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Discrete adjoint solvers for industrial design optimisation

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The computation of first derivatives with adjoint solvers is well understood and a large number of continuous and hand-discrete solvers have been presented. There also have been numerous applications of Automatic Differentiation (AD) to CFD codes to derive first derivative adjoints. Continuing advances with the scope and robustness of the AD tools have enabled users to apply AD to ever larger and more complex codes.

There has been less work on 2nd derivatives, mainly as the development effort is significant and the benefit of computed (rather than approximated) 2nd derivatives in shape optimisation has not been conclusively shown.

Industrial application of shape optimisation increasingly focuses on finding robust optima that are insensitive to design perturbations such as manufacturing tolerances, design changes or variations in operating conditions. Second derivatives can provide cost-effective sensitivities to achieve robust optima.

In this project a compressible in-house solver has been differentiated with the Tapenade AD tool to obtain first and second derivatives. The various options to derive the Jacobians and solve the resulting systems of equations are discussed and performance results for the various approaches are presented. Application to automotive testcases will be shown and discussed.