Package 'TUvalues'

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Type Package

Title Tools for Calculating Allocations in Game Theory using Exact and Approximated Methods

Version 0.1.0

Description The main objective of cooperative games is to allocate a good among the agents involved. This package includes the most well-known allocation rules, i.e., the Shapley value, the Banzhaf value, the egalitarian rule, and the equal surplus division value. In addition, it considers the point of view of a priori unions (situations in which agents can form coalitions). For this purpose, the package includes the Owen value, the Banzhaf-Owen value, and the corresponding extensions of the egalitarian rules. All these values can be calculated exactly or estimated by sampling.

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Encoding UTF-8

RoxygenNote 7.2.3

URL https://github.com/mariaguilleng/TUvalues

BugReports https://github.com/mariaguilleng/TUvalues/issues

Imports utils, gtools

NeedsCompilation no

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Contents

`banzhaf` *Banzhaf value*

Description

Calculate the Banzhaf value

Usage

```
banzhaf(
  characteristic_func,
  method = "exact",
  n_rep = 10000,
  n_players = 0,
  replace = FALSE
)
```

Arguments

`characteristic_func`	The valued function defined on the subsets of the number of players.
`method`	Method used to calculate the Banzhaf value. Valid methods are: `exact` for the exact calculation or `appro` for approximated polynomial calculation based on sampling.
`n_rep`	Only used if `method` is `appro`. The number of iterations to perform in the approximated calculation
`n_players`	Only used if `characteristic_func` is a `function`. The number of players in the game.
`replace`	should sampling be with replacement?

Value

The Banzhaf value for each player

Examples

```
n <- 10
v <- function(coalition) {
if (length(coalition) > n/2) {
   return(1)
 } else {
   return(0)
 }
}
banzhaf(v, method = "exact", n_players = n)
banzhaf(v, method = "appro", n_rep = 4000, n_players = n, replace = TRUE)

v<-c(0,0,0,1,2,1,3)
banzhaf(v, method = "exact")
banzhaf(v, method = "appro", n_rep = 4000, replace = TRUE)
```

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banzhaf_appro *Banzhaf Index (approximated)*

Description

Calculate the approximated Banzhaf Index based on sampling

Usage

```
banzhaf_appro(characteristic_func, n_players, n_rep, replace = TRUE)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
n_players	Only used if value_func is a function. The number of players in the game
n_rep	The number of iterations to perform in the approximated calculation
replace	should sampling be with replacement?

Value

The Banzhaf Index for each player

banzhaf_appro_func *Banzhaf Index (approximation)*

Description

Calculate the approximated Banzhaf Index based on sampling

Usage

```
banzhaf_appro_func(value_func, n_rep, n_players, replace = TRUE)
```

Arguments

value_func	The valued function defined on the subsets of the number of players
n_rep	The number of iterations to perform in the approximated calculation
n_players	Only used if value_func is a function. The number of players in the game.
replace	should sampling be with replacement?

Value

The Banzhaf Index for each player

banzhaf_appro_vector *Banzhaf Index (approximated)*

Description

Calculate the approximated Banzhaf Index based on sampling

Usage

```
banzhaf_appro_vector(value_func, n_rep)
```

Arguments

value_func	The valued function defined on the subsets of the number of players
n_rep	The number of iterations to perform in the approximated calculation

Value

The Banzhaf Index for each player

banzhaf_exact *Banzhaf Index (exact)*

Description

Calculate the approximated Banzhaf Index

Usage

```
banzhaf_exact(characteristic_func, n_players)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
n_players	The number of players in the game.

Value

The Banzhaf Index for each player

banzhaf_owen *Banzhaf-Owen value*

Description

Calculate the Banzhaf-Owen value

Usage

```
banzhaf_owen(
  characteristic_func,
  union,
  method = "exact",
  n_rep = 10000,
  n_players = 0,
  replace = TRUE
)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
union	List of vectors indicating the a priori unions between the players
method	Method used to calculate the Owen value. Valid methods are: `exact` for the exact calculation or `appro` for approximated polynomial calculation based on sampling.
n_rep	Only used if `method` is `appro`. The number of iterations to perform in the approximated calculation
n_players	Only used if `characteristic_func` is a `function`. The number of players in the game.
replace	should sampling be with replacement?

Value

The Banzhaf-Owen value for each player

Examples

```
characteristic_func <- c(0,0,0,0,30,30,40,40,50,50,60,70,80,90,100)
union <- list(c(1,3),c(2),c(4))
banzhaf_owen(characteristic_func, union)
banzhaf_owen(characteristic_func, union, method = "appro", n_rep = 4000)
```

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banzhaf_owen_appro *Banzhaf-Owen Value*

Description

Calculate the approximated Banzhaf-Owen value

Usage

```
banzhaf_owen_appro(characteristic_func, union, n_players, n_rep, replace)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
union	List of vectors indicating the a priori unions between the players
n_players	The number of players
n_rep	Only used if `method` is `appro`. The number of iterations to perform in the approximated calculation.
replace	should sampling be with replacement?

