

Package ‘schumaker’

October 14, 2022

Type Package

Title Schumaker Shape-Preserving Spline

Version 1.2.1

Date 2021-09-09

Author Stuart Baumann [aut, cre], Margaryta Klymak[aut]

Maintainer Stuart Baumann <Stuart@StuartBaumann.com>

Description This is a shape preserving spline <doi:10.1137/0720057> which is guaranteed to be monotonic and concave or convex if the data is monotonic and concave or convex. It does not use any optimisation and is therefore quick and smoothly converges to a fixed point in economic dynamics problems including value function iteration. It also automatically gives the first two derivatives of the spline and options for determining behaviour when evaluated outside the interpolation domain.

License MIT + file LICENSE

Suggests testthat, knitr, numDeriv, cobs, scam, rbenchmark

VignetteBuilder knitr

RoxygenNote 7.1.1

NeedsCompilation no

Repository CRAN

Date/Publication 2021-09-09 22:00:03 UTC

R topics documented:

make_approx_functions_from_dataframe	2
ppmak	3
ppmak2Deriv	3
ppmakDeriv	4
Schumaker	5
SchumakerIndInterval	6

Index	7
--------------	----------

```
make_approx_functions_from_dataframe
      make_approx_functions_from_dataframe
```

Description

make_approx_functions_from_dataframe

Usage

```
make_approx_functions_from_dataframe(
  dataframe,
  group_vars,
  x_var,
  y_var,
  approx_func
)
```

Arguments

dataframe	A data.frame with your data.
group_vars	The variable names in the dataframe that subset the data into the various groups.
x_var	The name of the x variable in the dataframe
y_var	The name of the y variable in the dataframe.
approx_func	A function that takes in two arguments, an x vector and a y vector. Make sure it can handle vectors of length 0 (if that can happen in your data).

Value

A function of the form function(groupvar1, groupvar2, ..., x).

Examples

```
# Generating example data.
# Consider we have equity prices for several days and times.
RICs = c("BARC.L", "VOD.L", "IBM.L")
Dates = as.Date(c("11-11-2019", "12-11-2019", "13-11-2019",
                 "14-11-2019", "15-11-2019"), format="%d-%m-%Y")
times = seq(0,28800, length.out = 10) # The number of seconds into the trading day.
dd = expand.grid(TIME = times, Date = Dates, RIC = RICs)
dd = merge(dd, data.frame(RIC = RICs, PRICE = c(160.00, 162.24, 137.24)))
randomness = rlnorm(dim(dd)[1])
dd$PRICE = dd$PRICE * cumprod(randomness)

approx_func = function(x,y){approxfun(x, y)}
dispatched_approxfun = make_approx_functions_from_dataframe(dd,
  group_vars = c("RIC", "Date"),
```

```

x_var = "TIME", y_var = "PRICE",
                                approx_func)
dispatched_approxfun("BARC.L", Dates[2], c(100, 156, 6045))

```

ppmak

ppmak

Description

Create a spline with given intervals and quadratic coefficients. This is an internal function that is called from the Schumaker function. It roughly works like ppmak in matlab.

Usage

```
ppmak(IntStarts, SpCoefs, Vectorised = TRUE)
```

Arguments

IntStarts	This is a vector with the start of each interval.
SpCoefs	This is a matrix with three columns. The first is the coefficient of the squared term followed by linear term coefficients and constants.
Vectorised	This is a boolean parameter. Set to TRUE if you want to be able to input vectors to the created spline. If you will only input single values set this to FALSE as it is a bit faster.

Value

A spline function for the given intervals and quadratic curves. Each function takes an x value (or vector if Vectorised = TRUE) and outputs the interpolated y value (or relevant derivative).

ppmak2Deriv

ppmak2Deriv

Description

Create the second derivative of the spline defined by given intervals and quadratic coefficients. This is an internal function that is called from the Schumaker function.

Usage

```
ppmak2Deriv(IntStarts, SpCoefs, Vectorised = TRUE)
```

Arguments

IntStarts	This is a vector with the start of each interval.
SpCoefs	This is a matrix with three columns. The first is the coefficient of the squared term followed by linear term coefficients and constants.
Vectorised	This is a boolean parameter. Set to TRUE if you want to be able to input vectors to the created spline. If you will only input single values set this to FALSE as it is a bit faster.

