Meshing for Multimaterial Biological Volumes

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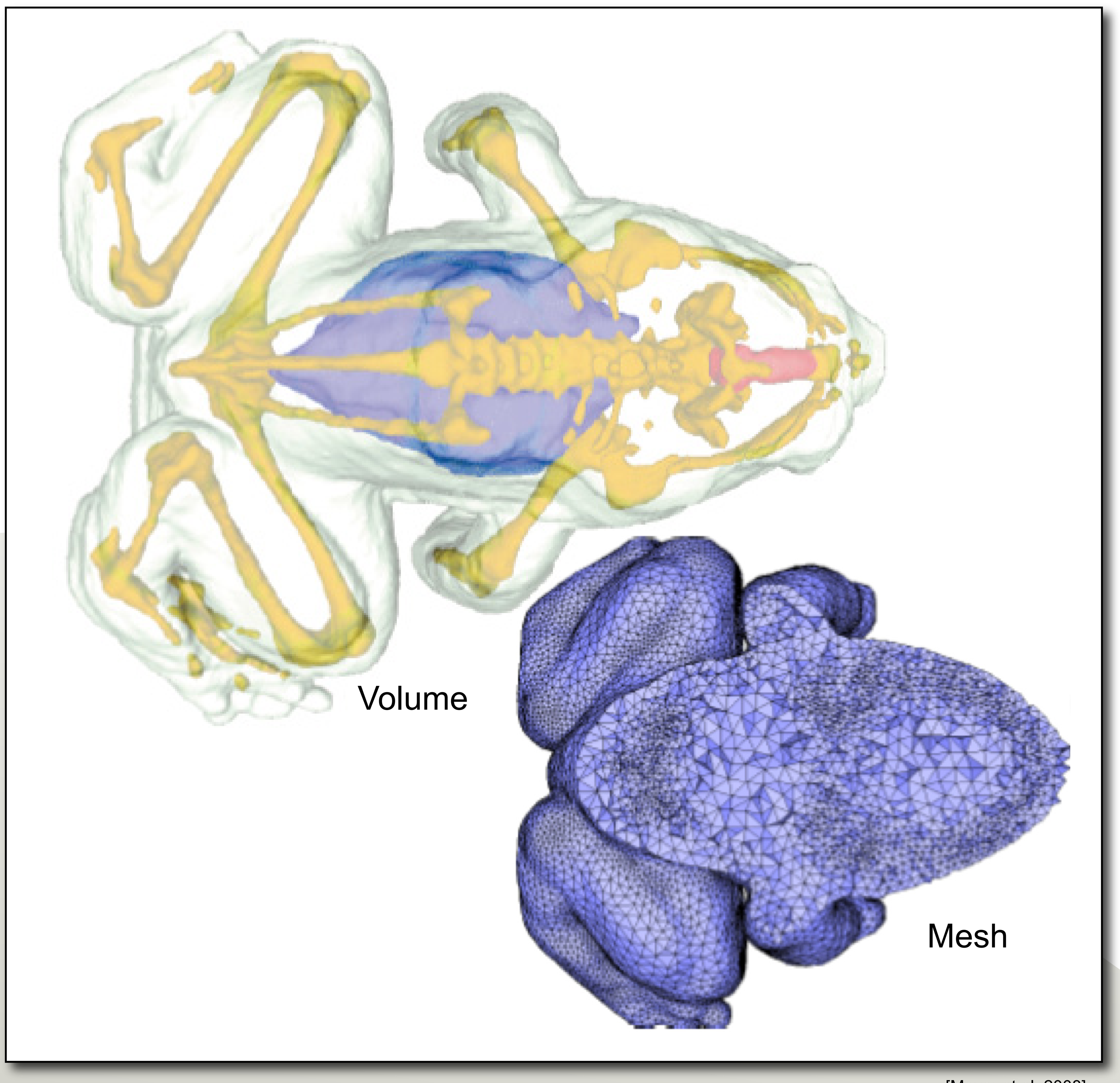
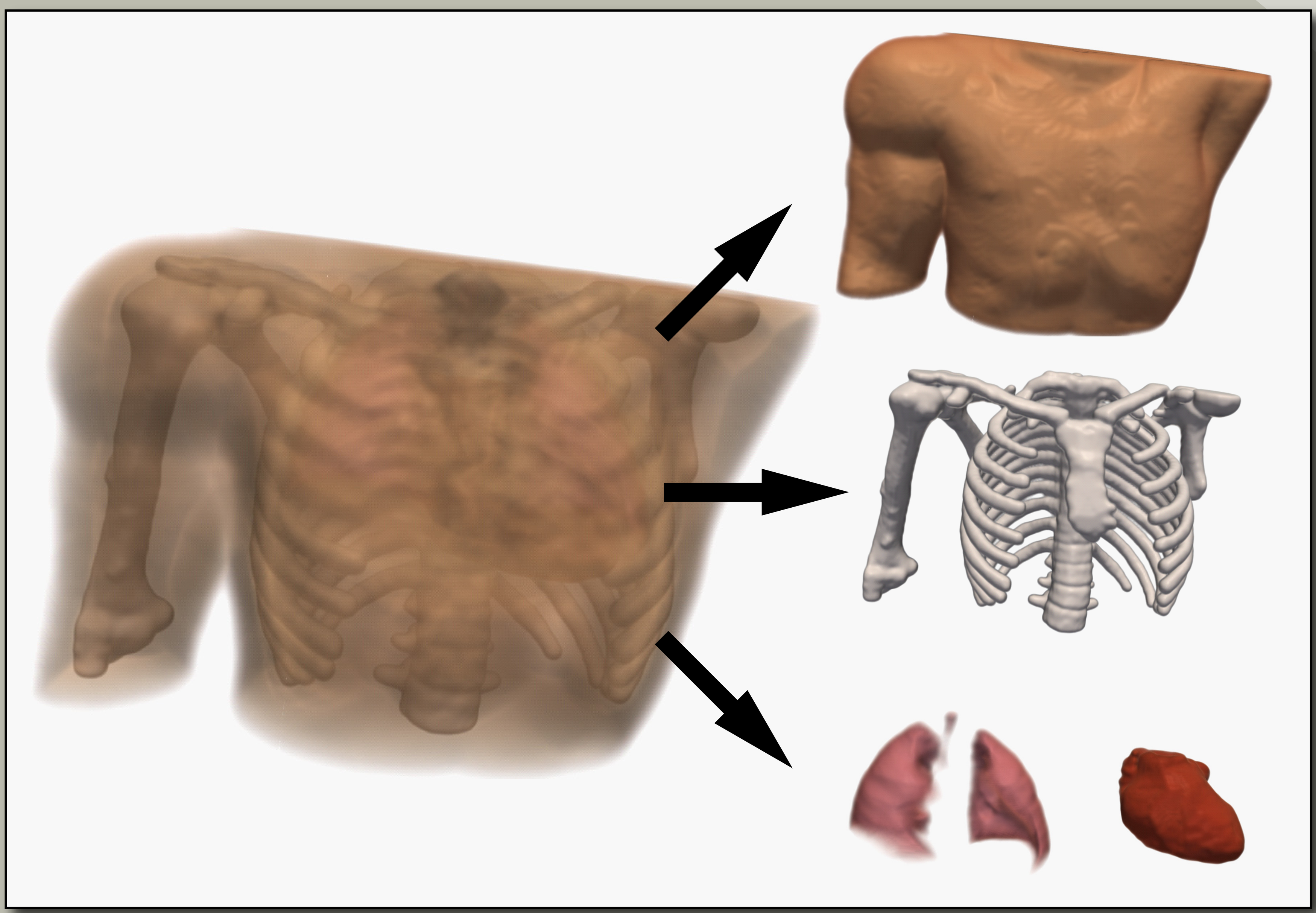
Volumetric data, such as CT or MRI scans, are some of the best sources of biological data. Unfortunately, these 3D images are not suitable for numerical simulations. Instead, researchers prefer geometric models, referred to as 'Meshes'. These meshes are composed of triangles in 2D, and tetrahedra in 3D.

