The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Algorithmic Differentiation for an efficient CFD solver

Bruno Maugars[1], Sébastien Bourasseau[1], Cédric Content[1,*], Bertrand Michel[1], Bérenger Berthoul[1], Jorge Nunez Ramirez[1], Itham Salah el Din[2], Pascal Raud[1], Laurent Hascoët[3]

[1] ONERA, 29 avenue de la division Leclerc, 92320 Châtillon, France
[2] ONERA, 8 rue des Vertugadins, 92190 Meudon, France
[3] INRIA Sophia Antipolis-Mediterranee. 2004, route des Lucioles - BP 93 06902 Sophia Antipolis Cedex, France
[*] cedric.content@onera.fr

Keywords: *Algorithmic Differentiation (AD), High Performance Computing (HPC), Computational Fluid Dynamics (CFD)*

The benefits of Algorithmic Differentiation (AD) are illustrated in the present paper regarding the development of aerodynamic flow numerical simulation softwares. In refining the architecture of the CFD solver elsA (Cambier et al. [1]), developed jointly by ONERA, Airbus, and Safran, we consider AD as a key technology to cut down development costs of derivatives of interest namely, tangent, adjoint, and Jacobian. The mathematical background making these particular derivatives central in the solver capabilities is recalled. The elsA software architecture is briefly presented as well as the design choices enabling its HPC capability. The impact of these choices on the use of AD is then discussed. To meet the expected efficiency requirements, a Source-Transformation approach of AD is adopted using Tapenade (Hascoet et al. [2]), which added value is demonstrated though aset of experiments and performance measurements presented here. Finally the results of recent large scale simulations performed with the improved version of the elsA software are provided.

REFERENCES

[1] L. Cambier and S. Heib and S. Plot, *The ONERA elsA CFD software : input from research and feedback from industry.* Mech. Ind. , 2013.

[2] L. Hascoët and V. Pascual, *The Tapenade automatic differentiation tool: Principles, model, and specification.* ACM Trans. Math. Softw. , 2013.