Batched Multi Triangulations

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VIS 05

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Introduction

Accurate adaptive efficient rendering
of very large static meshes

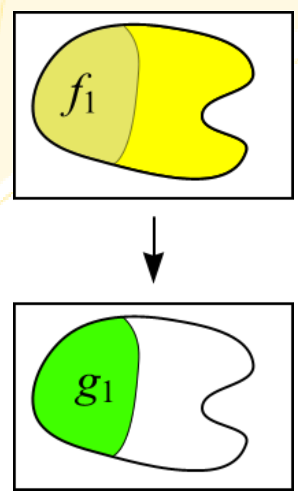
- Isosurfaces, scanned objects etc
- Hundreds of papers.
- Recent trends in multires surface representation (some)
  - To harness the power of graphics hw
  - Out of core management
  - Low CPU usage approaches

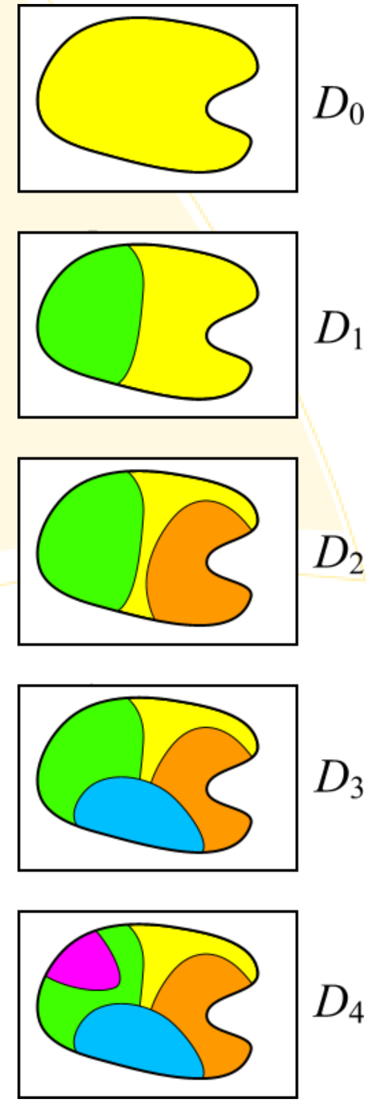
Multi Triangulations

- MT is a well known framework to describe a multiresolution models
- Consider a sequence of local modifications over a given description *D*
  - Each modification replaces a portion of the domain with a different conforming portion (simplified)
  - f_1 floor
  - g_1 the new fragment

