SISMA

Séminaire Informatique Scientifique & Mathématiques Appliquées

Towards a new approach of mesh adaptation methods and its impact on accuracy for the simulation of PDEs

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In this presentation, we address the objective of accurately simulating multi-scale PDES in time and space at a reasonable cost. This will lead to the use of dynamic mesh adaptation and dedicated numerical schemes. Our initial focus is on examining the impact of mesh adaptation on the accuracy of the solution. We draw attention to the potential destructive coupling of mesh adaptation and numerical scheme for the classical approaches and explain why we use fully adaptive multi-resolution in the sense of Harten based on wavelets. We present a theory based on modified equations for the convective part of the PDEs and include the fully adaptive multi-resolution in the error estimate. It provides a theoretical basis for understanding the impact of mesh adaptation / mesh compression on the quality of results. In the second part of the talk, we present the open-source code framework we use “samurai”, as well as a new data-structure based on interval representation and algebra of sets. This data-structure allows to both reach a very small memory trace of the compressed mesh as well as handle all the potential versions of the AMR and adaptive multiresolution with a single tool. If time allows, we will briefly present a variety of applications, where the code and numerical strategy have been adopted ranging from plasma physics, combustion, lithium battery simulation and two-phase flows.

https://github.com/hpc-maths/samurai