Algorithms that Satisfy a Stopping Criterion, Probably

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Abstract: Iterative numerical algorithms are typically equipped with a stopping criterion, where the iteration process is terminated when some error or misfit measure is deemed to be below a given tolerance. This is a useful setting for comparing algorithm performance, among other purposes.

However, in practical applications a precise value for such a tolerance is rarely known; rather, only some possibly vague idea of the desired quality of the numerical approximation is at hand. We discuss four case studies from different areas of numerical computation, where uncertainty in the error tolerance value and in the stopping criterion is revealed in different ways. This leads us to think of approaches to relax the notion of exactly satisfying a tolerance value.

We then concentrate on a $probabilistic$ relaxation of the given tolerance. This allows, for instance, derivation of proven bounds on the sample size of certain Monte Carlo methods. We describe an algorithm that becomes more efficient in a controlled way as the uncertainty in the tolerance increases, and demonstrate this in the context of some particular applications of inverse problems.

This work was supported in part by NSERC Discovery Grant 84306.

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