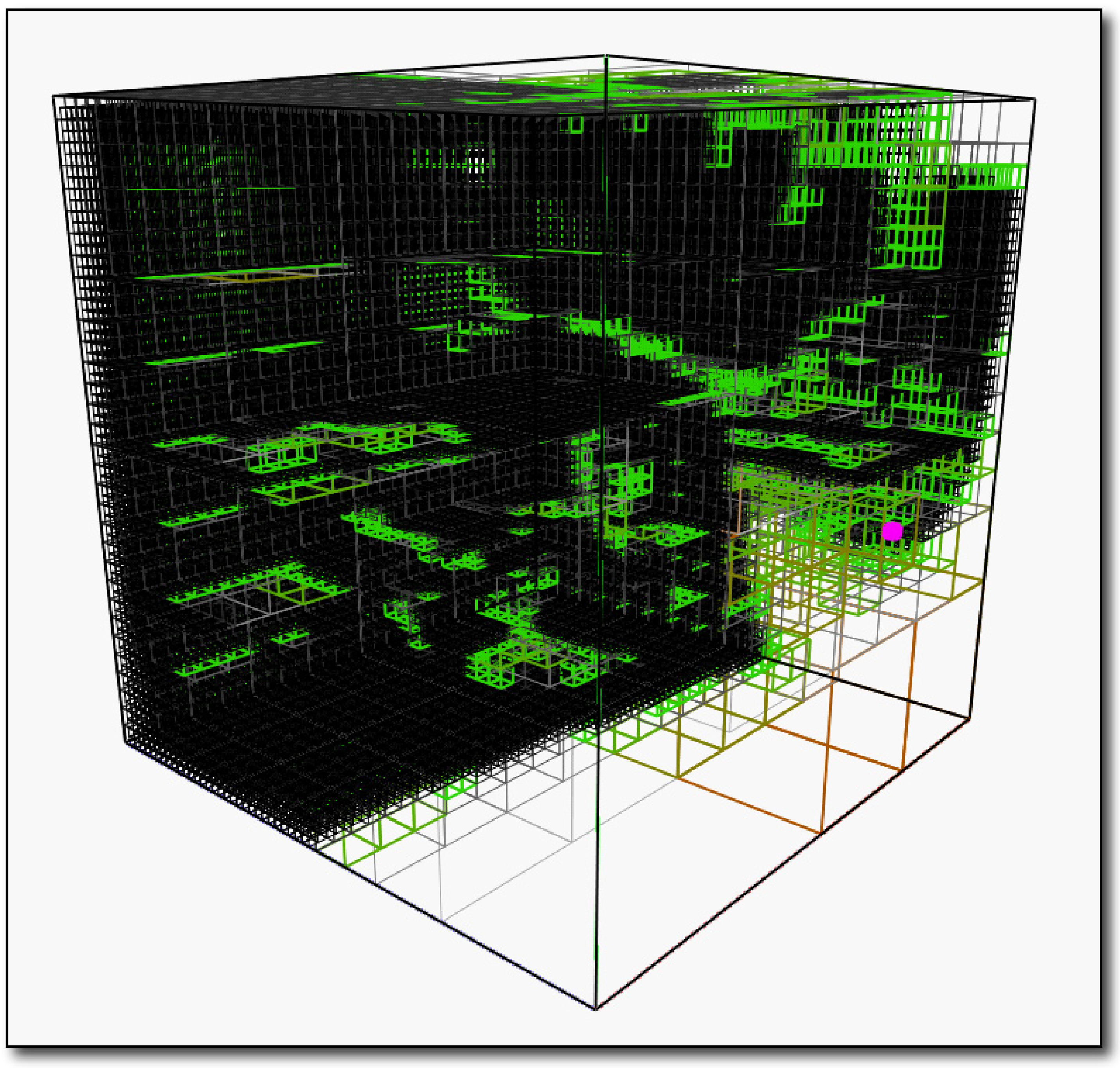


[Meyer et al. 2008]

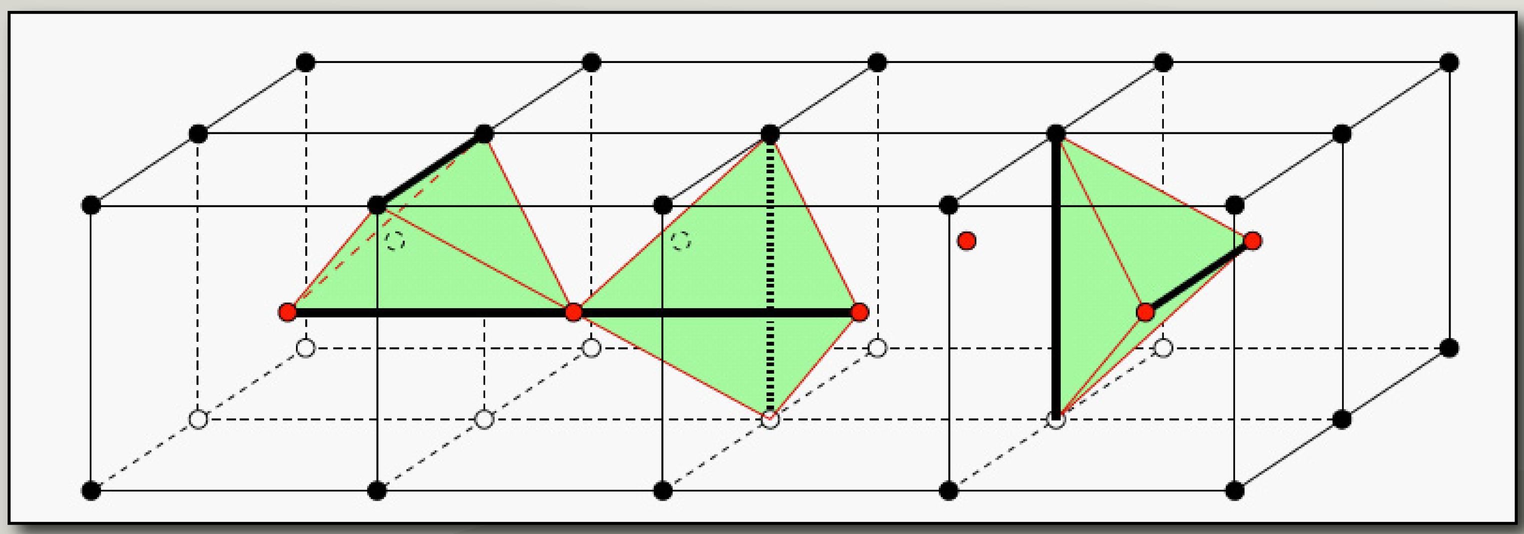
A key challenge to 'meshing' volumetric data, is preserving boundaries between different materials. These boundaries are ill-defined, but failing to capture them can break simulations outright. Our current work is capable of capturing any number of interacting materials.



