A posteriori local subcell correction of DG schemes through Finite Volume reformulation on unstructured grids

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This talk aims at presenting the 2D version of the *a posteriori* local subcell correction for discontinuous Galerkin (DG) schemes recently introduced in [1]. This is very well-known that DG method needs some sort of nonlinear limiting to avoid spurious oscillations due to the Gibbs phenomenon. Furthermore, numerical approximations may generate non-admissible solution (negative density or pressure in the case of gas dynamics for instance), which may lead to nonlinear instability or crash of the code. These fundamental issues has been extensively tackled in the past, and there is thus a vast literature on limiters. However, it is worth mentioning that the typical minimal length on which those techniques take action is exclusively, up to our knowledge, the cell size. And this is even the case for the different other so-called *subcell* techniques, as if a cell is considered as troubled, then all the subcells within it will be impacted.

The main idea motivating the present work was then to preserve as much as possible the high accuracy and the very precise subcell resolution of DG scheme. Consequently, an *a posteriori* correction will only be applied locally at the subcell scale where it is needed. Do to so, similarly to what we have done in 1D in [1], we first prove that it is possible to rewrite DG scheme as a subcell Finite Volume scheme provided with some specific numerical fluxes referred to as DG reconstructed flux. Then, at each time step, we compute a DG candidate solution and check if this solution is admissible (for instance positive, non-oscillating, ...). If it is the case, we go further in time. Otherwise, we return to the previous time step and correct locally, at the subcell scale, this solution. Practically, if the solution on a subcell has been detected as bad, we substitute the DG reconstructed flux on its boundary by a robust first-order numerical flux. And for subcell detected as admissible, we keep the high-order reconstructed flux to retain the accurate resolution of DG scheme. Numerical results on various type problems will be presented to assess the very good performance of the design correction, see **Figure 1**.

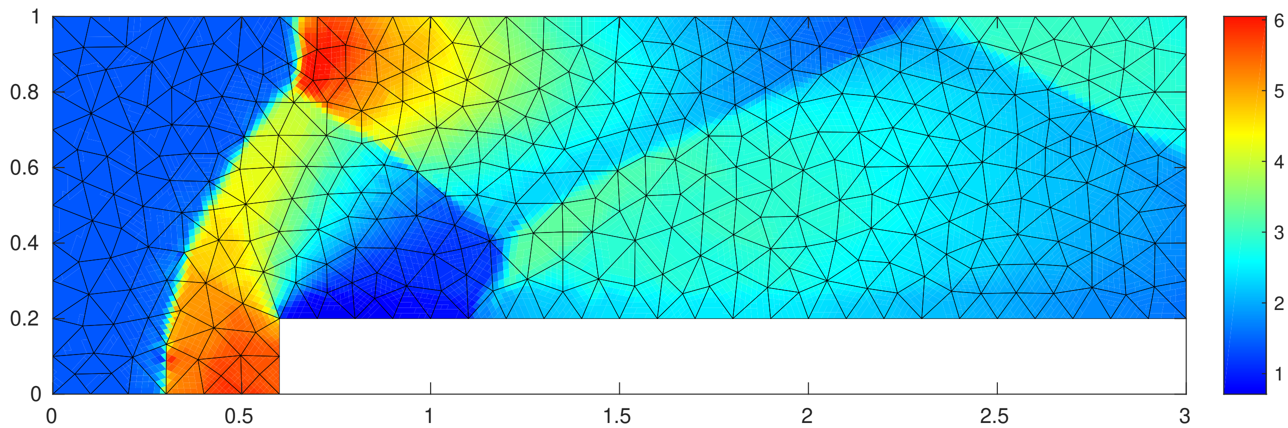

FIGURE 1 – Corrected 6^{th} order DG scheme for the Mach 3 wind tunnel problem on 680 cells : density subcell mean values.

[1] F. Vilar. *A posteriori correction of high-order discontinuous galerkin scheme through subcell finite volume formulation and flux reconstruction.* JCP, **387**, 245–279, 2019.

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