Spline Toolbox Release Notes

Note The Spline Toolbox 3.1 was released in Web-downloadable form after Release 12.1 was released, but before Release 13. The Spline Toolbox 3.1.1 that is part of Release 13 has no substantive changes from the Spline Toolbox 3.1.

The "Spline Toolbox 3.1.1 Release Notes" on page 1-1 describe the changes included in the latest version of the Spline Toolbox. The following topics are discussed in these Release Notes:

If you are upgrading from a release earlier than Release 12, you should also see "Spline Toolbox 3.0 Release Notes" on page 2-1.

Printing the Release Notes

If you would like to print the Release Notes, you can link to a PDF version.

Contents

1 Spline Toolbox 3.1.1 Release Notes

2 Spline Toolbox 3.0 Release Notes

1

Spline Toolbox 3.1.1 Release Notes

New Features

Note The Spline Toolbox 3.1 was initially released in Web-downloadable form after Release 12.1, but before Release 13. The Spline Toolbox 3.1.1 that is part of Release 13 has no substantive changes from the Spline Toolbox 3.1.

This section summarizes the new features and enhancements introduced in the Spline Toolbox 3.1 since Version 3.0 (Release 12.1), and included in Version 3.1.1.

If you are upgrading from the Spline Toolbox 2.0, then you should also see "New Features" on page 2-2 in the Spline Toolbox 3.0 Release Notes.

Smoothing Splines for Scattered Bivariate Data

The new command `tpaps` enables you to create thin-plate spline approximations *f* that satisfy, approximately or exactly, the equation $z = f(x, y)$ for given data values z at given scattered data sites (x,y) in the plane. The associated collocation matrix is provided by `stcol`. You can also create the first-order derivatives of a thin-plate spline.

The spline created by `tpaps` is in stform, as are its first-order derivatives. You can create an stform directly from its centers and coefficients using `stmak`. As with all forms, you can evaluate the splines in stform with `fnval`, plot them with `fnplt`, etc.

See "Fitting Values at Scattered 2-D Sites" and "The stform" in the Spline Toolbox documentation for more information.

splinetool Command History M-File

In the Spline Tool GUI (`splinetool`), you can now generate a function M-file that you can use to generate, from the original data, any or all graphs currently in the GUI. Select **File -> Save M-File** to save the M-file.

This M-file also provides you with a written record of the Spline Toolbox commands used to generate the current graph(s), and can be edited, or executed in a loop over different data sets.

Spline-Specific Zero Finder

A new command `fnzeros` enables you to find an ordered list of the zeros of a univariate, scalar-valued spline, in its basic interval or in a specified interval.

Spline-Specific Minimum Finder

A new command `fnmin` enables you to obtain the minimum or maximum value of a univariate, scalar-valued spline as well as its location, in its basic interval or in a specified interval.

Function Summary

Version 3.1 of the Spline Toolbox provides the following:

- New functions
- Functions with new or changed capabilities

New Functions

Function	Purpose
`fnmin`	Minimum of a function in a given interval
`fnzeros`	Find zeros of a function in a given interval
`stcol`	Scattered translates collocation matrix
`stmak`	Put together a function in stform
`tpaps`	Thin-plate smoothing spline

Spline Functions with New or Changed Capabilities

Function	Purpose
`fnbrk`	A new value of the `part` argument, `'variables'`, causes `fnbrk` to return the number of variables of the specified function.

Function	Purpose
`fnrfn`	As a new default, `fnrfn` now refines the partition (breaks or knots) of the given form by adding to it every midpoint. `fnrfn` previously had no default.
`splinetool`	`splinetool` now permits the entry of a vector whose elements replace that many entries in the weights display, starting with the marked entry.

`csaps`
`fnbrk`
`fnplt`
`optknt`
`slvblk`
`spaps`
`spcol`
`spcrv`
	These functions now treat an empty optional argument the same as not having that optional argument.

Major Bug Fixes

The Spline Toolbox 3.1.1 includes several bug fixes made since Version 3.0. This section describes the particularly important Version 3.1 bug fixes.

If you are viewing these Release Notes in PDF form, please refer to the HTML form of the Release Notes, using either the Help browser or the MathWorks Web site and use the link provided.

If you are upgrading from a Version 2.0, then you should also see “Major Bug Fix” on page 2-5.

Upgrading from an Earlier Release

This section describes the upgrade issues involved in moving from the Splines Toolbox 3.1 to Version 3.1.1.

Use playshow Command to Run Slideshow Style Demos

Starting in R13, to run slideshow style demos from the command line, you must use the `playshow` command. For example,

```
playshow splexmpl
```

You can continue to run other styles of demos from the command line by typing just the demo name. Splines Toolbox demos that are affected: `splexmpl`, `histodem`, `ppalldem`, `spapidem`, `getcurv2`, and `spalldem`.

2

Spline Toolbox 3.0 Release Notes

New Features

This section introduces the new features and enhancements added in the Spline Toolbox 3.0 since the Spline Toolbox 2.0.1 (Release 11.0).

