Package ‘CBSr’

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Type Package

Title Fits Cubic Bezier Spline Functions to Intertemporal and Risky Choice Data

Version 1.0.5

Description Uses monotonically constrained Cubic Bezier Splines (CBS) to approximate latent utility functions in intertemporal choice and risky choice data. For more information, see Lee, Glaze, Bradlow, and Kable <doi:10.1007/s11336-020-09723-4>.

License GPL-3

Depends R (>= 3.5)

Encoding UTF-8

LazyData true

Imports rJava (>= 0.9-11), NlcOptim (>= 0.6)

SystemRequirements Java (>= 7.0)

NeedsCompilation no

RoxygenNote 7.1.1

Author Sangil Lee [aut, cre]

Maintainer Sangil Lee <sangillee3rd@gmail.com>

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R topics documented:

CBSfunc *CBSfunc*

Description

Calculate either the Area Under the Curve (AUC) of a CBS function, or calculate the y coordinates of CBS function given x.

Usage

```
CBSfunc(xpos, ypos, x = NULL)
```

Arguments

xpos	Vector of real numbers of length 1+3n (n = 1, 2, 3, ...), corresponding to Bezier points' x-coordinates of a CBS function
ypos	Vector of real numbers of length 1+3n (n = 1, 2, 3, ...), corresponding to Bezier points' y-coordinates of a CBS function
x	Vector of real numbers, corresponding to x-coordinates of a CBS function. Default value is Null.

Value

If x is provided, return y coordinates corresponding to x. If x is not provided, return AUC.

Examples

```
CBSfunc(c(0,0.3,0.6,1),c(0.5, 0.2, 0.7, 0.9))
CBSfunc(c(0,0.3,0.6,1),c(0.5, 0.2, 0.7, 0.9),seq(0,1,0.1))
```

CBS_ITC *CBS_ITC*

Description

Fit either a 1-piece or 2-piece CBS latent utility function to binary intertemporal choice data.

Usage

```
CBS_ITC(choice, Amt1, Delay1, Amt2, Delay2, numpiece, numfit = NULL)
```

Arguments

`choice`	Vector of 0s and 1s. 1 if the choice was option 1, 0 if the choice was option 2.
`Amt1`	Vector of positive real numbers. Reward amount of choice 1.
`Delay1`	Vector of positive real numbers. Delay until the reward of choice 1.
`Amt2`	Vector of positive real numbers. Reward amount of choice 2.
`Delay2`	Vector of positive real numbers. Delay until the reward of choice 2.
`numpiece`	Either 1 or 2. Number of CBS pieces to use.
`numfit`	Number of model fits to perform from different starting points. If not provided, numfit = 10*numpiece

Details

The input data has n choices (ideally n > 100) between two reward options. Option 1 is receiving `Amt1` in `Delay1` and Option 2 is receiving `Amt2` in `Delay2` (e.g., $40 in 20 days vs. $20 in 3 days). One of the two options may be immediate (i.e., delay = 0; e.g., $40 in 20 days vs. $20 today). `choice` should be 1 if option 1 is chosen, 0 if option 2 is chosen.

Value

A list containing the following:

- `type`: either 'CBS1' or 'CBS2' depending on the number of pieces
- `LL`: log likelihood of the model
- `numparam`: number of total parameters in the model
- `scale`: scaling factor of the logit model
- `xpos`: x coordinates of the fitted CBS function
- `ypos`: y coordinates of the fitted CBS function
- `AUC`: area under the curve of the fitted CBS function. Normalized to be between 0 and 1.
- `normD` : The domain of CBS function runs from 0 to `normD`. Specifically, this is the constant used to normalize all delays between 0 and 1, since CBS is fitted in a unit square first and then scaled up.

Examples

```
# Fit example ITC data with 2-piece CBS function.
# Load example data (included with package).
# Each row is a choice between option 1 (Amt at Delay) vs option 2 (20 now).
Amount1 = ITCdat$Amt1
Delay1 = ITCdat$Delay1
Amount2 = 20
Delay2 = 0
Choice = ITCdat$Choice

# Fit the model
out = CBS_ITC(Choice,Amount1,Delay1,Amount2,Delay2,2)
```

```
# Plot the choices (x = Delay, y = relative amount : 20 / delayed amount)
plot(Delay1[Choice==1],20/Amount1[Choice==1],type = 'p',col="blue",xlim=c(0, 180), ylim=c(0, 1))
points(Delay1[Choice==0],20/Amount1[Choice==0],type = 'p',col="red")

# Plot the fitted CBS
x = 0:out$normD
lines(x,CBSfunc(out$xpos,out$ypos,x),col="black")
```

CBS_RC *CBS_RC*

Description

Fit either a 1-piece or 2-piece CBS latent utility function to binary risky choice data.

