Genetic Algorithm and Direct Search Toolbox™ Release Notes

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Summary by Version

This table provides quick access to what's new in each version. For clarification, see "Using Release Notes" on page 1.

Version (Release)	New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Latest Version V2.4.1 (R2009a)	No	No	Bug Reports Includes fixes	Printable Release Notes: PDF Current product documentation
V2.4 (R2008b)	Yes Details	No	No	No
V2.3 (R2008a)	Yes Details	Yes Summary	No	No
V2.2 (R2007b)	Yes Details	No	Bug Reports Includes fixes	No
V2.1 (R2007a)	Yes Details	Yes Summary	Bug Reports Includes fixes	No
V2.0.2 (R2006b)	Yes Details	Yes Summary	Bug Reports Includes fixes	No
V2.0.1 (R2006a)	No	No	Bug Reports Includes fixes	No
V2.0 (R14SP3)	Yes Details	No	Bug Reports Includes fixes	No

Using Release Notes

Use release notes when upgrading to a newer version to learn about:

- New features
- Changes
- Potential impact on your existing files and practices

Review the release notes for other MathWorks™ products required for this product (for example, MATLAB® or Simulink®) for enhancements, bugs, and compatibility considerations that also might impact you.

If you are upgrading from a software version other than the most recent one, review the release notes for all interim versions, not just for the version you are installing. For example, when upgrading from V1.0 to V1.2, review the release notes for V1.1 and V1.2.

What's in the Release Notes

New Features and Changes

- New functionality
- Changes to existing functionality

Version Compatibility Considerations

When a new feature or change introduces a reported incompatibility between versions, the **Compatibility Considerations** subsection explains the impact.

Compatibility issues reported after the product is released appear under Bug Reports at the MathWorks Web site. Bug fixes can sometimes result in incompatibilities, so you should also review the fixed bugs in Bug Reports for any compatibility impact.

Fixed Bugs and Known Problems

The MathWorks offers a user-searchable Bug Reports database so you can view Bug Reports. The development team updates this database at release time and as more information becomes available. This includes provisions for any known workarounds or file replacements. Information is available for bugs existing in or fixed in Release 14SP2 or later. Information is not available for all bugs in earlier releases.

Access Bug Reports using your MathWorks Account.

Version 2.4.1 (R2009a) Genetic Algorithm and Direct Search Toolbox Software

This table summarizes what's new in version 2.4.1 (R2009a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
No	No	Bug Reports Includes fixes	Printable Release Notes: PDF Current product documentation

New Demo

There is a new demo showing graphically how `patternsearch` works. To see the demo, enter `echodemo mtwashdemo` at the MATLAB command line.

Version 2.4 (R2008b) Genetic Algorithm and Direct Search Toolbox Software

This table summarizes what's new in version 2.4 (R2008b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	No	None

Optimization Tool Enables Parallel Functionality

You can now access built-in parallel functionality in Optimization Tool for relevant Genetic Algorithm and Direct Search Toolbox™ solvers. The option is available when you have a license for Parallel Computing Toolbox™ functions.

Version 2.3 (R2008a) Genetic Algorithm and Direct Search Toolbox Software

This table summarizes what's new in version 2.3 (R2008a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	Yes Summary	No	None

New features and changes introduced in this version are described here:

Parallel Computing Toolbox Support

The functions `ga`, `gamultiobj`, and `patternsearch` can take advantage of parallel computing. Furthermore, applicable hybrid functions can use parallel computing. For more information, see the following sections in the User's Guide:

- "Parallel Computing with Pattern Search"
- "Parallel Computing with the Genetic Algorithm"
- "Parallel Computing with gamultiobj"
- "Parallel Computing with Simulated Annealing and Threshold Acceptance Algorithms"

Genetic Algorithm Tool and Pattern Search Tool Combined Into Optimization Tool

The Genetic Algorithm Tool and Pattern Search Tool GUIs have been combined into the Optimization Toolbox™ Optimization Tool GUI. To access these GUIs, enter `optimtool` at the command line and choose the appropriate solver.