$$D' = D \setminus f \cup g$$

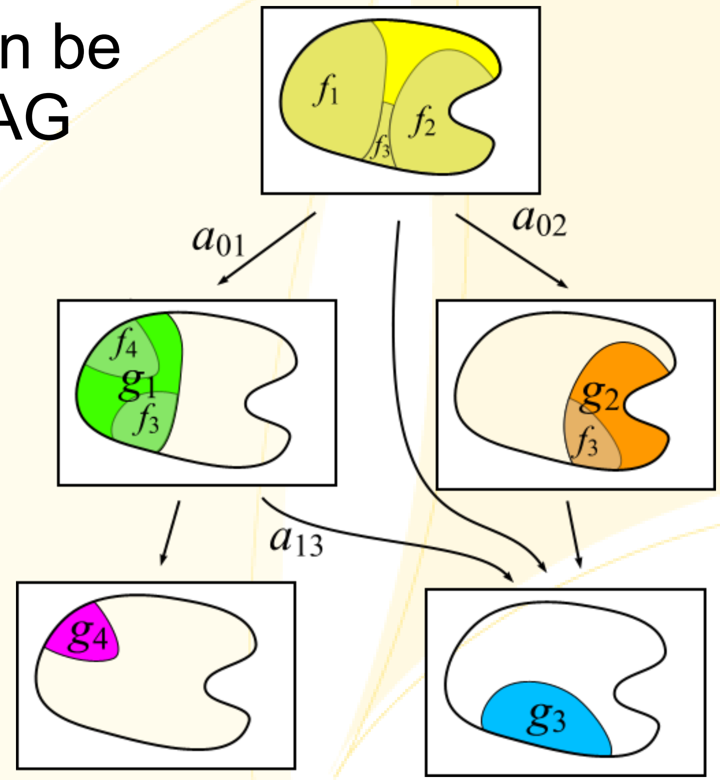
$$D_{i+1} = D_i \oplus g_{i+1}$$

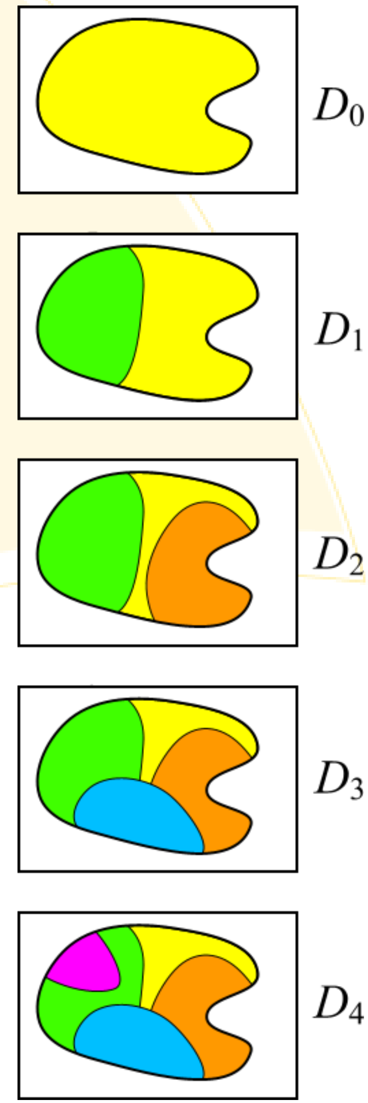




Multi Triangulations

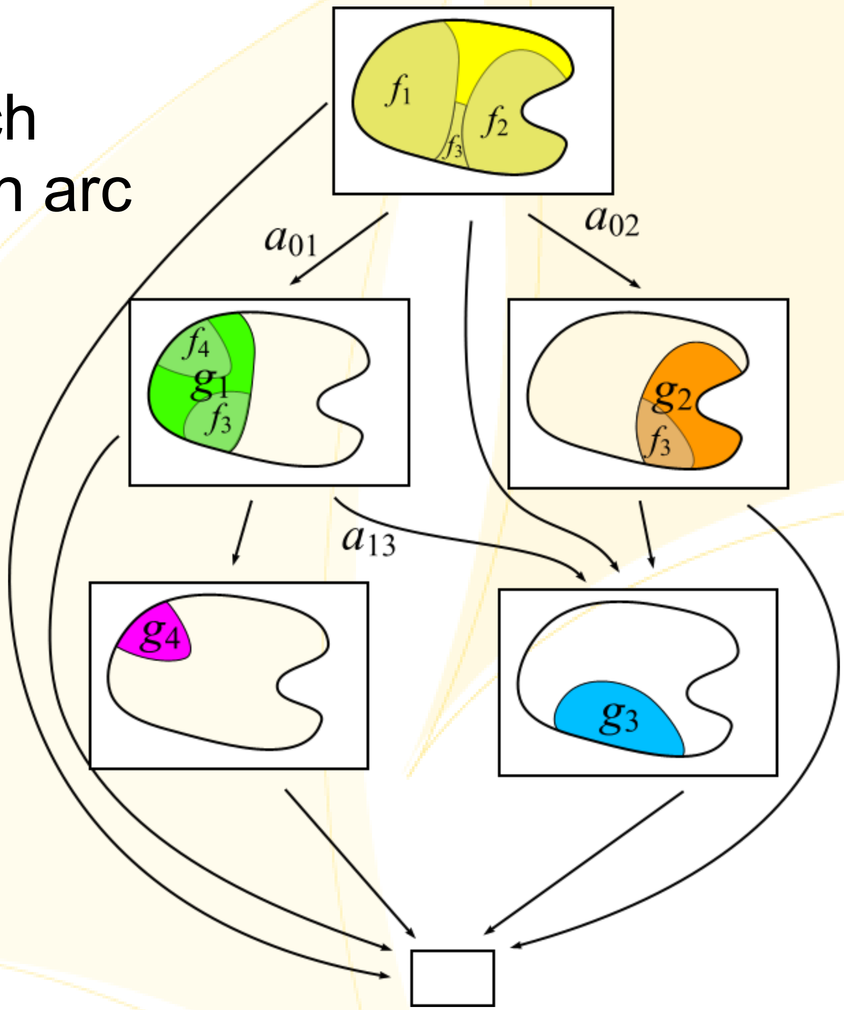
- Dependence between modifications can be arranged in a DAG

