A HHO formulation for variable density incompressible flows where the density is purely advected

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Abstract
We propose a Hybrid High-Order formulation for variable density incompressible flows where all unknowns are hybridized. Accordingly, velocity, pressure and density are discretized based on polynomial functions whose support is both the mesh and the mesh skeleton.
The model is based on conservation of volume, conservation of mass and balance of linear momentum. Since, by construction, the velocity field is pointwise divergence-free and the normal trace of the velocity is continuous on inter-element boundaries, conservation of volume is exactly satisfied at the discrete level. As a result, mass conservation states that density is a purely advected quantity. The formulation is pressure-robust, meaning that irrotational body forces only affect the pressure field and the velocity error is insensitive to the pressure error.
Time integration is carried out based on fully implicit ESDIRK schemes and efficiency of the solution strategy is achieved relying on static condensation and multilevel preconditioners.
To validate the implementation, we consider test cases where initial and boundary conditions are imposed according to manufactured solutions and we evaluate the spatial and temporal convergence rates. In order to highlight the benefits of the formulation in practice, several flow problems of benchmark will be performed.