Value

The Banzhaf-Owen Index for each player

`banzhaf_owen_exact` *Banzhaf-Owen Value*

Description

Calculate the approximated Banzhaf-Owen value

Usage

```
banzhaf_owen_exact(characteristic_func, union, n_players)
```

Arguments

`characteristic_func`	The valued function defined on the subsets of the number of players
`union`	List of vectors indicating the a priori unions between the players
`n_players`	The number of players in the game.

Value

The Banzhaf Index for each player

`coalitions` *coalitions*

Description

Create all the possible coalitions given the number of players

Usage

```
coalitions(n_players)
```

Arguments

`n_players`	Number of players

Value

A list containing a `data.frame` of the binary representation of the coalitions and a `vector` of the classical representation (as sets) of the coalitions

egalitarian *Egalitarian value*

Description

Calculate the egalitarian value

Usage

```
egalitarian(characteristic_func, n_players = 0)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
n_players	Only used if characteristic_func is a function. The number of players in the game.

Value

The egalitarian value for each player

Examples

```
n <- 10
v <- function(coalition) {
  if (length(coalition) > n/2) {
    return(1)
  } else {
    return(0)
  }
}
egalitarian(v,n)
```

equal_surplus_division *Equal Surplus Division value*

Description

Calculate the equal surplus division value

Usage

```
equal_surplus_division(characteristic_func, n_players = 0)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
n_players	Only used if characteristic_func is a function. The number of players in the game.

Value

The equal surplus division value for each player

Examples

```
n <- 10
v <- function(coalition) {
  if (length(coalition) > n/2) {
    return(1)
  } else {
    return(0)
  }
}
equal_surplus_division(v,n)
```

---

owen *Owen value*

Description

Calculate the Owen value

Usage

```
owen(
  characteristic_func,
  union,
  method = "exact",
  n_rep = 10000,
  n_players = 0
)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players.
union	List of vectors indicating the a priori unions between the players.
method	Method used to calculate the Owen value. Valid methods are: exact for the exact calculation or appro for approximated polynomial calculation based on sampling.

n_rep	Only used if method is appro. The number of iterations to perform in the approximated calculation.
n_players	The number of players in the game.

Value

The Owen value for each player.

Examples

```
n <- 10
v <- function(coalition) {
  if (length(coalition) > n/2) {
    return(1)
  } else {
    return(0)
  }
}
u <- lapply(1:(n/2), function(i) c(2*i - 1, 2*i))
owen(v, union = u, method = "appro", n_rep = 4000, n_players = n)

characteristic_func <- c(1,1,2,1,2,2,2)
union <- list(c(1,2),c(3))
owen(characteristic_func, union)
owen(characteristic_func, union, method = "appro", n_rep = 4000)
```

---

owen_appro *Owen value (approximation)*

Description

Calculate the approximated Owen value based on sampling

Usage

```
owen_appro(characteristic_func, union, n_players, n_rep)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
union	List of vectors indicating the a priori unions between the players
n_players	The number of players
n_rep	The number of iterations to perform in the approximated calculation

Value

The Owen value for each player

owen_exact *Owen value (exact)*

Description

Calculate the exact Owen

Usage

```
owen_exact(characteristic_func, union, n_players = NULL)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
union	List of vectors indicating the a priori unions between the players
n_players	The number of players

Value

The Owen value for each player

predecessor *Predecessor*

Description

Given a permutation 0 of players and a player i, calculate the set of predecessors of the player i in the order 0

Usage

```
predecessor(permutation, player, include_player = FALSE)
```

Arguments

permutation	A permutation of the players
player	Number of the player i
include_player	Whether the player i is included as predecessor of itself or not

Value

The set of predecessors of the player i in the order 0

shapley *Shapley value*

Description

Calculate the Shapley value

Usage

```
shapley(characteristic_func, method = "exact", n_rep = 10000, n_players = 0)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players.
method	Method used to calculate the Shapley value. Valid methods are: `exact` for the exact calculation or `appro` for approximated polynomial calculation based on sampling.
n_rep	Only used if `method` is `appro`. The number of iterations to perform in the approximated calculation.
n_players	Only used if `characteristic_func` is a `function`. The number of players in the game.

Value

The Shapley value for each player.

Examples

```
n <- 3
v <- c(1,1,2,1,2,2,2)
shapley(v, method = "exact")
shapley(v, method = "appro", n_rep = 4000)
```

shapley_appro *Shapley value (approximation)*

Description

Calculate the approximated Shapley value based on sampling

Usage

```
shapley_appro(characteristic_func, n_players, n_rep)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
n_players	The number of players
n_rep	The number of iterations to perform in the approximated calculation

Value

The Shapley value for each player

---

shapley_exact *Shapley value (exact)*

Description

Calculate the exact Shapley value

Usage

```
shapley_exact(characteristic_func, n_players)
```

Arguments

characteristic_func	The valued function defined on the subsets of the number of players
n_players	The number of players

Value

The Shapley value for each player

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