Goal-oriented mesh adaptation for Euler and (RANS) flows based on the total derivative of the goal w.r.t. volume mesh coordinates

Jacques PETER, ONERA BP 72 92322 Châtillon Cedex

In aeronautical CFD, engineers require accurate predictions of the forces and moments but they are less concerned with flow-field accuracy. Hence, the so-called "goal oriented" mesh adaptation strategies have been introduced to get satisfactory values of functional outputs at an acceptable cost, using local node displacement and insertion of new points rather than mesh refinement guided by uniform accuracy[2, 3, 4, 5]. Most often, such methods involve the adjoint vector of the function of interest.
Our purpose is to present goal oriented criteria of mesh quality and local mesh adaptation strategies in the framework of finite-volume schemes and a discrete adjoint vector method [1]. They are based on the total derivative of the goal with respect to (w.r.t.) mesh nodes (that is nowdays a common output of the adjoint module of the large CFD solvers). The principle of the method can be understood from left plot in the figure below: a large sensitivity of the goal with respect to the node coordinates, in a coarse zone of the mesh, indicates a large possible change of the function value when displacing the nodes. This is precisely what we seek to avoid to avoid by node displacement and addition [6, 7]. The method is assessed in the case of 2D and 3D Euler flow computations, with structured and unstructured meshes.

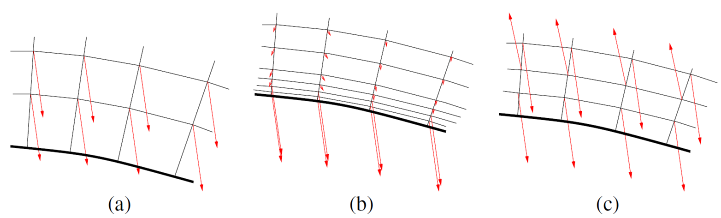

Figure 1: Possible aspects of goal sensitivity with respect to (w.r.t.) mesh node coordinates

Références

[1] J. Peter, R.P. Dwight. *Numerical sensitivity analysis: a survey of approaches.* Computers and Fluids Vol.39 (3). pp. 373-391. 2010

[2] D.A. Venditti, D.L. Darmofal. *Grid adaptation for functional outputs: Application to two-dimensional inviscid flows.* Journal of Computational Physics, Vol. 176 pp. 40–69. 2002.

[3] D.A. Venditti, D.L. Darmofal. *Anisotropic grid adaptation for functional outputs: Application to two-dimensional viscous flows.* Journal of Computational Physics, Vol. 187 pp. 22–46. 2003.

[4] R.P. Dwight. *Goal-oriented mesh adaptation using a dissipation based error indicator.* International Journal for Numerical Methods in Fluids Vol.56(8) pp. 1193-2000. 2007.

[5] R.P. Dwight. *Heuristic a posteriori estimation of error due to dissipation in finite volumes schemes and application to mesh adaptation.* Journal of Computational Physics, Vol. 227 pp. 2845–2863. 2008.

[6] J. Peter, M. Nguyen-Dinh, P. Trontin. *Goal oriented mesh adaptation using total derivative of aerodynamic functions with respect to mesh coordinates – With application to Euler flows.* Computers and Fluids, Vol. 72 pp. 194-214. 2012.

[7] M. Nguyen-Dinh, J.Peter, R. Sauvage, Matthieu Meaux, Jean-Antoine Désidéri. *Mesh quality assessment based on aerodynamic functional output total derivatives* European Journal of Mechanics B/Fluids, Vol. 45 pp 51–71. 2014.

Jacques PETER, ONERA 29 av. de la Division Leclerc BP 72 92322 Châtillon Cedex
`jacques.peter@onera.fr`