Package ‘deaR’

Version 1.2.5

Author Vicente Coll-Serrano, Vicente Bolos, Rafael Benitez Suarez <rabesua@uv.es>
Maintainer Vicente Bolos <vicente.bolos@uv.es>


License GPL
Encoding UTF-8
LazyData true

R topics documented:

  bootstrap_basic .................................................. 3
  Coelli_1998 .......................................................... 5
  Coll_Blasco_2006 .................................................... 6
  cross_efficiency .................................................... 7
  cross_efficiency_fuzzy ........................................... 10
  Departments ......................................................... 11
  Doyle_Green_1994 ................................................... 13
  Economy ............................................................. 14
  EconomyLong ......................................................... 15
R topics documented:

- efficiencies .......................................................... 16
- efficiencies.dea ...................................................... 17
- efficiencies.dea_fuzzy .............................................. 18
- Electric_plants ....................................................... 19
- Fortune500 .......................................................... 20
- Fried1993 ............................................................ 21
- Golany_Roll_1989 ................................................... 22
- Grifell_Lovell_1999 .................................................. 23
- Guo_Tanaka_2001 .................................................... 24
- Hotels ............................................................... 26
- Hua_Bian_2007 ....................................................... 27
- is.dea ................................................................. 28
- is.deadata ........................................................... 29
- is.deadata_fuzzy .................................................... 29
- is.dea_fuzzy .......................................................... 30
- is.friends ............................................................ 31
- Kao_Liu_2003 ........................................................ 32
- lambdas ............................................................... 33
- Leon2003 ............................................................. 34
- Libraries ............................................................. 35
- Lim_Zhu_2015 ........................................................ 37
- malmquist_index .................................................... 38
- maximal_friends ..................................................... 41
- modelfuzzy_guotanaka ............................................... 42
- modelfuzzy_kaoiliu .................................................. 44
- modelfuzzy_possibilistic ......................................... 46
- model_additive ..................................................... 48
- model_addsupereff ................................................ 50
- model_basic ........................................................ 52
- model_deaps ........................................................ 56
- model_fdh ........................................................... 58
- model_multiplier ................................................... 59
- model_nonradial .................................................... 62
- model_profit ........................................................ 64
- model_rdm ........................................................... 66
- model_sbmefeff ...................................................... 67
- model_sbmssupereff ............................................... 70
- model_supereff ..................................................... 72
- multipliers .......................................................... 73
- PFT1981 ............................................................. 74
- plot.dea ............................................................. 76
- plot.dea_fuzzy ...................................................... 77
- Power_plants ......................................................... 78
- read_data ............................................................ 79
- read_data_fuzzy ..................................................... 81
- read_malmquist ..................................................... 83
- references ........................................................... 85
- rts ............................................................... 86
Description

To bootstrap efficiency scores, deaR uses the algorithm proposed by Simar and Wilson (1998). For now, the function `bootstrap_basic` can only be used with basic DEA models (input- and output-oriented under constant and variable returns-to-scale).

Usage

```r
bootstrap_basic(datadea, 
    orientation = c("io", "oo"), 
    rts = c("crs", "vrs", "nirs", "ndrs", "grs"), 
    L = 1, 
    U = 1, 
    B = 2000, 
    h = NULL, 
    alpha = 0.05)
```

Arguments

- `datadea`: The data, including n DMUs, m inputs and s outputs.
- `orientation`: A string, equal to "io" (input oriented) or "oo" (output oriented).
- `rts`: A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).
- `L`: Lower bound for the generalized returns to scale (grs).
- `U`: Upper bound for the generalized returns to scale (grs).
- `B`: Number of bootstrap iterations.
- `h`: Bandwidth or smoothing window. By default h=0.014 (You can set h to any other value). The optimal bandwidth factor can also be calculated following the proposals of Silverman (1986) and Dario y Simar (2007). So, h="h1" is the optimal h referred as "robust normal-reference rule" (Dario and Simar, 2007).
h="h2" is the value of h1 but instead of the factor 1.06 with the factor 0.9, h="h3" is the value of h1 adjusted for scale and sample size (Dario and Simar, 2007 p.61), and h="h4" is the bandwith provided by a Gaussian kernel destiny estimate.

alpha Between 0 and 1 (for confidence intervals).

