Mesh generation is an important and expensive step in computational fluid dynamics (CFD). Automatic mesh adaptation aims to provide a mesh which offers improved solution and functional accuracies for a given computational cost. This is achieved by estimating the solution error and adapting the mesh towards an error equi-distribution in the computational domain. This work derives an a posteriori error estimation method using the continuous adjoint approach. The method gives an estimate of the local error contribution to a target output, e.g. lift or drag. The mesh is then refined in the regions of larger estimated errors.

This strategy is implemented and tested using the high-order spectral difference (SD) method. Within each cell, the solution accuracy is determined by the order of the approximation polynomials. In a high-order framework, there are two adaptation mechanisms: one is to split the cell into smaller cells, i.e. h-refinement, and the other is to raise the order of approximation polynomials, i.e. p-refinement. This work tests both approaches on 2D inviscid steady flows past a cylinder and past an airfoil. The results show that the adjoint-based error estimation accurately identifies regions around the stagnation points, stagnation lines and shocks as regions to be refined, and the adapted meshes give better solution and functional accuracies than uniformly refined meshes with respect to the number of degrees of freedom.