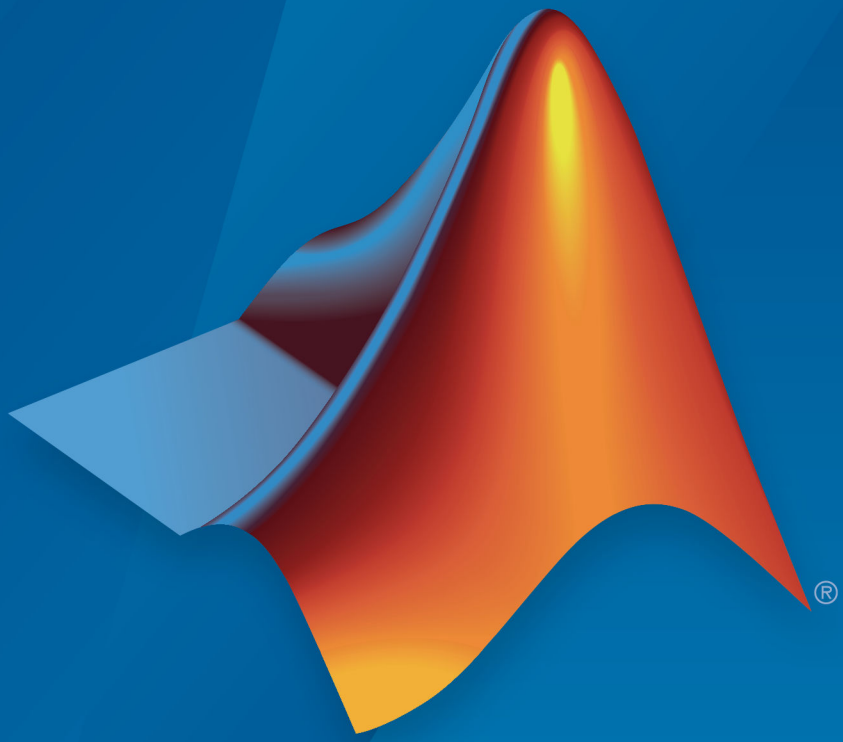
Fuzzy Logic Toolbox™ Release Notes



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

Fuzzy Logic Toolbox™ Release Notes

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Code Generation: Generate C and C++ code to load and evaluate fuzzy inference systems

You can now generate code for loading and evaluating a fuzzy inference system (FIS) using MATLAB® Coder™. The following existing functions now support code generation:

- `evalfis`
- `evalfisOptions`
- Built-in membership functions, such as `gaussmf` and `trimf`

For an example, see “Generate Code for Fuzzy System Using MATLAB Coder”.

Code generation using MATLAB Coder does not support the new FIS objects, `mamfis` and `sugfis`. To create a homogeneous FIS structure for code generation, use the new `getFISCodeGenerationData`.

Code generation using MATLAB Coder replaces the standalone C-code fuzzy inference engine. For more information, see “Support for deploying fuzzy systems using standalone C-code fuzzy inference engine will be removed” on page 1-13.

Improved Fuzzy Inference System Architecture: Implement fuzzy systems using objects with improved error handling

The Fuzzy Logic Toolbox now represents fuzzy inference systems using objects. These objects provide improved error handling over the previous structure-based representation.

The following table shows the new objects for representing a fuzzy inference system (FIS). The function for creating each object has the same name as the corresponding object.

Object	Description
`mamfis`	Mamdani FIS
`sugfis`	Sugeno FIS
`fisvar`	Input or output variable
`fismf`	Membership function
`fisrule`	Fuzzy rule

In addition to new objects, the improved FIS architecture includes several new functions for configuring fuzzy systems.

Function	Description
`addInput` and `addOutput`	Add input and output variables to a FIS (replace `addvar`)
`removeInput` and `removeOutput`	Remove input and output variables from a FIS (replace `rmvar`)
`removeMF`	Remove a membership function from an input or output variable in a FIS (replaces `rmmf`)
`convertToSugeno`	Convert a Mamdani FIS to a Sugeno FIS (replaces `mam2sug`)
`convertToStruct`	Convert a `mamfis` or `sugfis` object to a structure
`update`	Update the fields of a manually create `fisrule` object based on a given FIS

Compatibility Considerations

The improved FIS architecture introduces several compatibility considerations that require updates to your code. For more information on how to update your code to use fuzzy inference system objects in general, see “Support for representing fuzzy inference systems as structures will be removed” on page 1-4.

Several functions have changes in behavior or will be removed in a future release, as indicated in the following table.

