

Package ‘EvCombR’

July 21, 2025

Type Package

Title Evidence Combination in R

Version 0.1-4

Date 2022-04-21

Author Alexander Karlsson

Maintainer Alexander Karlsson <alexander.karlsson@his.se>

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Description Combine pieces of evidence in the form of uncertainty representations.

License GPL (>= 3)

Imports methods, utils

NeedsCompilation no

Repository CRAN

Date/Publication 2022-04-25 10:10:09 UTC

Contents

EvCombR-package	2
cComb	3
cComb-methods	5
credal	5
credal-class	6
credal-methods	7
dComb	8
dComb-methods	9
disc	9
disc-methods	10
EvCombRLicense	10
extPoints	11
extPoints-methods	12
focal	12
focal-methods	13
focal<-	13

focal<-methods	14
lower	14
lower-methods	16
mass	16
mass-class	17
mass-methods	19
massQ-class	19
mComb	20
mComb-methods	21
pign	21
pign-methods	22
relPl	23
relPl-methods	24
space	24
space-methods	25
space<-	25
space<-methods	26
upper	26
upper-methods	27
yComb	28
yComb-methods	29
[-methods	29
[<-methods	30
[[-methods	31
[[<-methods	31
Index	33

EvCombR-package

EvCombR - Evidence Combination in R

Description

Package for combining pieces of evidence.

Details

Implements Dempster's, Yager's, modified Dempster's, Bayesian, and credal combination (based on intervals).

Author(s)

Alexander Karlsson

Maintainer: Alexander Karlsson <alexander.karlsson@his.se>

References

- Dempster, A. P. (1969), A generalization of Bayesian inference, *Journal of the Royal Statistical Society*, **30**, 205-247
- Shafer, G. (1976), A Mathematical Theory of Evidence Princeton University Press
- Yager, R. (1987), On the Dempster-Shafer Framework and New Combination Rules, *Information Sciences* **41**: 93-137.
- Fixsen, D., Mahler, R. P. S. (1997), The modified Dempster-Shafer approach to classification, *IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans*, **27**, 96-104
- Arnborg, S. (2006), Robust Bayesianism: Relation to Evidence Theory, *Journal of Advances in Information Fusion*, **1**, 63-74
- Karlsson, A., Johansson, R., and Andler, S. F. (2011), Characterization and Empirical Evaluation of Bayesian and Credal Combination Operators, *Journal of Advances in Information Fusion*, **6**, 150-166

Examples

```
# construct a state space
stateSpace <- c("a", "b", "c")

# construct credal sets with the given state space
c1 <- credal(c(0.1, 0.1, 0.1), c(0.8, 0.8, 0.8), stateSpace)
c2 <- credal(c(0.2, 0.2, 0.2), c(0.9, 0.9, 0.9), stateSpace)

# combine the credal sets
cComb(c1, c2)

# construct mass functions
m1 <- mass(list("a"=0.1, "b"=0.1, "c"=0.4, "a/b/c"=0.4), stateSpace)
m2 <- mass(list("a"=0.2, "b"=0.2, "c"=0.2, "a/b/c"=0.4), stateSpace)

# combine the mass function by using Dempster's combination
dComb(m1, m2)

# Yager's combination operator
yComb(m1, m2)

# modified Dempster's combination using uniform prior
mComb(m1, m2)
```

cComb

Credal Combination Operator (restricted to intervals)

Description

Combine evidence in the form of credal sets (based on intervals) using the credal combination operator (also known as the robust Bayesian combination operator). The resulting credal set is approximated by using probability intervals.

Usage

cComb(x,y)

Arguments

x	credal set or a list of credal sets
y	credal set if x is a credal set, otherwise missing

Value

credal set

Author(s)

Alexander Karlsson

References

Levi, I. (1983), *The enterprise of knowledge*, The MIT press

Arnborg, S. (2006), Robust Bayesianism: Relation to Evidence Theory, *Journal of Advances in Information Fusion*, **1**, 63-74

Karlsson, A., Johansson, R., and Andler, S. F. (2011), Characterization and Empirical Evaluation of Bayesian and Credal Combination Operators, *Journal of Advances in Information Fusion*, **6**, 150-166

See Also

[dComb](#), [yComb](#), [mComb](#)

Examples

```
# construct a state space
stateSpace <- c("a", "b", "c")

# construct credal sets with the given state space
c1 <- credal(c(0.1, 0.1, 0.1), c(0.8, 0.8, 0.8), stateSpace)
c2 <- credal(c(0.2, 0.2, 0.2), c(0.9, 0.9, 0.9), stateSpace)

# combine the credal sets
cComb(c1, c2)
# or by
cComb(list(c1, c2))
```

cComb-methods*Methods for Function cComb*

Description

Combine credal sets (based on intervals) using the credal combination operator (also known as the robust Bayesian combination operator). For more detail see [cComb](#).