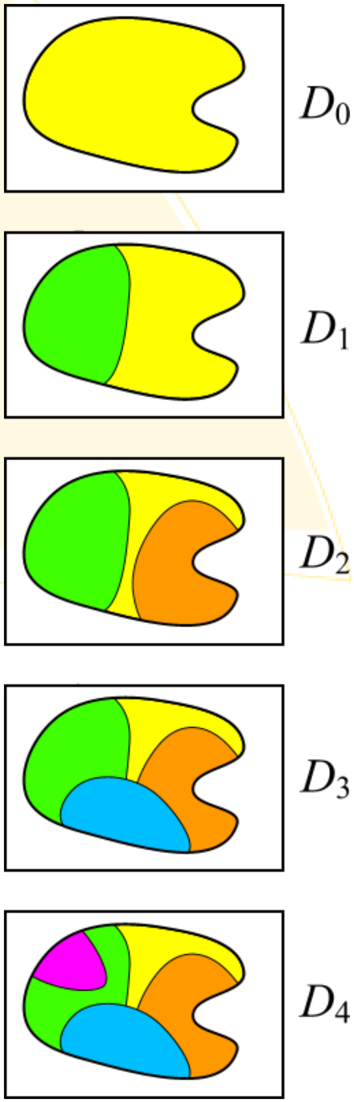




Multi Triangulations

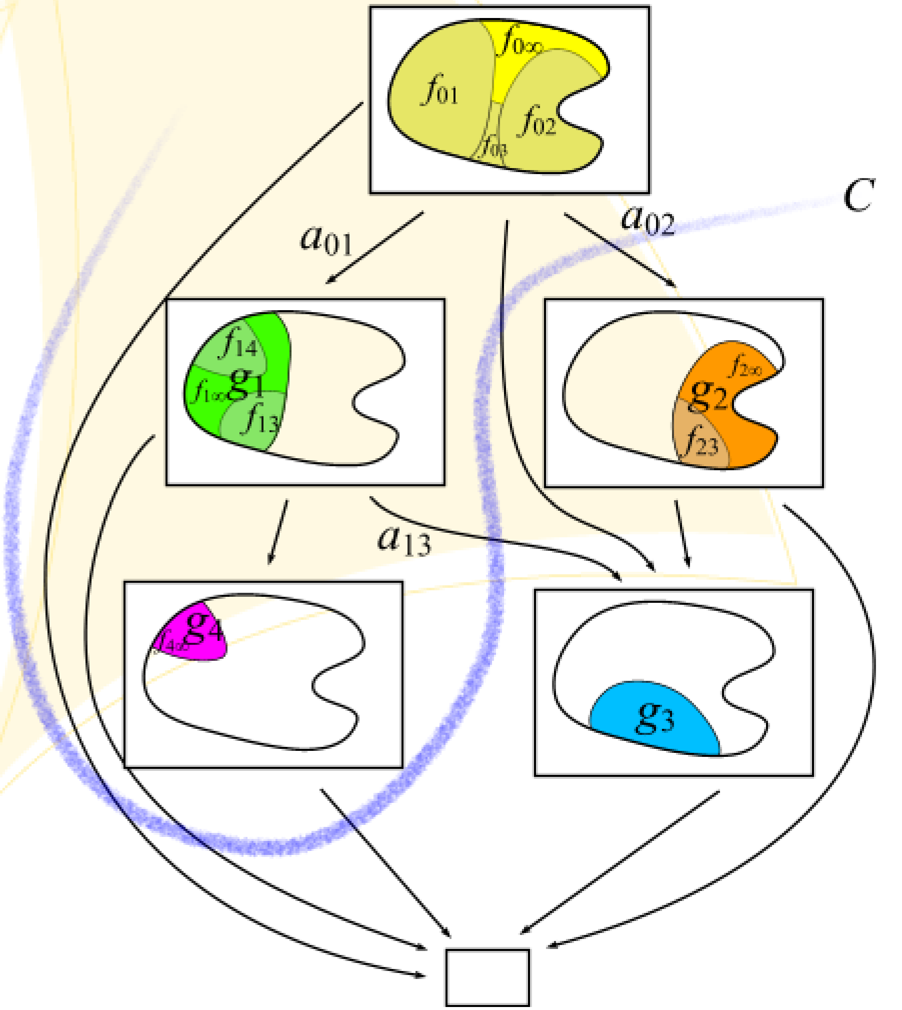
- Adding a sink to the DAG we can associate each fragment to an arc