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)

References


Examples

# To replicate the results in Simar y Wilson (1998, p. 58) you have to
# set B=2000 (in the example B = 100 to save time)
data("Electric_plants")
data_example <- read_data(Electric_plants,
  n1 = 3,
  no = 1)
result <- bootstrap_basic(datadea = data_example,
  orientation = "io",
  rts = "vrs",
Description
Data of five DMUs with two inputs and one output. Prices for inputs are available. Price for output is not from Coelli et al. (1998).

Usage

data("Coelli_1998")

Format
Data frame with 6 rows and 5 columns. Definition of inputs (X) and outputs (Y):

Input1  Input 1
Input2  Input 2
Output  Output
Price_input1  Price input 1
Price_input2  Price input 2
Price_output  Price output

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source

See Also
read_data
Examples

# Example. Replication of results in Coelli et al. (1998, p.166).
# Cost efficiency model.
data("Coelli_1998")
# Selection of prices: data_prices is the transpose where the prices for inputs are.
data_prices <- t(Coelli_1998[,5:6])

data_example <- read_data(Coelli_1998, dmus=1, ni=2, no=1)
result <- model_profit(data_example, price_input=data_prices, rts="crs", restricted_optimal=FALSE)
# notice that the option by default is restricted_optimal=TRUE
efficiencies(result)


Description

Data of six authorized dealers with two inputs and two outputs.

Usage

data("Coll_Blasco_2006")

Format

Data frame with 6 rows and 5 columns. Definition of inputs (X) and outputs (Y):

x1 = Employees  Number of employees
x2 = Capital    Impairment of assets
y1 = Vehicles   Number of vehicles sold
y2 = Orders     Number of orders received at the garage

Author(s)

Vicente Coll-Serrano (<vince.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.
Vicente Bolos (<vicente.bolos@uv.es>). Department of Business Mathematics
Rafael Benitez (<rafael.suarez@uv.es>). Department of Business Mathematics
University of Valencia (Spain)
**cross_efficiency**

**Source**


**See Also**

read_data

**Examples**

```r
# Example. How to read data with deaR
data("Coll_Blasco_2006")
data_example <- read_data(Coll_Blasco_2006,
dmus=1,
ni=2,
no=2)
```

---

**cross_efficiency**

**Cross efficiency tables**

**Description**

Computes arbitrary, benevolent and aggressive formulation of cross-efficiency under constant and variable returns-to-scale. Doyle and Green (1994) present three alternatives ways of formulating the secondary goal (which will minimize or maximize the other DMUs' cross-efficiencies in some way). Methods II and III are implemented in deaR with constant returns-to-scale. The maverick index is also calculated.

**Usage**

```r
cross_efficiency(datadea,
dmu_eval = NULL,
dmu_ref = NULL,
epsilon = 0,
orientation = c("io", "oo"),
rts = c("crs", "vrs", "nirs", "ndrs", "grs"),
L = 1,
U = 1,
selfapp = TRUE,
correction = FALSE,
M2 = TRUE,
M3 = TRUE)
```
Arguments

datadea: An object of class `dea` or `deadata`. If it is of class `dea` it must have been obtained with some of the multiplier DEA models.

dmu_eval: A numeric vector. Only the multipliers of DMUs in `dmu_eval` are computed. If `NULL` (default), all DMUs are considered.

dmu_ref: A numeric vector containing which DMUs are the evaluation reference set. If `NULL` (default), all DMUs are considered.

epsilon: Numeric, multipliers must be $\geq$ `epsilon`.

orientation: A string, equal to "io" (input-oriented) or "oo" (output-oriented).

rts: A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).

L: Lower bound for the generalized returns to scale (grs).

U: Upper bound for the generalized returns to scale (grs).

selfapp: Logical. If it is `TRUE`, self-appraisal is included in the average scores of A and e.

correction: Logical. If it is `TRUE`, a correction is applied in the "vrs" input-oriented model in order to avoid negative cross-efficiencies, according to Lim & Zhu (2015).

M2: Logical. If it is `TRUE`, it computes Method II for aggressive/benevolent estimations.

M3: Logical. If it is `TRUE`, it computes Method III for aggressive/benevolent estimations.

Note

1. We can obtain negative cross-efficiency in the input-oriented DEA model under no constant returns-to-scale. However, the same does not happen in the case of the output-oriented VRS DEA model. For this reason, the proposal of Lim and Zhu (2015) is implemented in `deaR` to calculate the input-oriented cross-efficiency model under no constant returns-to-scale.