Methods

signature(x = "credal", y = "credal") Combine two credal sets using the credal combination operator

signature(x = "list", y = "missing") Combine a list of credal sets using the credal combination operator

credal*Constructor Function for Credal Sets (based on intervals)*

Description

Construct a credal set based on probability intervals or a single probability function. The algorithm used for finding the extreme points corresponding to lower and upper bounds is described in De Campos et al. (1994).

Usage

```
credal(x, y, z)
```

Arguments

x	lower bounds of probability intervals (in the form of a numeric vector)
y	upper bounds for probability intervals or missing (i.e., upper bound of 1)
z	character vector representing the state space

Value

A credal set represented by a set of extreme points.

Author(s)

Alexander Karlsson

References

- Levi, I. (1983), The enterprise of knowledge, The MIT press
- Arnborg, S. (2006), Robust Bayesianism: Relation to Evidence Theory, *Journal of Advances in Information Fusion*, **1**, 63-74
- Karlsson, A., Johansson, R., Andler, S. F. (2011), Characterization and Empirical Evaluation of Bayesian and Credal Combination Operators, *Journal of Advances in Information Fusion*, **6**, 150-166
- De Campos L. M., Huete, J. F., Moral S., Probability Intervals: a Tool for Uncertain Reasoning, *International Journal of Uncertainty, Fuzziness, and Knowledge-Based Systems*, **2**, 167-196

See Also

[cComb](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# lower and upper bounds for probability intervals
c1 <- credal(c(0.1, 0.1, 0.1), c(0.8, 0.8, 0.8), stateSpace)

# single probability function (lower and upper bounds of probability intervals are equal)
c2 <- credal(c(0.1, 0.2, 0.7), c(0.1, 0.2, 0.7), stateSpace)
```

credal-class

Class "credal"

Description

Represents a credal set by a set of extreme points. For more detail see [credal](#).

Objects from the Class

Objects can be created by [credal](#).

Slots

extPoints: Object of class "matrix". Each row is an extreme point of the credal set.

Methods

[signature(x="credal", i="ANY", j="ANY"): extract an extreme point

[<- signature(x="credal", i="ANY", j="ANY", value="ANY"): replace and extreme point

cComb signature(x = "credal", y = "credal"): combine two credal sets

lower signature(x = "credal", set = "character"): calculate the lower bound for a specific set of states

lower signature(x = "credal", set = "missing"): calculate the lower bounds for all singleton states

upper signature(x = "credal", set = "character"): calculate the upper bound for a specific set of states

upper signature(x = "credal", set = "missing"): calculate the upper bounds for all singleton states

extPoints signature(x = "credal"): access method for the slot points

space signature(x = "credal"): access method for names of singleton states

space<- signature(x = "credal"): replace method for names of singleton states

Author(s)

Alexander Karlsson

credal-methods

Methods for Function credal

Description

Methods for constructing a credal set. For more detail see [credal](#).

Methods

signature(x = "numeric", y = "missing", z = "character") Construct a credal set based on the lower bounds of probability intervals for states (1 will be the upper bound for all probability intervals)

signature(x = "numeric", y = "numeric", z = "character") Construct a credal based on probability intervals for states

Author(s)

Alexander Karlsson

`dComb`*Dempster's Combination Operator*

Description

Combine evidence in the form of mass functions using Dempster's combination operator.

Usage

```
dComb(x, y)
```

Arguments

<code>x</code>	single mass function or a list of mass functions
<code>y</code>	single mass function if <code>x</code> is a single mass function, otherwise missing

Value

mass function

Author(s)

Alexander Karlsson

References

Dempster, A. P. (1969), A generalization of Bayesian inference, *Journal of the Royal Statistical Society*, **30**, 205-247

Shafer, G. (1976), A Mathematical Theory of Evidence Princeton University Press

See Also

[yComb](#), [mComb](#), [cComb](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass functions
m1 <- mass(list("a"=0.1, "a/b/c"=0.9), stateSpace)
m2 <- mass(list("a"=0.2, "a/b/c"=0.8), stateSpace)

# Dempster's combination
dComb(m1, m2)
# or
dComb(list(m1, m2))
```

dComb-methods	<i>Methods for Function dComb</i>
---------------	-----------------------------------

Description

Combine mass functions using Dempster's combination operator. For more detail see [dComb](#).

