Discontinuous Galerkin methods for first-order hyperbolic problems

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For a model linear hyperbolic scalar equation we show that a continuous stabilization of the method can be obtained just by adding a jump penalty term in the discrete equation, without using any kind of upwind. For a particular value of the penalty parameter we recover exactly the classical upwind scheme, which can then be interpreted as a "consistent artificial viscosity". The usual (sub)-optimal error estimates are proved for any positive value of the parameter, thus allowing a possible tune-up of the upwind.

As the same jump term is used for stabilizing DG approximations of diffusive operators, this can simplify the treatment of advection-diffusion problems. Moreover, the use of the jump stabilization makes the analysis simpler and somehow more elegant.