Function	More Information
`newfis`	“newfis will be removed” on page 1-5
`parsrule`	“parsrule will be removed” on page 1-6
`addvar`	“addvar will be removed” on page 1-7
`rmvar`	“rmvar will be removed” on page 1-7
`rmmf`	“rmmf will be removed” on page 1-8
`getfis`	“getfis will be removed” on page 1-8
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Function	More Information
`mf2mf`	“mf2mf will be removed” on page 1-9
`mam2sug`	“mam2sug will be removed” on page 1-10
`showfis`	“showfis will be removed” on page 1-10
`evalfis`	“evalfis input argument order has changed” on page 1-11
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`writefis`	“writefis is now writeFIS” on page 1-13

evalfis Function: Obtain intermediate rule firing strengths when evaluating fuzzy systems

You can now obtain intermediate rule firing strengths when evaluating a fuzzy inference system using `evalfis`. The rule firing strengths are obtained by applying the fuzzy operator to the values of the fuzzified inputs.

addRule Function: Specify rules using linguistic and symbolic expressions

The `addRule` function now supports adding rules to a fuzzy system using linguistic and symbolic expressions. This `addRule` functionality replaces the equivalent `parsrule` functionality. For more information, see “parsrule will be removed” on page 1-6.

Functionality Being Removed or Changed

Support for representing fuzzy inference systems as structures will be removed
Still runs

Support for representing fuzzy inference systems as structures will be removed in a future release. Use `mamfis` and `sugfis` objects instead. There are differences between these representations that require updates to your code. These differences include:

- Object property names that differ from the corresponding structure fields.
- Objects store text data as strings rather than as character vectors.

Also, all Fuzzy Logic Toolbox functions that accepted or returned fuzzy inference systems as structures now accept and return either `mamfis` or `sugfis` objects.

Update Code

To convert existing fuzzy inference system structures to objects, use the `convertfis` function.

This table shows some examples of how to update your code to use the new object property names.

If your code has this form:	Use this code instead:
`fis.andmethod`	`fis.AndMethod`
`fis.aggmethod`	`fis.AggregationMethod`
`fis.input(1).name`	`fis.Inputs(1).Name`
`fis.output(1).mf(1).params`	`fis.Outputs(1).MembershipFunctions(1).Parameters`

newfis will be removed

Still runs

`newfis` will be removed in a future release. Use `mamfis` or `sugfis` instead. There are differences between these functions that require updates to your code.

To create a Mamdani or Sugeno FIS, use `mamfis` or `sugfis`, respectively.

Update Code

This table shows some typical usages of `newfis` for creating fuzzy systems and how to update your code to use `mamfis` or `sugfis` instead.

If your code has this form:	Use this code instead:
`fis = newfis(name)`	`fis = mamfis('Name',name)`
`fis = newfis(name,'FISType','mamdani')`	`fis = mamfis('Name',name)`
`fis = newfis(name,'FISType','sugeno')`	`fis = sugfis('Name',name)`

If your code has this form:	Use this code instead:

`fis = newfis(name,...`
`'FISType','mamdani',...`
`'AndMethod','prod')`
	`fis = mamfis('Name',name,...`
	`'AndMethod','prod')`

`fis = newfis(name,...`
`'FISType','sugeno',...`
`'OrMethod','probor')`
	`fis = sugfis('Name',name,...`
	`'OrMethod','probor')`

parsrule will be removed
Still runs

`parsrule` will be removed in a future release. Use `addRule` instead.

Update Code

If you previously added rules using linguistic or symbolic expressions with `parsrule`, you can specify rules using the same expressions with `addrule`. `addRule` automatically detects the format of the strings or character vectors in your rule list. Therefore, it is no longer necessary to specify the rule format. To add a rule list using `addRule`, use the following command:

If you previously added rules using indexed expressions with `parsrule`, update your code to use arrays of indices instead. For example, if your code has the following form:

```
rule1 = "1 2, 1 4 (1) : 1";
rule2 = "-1 1, 3 2 (1) : 1";
rules = [rule1 rule2];
fis = parsrule(fis,rules,'Format','indexed');
```

use this code instead:

```
rule1 = [1 2 1 4 1 1];
rule2 = [-1 1 3 2 1 1];
rules = [rule1; rule2];
fis = addRule(fis,rules);
```

If you previously specified rules using the `'Lanuage'` name-value pair argument with `parsrule`, this functionality has been removed and there is no replacement. Specify your rules using `addRule` with a different rule format.

Previously, `parsrule` replaced the entire rule list in your fuzzy system. `addRule` appends your specified rules to the rule list.

addvar will be removed

Still runs

`addvar` will be removed in a future release. Use `addInput` or `addOutput` instead. There are differences between these functions that require updates to your code.

To add input or output variables to a fuzzy system, use `addInput` or `addOutput`, respectively.

Update Code

This table shows some typical usages of `addvar` and how to update your code to use `addInput` or `addOutput` instead.

If your code has this form:	Use this code instead:
`fis = addvar(fis,'input',...` `'service',[0 10])`	`fis = addInput(fis,[0 10],...` `'Name',"service")`
`fis = addvar(fis,'output',...` `'tip',[0 30])`	`fis = addOutput(fis,[0 30],...` `'Name',"tip")`

rmvar will be removed

Still runs

`rmvar` will be removed in a future release. Use `removeInput` or `removeOutput` instead. There are differences between these functions that require updates to your code.