Spline Tool Provides a Visual Interface to the Spline Toolbox

The `splinetool` function invokes a new visual interface that allows you to:

- Import data in various ways
- Try out and compare all the different spline fits available
- Vary the parameters, including the data
- Look at the error
- Look at the derivatives
- View the toolbox functions that produce specific spline fits
- Print the graphs, and save approximations for subsequent use

Automatic Knot Choice Simplifies Use of spapi and spap2

Until this release, if you wanted to construct a spline interpolant to given data, you had to specify the spline space from which this spline was to be chosen, by providing an appropriate knot sequence. Starting with this release, if you are not so certain about how to choose knots, you can simply specify the order of the spline to be used instead, and `spapi` will provide a suitable knot sequence.

The same difficulty of having to choose a knot sequence occurred in the construction of a least-squares spline approximation to given data, and here, too, you can instead merely specify the number of polynomial pieces of the given order to be used in the approximating spline in `spap2`.

Automatic Smoothing Parameter Choice Simplifies Use of csaps

You can now use `csaps` without specifying the smoothing parameter to be used. If none is specified, `csaps` will optionally return the one it chose for the given data, for further experimentation.

Use of Rational Splines

The relevant function functions (e.g., `fnval`, `fnplt`, `fntlr`, `fnbrk`, `fnrfn`, `fn2fm`, etc.) can now operate on rational splines (NURBS). Specific examples of a rational spline are provided by `rsmak`. Both `rsmak` and `rpmak` are available to generate arbitrary rational splines in B-form and ppform, respectively.

B-Spline Visual Interface

Splines in the Spline Toolbox are constructed as a linear combination of B-splines. Run `bspligui` to show how such a B-spline varies as you vary its knots. You can:

- Add knots
- Delete knots
- Move knots or breaks
- Increase/decrease the multiplicity of a knot

Other New Functions

The following functions have been added in the Spline Toolbox 3.0:

- `aptknt(x,k)` provides a good knot sequence for interpolation by splines of order `k` to data at `x`.
- `fndir` is available for the construction of directional derivatives, and hence of Jacobians, gradients, and surface normals.
- `fntlr` is available for the calculation of derivative values; this is particularly useful for rational splines for which formal differentiation is inefficient.
- `chbpnt(knots,k)` provides a good data site sequence for interpolation by splines of order `k` with knot sequence `knots`.

Other Enhancements

- Both `csaps` and `spaps` can now work with a nonconstant weight in the roughness measure.
- Both `csaps` and `spaps` can also now deal better with near-zero error weights.
- You can now give `spaps` a smoothing parameter rather than a tolerance.
- `fnbrk` can now change the basic interval of any form.

- You can now make `fnval` treat splines as continuous from the left.
- You can also now use `fnval` in the form `fnval(x,f)` as needed for `fzero`, `fminbnd`, etc.
- `fnplt` can now be made not to break the graph of a function at a jump.
- The second argument of `newknt(fn,newl)` has become optional.
- `aveknt(x,k)` can now handle an `x` of length `k` (of use in `aptknt`).
- `optknt` can now handle much more nonuniformly spaced data sites, particularly by using `optknt(tau,k,maxiter)` to increase the maximum number of steps used to iteratively solve for the optimal knots.

Major Bug Fix

The Spline Toolbox 3.0 includes several bug fixes, including the following particularly important bug fix.

spmak and ppmak Use Size Argument to Correctly Construct Multivariate Splines

If the spline to be constructed by `spmak (knots, coefs)` is multivariate, but is meant to be a constant function without any interior knots in its last variable, then the last dimension of `coefs` is necessarily 1.

For example, a one-piece trivariate constant function would have knots stored in a length 3 cell array and a 3-D coefficient array.

```
knots = {[0 1],[0 1],[0 1]};
coefs = ones([1,1,1]);
```

However, this `coefs` array would be truncated to 2-D because MATLAB suppresses all trailing singleton dimensions (dimensions greater than 2 whose size is 1). Thus in earlier versions of the toolbox, this would fail.

```
spmak(knots, coefs)
??? Error using ==> spmak
coefs must be a ([1+]length(KNOTS))-dimensional array
```

Even if you managed to construct the B-form of this constant function, the various `fn...` functions could not work with it.

For the Spline Toolbox 3.0, all these `fn...` functions now handle splines with coefficient arrays of this kind correctly. You can now specify the intended size of the coefficient array by

```
spmak(knots,coefs,sizec)
```

where `sizec` has the intended dimensionality of `coefs`. Now

```
spmak({[0 1],[0 1],[0 1]},ones([1,1,1]),[1 1 1])
```

will correctly construct a one-piece trivariate constant function, as will this.

```
spmak({[0 1],[0 1],[0 1]},1,[1 1 1]
```

Analogously, you can now use the optional third input argument, `d`, in

```
ppmak(breaks, coefs, d)
```

to specify the intended dimensions of the coefficient array.

Upgrading from an Earlier Release

This section describes the upgrade issues involved in moving from the Spline Toolbox 2.0 (Release 11) to the Spline Toolbox 3.0.

optknt and newknt Output No Longer Needs To Be Run Through augknt

In the Spline Toolbox 3.0, you no longer need to run the output from `optknt` and `newknt` through `augknt` to get a complete knot sequence. Running that output through `augknt` now does not cause any problems, but is unnecessary.