maple
Professional Toolbox SERIES™

Global Optimization

Functionality and Specifications

Overview

The Global Optimization Toolbox includes a solver that:

- Numerically computes global solutions to constrained and unconstrained nonlinear programs (NLP) over a bounded region
- Provides both branch-and-bound and adaptive stochastic search methods
- Supports arbitrary objective functions and constraints
- Does not require derivatives of the objective function or of the constraints
- Can evaluate constraints and objective functions at greater than hardware precision.
- Refines the solutions with a local search, using the solution from the global search as its initial point

Search Methods

The solver offers three global search strategies: branch-and-bound, global adaptive random search, and multi-start based random search.

Branch-and-Bound

- Based on the classical branch-and-bound algorithm
- Uses set partitioning with deterministic and randomized sampling
- Assumes that the objective function and constraints are Lipschitz continuous

Global Adaptive Random Search

- Adaptively narrows the search region using sample results
- Recommended for problems with minimal structure that may have a large number of local minima
- Assumes continuity of the objective function and constraints, which guarantees almost-sure convergence

Multi-Start Based Random Search

- Adaptive random search
- Total sampling effort is distributed over several searches
- Result of each search leads to a different initial point for subsequent local searching

The solver minimizes a merit function, incorporating a penalty term for the constraints. Global search results are further refined by a local search. This local search is based on a reduced-gradient algorithm.

Input Forms

Objective functions and constraints can be entered in any of the following formats.

- Algebraic expression form for easy problem definition
    - Accepts problem definitions using standard mathematical functions (for example, $\sin(x+y)$ and $v^2+\mathbf{e}^v$)
    - Supports arbitrary objective and constraint functions, including those defined in terms of special functions (for example, Bessel and hypergeometric), derivatives and integrals, and piecewise functions
- Operator (procedure) form for greater flexibility
    - Allows use of objective functions and constraints that cannot be expressed in algebraic form
    - Supports arbitrary Maple™ functions that return real values
- Matrix form for efficiency
    - Reduces storage and computation time

Maple Integration

The Global Optimization Toolbox is fully integrated into Maple.

- You can access the solver through a Maplet™ assistant or Maple commands.
- The Maplet assistant provides:
    - Easy selection and modification of solution method, option values, and stopping conditions
    - Easy access to built-in local Optimization package to allow flexible problem exploration
    - Syntax-free plotting of constraints and objectives
    - Built-in visualization capabilities
- Includes extensive help pages and examples

Visualization

Built-in visualization capabilities are available though the Maplet assistant.

- The objective function plot is obtained with respect to either one or two of the problem variables, corresponding to a 2-D or 3-D plot respectively, fixing all other problem variables to their values at the computed optimum.
- The constraints can be plotted as lines on the surface of the objective function or as vertical planes intersecting the objective function.
- Plot using problem domain or specified axes ranges.
- Rotate plots in real time.

Options

The toolbox automatically selects appropriate default values for calculations. You can specify custom values for options, for example:

- Minimize or maximize the objective function
- Initial point
- Search method
- Constraint penalty multiplier
- Feasibility tolerance used during the local search phase
- Stopping conditions:
    - Maximum number of merit function evaluations
    - Maximum computation time
    - Acceptable target value for the merit function
    - Maximum number of merit function evaluations performed without improvement in the merit function value
    - For local search phase, optimality tolerance and acceptable target value for the objective function

Note: Available for all Maple 9.5 supported platforms.

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