To remove input or output variables from a fuzzy system, use `removeInput` or `removeOutput`, respectively.

Update Code

This table shows some typical usages of `rmvar` and how to update your code to use `removeInput` or `removeOutput` instead. Previously, you specified the index of the variable that you wanted to remove. Now, to remove a variable, specify the variable name.

If your code has this form:	Use this code instead:
`fis = rmvar(fis,'input',1)`	`fis = removeInput(fis,"service")`
`fis = rmvar(fis,'output',1)`	`fis = removeOutput(fis,"tip")`

Previously, you had to delete any rules from your fuzzy system that contained the variable you wanted to remove. `removeInput` and `removeOutput` automatically remove these variables from the rule set of your fuzzy system.

rmmf will be removed

Still runs

`rmmf` will be removed in a future release. Use `removeMF` instead. There are differences between these functions that require updates to your code.

Update Code

The following table shows some typical usages of `rmmf` and how to update your code to use `removeMF` instead. Previously, you specified the index of the variable from which you wanted to remove the membership function and the index of the membership function that you wanted to remove. Now, to remove a membership function, specify the variable name and the membership function name.

If your code has this form:	Use this code instead:
`fis = rmmf(fis,'input',1,'mf',1)`	`fis = removeMF(fis,"service","poor")`
`fis = rmmf(fis,'output',1,'mf',1)`	`fis = removeMF(fis,"tip","cheap")`

Previously, you had to delete any references to a membership function you wanted to remove from the rule set. `removeMF` automatically removes these references from the rule set of your fuzzy system.

getfis will be removed

Still runs

`getfis` will be removed in a future release. Access fuzzy inference system properties using dot notation instead. There are differences between these approaches that require updates to your code.

Update Code

This table shows some typical usages of `getfis` for accessing fuzzy inference system properties and how to update your code to use dot notation instead.

If your code has this form:	Use this code instead:
`get(fis,'andmethod')`	`fis.AndMethod`
`getfis(fis,'input',1)`	`fis.Inputs(1)`
`getfis(fis,'input',1,'name')`	`fis.Inputs(1).Name`
`getfis(fis,'input',2,'mf',1)`	`fis.Inputs(2).MembershipFunctions(1)`

If your code has this form:	Use this code instead:
`getfis(fis,'input',2,'mf',1,...` `params)`	`fis.Inputs(2).MembershipFunctions(1).Parameters`

Previously, fuzzy inference systems were represented as structures. Now, fuzzy inference systems are represented as objects. Fuzzy inference system object properties have different names than the corresponding structure fields. For more information on fuzzy inference system objects, see `mamfis` and `sugfis`.

setfis will be removed
Still runs

`setfis` will be removed in a future release. Set fuzzy inference system properties using dot notation instead. There are differences between these approaches that require updates to your code.

Update Code

This table shows some typical usages of `setfis` for setting fuzzy inference system properties and how to update your code to use dot notation instead.

If your code has this form:	Use this code instead:
`fis = setfis(fis,'andmethod','prod')`	`fis.AndMethod = 'prod'`
`fis = setfis(fis,'input',1,...` `'name','service')`	`fis.Inputs(1).Name = "service"`

`fis = setfis(fis,'input',2,...`
`'mf',1,...`
`params,[5 10 15])`
	`fis.Inputs(2).MembershipFunctions(1).Parameters`
	`[5 10 15]`

Previously, fuzzy inference systems were represented as structures. Now, fuzzy inference systems are represented as objects. Fuzzy inference system object properties have different names than the corresponding structure fields. For more information on fuzzy inference system objects, see `mamfis` and `sugfis`.

mf2mf will be removed
Still runs

`mf2mf` will be removed in a future release. Convert membership functions using dot notation on `fismf` objects instead. There are differences between these approaches that require updates to your code.

Update Code

Previously, to change the type of a membership function in a fuzzy inference system, you converted the parameters using `mf2mf`.

```
fis = readfis('tipper');
oldType = fis.input(1).mf(1).type;
oldParams = fis.input(1).mf(1).params;
fis.input(1).mf(1).type = newType;
fis.input(1).mf(1).params = mf2mf(oldParams,oldType,newType);
```

Now, when you change the type of membership function, the parameters are converted automatically.

```
fis = readfis('tipper');
fis.Inputs(1).MembershipFunctions(1).Type = newType;
```

Previously, membership functions were represented as structures within a fuzzy inference system structure. Now, membership functions are represented as `fismf` objects within `mamfis` and `sugfis` objects. For more information on fuzzy inference system objects, see `mamfis` and `sugfis`.

`mam2sug` will be removed
Still runs

`mam2sug` will be removed in a future release. Use `convertToSugeno` instead. To update your code, change the function name from `mam2sug` to `convertToSugeno`. The syntaxes are equivalent.

