

# **Genetic Algorithm and Direct Search Toolbox™ Release Notes**

---

## How to Contact The MathWorks



[www.mathworks.com](http://www.mathworks.com) Web  
[comp.soft-sys.matlab](mailto:comp.soft-sys.matlab) Newsgroup  
[www.mathworks.com/contact\\_TS.html](http://www.mathworks.com/contact_TS.html) Technical Support



[suggest@mathworks.com](mailto:suggest@mathworks.com) Product enhancement suggestions  
[bugs@mathworks.com](mailto:bugs@mathworks.com) Bug reports  
[doc@mathworks.com](mailto:doc@mathworks.com) Documentation error reports  
[service@mathworks.com](mailto:service@mathworks.com) Order status, license renewals, passcodes  
[info@mathworks.com](mailto:info@mathworks.com) Sales, pricing, and general information



508-647-7000 (Phone)



508-647-7001 (Fax)



The MathWorks, Inc.  
3 Apple Hill Drive  
Natick, MA 01760-2098

For contact information about worldwide offices, see the MathWorks Web site.

*Genetic Algorithm and Direct Search Toolbox™ Release Notes*

© COPYRIGHT 2005–2009 by The MathWorks, Inc.

The software described in this document is furnished under a license agreement. The software may be used or copied only under the terms of the license agreement. No part of this manual may be photocopied or reproduced in any form without prior written consent from The MathWorks, Inc.

FEDERAL ACQUISITION: This provision applies to all acquisitions of the Program and Documentation by, for, or through the federal government of the United States. By accepting delivery of the Program or Documentation, the government hereby agrees that this software or documentation qualifies as commercial computer software or commercial computer software documentation as such terms are used or defined in FAR 12.212, DFARS Part 227.72, and DFARS 252.227-7014. Accordingly, the terms and conditions of this Agreement and only those rights specified in this Agreement, shall pertain to and govern the use, modification, reproduction, release, performance, display, and disclosure of the Program and Documentation by the federal government (or other entity acquiring for or through the federal government) and shall supersede any conflicting contractual terms or conditions. If this License fails to meet the government's needs or is inconsistent in any respect with federal procurement law, the government agrees to return the Program and Documentation, unused, to The MathWorks, Inc.

### Trademarks

MATLAB and Simulink are registered trademarks of The MathWorks, Inc. See [www.mathworks.com/trademarks](http://www.mathworks.com/trademarks) for a list of additional trademarks. Other product or brand names may be trademarks or registered trademarks of their respective holders.

### Patents

The MathWorks products are protected by one or more U.S. patents. Please see [www.mathworks.com/patents](http://www.mathworks.com/patents) for more information.

<b>Summary by Version</b> .....	<b>1</b>
<b>Version 2.4.2 (R2009b) Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>4</b>
<b>Version 2.4.1 (R2009a) Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>5</b>
<b>Version 2.4 (R2008b) Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>6</b>
<b>Version 2.3 (R2008a) Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>7</b>
<b>Version 2.2 (R2007b) Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>10</b>
<b>Version 2.1 (R2007a) Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>12</b>
<b>Version 2.0.2 (R2006b) Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>15</b>
<b>Version 2.0.1 (R2006a) Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>17</b>
<b>Version 2.0 (R14SP3) Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>18</b>
<b>Compatibility Summary for Genetic Algorithm and Direct Search Toolbox Software</b> .....	<b>21</b>



## Summary by Version

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

<b>Version (Release)</b>	<b>New Features and Changes</b>	<b>Version Compatibility Considerations</b>	<b>Fixed Bugs and Known Problems</b>	<b>Related Documentation at Web Site</b>
<b>Latest Version V2.4.2 (R2009b)</b>	Yes Details	Yes Summary	No	Printable Release Notes: PDF  Current product documentation
V2.4.1 (R2009a)	No	No	Bug Reports Includes fixes	No
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®). Determine if enhancements, bugs, or compatibility considerations in other products impact you.

If you are upgrading from a software version other than the most recent one, review the current release notes and all interim versions. For example, when you upgrade from V1.0 to V1.2, review the release notes for V1.1 and V1.2.

## **What Is 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 release appear under Bug Reports at The MathWorks™ Web site. Bug fixes can sometimes result in incompatibilities, so 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. Bug Reports include 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 2.4.2 (R2009b) Genetic Algorithm and Direct Search Toolbox Software

This table summarizes what's new in Version 2.4.2 (R2009b).