Methods

`signature(x = "mass", y = "mass")` Combine two mass functions using Dempster's combination operator

`signature(x = "list", y = "missing")` Combine a list of mass functions using Dempster's combination operator

Author(s)

Alexander Karlsson

disc	<i>Discounting Operator</i>
------	-----------------------------

Description

Discounts a mass function.

Usage

`disc(x,y)`

Arguments

x	a mass function
y	degree of reliability

Value

mass function

Author(s)

Alexander Karlsson

References

Smets, P. (2000), Data Fusion in the Transferable Belief Model, Proceedings of the Third International Conference on Information Fusion

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass function
m <- mass(list("a"=0.1, "a/b/c"=0.9), stateSpace)

# source is only 80% reliable
mDisc <- disc(m, 0.8)
```

disc-methods	<i>Methods for Function disc</i>
--------------	----------------------------------

Description

Discount an evidence structure. For more detail see [disc](#)

Methods

signature(x = "mass", y = "numeric") Discount a mass function.

EvCombRLicense	<i>License information for EvCombR</i>
----------------	--

Description

Displays some license information about EvCombR.

Usage

```
EvCombRLicense()
```

Author(s)

Alexander Karlsson

Examples

```
EvCombRLicense()
```

extPoints	<i>Extreme Points of a Credal Set</i>
-----------	---------------------------------------

Description

Returns the extreme points of a credal set

Usage

```
extPoints(x)
```

Arguments

x a credal set

Value

a matrix where the extreme points are stored by row

Author(s)

Alexander Karlsson

See Also

[lower](#), [upper](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# construct credal set
c <- credal(c(0.1, 0.1, 0.1), c(0.8, 0.8, 0.8), stateSpace)

# obtain extrem points
eMat <- extPoints(c)
```

extPoints-methods	<i>Methods for Function extPoints</i>
-------------------	---------------------------------------

Description

Returns the set of extreme points of a credal set. For more detail see [extPoints](#).

Methods

signature(x = "credal") Returns the set of extreme points

Author(s)

Alexander Karlsson

focal	<i>Focal Elements of a Mass Function</i>
-------	--

Description

Returns the set of focal elements of a mass function.

Usage

focal(x)

Arguments

x a mass function

Value

focal elements of x

Author(s)

Alexander Karlsson

References

Dempster, A. P. (1969), A generalization of Bayesian inference, *Journal of the Royal Statistical Society*, **30**, 205-247

Shafer, G., (1976), A Mathematical Theory of Evidence Princeton University Press, 1976

See Also

[points](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass functions
m <- mass(list("a"=0.1, "b"=0.1 , "c"=0.4, "a/b/c"=0.4), stateSpace)

# obtain focal elements
focal(m)
```

focal-methods	<i>Methods for Function focal</i>
---------------	-----------------------------------

Description

Methods for function focal

Methods

signature(x = "mass") Access function for slot focal

Note

See further [focal](#)

focal<-	<i>Replacement Function for Focal Elements</i>
---------	--

Description

Replaces focal elements of a mass function.

Usage

```
focal(x) <- value
```

Arguments

x	a mass function
value	new focal elements for the mass function

Value

mass function with focal elements replaced.

Author(s)

Alexander Karlsson

References

Dempster, A. P. (1969), A generalization of Bayesian inference, *Journal of the Royal Statistical Society*, **30**, 205-247

Shafer, G., (1976), A Mathematical Theory of Evidence Princeton University Press

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass functions
m <- mass(list("a"=0.1, "b"=0.1 , "c"=0.4, "a/b/c"=0.4), stateSpace)

# replace focal elements
focal(m) <- list("a/b"=1)
```

focal<-methods	<i>Methods for Function focal<-</i>
----------------	--

Description

Replacement function for focal elements. For more detail see [focal<-](#)

Methods

signature(x = "mass") Replace focal elements

lower	<i>Lower Bounds Based on Evidence Structure</i>
-------	---

Description

Calculate the lower bounds for a vector of sets

Usage

lower(x, sets)

Arguments

- x credal set or mass function
- sets vector of sets where each set is represented by state names separated by "/". If sets are missing, lower bounds on singletons are calculated.