Value

A spline function for the given intervals and quadratic curves. Each function takes an x value (or vector if Vectorised = TRUE) and outputs the interpolated y value (or relevant derivative).

ppmakDeriv

ppmakDeriv

Description

Create the derivative of the spline defined by given intervals and quadratic coefficients. This is an internal function that is called from the Schumaker function.

Usage

```
ppmakDeriv(IntStarts, SpCoefs, Vectorised = TRUE)
```

Arguments

IntStarts	This is a vector with the start of each interval.
SpCoefs	This is a matrix with three columns. The first is the coefficient of the squared term followed by linear term coefficients and constants.
Vectorised	This is a boolean parameter. Set to TRUE if you want to be able to input vectors to the created spline. If you will only input single values set this to FALSE as it is a bit faster.

Value

A spline function for the given intervals and quadratic curves. Each function takes an x value (or vector if Vectorised = TRUE) and outputs the interpolated y value (or relevant derivative).

Schumaker

*Create a Schumaker spline***Description**

Create a Schumaker spline

Usage

```
Schumaker(
  x,
  y,
  gradients = NA,
  Vectorised = TRUE,
  Extrapolation = c("Curve", "Constant", "Linear"),
  edgeGradients = c(NA, NA)
)
```

Arguments

x	A vector of x coordinates
y	A corresponding vector of y coordinates
gradients	(Optional) A corresponding vector of gradients at the data points. If this is NA then it will be estimated.
Vectorised	This is a boolean parameter. Set to TRUE if you want to be able to input vectors to the created spline. If you will only input single values set this to FALSE as it is a bit faster.
Extrapolation	This determines how the spline function responds when an input is received outside the domain of x. The options are "Curve" which outputs the result of the point on the quadratic curve at the nearest interval, "Constant" which outputs the y value at the end of the x domain and "Linear" which extends the spline using the gradient at the edge of x.
edgeGradients	This gives the options of specifying the gradients at either edge of the domain. By default this is c(NA,NA) meaning that the defaults from the original paper are used. If this is set to c(0,NA) for instance this will mean that the left edge gradient is zero and the right edge gradient is as recommended in the original paper. This setting has no impact if a full set of gradients is input.

Value

A list with 3 spline functions and a table with spline intervals and coefficients. The first spline is the schumaker spline, the second spline is the first derivative of the schumaker spline, the third spline is the second derivative of the schumaker spline. Each function takes an x value (or vector if Vectorised = TRUE) and outputs the interpolated y value (or relevant derivative).

References

- Schumaker, L.L. 1983. On shape-preserving quadratic spline interpolation. *SIAM Journal of Numerical Analysis* 20: 854-64.
- Judd (1998). *Numerical Methods in Economics*. MIT Press

Examples

```
x = seq(1,6)
y = log(x)
SSS = schumaker::Schumaker(x,y, Vectorised = TRUE)
xarray = seq(1,6,0.01)
Result = SSS$Spline(xarray)
Result2 = SSS$DerivativeSpline(xarray)
Result3 = SSS$SecondDerivativeSpline(xarray)
plot(xarray, Result, ylim=c(-0.5,2))
lines(xarray, Result2, col = 2)
lines(xarray, Result3, col = 3)
```

SchumakerIndInterval *SchumakerIndInterval*

Description

This creates quadratic coefficients for one interval of a domain. This is an internal function that is called from the Schumaker function.

Usage

```
SchumakerIndInterval(z, s, Smallt)
```

Arguments

z	This is the y value at edges of an interval.
s	This is the slope at edges of an interval.
Smallt	This is x values at the edge of an interval.

Value

The location of the knot and quadratic coefficients for an interval.

Index

make_approx_functions_from_dataframe,
[2](#)

ppmak, [3](#)
ppmak2Deriv, [3](#)
ppmakDeriv, [4](#)

Schumaker, [5](#)
SchumakerIndInterval, [6](#)