`showfis` will be removed
Still runs

`showfis` will be removed in a future release. View the properties of your FIS, `myFIS`, directly instead. If your code has the form:

```
showfis(myFIS)
```

use this code instead:

```
myFIS
```

To view additional FIS properties, use dot notation. For example, view information about the membership functions of the first input variable.

```
myFIS.Inputs(1).MembershipFunctions
```

For more information on fuzzy inference systems and their properties, see `mamfis` and `sugfis`.

evalfis input argument order has changed

Behavior change

The order of input arguments for `evalfis` has changed, which requires updates to your code.

Update Code

Previously, to evaluate a fuzzy inference system, `fis`, you specified the input variable values, `input`, as the first input argument. For example:

```
output = evalfis(input,fis);
output = evalfis(input,fis,options);
```

Update your code to specify the fuzzy inference system as the first input argument. For example:

```
output = evalfis(fis,input);
output = evalfis(fis,input,options);
```

evalmf now takes a fismf object as an input argument

Behavior change

`evalmf` now takes a `fismf` object as an input argument rather than the type and parameters of the membership function. Also, you can now evaluate multiple membership functions by passing an array of `fismf` objects to `evalmf`. There are differences between these approaches that require updates to your code.

Update Code

Previously, you evaluated a membership function for given input values, `x`, by specifying the type of membership function, `type`, and the membership functions parameters, `params`.

```
y = evalmf(x,params,type);
```

Update your code to first create a `fismf` object, `mf`. Then, pass this object to `evalmf`.

```
mf = fismf(type,params);
y = evalmf(mf,x);
```

Also, previously, to evaluate multiple membership functions you called `evalmf` once for each membership function.

```
y1 = evalmf(x,params1,type1);
y2 = evalmf(x,params2,type2);
y3 = evalmf(x,params3,type3);
```

Now, you can evaluate multiple membership functions by passing an array of `fismf` objects to `evalmf`.

```
mf1 = fismf(type1,params1);
mf2 = fismf(type2,params2);
mf2 = fismf(type3,params3);
y = evalmf([mf1 mf2 mf3],x);
```

Here, `y = [y1 y2 y3]';`

addmf is now addMF and its function syntax has changed
Behavior change

The name and behavior of the `addmf` function has changed. Now:

- `addmf` is `addMF`
- You specify the variable to which you want to add the membership function by name rather than by index.
- You specify the name of the membership function using a name-value pair argument.

These changes require updates to your code. For more information, see `addMF`.

Update Code

The following table shows some typical usages of `addmf` for adding membership functions to fuzzy variables and how to update your code. In this table, `fis` is a fuzzy inference system with two inputs, `service` and `food`, and one output, `tip`.

If your code has this form:	Use this code instead:

`fis = addmf(fis'input',1,...`
`'poor',...`
`'gaussmf',[1.5 0])`
	`fis = addMF(fis,"service",...`
	`"gaussmf",[1.5 0],`
	`'Name',"poor")`

`fis = addmf(fis,'input',2,...`
`'rancid',...`
`'trapmf',[-2 0 1 3])`
	`fis = addMF(fis,"food",...`
	`"trapmf",[-2 0 1 3],...`
	`'Name',"rancid")`

If your code has this form:	Use this code instead:

`fis = addmf(fis,'output',1,...`
`'cheap',...`
`'trimf',[0 5 10])`
	`fis = addMF(fis,"tip",...`
	`"trimf",[0 5 10],...`
	`'Name',"cheap")`

addrule is now addRule
Behavior change

`addrule` is now `addRule`. To update your code, change the function name from `addrule` to `addRule`. The syntaxes are equivalent. For more information see `addRule`.

writefis is now writeFIS
Behavior change

`writefis` is now `writeFIS`. To update your code, change the function name from `writefis` to `writeFIS`. The syntaxes are equivalent. For more information, see `writefis`.

Support for deploying fuzzy systems using standalone C-code fuzzy inference engine will be removed
Still runs

Support for deploying fuzzy systems using a standalone C-code fuzzy inference engine will be removed in a future release. Generate code using MATLAB Coder or Simulink® Coder instead.

For more information on:

- Code generation in MATLAB and Simulink, see “Deploy Fuzzy Inference Systems”.
- The standalone inference engine, see Fuzzy Inference Engine in the R2018a documentation.

R2018a

Fuzzy Logic Controller Block: Troubleshoot FIS evaluation using new diagnostic messages

The Fuzzy Logic Controller block now reports potential problems that can produce unexpected output values during a simulation. The block generates diagnostic messages for the following conditions:

- Input values outside of their specified variable ranges
- No rules fired for a given output at the current input values
- Empty output fuzzy sets

You can specify whether these diagnostic messages are reported as warnings, reported as errors, or ignored.

For more information, see Fuzzy Logic Controller.

New evalfisOptions Option Set: Specify options for evaluating fuzzy systems

You can now specify options for evaluating fuzzy systems at the command line using the new `evalfisOptions` option set. Using this option set, you can specify:

- The number of sample points to use when evaluating output fuzzy sets.
- Whether diagnostic messages for potential problems are reported as warnings, reported as errors, or ignored.