Value

lower bound of mass or probability for each set in the vector sets or if sets is missing lower bounds on singletons

Note

This is equivalent to belief in Dempster-Shafer theory

Author(s)

Alexander Karlsson

References

Shafer, G., (1976), A Mathematical Theory of Evidence Princeton University Press

Walley, P. (2000), Towards a unified theory of imprecise probability, *International Journal of Approximate Reasoning*, **24**, 125-148

See Also

[upper](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass function
m <- mass(list("a"=0.1, "b"=0.1 ,
              "c"=0.4, "a/b/c"=0.4), stateSpace)

# credal set
c <- credal(c(0.1, 0.1, 0.1),
           c(0.8, 0.8, 0.8), stateSpace)

# calculate lower bounds
lower(m, c("a", "a/b"))
lower(c, c("a", "a/b"))

# lower bounds on singletons
lower(m)
```

lower-methods	<i>Methods for Function lower</i>
---------------	-----------------------------------

Description

Calculate lower bounds for a vector of sets with respect to the evidence structure. For more detail see [lower](#)

Methods

- signature(x = "credal", sets = "character") obtain lower bounds for a vector of sets
- signature(x = "credal", sets = "missing") obtain lower bounds for all singleton states
- signature(x = "mass", sets = "character") obtain the belief, or lower bounds, for a vector of sets
- signature(x = "mass", sets = "missing") obtain the belief, or lower bounds, for all singleton states

mass	<i>Constructor Function for Mass Functions</i>
------	--

Description

Construct a mass function based on a named list of focal elements or a [massQ-class](#) object. For more information, see the details section.

Usage

mass(x, y)

Arguments

- x a named list of focal elements or a [massQ-class](#) object
- y a character vector representing the state space or missing if x is an massQ object.

Details

Focal elements are represented by the notation "<sl>/...<sn>" where <sl>...<sn> are any states within the state space (see the examples below). Note that the word "ES" and the symbol "/" are reserved.

Value

mass function

Author(s)

Alexander Karlsson

References

Dempster, A. P. (1969), A generalization of Bayesian inference, *Journal of the Royal Statistical Society*, **30**, 205-247

Shafer, G. (1976), A Mathematical Theory of Evidence Princeton University Press

See Also

[dComb](#), [mComb](#), [yComb](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# construct mass functions
m1 <- mass(list("a"=0.1, "b"=0.1, "c"=0.4, "a/b/c"=0.4), stateSpace)
m2 <- mass(list("a"=0.1, "b"=0.1, "c"=0.1, "a/b"=0.1, "a/c"=0.1,
               "b/c"=0.1, "a/b/c"=0.4), stateSpace)

# apply Yager's combination operator, m12 will be a massQ-object
m12Q <- yComb(m1,m2)

# construct a mass function from an massQ-object
m12 <- mass(m12Q)
```

mass-class

Class "mass"

Description

Represents a mass function by a list of focal elements and corresponding mass. For more detail see [mass](#).

Objects from the Class

Objects can be created by [credal](#).

Slots

focal: a list of focal elements represented by statenames seperated by "/"

space: the state space represented by a character vector

Methods

[signature(x = "mass", i = "character", j = "missing"): extract focal elements
 [[signature(x = "mass", i = "character", j = "missing"): extract a single focal element
 [<- signature(x = "mass", i = "character", j = "missing", value = "ANY"): replace focal elements
 [[<- signature(x = "mass", i = "character", j = "missing", value = "ANY"): replace a single focal element
dComb signature(x = "mass", y = "mass"): combine two mass functions by Dempster's combination
focal signature(x = "mass"): access focal elements
focal<- signature(x = "mass"): replace focal elements
lower signature(x = "mass", set = "character"): calculate the lower bounds for some focal element
lower signature(x = "mass", set = "missing"): calculate the lower bounds for singletons
mComb signature(x = "mass", y = "mass", z = "function"): combine two mass functions by modified Dempster's combination using a prior distribution z
mComb signature(x = "mass", y = "mass", z = "missing"): combine two mass functions by modified Dempster's combination using a uniform prior distribution z
pign signature(x = "mass"): calculate the pignistic transformation for single states
relPl signature(x = "mass"): calculate the relative plausibility for single states
space signature(x = "mass"): access the state space (frame of discernment)
space<- signature(x = "mass"): replace the state space (frame of discernment)
upper signature(x = "mass", set = "character"): calculate the upper bound for some focal element
upper signature(x = "mass", set = "missing"): calculate the upper bounds for singletons
yComb signature(x = "mass", y = "mass"): combine two mass functions using Yager's rule
disc signature(x = "mass", y = "numeric"): discount mass function

