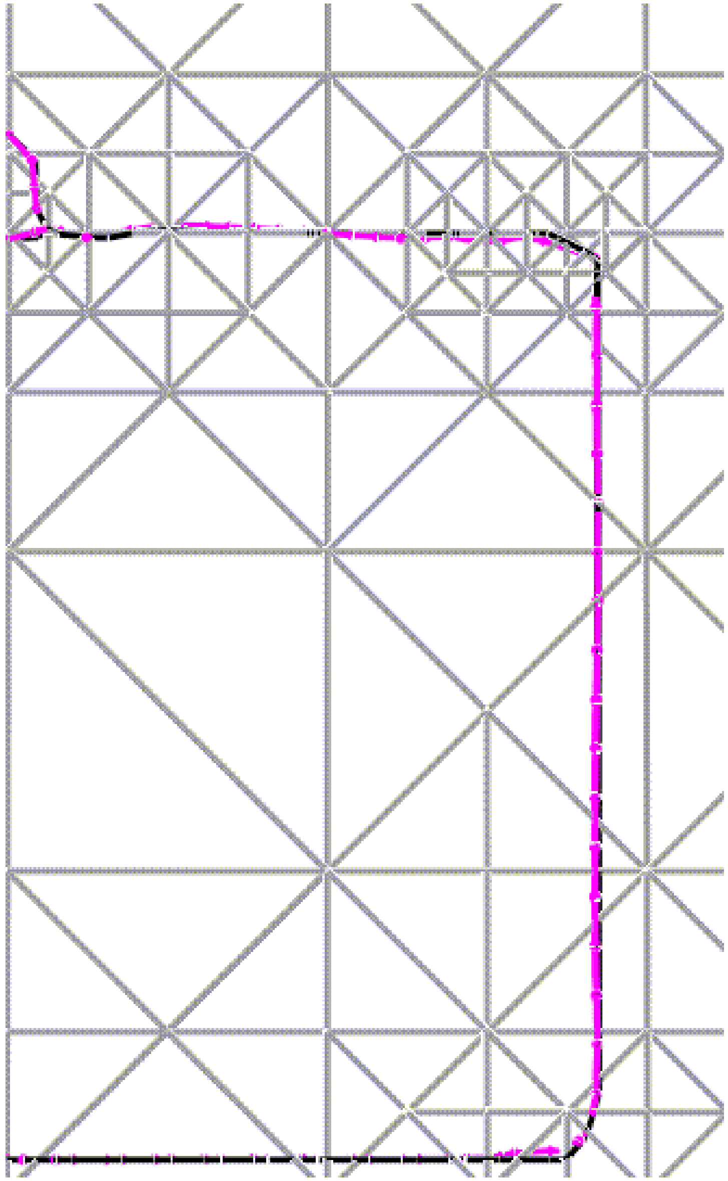
Error Metrics

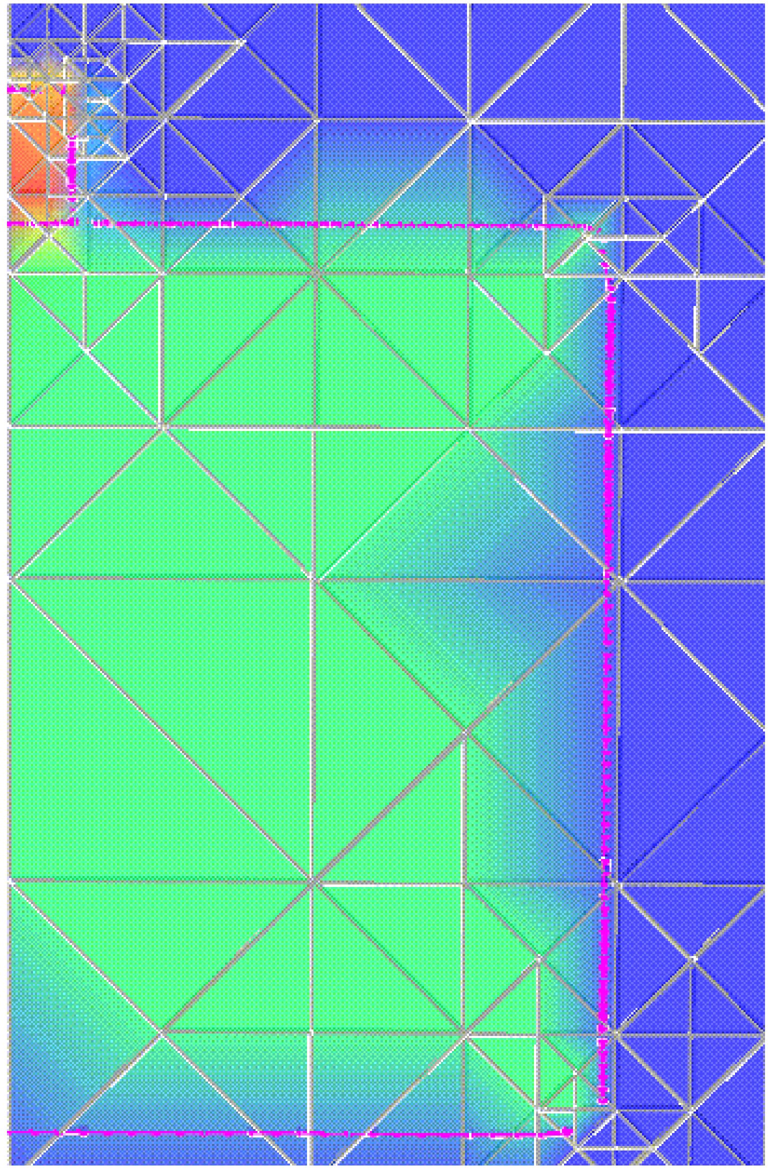
- Each cell has field and interface errors.
- $\text{cell}_{\text{err}} = \max(\text{child}_{\text{err}}) + \text{split vertex}_{\text{err}}$
- Interface error is the max distance of an interface vertex from the approximation.
- Original Mesh must be composed of *Native Data Elements* (NDE).
- NDE must have a spatial extent and a well defined method of interpolation.

Error Metrics cont.

- One of our cells (tetrahedron) can intersect several NDE.
- We assume it is possible to bound the difference between our field and the original field over this common region.
- Cell error is the maximum difference for all NDE that intersect the cell.
- Currently NDE are grid points.







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