A new method for bound-constrained derivative-free global optimization and its application to parameter estimation in astrophysics

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Abstract

The purpose of this talk is twofold. First, we present a new algorithm for the global minimization of a function subject to simple bounds, without the use of its derivatives. The underlying algorithm is a pattern search method, more specifically a coordinate search method, which guarantees convergence to stationary points from arbitrary starting points. In the optional search phase of pattern search the algorithm incorporates a particle swarm scheme to globally explore the possible nonconvexity of the objective function. Our extensive numerical experiments showed that the resulting algorithm is highly competitive with other global optimization methods also based on function values.

In the second part of the talk we discuss the application of the proposed optimization method to identify optimal parameters in astrophysics models. The main goal is to estimate stellar masses and ages, as well as other parameters such as initial individual abundance of helium and hydrogen, from the observed stellar surface temperatures and total luminosities. The estimation problems consist of the minimization a least-squares type residual function subject to bounds on the variables. Due to the simulation process involved, derivatives of the objective function are unavailable.

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