Author(s)

Alexander Karlsson

References

- Dempster, A. P. (1969), A generalization of Bayesian inference, *Journal of the Royal Statistical Society*, **30**, 205-247
 Shafer, G., (1976), A Mathematical Theory of Evidence Princeton University Press
 Yager, R. (1987), On the Dempster-Shafer Framework and New Combination Rules, *Information Sciences* **41**: 93-137.
 Fixsen, D., Mahler, R. P. S. (1997), The modified Dempster-Shafer approach to classification, *IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans*, **27**, 96-104

mass-methods	<i>Methods for Function mass</i>
--------------	----------------------------------

Description

Methods for constructing a mass function. For more detail see [mass](#)

Methods

`signature(x = "list", y = "character")` Construct a mass functions by a named list of focal elements and a given state space

`signature(x = "massQ", y = "missing")` Construct a mass function from a [massQ-class](#) object

Author(s)

Alexander Karlsson

massQ-class	<i>Class "massQ"</i>
-------------	----------------------

Description

Class that maintains information about the mass on the empty set. The class is used for Yager's combination operator

Objects from the Class

A massQ-object is obtained as a result of Yager's combination operator [yComb](#).

Slots

qEmpty: mass on the empty set with respect to the previous combination

focal: a list of focal elements represented by statenames seperated by "/"

space: the state space represented by a character vector

Extends

Class "[mass](#)", directly.

Methods

All methods inherited from [mass-class](#) and in addition:

mass `signature(x = "massQ", y = "missing")`: convert the massQ-object to a mass-object

Author(s)

Alexander Karlsson

References

Yager, R. (1987), On the Dempster-Shafer Framework and New Combination Rules, *Information Sciences 41*: 93-137.

mComb	<i>Modified Dempster's Combination Operator</i>
-------	---

Description

Combine evidence in the form of mass functions using modified Dempster's combination operator.

Usage

mComb(x, y, z)

Arguments

- | | |
|---|---|
| x | single mass function or a list of mass functions |
| y | single mass function if x is a single mass function, a prior distribution or missing if x is a list |
| z | prior distribution if x and y are mass functions, otherwise missing |

Details

The prior distribution is provided in the form of a list where the names are equivalent to the state space. See the examples.

Value

mass function

Author(s)

Alexander Karlsson

References

Fixsen, D., Mahler, R. P. S. (1997), The modified Dempster-Shafer approach to classification, *IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans*, **27**, 96-104

See Also

[dComb](#), [yComb](#), [cComb](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass functions
m1 <- mass(list("a"=0.1, "a/b/c"=0.9), stateSpace)
m2 <- mass(list("a"=0.2, "a/b/c"=0.8), stateSpace)

# modified Dempster's combination using the uniform prior
mComb(m1, m2)
# or
mComb(list(m1, m2))

# modified Dempster's combination using a specific prior
mComb(m1, m2, list("a"=0.1, "b"=0.1, "c"=0.8))
# or
mComb(list(m1, m2), list("a"=0.1, "b"=0.1, "c"=0.8))
```

mComb-methods

*Methods for Function mComb***Description**

Combine mass functions using modified Dempster's combination operator. For more detail see [mComb](#).

Methods

signature(x = "mass", y = "mass", z = "list") Combine two mass functions using modified Dempster's combination operator and a prior

signature(x = "mass", y = "mass", z = "missing") Combine two mass functions using modified Dempster's combination operator and the uniform prior

signature(x = "list", y = "list", z = "missing") Combine a list of mass functions using modified Dempster's combination operator and a prior

signature(x = "list", y = "missing", z = "missing") Combine a list of mass functions using modified Dempster's combination operator and the uniform prior

pign

*Pignistic Transformation***Description**

The pignistic transformation transforms a mass function into a probability function.

Usage

```
pign(x)
```

Arguments

x a mass function

Value

a singleton credal set

Author(s)

Alexander Karlsson

References

Smets, P. & Kennes, R. (1994), The transferable belief model, *Artificial Intelligence*, **66**, 191-234

See Also

[relPl](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass function
m <- mass(list("a"=0.1, "a/b/c"=0.9), stateSpace)

# obtain a singleton credal set
c <- pign(m)
```

pign-methods

Methods for Function pign

Description

The pignistic transformation transform a mass function to probability function. For more detail see [pign](#)