2. The multiplier model can have alternate optimal solutions (see note 1 in `model_multiplier`). So, depending on the optimal weights selected we can obtain different cross-efficiency scores.

Author(s)

Vicente Coll-Serrano (vicente.coll@uv.es). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (vicente.bolos@uv.es). Department of Business Mathematics

Rafael Benítez (rafael.suarez@uv.es). Department of Business Mathematics

University of Valencia (Spain)

References

cross_efficiency


See Also

model_multiplier, cross_efficiency_fuzzy

Examples

# Example 1.
# Arbitrary formulation. Input-oriented model under constant returns-to-scale.
data("Golany_Roll_1989")
data_example <- read_data(datadea = Golany_Roll_1989, inputs = 2:4, outputs = 5:6)
result <- cross_efficiency(data_example, orientation = "io", rts = "crs", selfapp = TRUE)
result$Arbitrary$cross_eff
result$Arbitrary$e

# Example 2.
# Benevolent formulation (method II). Input-oriented.
data("Golany_Roll_1989")
data_example <- read_data(datadea = Golany_Roll_1989, inputs = 2:4, outputs = 5:6)
result <- cross_efficiency(data_example, orientation = "io", selfapp = TRUE)
result$M2_ben$cross_eff
result$M2_ben$e

# Example 3.
# Benevolent formulation (method III). Input-oriented.
data("Golany_Roll_1989")
data_example <- read_data(datadea = Golany_Roll_1989, inputs = 2:4, outputs = 5:6)
result <- cross_efficiency(data_example, orientation = "io", selfapp = TRUE)
result$M3_ben$cross_eff
result$M3_ben$e
# Example 4.
# Arbitrary formulation. Output-oriented.
data("Golany_Roll_1989")
data_example <- read_data(datadea = Golany_Roll_1989,
                      inputs = 2:4,
                      outputs = 5:6)
result <- cross_efficiency(data_example,
                           orientation = "oo",
                           selfapp = TRUE)
result$Arbitrary$cross_eff
result$Arbitrary$e

# Example 5.
# Arbitrary formulation. Input-oriented model under vrs returns-to-scale.
data("Lim_Zhu_2015")
data_example <- read_data(Lim_Zhu_2015,
                          ni = 1,
                          no = 5)
cross <- cross_efficiency(data_example,
                         epsilon = 0,
                         orientation = "io",
                         rts = "vrs",
                         selfapp = TRUE,
                         M2 = FALSE,
                         M3 = FALSE)
cross$Arbitrary$e

cross_efficiency_fuzzy

Cross efficiency fuzzy tables

Description

Computes the cross-efficiency fuzzy table from dea data or a Guo-Tanaka dea model solution. The (crisp) relative efficiencies for the case $h = 1$ are obtained from the CCR model (model_multiplier).

Usage

cross_efficiency_fuzzy(datadea,
                          orientation = c("io", "oo"),
                          h = 1,
                          selfapp = TRUE)

Arguments

datadea An object of class dea_fuzzy or deadata_fuzzy. If it is of class dea_fuzzy it must have been obtained with modelfuzzy_guotanaka.
orientation A string, equal to "io" (input-oriented) or "oo" (output-oriented).
Departments 11

h  A numeric vector with the h-levels (in [0,1]).
selfapp  Logical. If it is TRUE, self-appraisal is included in the average scores of A and e.

Author(s)

**Vicente Coll-Serrano** (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2).* Applied Economics.

**Vicente Bolós** (<vicente.bolos@uv.es>). *Department of Business Mathematics*

**Rafael Benítez** (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References


Examples

data("Guo_Tanaka_2001")
data(dea <- read_data_fuzzy(datadea = Guo_Tanaka_2001, inputs.mL = 2:3, inputs.dL = 4:5, outputs.mL = 6:7, outputs.dL = 8:9))
result <- cross_efficiency_fuzzy(datadea = dea, h = seq(0, 1, 0.2))

---

**Departments**

*Data: Tomkins and Green (1988).*

Description

Data from 20 University accounting departments in the UK.