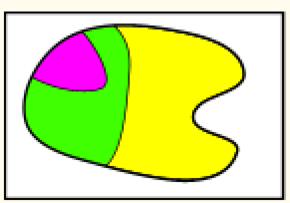




MT Cuts

- A cut on the DAG defines a new representation
-



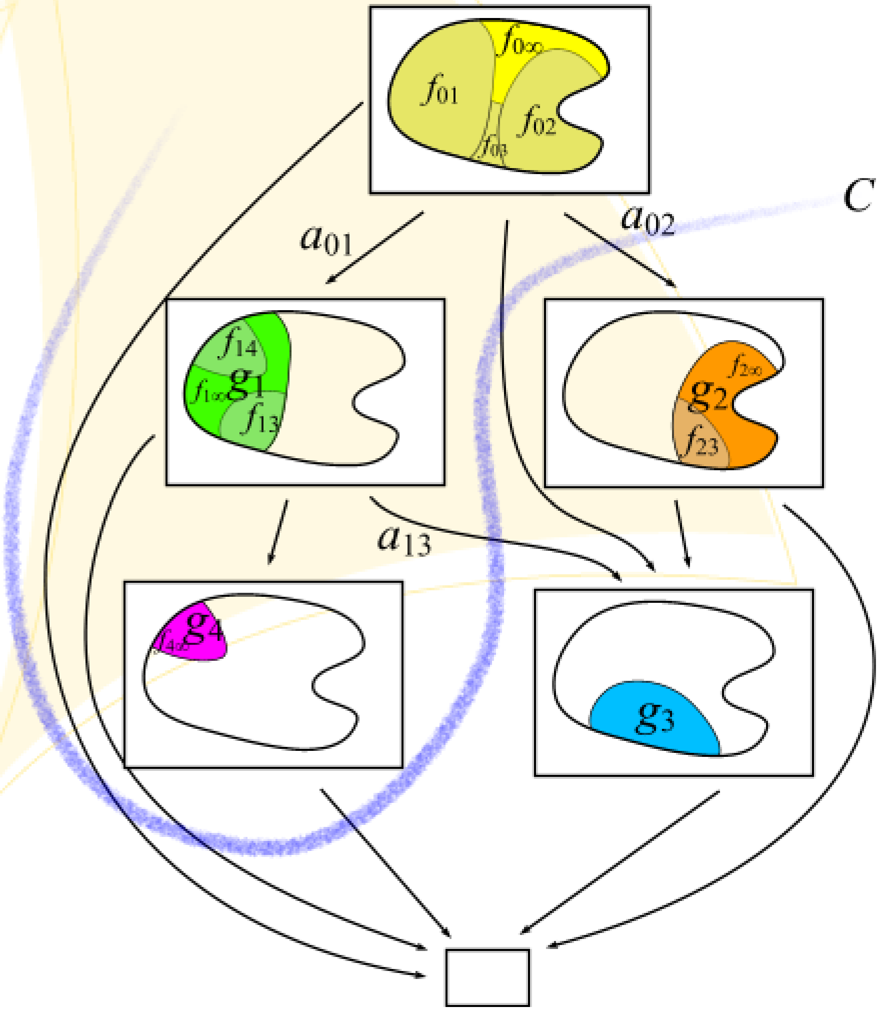


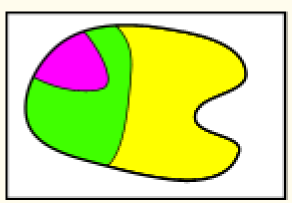
D^*

$$D^* = D_0 \oplus g_1 \oplus g_2 \oplus g_4$$

MT Cuts

- A cut on the DAG defines a new representation
- Collect all the fragment floors of cut arcs and you get a new conforming mesh
  - just load and render
  - low cpu workload
  - fit very well in extended memory hierarchies





D^*

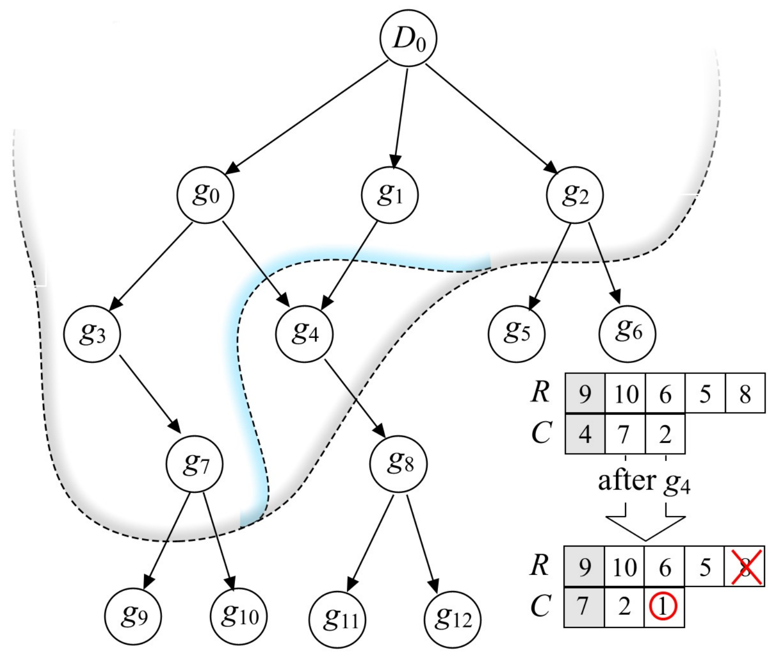
$$D^* = D_0 \oplus g_1 \oplus g_2 \oplus g_4 = f_{0\infty} \cup f_{02} \cup f_{03} \cup f_{13} \cup f_{1\infty} \cup f_{4\infty}$$