For more information, see `evalfisOptions` and `evalfis`.

Compatibility Considerations

Previously, when evaluating a FIS using `evalfis`, you specified the number of sample points in output fuzzy sets using the optional input argument `numPts`.

```
output = evalfis(fis,input,numPts);
```

Starting in R2018a, modify your code to use an `evalfisOptions` option set.

```
opt = evalfisOptions('NumSamplePoints',numPts);
output = evalfis(fis,input,opt);
```

evalfis Function: New diagnostic message behavior

You can now control how the `evalfis` function reports potential problems that can produce unexpected output values during a simulation. The function generates diagnostic messages for the following conditions:

- Input values outside of their specified variable ranges
- No rules fired for a given output at the current input values
- Empty output fuzzy sets

You can specify whether these diagnostic messages are reported as warnings, reported as errors, or ignored. To do so, specify the corresponding options in an `evalfisOptions` option set.

For more information, see `evalfisOptions` and `evalfis`.

Compatibility Considerations

Previously, the `evalfis` function had the following behaviors for diagnostic conditions.

Diagnostic Condition	Previous Behavior
Input values outside of their specified variable ranges	MATLAB warning
No rules fired for a given output at the current input values	MATLAB Command Window message
Empty output fuzzy sets	MATLAB Command Window message

Starting in R2018a, these diagnostic conditions are reported as MATLAB warnings by default. You can change this behavior by specifying the corresponding options in an `evalfisOptions` option set.

evalfis Function: Intermediate fuzzy inference outputs for Sugeno systems analogous to outputs for Mamdani systems

When evaluating a Sugeno system using the following syntax, the intermediate fuzzy inference results are now analogous to the intermediate results for Mamdani systems.

```
[output,fuzzifiedInputs,ruleOutputs,aggregatedOutput] = evalfis(input,fis);
```

For a Sugeno system:

- `ruleOutputs` now returns an array that contains the scalar output value for each rule; that is, the product of the rule firing strength and the rule output level.
- `aggregatedOutput` now returns the sum of all the rule output values for each output variable.

For more information, see `evalfis`.

Compatibility Considerations

Previously, for a Sugeno fuzzy system:

- `ruleOutputs` returned an array that contained the output level for each rule.
- `aggregatedOutput` returned an array that contained the firing strength for each rule.

Starting in R2018a, if your code returns intermediate fuzzy inference results when evaluating a Sugeno system using `evalfis`, modify your code to use the new `ruleOutputs` and `aggregatedOutput` results.

Functionality being removed or changed

Functionality	Result	Use This Instead	Compatibility Considerations

`output = evalfis(fis,input,numPts);`	Still works	`opt = evalfisOptions('NumSamplePoints',numPts);`
		
		`output = evalfis(fis,input,opt);`
			To specify the number of sample points for output fuzzy sets, use an `evalfisOptions` option set. For more information, see “New evalfisOptions Option Set: Specify options for evaluating fuzzy systems” on page 2-2.

Functionality	Result	Use This Instead	Compatibility Considerations
Diagnostic messages when evaluating fuzzy systems using `evalfis`	Still works	Not applicable	By default, diagnostic messages are now reported as warnings. To change this behavior, specify the corresponding options in an `evalfisOptions` option set. For more information see, “evalfis Function: New diagnostic message behavior” on page 2-3.
`[output,fuzzifiedInputs,ruleOutputs,aggregatedOutput] = evalfis(input,fis)` when evaluating Sugeno systems	Still works	Not applicable	The behaviors of the `ruleOutputs` and `aggregatedOutput` argument of `evalfis` have changed for evaluating Sugeno systems. For more information, see “evalfis Function: Intermediate fuzzy inference outputs for Sugeno systems analogous to outputs for Mamdani systems” on page 2-3.

R2017b

Version: 2.3

New Features

Bug Fixes

Code Generation Improvements: Generate code for single and fixed-point data types, and custom membership and inference functions

The Fuzzy Logic Controller block now supports code generation for fuzzy systems using:

- Single-precision data.
- Fixed-point data. To generate code for fixed-point data, you need Fixed-Point Designer™ software.
- Custom membership functions and custom inference functions. For more information on specifying custom functions for a fuzzy system, see Build Fuzzy Systems Using Custom Functions.

You can generate code using either Simulink Coder or Simulink PLC Coder™ software.

PLC Deployment: Generate IEC 61131-3 Structured Text from fuzzy logic controllers

The Fuzzy Logic Controller block now supports generation of IEC 61131-3 Structured Text for PLC deployment using Simulink PLC Coder software.

Fuzzy Logic Controller Block Improvements: Configure additional block parameters, and access intermediate fuzzy inference results

For the Fuzzy Logic Controller block, you can now:

- Use a double-precision, single-precision, or fixed-point data type.
- Specify the number of sample points for evaluating the output range of a Mamdani system.
- Access intermediate fuzzy inference results using new optional output ports.