Usage

data("Departments")
Format

Data frame with 20 rows and 11 columns. Definition of inputs (X) and outputs (Y):

- **x1 = Staff**  Average Full Time Academic Staff 82/3-84/5
- **x2 = Salaries**  1984-5 Salaries Academics and Related (in pounds)
- **x3 = Other_Exp**  1984-5 Other Expenses (in pounds)
- **y1 = Undergrad**  Average Number Undergraduates 82/3-84/5
- **y2 = Research_post**  Research Postgraduates
- **y3 = Taught_post**  Taught Postgraduates
- **y4 = Res_co_income**  Research council income (in pounds)
- **y5 = Other_res_income**  Other research income (in pounds)
- **y6 = Other_income**  Other income (in pounds)
- **y7 = Publications**  Number of publications

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source


See Also

*read_data*, *model_basic*

Examples

```r
# Example.
# Replication of results DEA1 in Tomkins and Green (1988)
data("Departments")
# Calculate Total income
Departments$Total_income <- Departments[,5]+Departments[,6]+Departments[,7]
data_example <- read_data(Departments, 
  inputs=9, 
  outputs=c(2,3,4,12))
result <- model_basic(data_example, 
  orientation="io", 
  rts="crs")
efficiencies(result) # Table 3 (p.156)
references(result) # Table 3 (p.157)
```
Data: Doyle and Green (1994).

**Description**

Data adapted from Tomkins and Green (1988). 13 DMUs using 3 inputs to produce 2 outputs.

**Usage**

```r
data("Doyle_Green_1994")
```

**Format**

Data frame with 13 rows and 6 columns. Definition of inputs (X) and outputs (Y):

- **y1 = Undergraduate**  Number of undergraduates
- **y2 = Postgraduates**  Number of postgraduates (taught and research)
- **y3 = Research_income**  Research and other income
- **y4 = Publications**  Number of publications
- **x1 = Salaries**  Salaries of academic and related staff
- **x2 = Other_expenses**  Other expenses

**Author(s)**

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

**Source**


**See Also**

read_data, model_multiplier, cross_efficiency
Examples

# Example.
data("Doyle_Green_1994")
data_example <- read_data(datadea = Doyle_Green_1994,
dmus = 1,
inputs = 6:7,
outputs = 2:5)
result <- cross_efficiency(data_example,
orientation = "io",
selfapp = TRUE)
result$Arbitrary$cross_eff
result$Arbitrary$e
# Aggressive using method II
result$M2_agg$cross_eff
# Aggressive using method III
result$M3_agg$cross_eff


Description


Usage

data("Economy")

Format

Data frame with 31 rows and 16 columns. Definition of inputs (X) and outputs (Y):

x1 = Capital  Total assets (in 100 million RMB)
x2 = Labor  Annual average employed persons (in 10000 persons)
y1 = GIOV  Gross industrial output value (in 100 million RMB)

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolos (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benitez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)
Source

See Also
read_malmquist, malmquist_index

Examples
# Example. Data in wide format.
# Replication of results in Wang and Lan (2011, p. 2768)
data("Economy")
data_example <- read_malmquist(Economy,
   nper=5,
   arrangement="horizontal",
   ni = 2,
   no = 1)
result <- malmquist_index(data_example)

Description

Usage
data("EconomyLong")

Format
Data frame with 155 rows and 5 columns. Definition of inputs (X) and outputs (Y):
x1 = Capital  Total assets (in 100 million RMB)
x2 = Labor   Annual average employed persons (in 10000 persons)
y1 = GIOV   Gross industrial output value (in 100 million RMB)

Author(s)
Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.
Vicente Bolos (<vicente.bolos@uv.es>). Department of Business Mathematics
Rafael Benitez (<rafael.suarez@uv.es>). Department of Business Mathematics
University of Valencia (Spain)
Source


See Also

read_malmquist, malmquist_index

Examples

# Example. Data in long format.
# Replication of results in Wang and Lan (2011, p. 2768)
data("EconomyLong")
data_example <- read_malmquist(EconomyLong,
   percol=2,
   arrangement="vertical",
   ni = 2,
   no = 1)
result <- malmquist_index(data_example)

efficiencies

<table>
<thead>
<tr>
<th>efficiencies</th>
<th>Efficiencies</th>
</tr>
</thead>
</table>

Description

Extracts efficiencies from dea/dea_fuzzy objects.

Usage

efficiencies(x, ...)

Arguments

x               dea / dea_fuzzy object
...             ignored
Description

Extract the efficiencies of the DMUs from a dea solution.