Rendering a MT

- Fragment are patches of triangles
  - Optimized (tristripped) and stored compressed on disk
  - Obtained with an high quality simplification alg.
  - DAG << original mesh (patches composed by 8k tri)
- At run time two threads: Render and PatchServer
  - ***Render***
    - Update the cut (moving in and out MT nodes)
    - Choose patches to be prefetched
    - Render the selected fragments
  - ***PatchServer***
    - Load and uncompress requested patches from disk into memory
- Culling
  - Standard frustum and hw based occlusion techniques defined for generic hierarchies can be easily adapted to DAGs

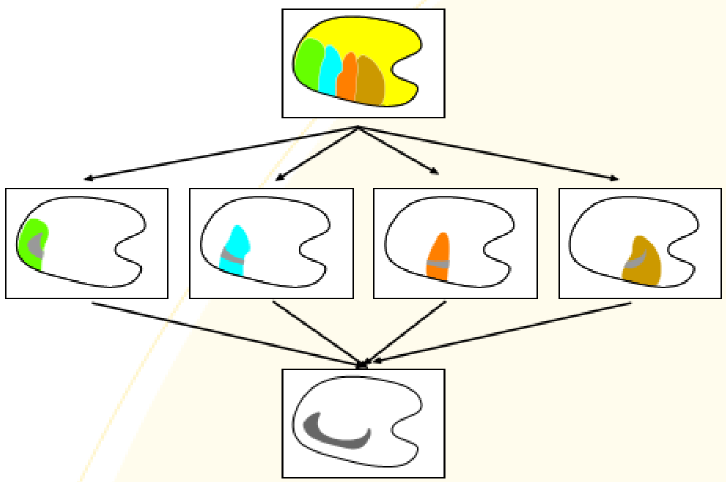
Rendering a MT

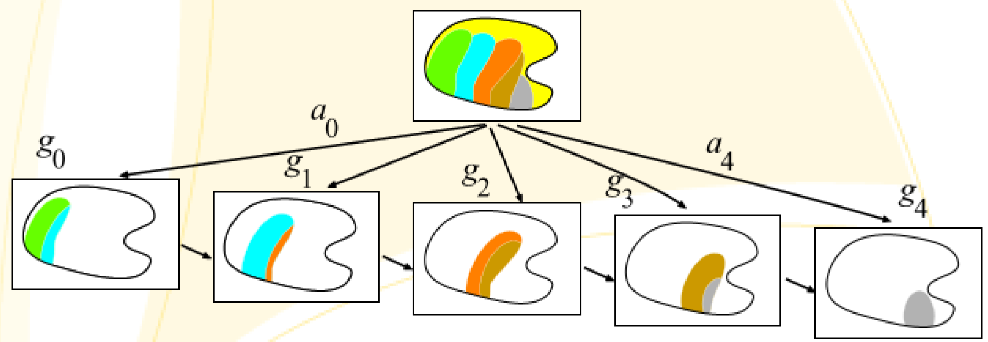
- To update the cut we use two priority queues R & C for refinement and coarsening of MT nodes
  - R top is ***max*** screen space error
  - C top is ***min*** screen space error
- Cost function for each node
  - According to its size and if it is loaded
- Refine until budget is full
- Coarsen otherwise
- Take care of node feasibility



Not well conditioned Dag

- Possible DAG problems:
  - The topology of dependencies lowers the adaptivity of the multiresolution structure
  - Cascading dependencies are BAD





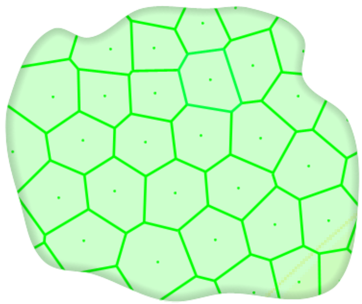
Sequence of Partitions

Goal: Building a nice sequence of fragments

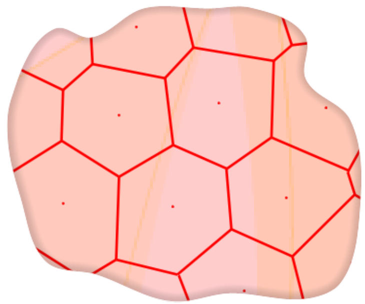
- Consider a partition Ψ of the space into disjoint regions $\{\psi_j\}$
  - Partitions can be applied to triangulations
- Given two partitions Ψ, Φ we define the *crossing* of the partitions as

$$\Psi \otimes \Phi = \bigcup_{i=0\ldots|\Psi|,\ j=0\ldots|\Phi|} \{\psi_i \cap \phi_j\}$$