Methods

signature(x = "mass") Apply the pignistic transformation on a mass function

relPl	<i>Relative Plausibility Transform</i>
-------	--

Description

The relative plausibility transform transform a mass function to a probability function

Usage

```
relPl(x)
```

Arguments

x	a mass function
---	-----------------

Value

a singleton credal set

Author(s)

Alexander Karlsson

References

Cobb, B. & Shenoy, P. (2006), On the plausibility transformation for translating belief function models to probability models, *International Journal of Approximate Reasoning*, **42**, 3, 314 - 330

See Also

[pign](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass function
m <- mass(list("a"=0.1, "a/b/c"=0.9), stateSpace)

# obtain a singleton credal set
c <- relPl(m)
```

relPl-methods	<i>Methods for Function relPl</i>
---------------	-----------------------------------

Description

The relative plausability transform transforms a mass function to probability function. For more detail see [relPl](#)

Methods

signature(x = "mass") Apply the relative plausability transform on a mass function

space	<i>State Space of and Evidence Structure</i>
-------	--

Description

This functions returns the state space of an evidence structure.

Usage

```
space(x)
```

Arguments

x mass function or credal set

Value

a character vector with the names within the state space

Author(s)

Alexander Karlsson

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# construct mass function
m <- mass(list("a"=0.1, "b"=0.1, "c"=0.4, "a/b/c"=0.4), stateSpace)

# obtain state space
space(m)
```

space-methods	<i>Methods for Function space</i>
---------------	-----------------------------------

Description

Returns the state space for an evidence structure. For more detail see [space](#).

Methods

`signature(x = "credal")` Returns the state space for a credal set

`signature(x = "mass")` Returns the state space for a mass function

space<-	<i>Replacement Function for State Space</i>
---------	---

Description

Replace the names of the state space

Usage

```
space(x) <- value
```

Arguments

`x` mass function or credal set

`value` new state space given as a character vector

Value

new mass function or credal set with the state space replaced

Author(s)

Alexander Karlsson

See Also

[focal<-](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# construct mass function
m <- mass(list("a"=0.1, "b"=0.1 , "c"=0.4, "a/b/c"=0.4), stateSpace)

# replace state space
space(m) <- c("d", "e", "f")
```

space<-methods	<i>Methods for Function space<-</i>
----------------	--

Description

Replace the state space of an evidence structure. For more details see [space](#).

Methods

signature(x = "credal") Replace state space of a credal set
signature(x = "mass") Replace the state space of a mass function

upper	<i>Upper Bounds Based on Evidence Structure</i>
-------	---

Description

Calculate the upper bounds for a vector of sets

Usage

```
upper(x, sets)
```

Arguments

x	credal set or mass function
sets	vector of sets where each set is represented by state names separated by "/". If sets are missing, upper bounds on singletons are calculated.

Value

upper bound of mass or probability for each set in the vector sets or if sets is missing upper bounds on singletons

Note

This is equivalent to Belief in Dempster-Shafer theory

Author(s)

Alexander Karlsson

References

Shafer, G., (1976), A mathematical theory of evidence, Princeton University Press

Walley, P. (2000), Towards a unified theory of imprecise probability, *International Journal of Approximate Reasoning*, **24**, 125-148

See Also

[upper](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass function
m <- mass(list("a"=0.1, "b"=0.1 ,
              "c"=0.4, "a/b/c"=0.4), stateSpace)

# credal set
c <- credal(c(0.1, 0.1, 0.1),
            c(0.8, 0.8, 0.8), stateSpace)

# calculate upper bounds
upper(m, c("a", "a/b"))
upper(c, c("a", "a/b"))

# upper bounds on singletons
upper(m)
```

upper-methods

Methods for Function upper

Description

Calculate lower bounds for a vector of sets with respect to the evidence structure. For more detail see [upper](#)

Methods

signature(x = "credal", sets = "character") obtain upper bounds for a vector of sets
signature(x = "credal", sets = "missing") obtain upper bounds for all singletons
signature(x = "mass", sets = "character") obtain the plausability, or upper bounds, for a vector of sets
signature(x = "mass", sets = "missing") obtain the plausability, or upper bounds, for all singletons

yComb

*Yager's Combination Operator***Description**

Combine evidence in the form of mass functions using Yager's combination operator.

Usage

```
yComb(x, y)
```

Arguments

x single mass function or a list of mass functions
y single mass function if x is a single mass function, otherwise missing

Value

mass function ([massQ-class](#))

Note

Yager's combination operator is quasi-associative and therefore we need to keep track of the mass on the empty set by using the class `massQ`.

