LGO

An Integrated Model Development and Solver System for Global Optimization

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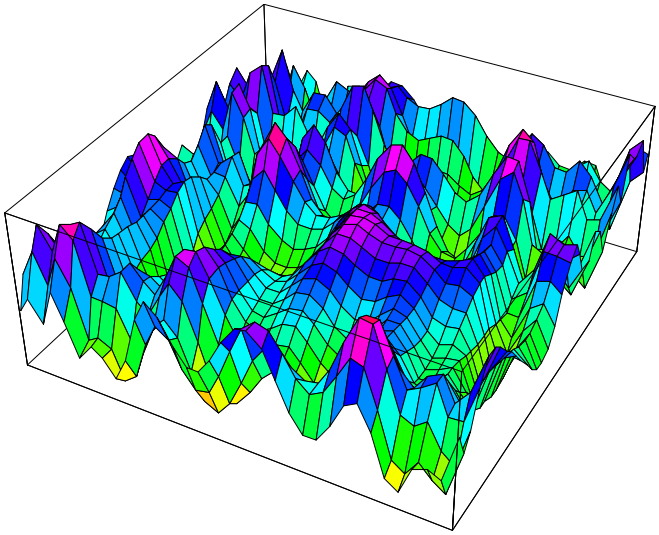

Global Optimization • The objective of global optimization (GO) is to find the 'absolutely best' solution of nonlinear decision models, in the (possible) presence of multiple local optima. The traditional methodology of convex optimization does not guarantee search for the global optimum in such problems. GO is a rapidly growing field of theoretical and computational challenge, as well as of great practical importance. For a detailed discussion of GO models and solution strategies consult, e.g., the *Handbook of Global Optimization* edited by Horst and Pardalos (1995). In recent years, dozens of textbooks, several informative WWW sites and thousands of research articles have been devoted to this subject.

LGO: Principal System Features • The program system **LGO**—abbreviating Lipschitz(-Continuous) Global Optimizer—solves GO problems, under very general structural assumptions. **LGO** is particularly suitable to handle problems that are related to complete stand-alone (confidential or other 'black box') system models, or to models supported by limited, difficult-to-use, or tentative—possibly often changing—analytical information. This unique feature makes **LGO** applicable to a broad variety of practical decision problems. Consult, for instance, Pintér (1996, 2001b) for non-trivial numerical examples and case studies.
LGO seamlessly integrates a suite of robust and efficient global and local scope search algorithms: these can be applied in fully automatic and interactive operational modes. **LGO** also has unique model visualization and automatic report generation features. Concise help files—directly available from the **LGO** menu environment—and a User's Guide Pintér (2001a) assist in the application development process.

Software Implementations • **LGO** has been developed primarily on personal computer platforms, but it is portable to other hardware environments. Currently, the following versions are readily available:

- **LGO/WiSK** is a fully Microsoft Windows 95/98/NT/2000 compatible product. In this version, **LGO** is embedded under a menu-driven user interface, thus providing an easy-to-use integrated development environment for model formulation, solution and analysis.
- **LGO/CL** is a standard Fortran (77/90) version with a simpler screen text interface; all other numerical functionality is the same as in the above **LGO** version. **LGO/CL** has been developed primarily for workstations and mainframes (or PCs) equipped with a professional Fortran development platform.
- **LGO/SM** 'Silent mode' implementations—callable from user applications—can also be made available. (Such versions typically need special licensing arrangements.)

Connectivity to Application Development Environments • **LGO** can be directly connected to user applications by making use of sample files provided with the software. Among other connectivity options, **LGO** can be called from user applications that enable external calls. Similarly, **LGO** can call external programs and procedures, to evaluate functions that may define components of the GO model analyzed. **LGO** has been developed using Lahey Fortran (LF) 90 and 95 (Lahey Computer Systems, 1998, 1999). Dynamic Link Library (DLL) connection is readily supported by LF with respect to the following widely used development environments: Borland C/C++ and Delphi, Microsoft Visual C/C++ and Visual Basic. General Windows API connectivity and static link to the C/C++ environments are also supported.

Applications • In recent years, **LGO** has been successfully applied to solve complicated GO problems defined by hundreds of variables and constraints. Application areas include the following:

- combination of deterministic or statistical expert 'opinions' (forecasts, votes, positions, assessments)
- data classification, pattern recognition, and visualization in scientific data analysis
- extremal energy problems related to mathematical, physical, chemical, and biological modeling
- generic 'black box' system design and operation (including the analysis of closed, confidential models)
- inverse model fitting (calibration) to observation data, in the applied sciences
- nonlinear approximation, including general curve/surface fitting and shape design problems
- optimized tuning/operation of equipment and instruments, in chemical and medical research
- resource allocation in cutting, loading, packing, scheduling, and sequencing contexts
- risk analysis and management in industrial, civil, and environmental engineering
- robust product/mixture design in aerospace engineering, and in chemical process industries
- systems of nonlinear equations and inequalities in the natural sciences, engineering, and economics.

Several of these application-types are discussed in detail by Pintér (1996); this monograph was awarded the **2000 INFORMS Computing Society Prize**. Please consult also Pintér (2001a,b) for further application examples. **LGO** recently has received a very positive review in ***OR/MS Today*** (Benson and Sun, 2000).

Distribution, User Support and Further Services • The **LGO** professional software product and related consulting services—including GO tutorials and workshops—are offered to businesses, academia, and research organizations. Group, department, network, and site **LGO** licenses are also available. For universities significant educational discounts are offered.
Registered users receive the current User's Guide (Pintér, 2001a) together with the software; they are also entitled to free technical support and software revisions (patches). Future development versions—i.e., substantial software upgrades—are also offered at a significant discount.

LGO is used worldwide by prominent universities, research institutes, consulting companies, and major industrial clients in some 15 countries. Demonstration program versions—fully functional, possibly customized executable programs—a detailed list of relevant professional references, and additional information are available. Potential **LGO** users are encouraged to send test problems, simply customizing ('filling out') given user file templates that are provided upon request.

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Illustrative References

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Pintér, J.D. (2001b) Computational Global Optimization in Nonlinear Systems – An Interactive Tutorial. Published for INFORMS by Lionheart Publishers, Atlanta, GA. (Available in electronic, as well as in paper copy forms.)