Usage

```
CBS_RC(choice, Amt1, Prob1, Amt2, Prob2, numpiece, numfit = NULL)
```

Arguments

`choice`	Vector of 0s and 1s. 1 if the choice was option 1, 0 if the choice was option 2.
`Amt1`	Vector of positive real numbers. Reward amount of choice 1.
`Prob1`	Vector of positive real numbers between 0 and 1. Probability of winning the reward of choice 1.
`Amt2`	Vector of positive real numbers. Reward amount of choice 2.
`Prob2`	Vector of positive real numbers between 0 and 1. Probability of winning the reward of choice 2.
`numpiece`	Either 1 or 2. Number of CBS pieces to use.
`numfit`	Number of model fits to perform from different starting points. If not provided, numfit = 10*numpiece

Details

The input data has n choices (ideally n > 100) between two reward options. Option 1 is receiving `Amt1` with probability `Prob1` and Option 2 is receiving `Amt2` with probability `Prob2` (e.g., $40 with 53% chance vs. $20 with 90% chance). One of the two options may be certain (i.e., prob = 1; e.g., $40 with 53% chance vs. $20 for sure). `choice` should be 1 if option 1 is chosen, 0 if option 2 is chosen.

Value

A list containing the following:

- `type`: either 'CBS1' or 'CBS2' depending on the number of pieces
- `LL`: log likelihood of the model

- `numparam`: number of total parameters in the model
- `scale`: scaling factor of the logit model
- `xpos`: x coordinates of the fitted CBS function
- `ypos`: y coordinates of the fitted CBS function
- `AUC`: area under the curve of the fitted CBS function. Normalized to be between 0 and 1.

Examples

```
# Fit example Risky choice data with 2-piece CBS function.
# Load example data (included with package).
# Each row is a choice between option 1 (Amt with prob) vs option 2 (20 for 100%).
Amount1 = RCdat$Amt1
Prob1 = RCdat$Prob1
Amount2 = 20
Prob2 = 1
Choice = RCdat$Choice

# Fit the model
out = CBS_RC(Choice,Amount1,Prob1,Amount2,Prob2,2)

# Plot the choices (x = Delay, y = relative amount : 20 / risky amount)
plot(Prob1[Choice==1],20/Amount1[Choice==1],type = 'p',col="blue",xlim=c(0, 1), ylim=c(0, 1))
points(Prob1[Choice==0],20/Amount1[Choice==0],type = 'p',col="red")

# Plot the fitted CBS
x = seq(0,1,.01)
lines(x,CBSfunc(out$xpos,out$ypos,x))
```

`ITCdat` *Sample participant data from a binary intertemporal choice task (aka delay discounting task)*

Description

A dataset containing one sample participant's 120 binary choices between a delayed monetary option (`Amt1` in `Delay1`) and a immediate monetary option ($20 now). The immediate monetary option was always '$20 now' across all trials

Usage

```
ITCdat
```

Format

A data frame with 120 rows and 3 variables:

Amt1 Delayed reward amount, in dollars

Delay1 Delay until the receipt of `Amt1`, in days

Choice Choice between binary options. `Choice==1` means participnat chose the delayed option (i.e., `Amt1` in `Delay1` days). `Choice==0` means participnat chose the immediate option (i.e., $20 now)

Source

Kable, J. W., Caulfield, M. K., Falcone, M., McConnell, M., Bernardo, L., Parthasarathi, T., ... & Diefenbach, P. (2017). No effect of commercial cognitive training on brain activity, choice behavior, or cognitive performance. Journal of Neuroscience, 37(31), 7390-7402.

`RCdat` *Sample participant data from a binary risky choice task (aka risk aversion task)*

Description

A dataset containing one sample participant's 120 binary choices between a probabilistic monetary option (`Amt1` with `Prob1` chance of winning) and a certain monetary option ($20 for sure). The certain monetary option was always '$20 for sure' across all trials

Usage

```
RCdat
```

Format

A data frame with 120 rows and 3 variables:

Amt1 Probabilistic reward amount, in dollars

Prob1 Probability of winning `Amt1`, if it were to be chosen

Choice Choice between binary options. `Choice==1` means participnat chose the probabilistic option (i.e., `Amt1` with `Delay1` chance of winning). `Choice==0` means participnat chose the certain option (i.e., $20 for sure)

Source

Kable, J. W., Caulfield, M. K., Falcone, M., McConnell, M., Bernardo, L., Parthasarathi, T., ... & Diefenbach, P. (2017). No effect of commercial cognitive training on brain activity, choice behavior, or cognitive performance. Journal of Neuroscience, 37(31), 7390-7402.

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