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Review of the electronic book "Global Optimization with Maple" by János D. Pintér

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Résumé de l'article

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Book Reviews

Review of the electronic book "Global Optimization with Maple" by János D. Pintér

Abstract

We review the recent e-book authored by János D. Pintér, Global Optimization with Maple, Maplesoft and Pintér Consulting Services 2006,

ISBN 1–897310–15–3, price: 99 USD.

Key words: Global optimization, nonconvex propramming, derivative-free methods, nonlinear programming

1. Introduction

Maple — besides other computer algebra systems like for example Mathematica — is one of the most mature products and in many respects a powerful tool for scientific computing in mathematics, natural sciences, engineering and economics. Its benefits not only come from the combination of symbolic and numerical computing, but also from its visualization abilities of functions and geometric 2D/3D-objects. These components blend together to a powerful working environment for research and teaching. The power of Maple is enhanced by numerous add-on packages. Since version 9 Maple offers the *Optimization* package, which consists of highly efficient algorithms for local optimization coming from NAG library and at the same time gives full access to the power of Maple.

In 2004 Maplesoft introduced the so-called *Professional Toolboxes* that can be purchased separately as add-on products to extend the scope and functionality of Maple in key application areas. The first of these add-on products has been *the Global Optimization Toolbox* (GOT) the core of which is based on the LGO (Lipschitz Global Optimization) solver developed by Pintér Consulting Services. LGO runs on several other platforms. For example, Mathematica users can avail themselves of an add-on called *MathOptimizer*. For a review of the GOT for Maple we refer to [Hen].

In July 2006 the electronic book **Global Optimization with Maple** was published by Maplesoft and Pintér

Consulting Services. This e-book can be viewed as a detailed, hands-on introduction to the GOT, presenting also the basics for users with little or even no knowledge of optimization theory. The book is available in the form of a set of hyperlinked worksheets, that can be used interactively and are readily modifiable. It describes Maple — together with the GOT — as a fascinating tool to solve a very important and challenging class of optimization problems.

2. Contents

The e-book consists of five chapters plus front material and references, in approximately 160 pages (when printed). Sections 3 and 4 contain the essence of chapter 1. They state the global optimization model and describe its ingredients like the objective function, the component-wise vector bounds and the constraint functions. Furthermore they give some short details of the LGO solver, which offers the following four optional solution strategies:

- branch-and-bound based global search
- global adaptive random search (single-start)
- random multi-start based global search
- generalized reduced gradient algorithm based local search

For technical details the author refers the reader to his elaborate monograph [Pint1995]. Even in case of lacking in-depth technical knowledge, GOT can be easily used as a black-box solver.

Chapter 2 gives some information concerning the installation of the GOT, which is necessary to work with this e-book. Invoking the *GlobalOptimization* package we get two options to use the GOT. *GlobalSolve* is its command-line usage, *Interactive* uses the interactive Maplet graphical interface. We can also use the *Maple help system* for more information about the GOT. Furthermore we can get additional information during the solution process by using higher information levels, and there are numerous options whose default settings can be adapted. In contrast to the *Optimization* package, the GOT does not rely on the *objectivegradient*, *objectivejacobian* and *constraintjacobian* options, since the GOT requires only computable model function values of continuous functions. The global search options do not rely on derivatives, and the local search option applies central finite difference based gradient estimates. At the end of the chapter, the author presents some valuable suggestions on model formulation and solution strategies to get meaningful results in an efficient manner.

Chapters 3 to 5 present a detailed introduction and discussion of the GOT, offering details that are significantly beyond the built-in GOT related help file entries. They present a lot of numerical examples, starting from simple illustrations of the key tools and options in chapter 3 to advanced challenges in chapter 4. Finally, in chapter 5 illustrative case studies from sciences and engineering are considered.

3. Conclusion

The aim of this e-book is the interplay between Maple and the underlying optimization tools. In a first version I got to review, the visualization of the objective functions by means of the *plot3d*-command with the default option "'style=patch'" did not seem to be adequate in this context. I suggested to use the options "'style=patchcontour, shading=zhue'" which yield a multi-colored graph and contour lines of the surface.

In addition I pointed out that the command *contourplot* is a useful tool to identify maxima, minima and saddle points. Feasible regions defined by *linear* systems of inequalities can be plotted by means of the standard command *inequal*. For nonlinear inequalities (cf. sections 1 and 9 of chapter 3) the command *inequalities* from the Maple Advisor Database by Robert Israel is recommendable.

Many of these suggestions are incorporated in the actual version of the e-book. Additionally for some of the examples (cf. sections 1 and of 7 of chapter 3) the symbolic and numerical computing power of Maple is applied to determine the stationary points and to analyze them for finding the global extrema. Further improvements are planned by the author in a forthcoming edition. Altogether I can recommend this e-book as a very useful tool for those Maple users who are interested in global optimization.

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