<b>New Features and Changes</b>	<b>Version Compatibility Considerations</b>	<b>Fixed Bugs and Known Problems</b>	<b>Related Documentation at Web Site</b>
Yes Details below	Yes—Details labeled as <b>Compatibility Considerations</b> , below. See also Summary.	No	Printable Release Notes: PDF  Current product documentation

### **threshacceptbnd Function Deprecated**

The `threshacceptbnd` function will be removed in a future release.

#### **Compatibility Considerations**

The `threshacceptbnd` function now warns that it will be removed in a future release. Use `simulannealbnd` for similar functionality. To obtain results using a threshold acceptance algorithm, write a custom acceptance function for `simulannealbnd`—see `AcceptanceFcn` in “Algorithm Settings”.



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

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

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

### **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):

<b>New Features and Changes</b>	<b>Version Compatibility Considerations</b>	<b>Fixed Bugs and Known Problems</b>	<b>Related Documentation at Web Site</b>
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” on page 7
- “Genetic Algorithm Tool and Pattern Search Tool Combined Into Optimization Tool” on page 8
- “New Optimization Tool Support for gamultiobj, simulannealbnd, and threshacceptbnd” on page 8
- “New Automatic Population Generation in ga and gamultiobj” on page 8
- “New Default StallTimeLimit Option = Inf in Genetic Algorithm” on page 9

### 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”

## **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” on page 10
- “Multiobjective Optimization with Genetic Algorithm and Custom Data Types” on page 11
- “Hybrid Multiobjective Optimization Combining Genetic Algorithm with Optimization Toolbox” on page 11
- “Vectorized Function Inputs with Nonlinear Constraints” on page 11
- “New Demos” on page 11

### 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 11.

## **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 <b>Compatibility Considerations</b> , 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 12
- “ga Output Argument exitflag Returns Numeric Value” on page 13

### 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.
<code>saoptimset</code>	Create or modify optimization options for <code>simulannealbnd</code> or <code>threshacceptbnd</code> .
<code>saoptimget</code>	Access options for <code>simulannealbnd</code> or <code>threshacceptbnd</code> .

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 <b>Compatibility Considerations</b> , 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] =
searchfcn(template(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 searchfcn(template
```

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] =  
searchfcn(template(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):

<b>New Features and Changes</b>	<b>Version Compatibility Considerations</b>	<b>Fixed Bugs and Known Problems</b>	<b>Related Documentation at Web Site</b>
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” on page 18
- “Direct Search Now Implements Two Algorithms — Generalized Pattern Search Algorithm (GPS) and Mesh Adaptive Search Algorithm (MADS)” on page 19
- “New Options Available in the Genetic Algorithm” on page 19
- “New Options Available in the Pattern Search Algorithm” on page 20
- “New Demos” on page 20

### 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 the 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
<b>Latest Version</b> <b>V2.4.2 (R2009b)</b>	See the <b>Compatibility Considerations</b> subheading for each of these new features or changes: <ul style="list-style-type: none"> <li>• “threshacceptbnd Function Deprecated” on page 4</li> </ul>
V2.4.1 (R2009a)	None
V2.4 (R2008b)	None
V2.3 (R2008a)	See the <b>Compatibility Considerations</b> subheading for each of these new features or changes: <ul style="list-style-type: none"> <li>• “Genetic Algorithm Tool and Pattern Search Tool Combined Into Optimization Tool” on page 8</li> <li>• “New Automatic Population Generation in ga and gamultiobj” on page 8</li> <li>• “New Default StallTimeLimit Option = Inf in Genetic Algorithm” on page 9</li> </ul>
V2.2 (R2007b)	None

<b>Version (Release)</b>	<b>New Features and Changes with Version Compatibility Impact</b>
V2.1 (R2007a)	See the <b>Compatibility Considerations</b> subheading for each of these new features or changes: <ul style="list-style-type: none"><li>• “ga Output Argument exitflag Returns Numeric Value” on page 13</li></ul>
V2.0.2 (R2006b)	See the <b>Compatibility Considerations</b> subheading for each of these new features or changes: <ul style="list-style-type: none"><li>• “New Syntax for Search Method Option in Pattern Search Algorithm Improves Speed and Memory” on page 15</li></ul>
V2.0.1 (R2006a)	None
V2.0 (R14SP3)	None