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Sensitivity Analysis of Chaotic Flow around Two-Dimensional Airfoil PATRICK BLONIGAN, QIQI WANG, Massachusetts Inst of Tech-MIT, ERIC NIELSEN, NASA Langley Research Center, BORIS DISKIN, National Institute of Aerospace — Computational methods for sensitivity analysis are invaluable tools for fluid dynamics research and engineering design. These methods are used in many applications, including aerodynamic shape optimization and adaptive grid refinement. However, traditional sensitivity analysis methods, including the adjoint method, break down when applied to long-time averaged quantities in chaotic fluid flow fields, such as high-fidelity turbulence simulations. This break down is due to the "Butterfly Effect"; the high sensitivity of chaotic dynamical systems to the initial condition. A new sensitivity analysis method developed by the authors, Least Squares Shadowing (LSS), can compute useful and accurate gradients for quantities of interest in chaotic dynamical systems. LSS computes gradients using the "shadow trajectory", a phase space trajectory (or solution) for which perturbations to the flow field do not grow exponentially in time. To efficiently compute many gradients for one objective function, we use an adjoint version of LSS. This talk will briefly outline Least Squares Shadowing and demonstrate it on chaotic flow around a Two-Dimensional airfoil.

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