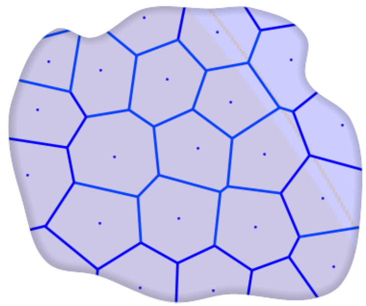
Crossing Partitions



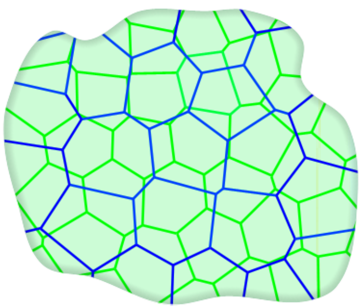
V_0



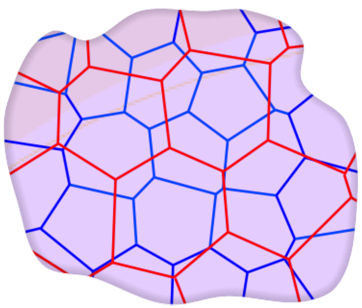
V_1



V_2



$V_0 \otimes V_1$

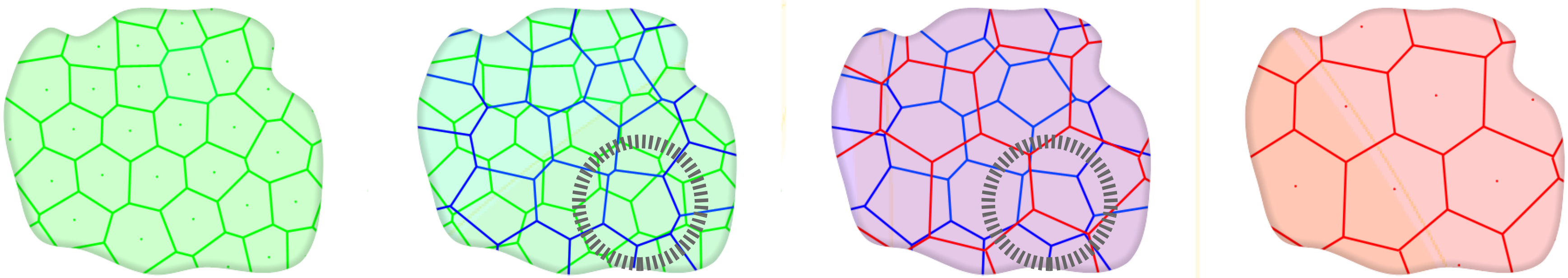


$V_1 \otimes V_2$

MT and sequence of partitions

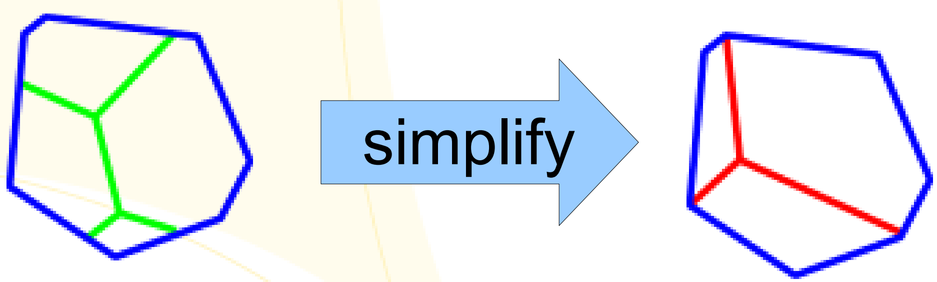
- At step i we substitute independently all the regions of a partition V_i with a simpler representation.
- Iterating this process generates a set of fragments belonging to the various *crossing* of the partitions $V_{i-1} \otimes V_i$ and $V_i \otimes V_{i+1}$
- These pieces (the portions of floor fragmens) are the building blocks that we will use to build new conforming triangulations

