

Automatic Analysis and Evaluation of Scarce Jacobian Matrices

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Abstract: Some numerical methods require the evaluation of Jacobians or Hessians for vector functions or scalar functions given as evaluation procedures. Other methods require only the evaluation of products of Jacobians or their transposes with a sequence of vectors of the appropriate dimensions. For preconditioning purposes one may be interested in evaluating only the diagonal or in obtaining some other selective information about a Jacobian or Hessian. Often the ultimate purpose is to calculate or approximate a Newton-step, which requires the possibly inexact solution of a linear system in the Jacobian or Hessian.

The talk addresses the question how Jacobians and Hessians should be analyzed and provided most appropriately for the purposes sketched above. As it turns out their explicit accumulation as a rectangular array of numbers may be wasteful and destroy structure even if sparsity is taken into account. We illustrate the new concept of Jacobian scarcity and present some basic theoretical and numerical results concerning partial accumulation procedures for minimizing the costs of matrix-vector products and Newton-step calculations.

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