Adaptive Mesh Refinement

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What is Adaptive Mesh Refinement?

Refined regions are organized into rectangular patches. Refinement performed in time as well as in space.

Built on a foundation from DOE Applied Mathematics

- Mathematical analysis of applied nonlinear PDE: well-posedness, locality, local regularity.
- Finite-volume methods for conservation laws.
- Analysis of multiphysics problems.
Collaboration between mathematics and computer science.

- Data structures beyond rectangular arrays.
- HPC on vector computers, distributed memory multiprocessors.
- Use of modern software technologies (C++ frameworks that look like embedded DSLs).
- Other innovative techniques, e.g. edge detection algorithms for grid generation (Berger and Rigoutsos), cut-cell grid generation using adaptive precision arithmetic (Aftosmis, Berger, and Melton).
Developed hand-in-hand with scientific applications

- Shock physics.
- Low-Mach number combustion.
- Astrophysics.
- Aerodynamics.
- Subsurface flows.
- Plasma physics.
- ...
Growth of a community

Figure 3.1. The Berger-Colella-Bell Stream of AMR Development

Figure 3.2. Representative Network Created by Applied Math People Movement

From a report to the DOE Office of Science by S. Mohrman and J. Galbraith, USC Marshall School of Business, 2005
Keys to Success

- A broadly-applicable technology being developed in tandem with specific difficult science problems being solved.
- Long-term support.
- Engagement with visionary science partners.
- Flexibility about bureaucratic boundaries.