Automatic Differentiation: Approaches and Optimizations

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Abstract of Talk: Automatic differentiation refers to a set of techniques which can accurately compute the derivatives of a function without any symbolic manipulation. Indeed, with the application of a few familiar rules, there is enough information in the mere definition of a function to compute arbitrarily many of its derivatives. This presentation will begin with the basic single-variable, single-derivative case. Then, extrapolating from this groundwork, two competing methods of multivariable differentiation will be discussed. The first process relies heavily on the recursive nature of higher-order derivatives (see Kalman, Doubly Recursive Multivariate Automatic Differentiation, Mathematics Magazine, June 2002). The second technique utilizes direct loops, and while less elegant than the previous implementation, may prove to be a more efficient solution (see Neidinger, Computing Multivariable Taylor Series to Arbitrary Order, ACM APL Quote Quad, vol. 25). After introducing these two approaches, optimizations in the algorithms will be investigated. Finally, timing results between the various implementations will be presented in an attempt to find the most efficient solution.