Compatibility Considerations

The functions `gatool` and `psearchtool` continue to work, calling `optimtool` with the appropriate solver selected (`ga` or `patternsearch`). However, the functions `gatool` and `psearchtool` are no longer listed in the documentation.

New Optimization Tool Support for gamultiobj, simulannealbnd, and threshacceptbnd

The Optimization Tool GUI now includes the functions `gamultiobj`, `simulannealbnd`, and `threshacceptbnd`. Therefore, all Genetic Algorithm and Direct Search Toolbox solvers are supported in Optimization Tool. To access these GUIs, enter `optimtool` at the command line and choose the appropriate solver.

New Automatic Population Generation in ga and gamultiobj

`ga` and `gamultiobj` can now create populations satisfying bounds and linear constraints, with well-dispersed populations, using the function `gacreationlinearfeasible`.

Compatibility Considerations

The previous creation function, `gacreationuniform`, is accessible by using `gaoptimset` to set `CreationFcn` to `@gacreationuniform`. The new default behavior is to use `gacreationlinearfeasible` when there are linear constraints, and `gacreationuniform` when there are bounds or no constraints.

New Default StallTimeLimit Option = Inf in Genetic Algorithm

The default value of `StallTimeLimit` in `ga` used to be `20`. It was changed to `Inf` in order to avoid time-outs when using computationally intensive fitness functions.

Compatibility Considerations

Change `StallTimeLimit` to `20` using `gaoptimset` to get the previous behavior.

Version 2.2 (R2007b) Genetic Algorithm and Direct Search Toolbox Software

This table summarizes what's new in version 2.2 (R2007b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	Bug Reports Includes fixes	None

New features and changes introduced in this version are described here:

Multiobjective Optimization with Genetic Algorithm

Multiobjective optimization, with linear and bound constraints, is now available through the new function `gamultiobj`. This function determines optimal Pareto fronts from specified criteria, including Pareto fronts that are nonconvex, disconnected, or both.

Optimization Toolbox also contains multiobjective functionality, but cannot reliably generate optimal Pareto fronts if these are nonconvex or disconnected.

Two new demos illustrate this feature. See "New Demos" on page 9.

Multiobjective Optimization with Genetic Algorithm and Custom Data Types

The new function `gamultiobj` also supports multiobjective optimization with custom data types, including binary.

Hybrid Multiobjective Optimization Combining Genetic Algorithm with Optimization Toolbox

To determine multiobjective optimizations more accurately, you can now combine the new function `gamultiobj` with the existing function `fgoalattain` from Optimization Toolbox.

Vectorized Function Inputs with Nonlinear Constraints

The functions `ga` and `patternsearch` now accept vectorized function inputs with nonlinear constraints. The new function `gamultiobj` does as well.

New Demos

Two accompanying demos illustrate the use of the new multiobjective genetic algorithm function `gamultiobj`:

- `gamultiobjfitness` uses `gamultiobj` to solve a simple problem with one decision variable and two objectives.
- `gamultiobjoptionsdemo` shows how to set options for multiobjective optimization with a simple genetic algorithm problem.

Version 2.1 (R2007a) Genetic Algorithm and Direct Search Toolbox Software

This table summarizes what's new in version 2.1 (R2007a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	Yes–Details labeled as **Compatibility Considerations**, below. See also Summary.	Bug Reports Includes fixes	None

New features and changes introduced in this version are described here:

- "New Functions for Simulated Annealing and Threshold Acceptance" on page 10
- "ga Output Argument exitflag Returns Numeric Value" on page 11

New Functions for Simulated Annealing and Threshold Acceptance

The following functions have been added for simulated annealing and threshold acceptance:

`simulannealbnd`	Perform unconstrained or bound-constrained minimization of a function of several variables using simulated annealing. The default algorithm uses adaptive annealing, but options can be changed to use Boltzmann annealing, fast annealing, and other variants.
`threshacceptbnd`	Perform unconstrained or bound-constrained minimization of

	a function of several variables using threshold acceptance.
`saoptimset`	Create or modify optimization options for `simulannealbnd` or `threshacceptbnd`.
`saoptimget`	Access options for `simulannealbnd` or `threshacceptbnd`.