Usage

```r
## S3 method for class 'dea'
 efficiencies(x, ...)
```

Arguments

- `x`: Object of class `dea` or `dea_fuzzy` obtained with some of the dea model functions.
- `...`: Other options (for compatibility reasons)

Author(s)

- **Vicente Coll-Serrano** (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2)*. *Applied Economics*.
- **Vicente Bolós** (<vicente.bolos@uv.es>). *Department of Business Mathematics*
- **Rafael Benítez** (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Examples

```r
# Replication results model DEA1 in Tomkins and Green (1988)
data("Departments")
# Calculate Total income
Departments$Total_income <- Departments[, 5] + Departments[, 6] + Departments[, 7]
data_DEA1 <- read_data(Departments,
                       inputs = 9,
                       outputs = c(2, 3, 4, 12))
result <- model_basic(data_DEA1,
                      orientation = "io",
                      rts = "crs")
efficiencies(result) # Table 3 (p.156)
```
Description

Extract the efficiencies of the DMUs from a dea_fuzzy solution.

Usage

```r
## S3 method for class 'dea_fuzzy'
 efficiencies(x, ...)
```

Arguments

- `x` Object of class dea or dea_fuzzy obtained with some of the dea model functions.
- `...` Other options (for compatibility)

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Examples

```r
# Replication results model DEA1 in Tomkins and Green (1988)
data("Departments")
# Calculate Total income
Departments$Total_income <- Departments[, 5] + Departments[, 6] + Departments[, 7]
data_DEA1 <- read_data(Departments,
    inputs = 9,
    outputs = c(2, 3, 4, 12))
result <- model_basic(data_DEA1,
    orientation = "io",
    rts = "crs")
efficiencies(result) # Table 3 (p.156)
```
Electric_plants


Description

Data of 19 coal-fired steam-electric generating plants operating in Illinois in 1978. Each plant uses 3 inputs to produce 1 output.

Usage

data("Electric_plants")

Format

Data frame with 18 rows and 5 columns. Definition of inputs (X) and outputs (Y):

- **x1 = Labor**  Labor average annual employment
- **x2 = Fuel**  Fuel $10^{10}$ Btu
- **x3 = Capital**  Capital MW (fixed input)
- **y1 = Output**  Output $10^6$ Kwh

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source


See Also

read_data, model_basic
Examples

```r
data("Electric_plants")
data_example <- read_data(Electric_plants, 
dmusp = 1, 
ni=3, 
no=1)
result <- model_basic(data_example, 
orientation="io", 
rtsc="vrs")
efficiencies(result)
```

**Fortune500**

Data: Zhu (2014).

Description

This dataset consists of 15 firms from the Fortune 500 list 1995 (https://fortune.com/fortune500/) with 3 inputs and 2 outputs.

Usage

```r
data("Fortune500")
```

Format

Data frame with 15 rows and 6 columns. Definition of inputs (X) and outputs (Y):

- **x1 = Assets** Assets (millions of dollars)
- **x2 = Equity** Equity (millions of dollars)
- **x3 = Employees** Number of employees
- **y1 = Revenue** Revenue (millions of dollars)
- **y2 = Profit** Profit (millions of dollars)

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source

See Also

read_data, model_multiplier

Examples

data("Fortune500")
data_Fortune <- read_data(datadea = Fortune500,
  dmus = 1,
  inputs = 2:4,
  outputs = 5:6)
result <- model_multiplier(data_Fortune,
  epsilon=0.000001,
  orientation="io",
  rts="crs")
# results for General Motors and Ford Motor are not shown
# by deaR because the solution is infeasible
efficiencies(result)
multipliers(result)

Fried1993


Description

Data of 11 DMUs with two inputs and one output.

Usage

data("Fried1993")

Format

Data frame with 11 rows and 4 columns. Definition of inputs (X) and outputs (Y):

- x1 Input 1
- x2 Input 2
- y1 Output 1

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolos (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benitez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)
Source

See Also
read_data, model_basic

Examples

# Example. Replication of results in Ali and (1993, p.143).
data("Fried1993")
data_example <- read_data(Fried1993,
ni=2,
no=1)
result <- model_basic(data_example,
orientation="oo",
rt="vrs")
efficiencies(result)
targets(result)

Data: Golany and Roll (1989).

Description
Data of 13 DMUs using 3 inputs to produce 2 outputs.

