RIGOROUS GLOBAL OPTIMIZATION FOR PARAMETER ESTIMATES AND LONG-TERM STABILITY BOUNDS

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Abstract

The code COSY INFINITY supports rigorous computations with numerical verification based on Taylor models, a tool developed by us that can be viewed as an extension of the differential algebraic methods that also determines rigorous Taylor remainder bounds. Such verified computation techniques can be utilized for global optimization tasks, resulting in a guarantee that the true optimum over a given domain is found. The method of Taylor models has a high order scaling property, suppressing the problem of overestimation that is a common problem of reliable computational methods. We have applied the method to some of typical optimization tasks in accelerator physics such as lattice design parameter optimizations and the Lyapunov function based long-term stability estimates for storage rings. The implementation of Taylor models in COSY INFINITY has inherited all the advantageous features of the implementation of differential algebras in the code, resulting in very efficient execution. COSY-GO, the Taylor model based rigorous global optimizer of COSY INFINITY, can run either on a single processor or in a multi processor mode based on MPI. We present various results of optimization problems run on more than 2,000 processors at NERSC operated by the US Department of Energy. Specifically, we discuss rigorous long-term stability estimates of the Tevatron, as well as high-dimensional rigorous design optimization of RIA fragment separators.

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