For more information, see Fuzzy Logic Controller.

evalfis Command: Evaluate FIS output variable ranges over a smaller number of sample points

You can now specify the number of sample points for evaluating the output range of a Mamdani fuzzy inference system at the command line as any value greater than `1`. Previously, the minimum value was `101`.

This change applies to the:

- `numPts` input argument of `evalfis`.
- `NumSamplePoints` property of `gensurfOptions`.

R2017a

Unified genfis Command: Generate fuzzy inference system structures using a single command

The commands for generating the structure of a fuzzy inference system have been unified into a single `genfis` command, which you configure using a new `genfisOptions` option set.

Starting in R2017a, to generate a FIS structure, first create a default `genfisOptions` option set, specifying one of the following structure generation algorithms:

- Grid partitioning

  ```
  opt = genfisOptions('GridPartition');
  ```

- Subtractive clustering

  ```
  opt = genfisOptions('SubtractiveClustering');
  ```

- Fuzzy c-means clustering

  ```
  opt = genfisOptions('FCMClustering');
  ```

You can then modify the options using dot notation. Any options you do not modify remain at their default values.

Compatibility Considerations

Previously, to generate FIS structures, you used the `genfis1`, `genfis2`, or `genfis3` commands with optional input arguments.

These commands may be removed in a future release and, starting in R2017a, using these commands generates a warning. If your code uses `genfis1`, `genfis2`, or `genfis3`, modify the code to use the `genfis` command, specifying options using a `genfisOptions` option set.

Algorithm	Old Syntax	New Syntax

Grid partitioning	`fis = genfis1(data,...`
	`numMFs,...`
	`inmftype,...`
	`outmftype)`
		`opt = genfisOptions('GridPartition');`
		`opt.NumMembershipFunctions = numMFs;`
		`opt.InputMembershipFunctionType = inmftype;`
		`opt.OutputMembershipFunctionType = outmftype;`
		`inputData = data(:,end-1);`
		`outputData = data(:,end);`
		`fis = genfis(inputData,outputData,opt);`

Subtractive clustering	`fis = genfis2(inputData,...`
	`outputData,...`
	`radii,...`
	`xBounds,...`
	`options,...`
	`userCenters)`
		`opt = genfisOptions('SubtractiveClustering');`
		`opt.ClusterInfluenceRange = radii;`
		`opt.DataScale = xBounds;`
		`opt.SquashFactor = options(1);`
		`opt.AcceptRatio = options(2);`
		`opt.RejectRatio = options(3);`
		`opt.Verbose = options(4);`
		`opt.CustomClusterCenters = userCenters;`
		`fis = genfis(inputData,outputData,opt);`

FCM clustering	`fis = genfis3(inputData,...`
	`outputData,...`
	`type,...`
	`cluster_n,...`
	`fcmoptions)`
		`opt = genfisOptions('FCMClustering');`
		`opt.FISType = type;`
		`opt.NumClusters = cluster_n;`
		`opt.Exponent = fcmoptions(1);`
		`opt.MaxNumIteration = fcmoptions(2);`
		`opt.MinImprovement = fcmoptions(3);`
		`opt.Verbose = fcmoptions(4);`
		`fis = genfis(inputData,outputData,opt);`

The syntaxes in this table assume that you are specifying all the options for each algorithm. Since the initial `genfisOptions` option set contains default algorithm options, you have to specify only nondefault options. For example, create an FIS using FCM clustering with three clusters, leaving all other options at their default values.

```
opt = genfisOptions('FCMClustering');
opt.NumClusters = 3;
fis = genfis(Xin,Xout,opt);
```

anfisOptions Command: Specify options for training adaptive neuro-fuzzy inference systems

To specify options for training adaptive neuro-fuzzy inference systems using the `anfis` command, you now create an `anfisOptions` option set. You can then modify the options using dot notation. Any options you do not modify remain at their default values.

Compatibility Considerations

Previously, to train an adaptive neuro-fuzzy inference system using `anfis`, you specified the training options using optional input arguments.

```
fis = anfis(trnData,initFIS,trnOpt,dispOpt,chkData,optMethod);
```

Starting in R2017a, if your code uses `anfis`, modify the code to use an `anfisOptions` option set.

```
opt = anfisOptions;
opt.InitialFIS = 3;
fis = anfis(trnData,opt);
```

The following table shows the mapping of the old `anfis` input arguments to the new `anfisOptions` option set.

Old `anfis` Input Argument	New `anfisOptions` Option
`initFIS`	`InitialFIS`
`trnOpt(1)`	`EpochNumber`
`trnOpt(2)`	`ErrorGoal`
`trnOpt(3)`	`InitialStepSize`
`trnOpt(4)`	`StepSizeDecreaseRate`
`trnOpt(5)`	`StepSizeIncreaseRate`
`dispOpt(1)`	`DisplayANFISInformation`
`dispOpt(2)`	`DisplayErrorValues`
`dispOpt(3)`	`DisplayStepSize`
`dispOpt(4)`	`DisplayFinalResults`
`chkData`	`ValidationData`

Old anfis Input Argument	New anfisOptions Option
optMethod	OptimizationMethod

gensurfOptions Command: Specify options for generating fuzzy inference system output surfaces

To specify options for generating fuzzy inference system output surfaces using the `gensurf` command, you now create a `gensurfOptions` option set. You can then modify the options using dot notation. Any options you do not modify remain at their default values.

