

# Package ‘fctbases’

May 17, 2022

**Type** Package

**Title** Functional Bases

**Version** 1.1.1

**Date** 2022-05-17

**Author** Niels Olsen

**Maintainer** Niels Olsen <na1o@dtu.dk>

**Description** Easy-to-use, very fast implementation of various functional bases. Easily used together with other packages.

A functional basis is a collection of basis functions  $[\phi_1, \dots, \phi_n]$  that can represent a smooth function, i.e.  $f(t) = \sum c_k \phi_k(t)$ .

First- and second-order derivatives are also included. These are the mathematically correct ones, no approximations applied.

As of version 1.1, this package includes B-splines, Fourier bases and polynomials.

**URL** <https://github.com/naolsen/fctbases>

**License** GPL-3

**Imports** Rcpp ( $\geq 0.12.19$ )

**Suggests** knitr, rmarkdown, microbenchmark

**LinkingTo** Rcpp, RcppArmadillo

**NeedsCompilation** yes

**Repository** CRAN

**Date/Publication** 2022-05-17 17:10:02 UTC

## R topics documented:

fctbases-package . . . . .	2
Functional basis function . . . . .	2
make.bspline.basis . . . . .	3
make.fourier.basis . . . . .	4
make.pol.basis . . . . .	5
make.std.bspline.basis . . . . .	5
object.info . . . . .	6

**Index**[7](#)


---

fctbases-package      *fctbases: Functional bases*

---

**Description**

fctbases is a fast and easy implementation of functional bases in R. Simply initialize the desired basis, which returns function of class `fctbasis`.

**Details**

Internally, functions are stored as C++ objects, which are masked by the package. The package maintains the bookkeeping of `fctbasis` objects. Parameters are validated at initialization which also reduces some of the overhead. `fctbases` objects cannot be saved across sessions and must be re-initialised.

Derivatives are provided. These are the mathematically correct ones and are as fast as the non-derivatives.

**See Also**

[Functional basis function](#)

---

Functional basis function  
*Functional basis function*

---

**Description**

A `fctbases` object is a function of class `fctbasis` which takes three arguments (`t`, `x`, `deriv`)

**Arguments**

<code>t</code>	time points
<code>x</code>	vector or matrix of coefficients (optional)
<code>deriv</code>	Should the derivative be used and which order? Defaults to FALSE

**Details**

If `deriv` is zero or FALSE, the function itself is evaluated. If `deriv` is one or TRUE, the first derivative is evaluated. If `deriv` is two, the second derivative is evaluated.

The dimension of `x` must match the number of basis functions.

**Value**

Returns a matrix of dimension `length(t)` times no. of bases if `x` is missing. If `x` is provided and is a vector, it returns a vector of same length as `t`. If `x` is provided and is a matrix, it returns a matrix of dimension `length(t)` times `ncol(x)`

**Examples**

```
## Create basis (here a b spline)
bf <- make.bspline.basis(knots = 0:12/12)

## Use a functional basis

bf(0.2)
tt <- seq(0,1, length = 50)
bf(tt) ## evaluates bf in tt
bf(tt, deriv = TRUE) ## evaluates derivative of bf in tt

## Apply bf to some coefficients
set.seed(661)
x <- runif(15)
bf(tt, x) ## Evaluate bf in tt with coefficients x.

bf(0.2, deriv = 2) ## Second derivative.
bf(0.2, x, deriv = 2) ## Second derivative with coefficients x.
```

---

<code>make.bspline.basis</code>	<i>Make B-spline basis</i>
---------------------------------	----------------------------

---

**Description**

Make B-spline basis

**Usage**

```
make.bspline.basis(knots, order = 4)
```

**Arguments**

<code>knots</code>	Knots of the basis, including endpoints
<code>order</code>	Spline order. Defaults to 4.

**Value**

Function of class "fctbasis"

**See Also**

[Functional basis function](#), [make.std.bspline.basis](#)

## Examples

```
## B-spline with equidistant knots with 13 basis function
bf <- make.bspline.basis(knots = 0:10, order = 4)

## B-spline of order 2 (ie. a linear approximation) with some uneven knots
bf <- make.bspline.basis(knots = c(-1.3, 0, 0.5, 0.7, 1.1), order = 2)
```

---

make.fourier.basis      *Make fourier basis*

---

## Description

Make fourier basis

## Usage

```
make.fourier.basis(range, order, use.trig.id = FALSE)
```

## Arguments

range	Left and right end points.
order	Order of harmonics
use.trig.id	Use trigonometrical identities with this function?

## Details

The number of basis elements (degrees of freedom) is  $2 * \text{order} + 1$ .

The basis functions are ordered [1, sin(t), cos(t), sin(2t), cos(2t), ...]

Using trigonometrical identities is faster, but introduces (negligible) round-off errors.

## Value

Function of class "fctbasis"

## See Also

[Functional basis function](#)

## Examples

```
## A fourier basis with period 1 and 11 basis functions.
bf <- make.fourier.basis(c(0,1), order = 5)
```

---

make.pol.basis            *Make polynomial basis*

---

**Description**

Make polynomial basis

**Usage**

```
make.pol.basis(order)
```

**Arguments**

order            Order of polynomial (= degree + 1)

**Details**

The polynomial basis is ordered [1, t, t<sup>2</sup>, t<sup>3</sup>, ..., t<sup>n</sup>]

**Value**

Function of class "fctbasis"

**See Also**

[Functional basis function](#)

**Examples**

```
## A four-degree polynomial  
mypol <- make.pol.basis(order = 5)
```

---

make.std.bspline.basis  
                          *'Standard' B-spline basis*

---

**Description**

This initializes a bspline of order 4 with uniformly places knots. df = intervals + 3.

**Usage**

```
make.std.bspline.basis(range = c(0, 1), intervals)
```

**Arguments**

range	End points of spline
intervals	Number of intervals

**Details**

`make.std.bspline.basis` uses a different implementation than `make.bspline.basis`, but is not faster in all uses.

**Value**

function

**See Also**

[Functional basis function](#), [make.bspline.basis](#)

**Examples**

```
## 16 equidistant knots between 0 and 2 (both included)
bf <- make.std.bspline.basis(range = c(0,2), intervals = 15)
```

---

object.info

*Functional basis info*

---

**Description**

This function returns details about a functional basis.

**Usage**

```
object.info(fctbasis)
```

**Arguments**

fctbasis	object of class fctbasis
----------	--------------------------

**Value**

A named list including no. of basis, type of basis, and possibly additional information.

# Index

fctbases (fctbases-package), [2](#)  
fctbases-package, [2](#)  
Functional basis function, [2](#), [2](#), [3-6](#)  
  
make.bspline.basis, [3](#), [6](#)  
make.fourier.basis, [4](#)  
make.pol.basis, [5](#)  
make.std.bspline.basis, [3](#), [5](#)  
  
object.info, [6](#)