A meshing technique known as "Isosurface Stuffing" was created several years ago by Francois Labelle and Jonathan Shewchuck. The method involves laying volumetric data overtop a Body-Centered Cubic Lattice. This regular structure is made of cubes, with four tetrahedra spanning neighboring cubes. In this way, we only need to define rules to mesh a small number of cases of planes intersecting Lattice Tetrahedra. These cases can be quickly looked up, from a precomputed table.

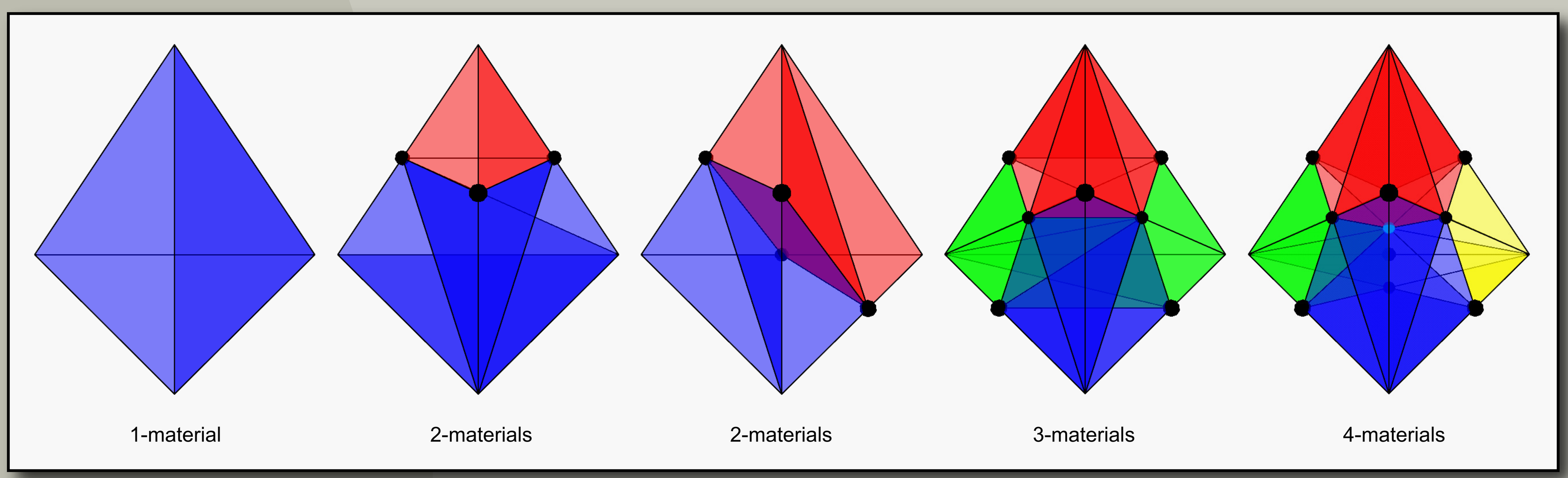


We aim to solve a more difficult problem, meshing Multimaterial volumes. Instead of a single plane passing through Lattice Tetrahedron, up to four unique materials can interact, leading to many more cases.



[Labelle and Shewchuk 2007]

Whereas some meshing techniques can provide very high quality multimaterial meshes, they do so at consderaibly slow speeds. This 'stencil' based approach provides meshes at exceptionally fast speeds, with a tradeoff of decreased quality. For some purposes, a reasonable quality mesh made available immediately, is more useful than a high quality mesh available hours later.



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