Author(s)

Alexander Karlsson

References

Yager, R. (1987), On the Dempster-Shafer Framework and New Combination Rules, *Information Sciences* 41: 93-137.

See Also

[dComb](#), [mComb](#), [cComb](#)

Examples

```
# state space
stateSpace <- c("a", "b", "c")

# mass functions
m1 <- mass(list("a"=0.1, "a/b/c"=0.9), stateSpace)
m2 <- mass(list("b"=0.2, "a/b/c"=0.8), stateSpace)

# Yager's combination
yComb(m1, m2)
# or
yComb(list(m1, m2))
```

yComb-methods	<i>Methods for Function yComb</i>
---------------	-----------------------------------

Description

Combine mass functions using Yager's combination operator. For more detail see [yComb](#).

Methods

signature(x = "mass", y = "mass") Combine two mass functions using Yager's combination operator

signature(x = "list", y = "missing") Combine a list of mass functions using Yager's combination operator

[-methods	<i>Methods for Function [</i>
------------	-------------------------------

Description

Extract part of evidence structure [

Methods

signature(x = "credal", i = "ANY", j="ANY", value="ANY") Extract probabilities

signature(x = "mass", i = "character", j="missing", value="ANY") Extract focal element(s)

Author(s)

Alexander Karlsson

Examples

```
# construct a state space
stateSpace <- c("a", "b", "c")

# construct credal sets with the given state space
c <- credal(c(0.1, 0.1, 0.1), c(0.8, 0.8, 0.8), stateSpace)

# extract first and second extreme point
c[1:2,]

# mass functions
m <- mass(list("a"=0.1, "b"=0.1, "c"=0.4, "a/b/c"=0.4), stateSpace)

# extract focal elements
m[c("a", "a/b/c")]
```

[<-methods

Methods for Function [<-**Description**

Replace part of an evidence structure

Methods

signature(x="credal", i="ANY", j="ANY", value="ANY") Replace probabilities
signature(x="mass", i="character", j="missing", value="ANY") Replace focal element(s)

Author(s)

Alexander Karlsson

Examples

```
# construct a state space
stateSpace <- c("a", "b", "c")

# construct credal sets with the given state space
c <- credal(c(0.1, 0.1, 0.1), c(0.8, 0.8, 0.8), stateSpace)

# replace first and second extreme point
c[1:2,] <- rbind(c(0.1, 0.1, 0.8), c(0.2, 0.2, 0.6))

# mass function
m <- mass(list("a"=0.1, "b"=0.1, "c"=0.4, "a/b/c"=0.4), stateSpace)

# switch mass on focal elements "b" and "a/b/c"
temp <- m["b"]
m["b"] <- m["a/b/c"]
```

```
m["a/b/c"] <- temp
```

[[methods

Methods for Function [[

Description

Methods for function [[

Methods

signature(x="mass", i="character", j="missing") Extract a single focal element from the list of focal elements

Author(s)

Alexander Karlsson

Examples

```
# construct a state space
stateSpace <- c("a", "b", "c")

#mass functions
m <- mass(list("a"=0.1, "b"=0.1, "c"=0.4, "a/b/c"=0.4), stateSpace)

# extract focal element
m[["a"]]
```

[[<-methods

Methods for Function [[<-

Description

Replace part of an evidence structure

Methods

signature(x="mass", i="character", j="missing", value="ANY") Replace focal element(s)

Author(s)

Alexander Karlsson

Examples

```
# construct a state space
stateSpace <- c("a", "b", "c")

# mass function
m <- mass(list("a"=0.1, "b"=0.1 , "c"=0.4, "a/b/c"=0.4), stateSpace)

# obtain value only
m[["a"]]
```