Compatibility Considerations

Previously, to generate an output surface for a fuzzy inference system using `gensurf`, you specified the generation options using optional input arguments.

```
gensurf(fis,inputs,output,grids,refInput,points);
```

Starting in R2017a, if your code uses `gensurf`, modify the code to use a `gensurfOptions` option set.

```
opt = gensurfOptions;
opt.InputIndex = [1 3];
fis = gensurf(fis,opt);
```

The following table shows the mapping of the old `gensurf` input arguments to the new `gensurfOptions` option set.

Old gensurf Input Argument	New gensurfOptions Option
inputs	InputIndex
output	OutputIndex
grids	NumGridPoints
refinput	ReferenceInputs
points	NumSamplePoints

newfis Command: Specify options using Name,Value pairs

To specify options for creating new fuzzy inference systems using the `newfis` command, you now use `Name,Value` pair arguments. Any `Name,Value` pair arguments that you do not specify remain at their default values.

Compatibility Considerations

Previously, you specified options for the `newfis` command using optional input arguments.

```
fis = newfis('My FIS',fisType,andMethod,orMethod,impMethod,aggMethod,defuzzMethod);
```

Starting in R2017a, if your code uses `newfis`, modify the code to use one or more `Name,Value` pair arguments. For example, create a Mamdani FIS with default options.

```
fis = newfis('My FIS','FISType','mamdani');
```

The following table shows the mapping of the old input arguments to the new `Name,Value` pair arguments.

Old `newfis` Input Argument	New `Name,Value` Argument
`fisType`	`'FISType'`
`andMethod`	`'AndMethod'`
`orMethod`	`'OrMethod'`
`impMethod`	`'ImplicationMethod'`
`aggMethod`	`'AggregationMethod'`
`defuzzMethod`	`'DefuzzificationMethod'`

parsrule Command: Specify options using Name,Value pairs

To specify options for creating new fuzzy inference systems using the `parsrule` command, you now use `Name,Value` pair arguments. Any `Name,Value` pair arguments that you do not specify remain at their default values.

Compatibility Considerations

Previously, you specified options for the `parsrule` command using optional input arguments `ruleFormat` and `lang`.

```
outFIS = parsrule(inFIS,ruleList,ruleFormat,lang);
```

Starting in R2017a, if your code uses `newfis`, modify the code to use one or more `Name,Value` pair arguments. For example, add a list of rules in `'symbolic'` format.

```
fis = parsrule(inFIS,ruleList,'Format','symbolic');
```

The following table shows the mapping of the old input arguments to the new `Name,Value` pair arguments.

Old `parsrule` Input Argument	New `Name,Value` Argument
`ruleFormat`	`'Format'`
`lang`	`'Language'`

showrule Command: Specify options using Name,Value pairs

To specify options for viewing the rules of a fuzzy inference system using the `showrule` command, you now use `Name,Value` pair arguments. Any `Name,Value` pair arguments that you do not specify remain at their default values.

Compatibility Considerations

Previously, you specified options for the `showrule` command using optional input arguments `indexList`, `format`, and `lang`.

```
showrule(fis,indexList,format,lang);
```

Starting in R2017a, if your code uses `newfis`, modify the code to use one or more `Name,Value` pair arguments. For example, view the first fuzzy rule in `fis`.

```
showrule(fis,'RuleIndex',1);
```

The following table shows the mapping of the old input arguments to the new `Name,Value` pair arguments.

Old showrule Input Argument	New Name,Value Argument
indexList	'RuleIndex'
format	'Format'
lang	'Language'

subclust Command: Specify options using Name,Value pairs

To specify options for subtractive clustering using the `subclust` command, you now use `Name,Value` pair arguments. Any `Name,Value` pair arguments that you do not specify remain at their default values.

Compatibility Considerations

Previously, you specified options for the `subclust` command using optional input arguments `xBounds` and `options`.

```
fisOut = subclust(fisIn,radii,xBounds,options);
```

Starting in R2017a, if your code uses `newfis`, modify the code to use one or more `Name,Value` pair arguments. For example, specify clustering options.

```
fisOut = subclust(fisIn,radii,'Options',options);
```

The following table shows the mapping of the old input arguments to the new `Name,Value` pair arguments.

Old subclust Input Argument	New Name,Value Argument
xBounds	'DataScale'
options	'Options'

Obtain fuzzy inference system properties using improved getfis command

Several `getfis` syntaxes that previously printed formatted properties to the Command Window and also returned properties now perform a single action.

