Error Estimation and Adaptive Methods in CFD

Serge Prudhomme*, Diane Guignard[†], and Kenan Kergrene[§]

* Corresponding MS Organizer
Department of Mathematics and Industrial Engineering
Polytechnique Montréal
C.P. 6079, succ. Centre-ville, Montréal QC, Canada H3C 3A7
e-mail: serge.prudhomme@polymtl.ca
web page: https://www.polymtl.ca/expertises/en/prudhomme-serge

[†] Department of Mathematics and Statistics
University of Ottawa
STEM Complex, 150 Louis-Pasteur Pvt, Ottawa, ON, Canada K1N 6N5
e-mail: dguignard@uottawa.ca
web page: https://mysite.science.uottawa.ca/dguignar/

[§] Laboratoire Roberval
Université de Technologie de Compiègne
Rue du docteur Schweitzer CS 60319, 60203 Compiègne Cedex, France
e-mail: kenan.kergrene@utc.fr

ABSTRACT

Error estimation and adaptation in Computational Sciences and Engineering aim at developing efficient methods to assess the accuracy of computer simulations and to design optimal adaptive strategies for reliable predictions of physical phenomena. Virtually all discretization methods in PDE solvers require the use of meshes or nodal distributions over computational domains. Defining optimal distributions of points is therefore of paramount important for reducing computational costs when considering, for example, multi-query simulations, such as is the case in uncertainty analysis or design optimization. Today, the topic also extends beyond classical discretization error assessment and mesh refinement. It also encompasses adaptive modeling with the objective of adaptively enriching surrogate models that can arise from concurrent coupling techniques, model reduction, or response surface techniques. It further includes novel topics relevant to engineering applications, such as goal-oriented methods, for the control of errors in quantities of interest, or the control of errors in uncertainty analyses.

The objectives of the mini symposium will be to present the latest contributions to a posteriori error estimation and adaptive methods with applications to computational fluid mechanics. We anticipate contributions on the following topics:

1. Estimation of discretization and modeling errors for linear, nonlinear, or time-dependent problems,
2. Stability, convergence, and optimality analysis of adaptive methods,
3. r-adaptivity based on optimization formulations, moving mesh methods, or optimal transport,
4. Goal-oriented approaches,
5. Control of errors in Multiphysics and Multiscale problems,
6. Adaptive approaches in model reduction techniques,
7. Error estimation and adaptive schemes for uncertainty quantification,
8. Use of machine learning techniques for error estimation and adaptivity.