If you are viewing this documentation in the Help browser, the following demos are available:

- Minimization Using Simulated Annealing And Threshold Acceptance Algorithms
- Simulated Annealing and Threshold Acceptance Options
- Custom Data Type Optimization Using Simulated Annealing

ga Output Argument exitflag Returns Numeric Value

The third output argument returned by the `ga` function is now a numeric value. This change is consistent with other optimization solvers in MATLAB and makes it easier to programmatically determine the reason the solver stopped. As in previous versions, the fourth output argument is a structure with the field `message` containing a string that indicates the reason the solver stopped.

The new syntax is as follows:

```
[x,fval,exitflag,output] = ga(fitnessfcn, ...)
```

For more information, including a description of the messages that correspond to the numeric values for each `exitflag` value, see the `ga` function reference page in the Genetic Algorithm and Direct Search Toolbox User's Guide for more information.

Compatibility Considerations

In previous versions, the third output argument returned by `ga` is a string describing the reason the solver stopped.

```
[x,fval,reason] = ga(fitnessfcn, ...)
```

If you used the third output argument of the `ga` function programmatically in a previous release, for example, to compare the value to a string, this code will now produce an error.

Version 2.0.2 (R2006b) Genetic Algorithm and Direct Search Toolbox Software

This table summarizes what's new in version 2.0.2 (R2006b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	Yes–Details labeled as **Compatibility Considerations**, below. See also Summary.	Bug Reports Includes fixes	No

New features and changes introduced in this version are described here:

New Syntax for Search Method Option in Pattern Search Algorithm Improves Speed and Memory

The new syntax is more efficient both with speed and memory. This is done by changing the way linear and bound constraints are stored and passed to a search function. The following describes the new calling syntax:

```
function [successSearch,xBest,fBest,funccount] =
searchfcntemplate(fun,x,A,b,Aeq,beq,lb,ub, ...
    optimValues,options)
```

For more information on how to use the new search function syntax, see "Structure of the Search Function" in the Genetic Algorithm and Direct Search Toolbox User's Guide. To see a template that you can view and edit, type

```
edit searchfcntemplate
```

at the Command Window.

Compatibility Considerations

Using your search functions in Version 2.0.2. In previous versions, a search function required the following calling syntax:

```
function [successSearch,nextIterate,optimState] =
searchfcntemplate(fun,iterate,tol,A,L,U, ...
    funeval,maxfun,searchoptions,objfcnarg, ...
    iterlimit,factors)
```

If you have a search function written for use in a previous release, the function performs correctly in Version 2.0.2 but returns a warning. Custom search functions written in a previous version need to be updated with the new syntax. In later versions, this syntax may cause a warning or error.

Converting your search functions to the Version 2.0.2 syntax. The `searchConversion` utility function is provided to convert your search functions from previous releases to the new syntax of Version 2.0.2. For more information on obtaining and using the conversion function, see this technical support solution.

Version 2.0.1 (R2006a) Genetic Algorithm and Direct Search Toolbox Software

This table summarizes what's new in version 2.0.1 (R2006a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
No	No	Bug Reports Includes fixes	None

Version 2.0 (R14SP3) Genetic Algorithm and Direct Search Toolbox Software

This table summarizes what's new in version 2.0 (R14SP3):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	Bug Reports Includes fixes	None

New features and changes introduced in this version are organized by these topics:

Both the Genetic Algorithm and the Pattern Search Algorithm Now Accept Nonlinear Constraints

Previously, the genetic algorithm solver only solved unconstrained optimization problems, and the pattern search solver solved unconstrained optimization problems as well as those with linear constraints and bounds. Now, both solvers have to ability to solve general nonlinear optimization problems with linear constraints, bounds, and nonlinear constraints by accepting a nonlinear constraint function. The M-file for the nonlinear constraint function is accepted as an input argument at the command line for both the `ga` and `patternsearch` functions, as well as in the **Constraints** panel of `psearchtool` and `gatool`.

