Fine-grained NUMA-aware parallel scheme for anisotropic mesh adaptation

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Abstract

In this work, we provide a fine-grained parallel scheme for anisotropic mesh adaptation on non-uniform memory access (NUMA) multicore architectures. Data dependencies are expressed by a task graph for each remeshing stage. Concurrency is extracted through speculative parallel graph coloring [2]. To ensure data consistency, tasks are structured into bulk-synchronous steps using the queuing shared-memory (QSM) bridging model [3,4]. Thus interleaved mesh requests/updates patterns are avoided. To ensure performance portability, theoretical guarantees on asymptotical execution time and load imbalance are given. Furthermore, the impact of degree distribution and memory accesses penalties on scalability is highlighted.

Contributions

EXISTING SCHEMES

✓ coarse-grained: almost 80% of the state-of-the-art. manycore era: serial kernel based schemes will be inefficient.

X fine-grained: no performance portability guarantees, limited scalability in NUMA context.

CHALLENGES.

• memory-bound: requires a large amount of prefetched data to reduce stalled CPU cycles.
• irregular: data dependencies cannot be statically resolved.
• anisotropy: irregular degree distribution ⇒ load imbalance

OUR SCHEME

✓ scalable, multi-dimensional, lock-free and race-free scheme: generalizable to other irregular algorithms.
✓ theoretical background ⇒ performance predictability.

Results

References