Partitions in practice: Simplification

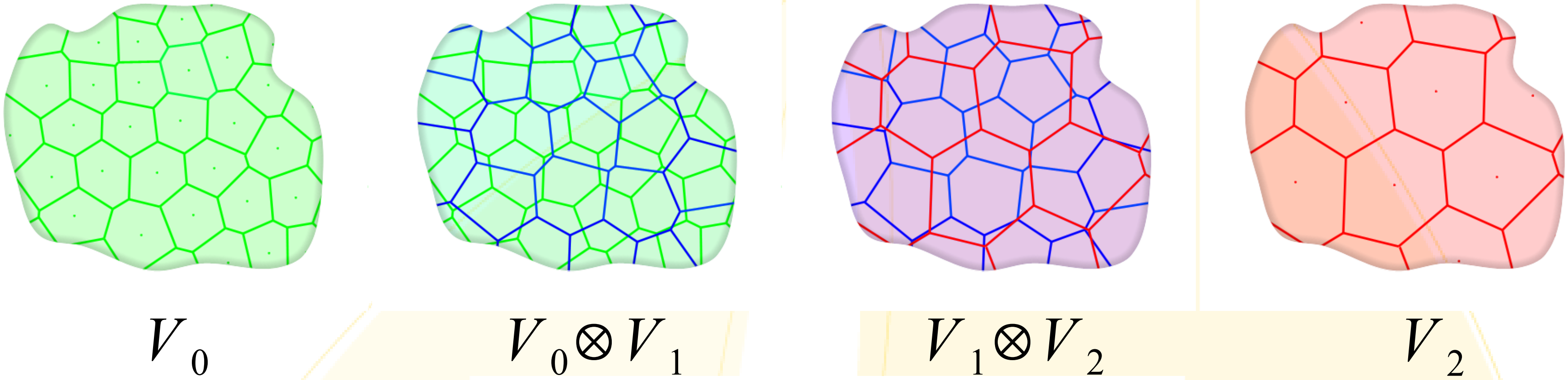


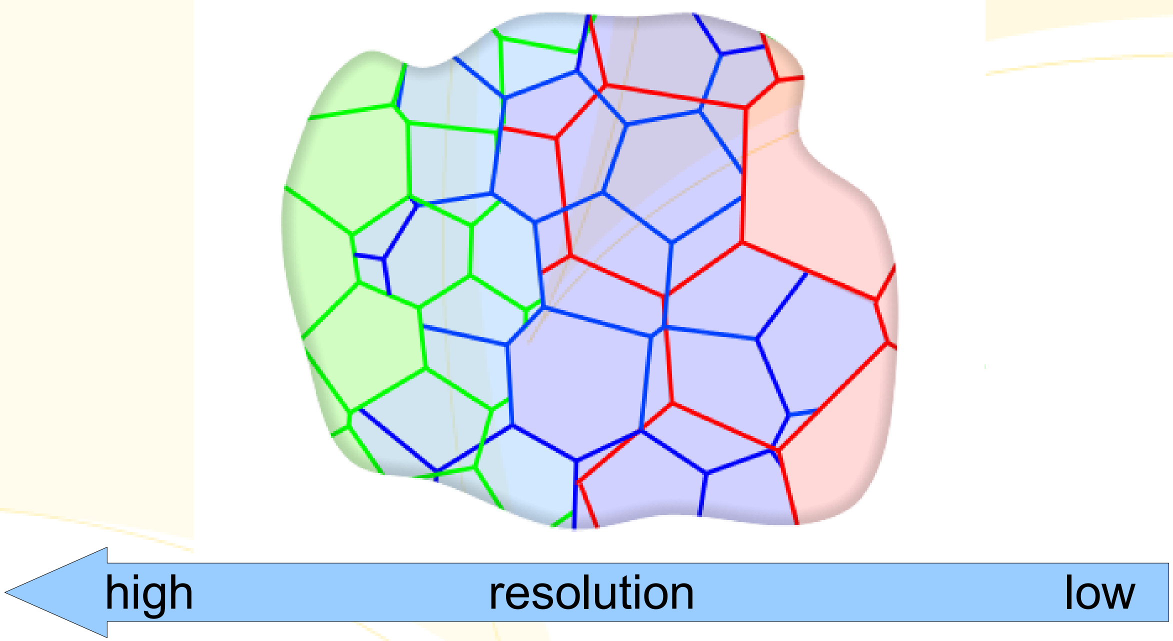
V_{i-1} $\quad$ $V_{i-1} \otimes V_i$ $\quad$ $V_i \otimes V_{i+1}$ $\quad$ V_{i+1}

- Load the patches of $V_{i-1} \otimes V_i$ that compose a region of V_i
- Join and simplify preserving just the blue border
  - Simplification of patches is independent (out of core and parallel)
- Save this region partitioned according to $V_i \otimes V_{i+1}$