Direct Search Now Implements Two Algorithms — Generalized Pattern Search Algorithm (GPS) and Mesh Adaptive Search Algorithm (MADS)

The GPS algorithm is the pattern search algorithm implemented in previous versions of the toolbox. The MADS algorithm is a modification of the GPS algorithm. The algorithms differ in how the set of points forming the mesh is computed. The GPS algorithm uses fixed direction vectors, whereas the new MADS algorithm uses a random selection of vectors to define the mesh.

New Options Available in the Genetic Algorithm

The following options are available in the `gatool` and when using the `ga` function at the command prompt:

- The new **Constraints** panel has a **Nonlinear constraint function** field in addition to fields for linear constraints and bounds for solving constrained optimization problems
- New **Max constraint** (`@gaplotmaxconstr`) option in the **Plot** pane to plot the maximum nonlinear constraint violation at each generation
- New crossover function, `Arithmetic` (`@crossoverarithmetic`), available in the **Crossover** panel that creates children that are the weighted arithmetic mean of two parents
- New mutation function, `Adaptive Feasible` (`mutationadaptfeasible`), available in the **Crossover** panel that randomly generates directions that are adaptive with respect to the last successful or unsuccessful generation. This function is the default for constrained problems
- New **Algorithm settings** panel for selecting algorithm specific parameters, such as the penalty parameters, **Initial penalty** and **Penalty factor**, for a nonlinear constraint algorithm
- New **Hybrid function**, `fmincon`, for constrained problems
- New **Nonlinear constraint tolerance** parameter in **Stopping criteria**

New Options Available in the Pattern Search Algorithm

The following options are available in the `psearchtool` and when using the `patternsearch` function at the command prompt:

- **Constraints** now has a **Nonlinear constraint function** option to solve for constrained optimization problems
- New **Max constraint** (`@psplotmaxconstr`) option in the **Plot** pane to plot the maximum nonlinear constraint violation at each generation
- Updated **Poll method** and **Search method** options for selecting the GPS or MADS algorithms
- New **Algorithm settings** panel for selecting algorithm specific parameters, such as the penalty parameters, **Initial penalty** and **Penalty factor**, for a nonlinear constraint algorithm
- New **Time limit** and **Nonlinear constraint tolerance** parameters in **Stopping criteria**

New Demos

The Genetic Algorithm and Direct Search Toolbox contains the following new demos for Version 2.0:

- Optimization of Non-smooth Objective Function
- Constrained Minimization Using the Genetic Algorithm
- Constrained Minimization Using the Pattern Search
- Optimization of Stochastic Objective Function
- Using the Genetic Algorithm and Direct Search Toolbox

Compatibility Summary for Genetic Algorithm and Direct Search Toolbox Software

This table summarizes new features and changes that might cause incompatibilities when you upgrade from an earlier version, or when you use files on multiple versions. Details are provided in the description of the new feature or change.

Version (Release)	New Features and Changes with Version Compatibility Impact
Latest Version V2.4.1(R2009a)	None
V2.4 (R2008b)	None
V2.3 (R2008a)	See the **Compatibility Considerations** subheading for each of these new features or changes: • "Genetic Algorithm Tool and Pattern Search Tool Combined Into Optimization Tool" on page 6 • "New Automatic Population Generation in ga and gamultiobj" on page 6 • "New Default StallTimeLimit Option = Inf in Genetic Algorithm" on page 7
V2.2 (R2007b)	None

Version (Release)	New Features and Changes with Version Compatibility Impact
V2.1 (R2007a)	See the **Compatibility Considerations** subheading for each of these new features or changes: • "ga Output Argument exitflag Returns Numeric Value" on page 11
V2.0.2 (R2006b)	See the **Compatibility Considerations** subheading for each of these new features or changes: • "New Syntax for Search Method Option in Pattern Search Algorithm Improves Speed and Memory" on page 13
V2.0.1 (R2006a)	None
V2.0 (R14SP3)	None