Index

- * **classes**
 - credal-class, [6](#)
 - mass-class, [17](#)
- * **methods**
 - [[-](#)methods, [29](#)
 - [[<](#)-methods, [30](#)
 - [[\[](#)-methods, [31](#)
 - [[\[](#)<-methods, [31](#)
 - cComb-methods, [5](#)
 - credal-methods, [7](#)
 - dComb-methods, [9](#)
 - disc-methods, [10](#)
 - focal-methods, [13](#)
 - focal<-methods, [14](#)
 - lower-methods, [16](#)
 - mass-methods, [19](#)
 - mComb-methods, [21](#)
 - pign-methods, [22](#)
 - relPl-methods, [24](#)
 - space-methods, [25](#)
 - space<-methods, [26](#)
 - upper-methods, [27](#)
 - yComb-methods, [29](#)
- * **package**
 - EvCombR-package, [2](#)
 - [, credal, ANY, ANY-method ([\[](#)-methods), [29](#)
 - [, mass, character, missing-method ([\[](#)-methods), [29](#)
 - [[-](#)methods, [29](#)
 - [[<](#)-methods, [30](#)
 - [[<](#)-, credal, ANY, ANY-method ([\[](#)<-methods), [30](#)
 - [[<](#)-, mass, character, missing-method ([\[](#)<-methods), [30](#)
 - [[\[](#)-, mass, character, missing-method ([\[](#)[[-](#)methods), [31](#)
 - [[\[](#)-methods, [31](#)
 - [[\[](#)<-methods, [31](#)
 - [[\[](#)<- , mass, character, missing-method ([\[](#)[[<](#)-methods), [31](#)
 - cComb, [3](#), [5](#), [6](#), [8](#), [20](#), [28](#)
 - cComb, credal, credal-method ([cComb](#)-methods), [5](#)
 - cComb, list, missing-method ([cComb](#)-methods), [5](#)
 - cComb-methods, [5](#)
 - credal, [5](#), [6](#), [7](#), [17](#)
 - credal, matrix, character, missing-method ([credal](#)-methods), [7](#)
 - credal, numeric, missing, character-method ([credal](#)-methods), [7](#)
 - credal, numeric, numeric, character-method ([credal](#)-methods), [7](#)
 - credal-class, [6](#)
 - credal-methods, [7](#)
 - dComb, [4](#), [8](#), [9](#), [17](#), [20](#), [28](#)
 - dComb, list, missing-method ([dComb](#)-methods), [9](#)
 - dComb, mass, mass-method ([dComb](#)-methods), [9](#)
 - dComb-methods, [9](#)
 - disc, [9](#), [10](#)
 - disc, mass, numeric-method ([disc](#)-methods), [10](#)
 - disc-methods, [10](#)
 - EvCombR (EvCombR-package), [2](#)
 - EvCombR-package, [2](#)
 - EvCombRLicense, [10](#)
 - extPoints, [11](#), [12](#)
 - extPoints, credal-method ([extPoints](#)-methods), [12](#)
 - extPoints-methods, [12](#)
 - focal, [12](#), [13](#)
 - focal, mass-method ([focal](#)-methods), [13](#)
 - focal-methods, [13](#)

- focal<-, 13
- focal<-methods, 14
- focal<-,mass,list-method
(focal<-methods), 14
- lower, 11, 14, 16
- lower,credal,character-method
(lower-methods), 16
- lower,credal,missing-method
(lower-methods), 16
- lower,mass,character-method
(lower-methods), 16
- lower,mass,missing-method
(lower-methods), 16
- lower-methods, 16
- mass, 16, 17, 19
- mass,list,character-method
(mass-methods), 19
- mass,massQ,missing-method
(mass-methods), 19
- mass-class, 17
- mass-methods, 19
- massQ-class, 19
- mComb, 4, 8, 17, 20, 21, 28
- mComb,list,list,missing-method
(mComb-methods), 21
- mComb,list,missing,missing-method
(mComb-methods), 21
- mComb,mass,mass,list-method
(mComb-methods), 21
- mComb,mass,mass,missing-method
(mComb-methods), 21
- mComb-methods, 21
- pign, 21, 22, 23
- pign,mass-method (pign-methods), 22
- pign-methods, 22
- points, 12
- relPl, 22, 23, 24
- relPl,mass-method (relPl-methods), 24
- relPl-methods, 24
- space, 24, 25, 26
- space,credal-method (space-methods), 25
- space,mass-method (space-methods), 25
- space-methods, 25
- space<-, 25
- space<-methods, 26
- space<-,credal,character-method
(space<-methods), 26
- space<-,mass,character-method
(space<-methods), 26
- upper, 11, 15, 26, 27
- upper,credal,character-method
(upper-methods), 27
- upper,credal,missing-method
(upper-methods), 27
- upper,mass,character-method
(upper-methods), 27
- upper,mass,missing-method
(upper-methods), 27
- upper-methods, 27
- yComb, 4, 8, 17, 19, 20, 28, 29
- yComb,list,missing-method
(yComb-methods), 29
- yComb,mass,mass-method (yComb-methods),
29
- yComb-methods, 29