Parallelization of Multiscale-Based Grid Adaptation using Space Filling Curves

For the past 10 years, the concept of multiresolution-based grid adaptation for finite volume schemes applied to hyperbolic conservation laws has been developed and investigated. The basic idea of this concept is to transform the array of cell averages associated with any finite volume discretization into a different format that reveals insight into the local behavior of the solution. For this purpose, the cell averages on a given highest level of resolution are represented as cell averages on some coarse level, where the fine scale information is encoded in arrays of detail coefficients of ascending resolution. Then the detail coefficients are thresholded and a locally refined grid is constructed by the remaining significant coefficients. By now, this concept has been applied to various flow problems, arising, for instance, in engineering.

Although grid adaptation can significantly reduce computational resources, these concepts have to be realized on highly parallel computer architectures with distributed memory. The performance of the parallelized algorithm crucially depends on an appropriate data partitioning strategy. This strategy should provide a well-balanced data load on the different processors, such that the interprocessor communication is minimized. For our purpose, a partition of a locally refined grid is needed, where not all cells on all levels of refinement are active. A natural representation of a multilevel partition of a mesh is a global enumeration of the active cells. This has to be realized at runtime, as the adaptive mesh is also created at runtime using the multiscale representation techniques. Such an enumeration is provided by Space Filling Curves. In the talk, it will be outlined how to employ this concept in order to parallelize the multiscale-based grid adaptation scheme. The performance of the parallelized scheme will be demonstrated by some CFD computations.