MT in action



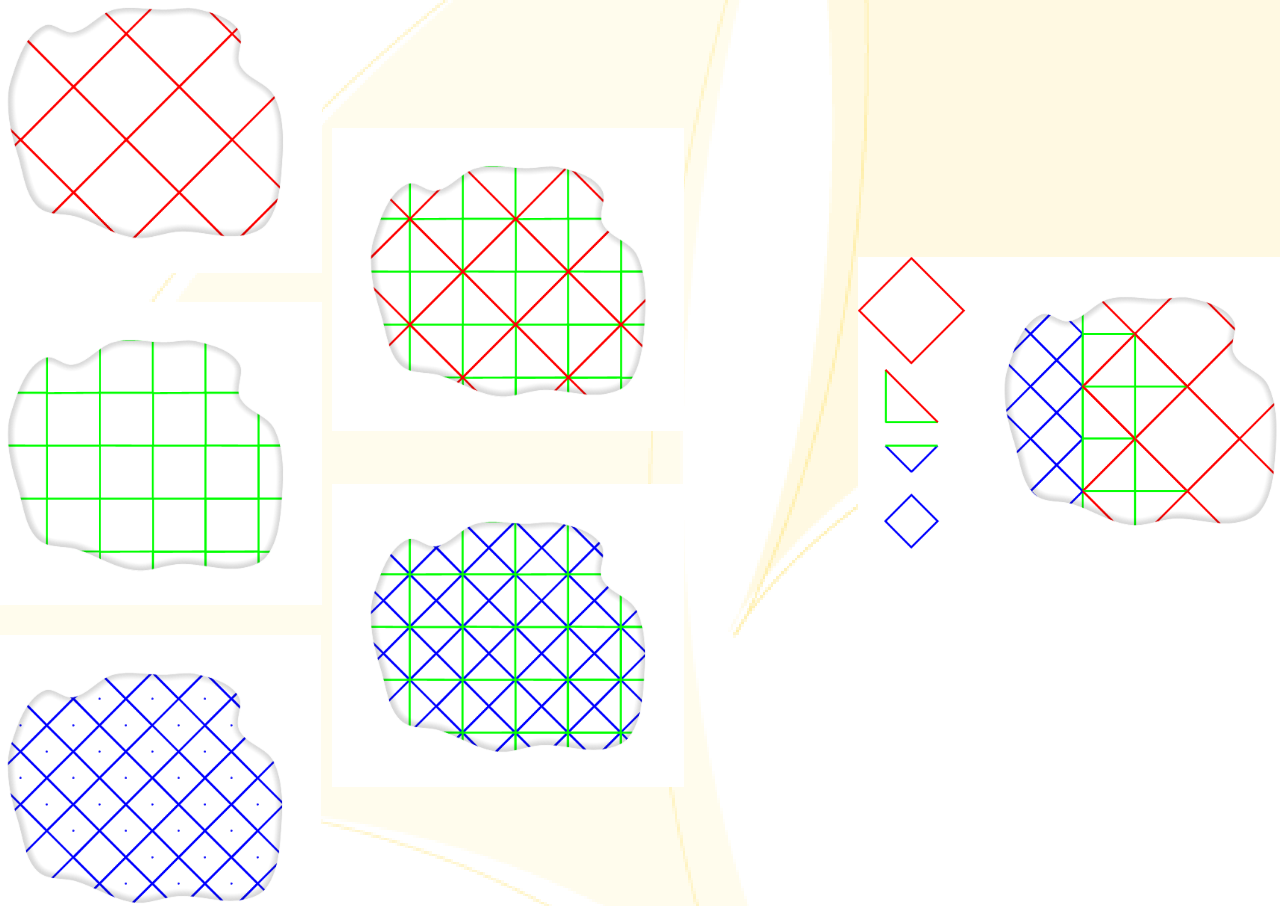


Partition in practice: building

- We need a sequence of nice partitions
- Voronoi partitioning of space
  - Nice shape of the regions
  - Easy to attribute triangles to regions
  - generating seeds
- Regularly sampled seeds
  - Finer and finer grids
- Adaptive distribution of seed
  - Choose a patch radius *r*
  - Stream the triangles adding a seed every time we encounter a triangle farther than *r* from all previous seeds
  - Apply Lloyd relaxation

General Framework

- Encompasses existing partitioning schemas like right angle hierarchies and Tetrapuzzles/SlowGrowingSubdivisions



Conclusions

- Yet another multiresolution algorithm for rendering large static meshes.
  - General framework
  - Easy to implement
  - State of the art performance
    - >4Mtri/frame at >30 fps