- `getfis(fis)` now just prints FIS properties to the Command Window.

- `getfis(fis,vartype,varindex)` now just returns variable properties in a structure.
- `getfis(fis,vartype,varindex,'mf',mfIndex)` now just returns membership function properties in a structure.

Compatibility Considerations

Starting in R2017a, the following `getfis` syntaxes have a new behavior.

Syntax	Previous Behavior	New Behavior
`getfis(fis)`	Print formatted list of FIS properties to Command Window, and return FIS name.	Print formatted list of FIS properties to Command Window.
`getfis(fis,varType,varIndex)`	Print formatted list variable properties to Command Window, and return structure that contains variable properties.	Return structure that contains variable properties.
`getfis(fis,varType,varIndex,'mf',mfIndex)`	Print formatted list membership function properties to Command Window, and return structure that contains membership function properties.	Return structure that contains membership function properties.

Functionality being removed or changed

Functionality	Result	Use This Instead	Compatibility Considerations
`genfis1`, `genfis2`, and `genfis3` commands	Warns	`genfis` command	See “Unified genfis Command: Generate fuzzy inference system structures using a single command” on page 4-2.
Specify optional input arguments for the `anfis` command	Still works	Specify options using `anfisOptions` command.	See “anfisOptions Command: Specify options for training adaptive neuro-fuzzy inference systems” on page 4-4.

Functionality	Result	Use This Instead	Compatibility Considerations
Specify optional input arguments for the `gensurf` command	Still works	Specify options using `gensurfOptions` command.	See “gensurfOptions Command: Specify options for generating fuzzy inference system output surfaces” on page 4-5.
Specify optional input arguments for `newfis` command	Still works	Specify options using `Name,Value` pair arguments.	See “newfis Command: Specify options using Name,Value pairs” on page 4-6.
Specify optional input arguments for `parsrule` command	Still works	Specify options using `Name,Value` pair arguments.	See “parsrule Command: Specify options using Name,Value pairs” on page 4-6.
Specify optional input arguments for `showrule` command	Still works	Specify options using `Name,Value` pair arguments.	See “showrule Command: Specify options using Name,Value pairs” on page 4-7.
Specify optional input arguments for `subclust` command	Still works	Specify options using `Name,Value` pair arguments.	See “subclust Command: Specify options using Name,Value pairs” on page 4-8.
`getfis` command syntaxes that both print and return properties	Still works	Syntaxes now either print or return properties, not both.	See “Obtain fuzzy inference system properties using improved getfis command” on page 4-8.

R2016b

Version: 2.2.24

New Features

Bug Fixes

Standalone Applications for ANFIS Training: Deploy neuro-adaptive fuzzy inference code using MATLAB Compiler

The `anfis` command now supports application deployment using MATLAB Compiler™. For more information on building and deploying standalone applications from MATLAB programs, see MATLAB Compiler.

R2016a

Version: 2.2.23

Bug Fixes

R2015b

Version: 2.2.22

Bug Fixes

R2015a

Version: 2.2.21

Bug Fixes

R2014b

Version: 2.2.20

New Features

Bug Fixes

Commands to open Fuzzy Logic Designer and Neuro-Fuzzy Designer renamed

`fuzzy` is renamed to `fuzzyLogicDesigner`. Use this command to open the Fuzzy Logic Designer app.

`anfisedit` is renamed to `neuroFuzzyDesigner`. Use this command to open the Neuro-Fuzzy Designer app.

R2014a

Version: 2.2.19

New Features

Bug Fixes

Example that shows how to use a fuzzy inference system to detect edges in an image

The Fuzzy Logic Image Processing example shows how to use a fuzzy inference system to detect edges in an image.

R2013b

Version: 2.2.18

Bug Fixes

R2013a

Version: 2.2.17

No New Features or Changes

R2012b

Version: 2.2.16

No New Features or Changes

R2012a

Version: 2.2.15

No New Features or Changes

R2011b

Version: 2.2.14

No New Features or Changes

R2011a

Version: 2.2.13

No New Features or Changes

R2010b

Version: 2.2.12

No New Features or Changes

R2010a

Version: 2.2.11

No New Features or Changes

R2009b

Version: 2.2.10

No New Features or Changes

R2009a

Version: 2.2.9

No New Features or Changes

R2008b

Version: 2.2.8

No New Features or Changes

R2008a

Version: 2.2.7

No New Features or Changes

R2007b

Version: 2.2.6

New Features

New Demo

Fuzzy Logic Toolbox software has a new demo Fuzzy C-Means Clustering for Iris Data, which illustrates the use of Fuzzy C-Means clustering for Iris dataset.

R2007a

Version: 2.2.5

No New Features or Changes

R2006b

Version: 2.2.4

No New Features or Changes

R2006a

Version: 2.2.3

No New Features or Changes

R14SP3

Version: 2.2.2

No New Features or Changes

R14SP2

Version: 2.2.1

No New Features or Changes