Usage
data("Golany_Roll_1989")

Format
Data frame with 13 rows and 6 columns. Definition of inputs (X) and outputs (Y):

x1 Input 1
x2 Input 2
x3 Input 3
y1 Output 1
y1 Output 2
Author(s)

**Vicente Coll-Serrano** (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

**Vicente Bolos** (<vicente.bolos@uv.es>). *Department of Business Mathematics*

**Rafael Benitez** (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source


See Also

`read_data`, `model_multiplier`, `cross_efficiency`

Examples

```r
# Example.
data("Golany_Roll_1989")
data_example <- read_data(datadea = Golany_Roll_1989, 
dmus = 1, 
inputs = 2:4, 
outputs = 5:6)
result <- cross_efficiency(data_example, 
orientation = "io", 
selfapp = TRUE)
result$Arbitrary$cross_eff
result$Arbitrary$e
```

---

**Grifell_Lovell_1999** *Data: Grifell-Tatjé and Lovell (1999).*

Description

Data of 8 DMUs producing 1 output (Y) by using 1 input (X) for two periods of time.

Usage

```r
data("Grifell_Lovell_1999")
```

Format

Data frame with 16 rows and 4 columns. Definition of inputs (X) and outputs (Y):

- X Input
- Y Output
Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2)*. *Applied Economics*.

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source


See Also

read_malmquist, malmquist_index

Examples

```r
# Example. Replication of results in Grifell-Tatjé and Lovell (1999, p. 100).
data("Grifell_Lovell_1999")
data_example <- read_malmquist(Grifell_Lovell_1999, 
percol=1, 
  dmus = 2, 
  inputs = 3, 
  outputs = 4, 
  arrangement="vertical")

result_fgnz <- malmquist_index(data_example, 
  orientation= "oo", 
  rts="vrs", 
  type1 = "cont", 
  type2 = "fgnz")

result_fgnz$mi
```


Description

Data of 5 DMUs with two symmetric triangular fuzzy inputs, Xj=(xj,alphaj), and two symmetric triangular fuzzy outputs, Yj=(yj,betaj).
Usage
data("Guo_Tanaka_2001")

Format
Data frame with 5 rows and 9 columns. Definition of fuzzy inputs (X) and fuzzy outputs (Y):

- `x1` Input 1
- `x2` Input 2
- `alpha1` spread vector Input 1
- `alpha2` spread vector Input 2
- `y1` Output 1
- `y2` Output 2
- `beta1` spread vector Output 1
- `beta2` spread vector Output 2

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source

See Also
`read_data_fuzzy`, `modelfuzzy_guotanaka`, `cross_efficiency_fuzzy`

Examples

data("Guo_Tanaka_2001")
data_example <- read_data_fuzzy(Guo_Tanaka_2001, 
dmus=1, 
inputs.mL=2:3, 
inputs.dL=4:5, 
outputs.mL=6:7, 
outputs.dL=8:9)
result <- modelfuzzy_guotanaka(data_example, 
    h = seq(0,1,by=0.1), 
    orientation="io")

efficiencies(result)
Hotels


Description
This dataset consists of 23 four- and five-plum ITHs in Taipei in 2006. Authors consider 4 inputs and 3 outputs.

Usage
data("Hotels")

Format
Data frame with 23 rows and 8 columns. Definition of inputs (X) and outputs (Y):

- **x1 = Employees**  Total number of employees
- **x2 = Guest_rooms**  Total number of guest rooms
- **x3 = Area_F&B**  Total area of F&B departments (in 36 square-feet)
- **x4 = Operating_cost**  Total operating cost (in NT$)
- **y1 = Room_revenue**  Room revenues (in NT$)
- **y2 = F&B_revenue**  F&B revenues (in NT$)
- **y3 = Other_revenue**  Other revenues (in NT$)

Author(s)
Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*
Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*
Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*
University of Valencia (Spain)

Source

See Also
read_data, model_nonradial
Examples

# Example. Replication of results in Wu,Tsai and Zhou (2011)
data("Hotels")
data_hotels <- read_data(Hotels, 
dmus = 1, 
inputs = 2:5, 
outputs = 6:8)
result <- model_nonradial(data_hotels, 
orientation="oo", 
rts="vrs")
efficiencies(result)

Data: Hua and Bian (2007).

Description

Data of 30 DMUs with two desirable inputs, two desirable outputs and one undesirable output.

Usage

data("Hua_Bian_2007")

Format

Data frame with 30 rows and 6 columns. Definition of inputs (X) and outputs (Y):

x1 = D-Input1 Desirable Input 1
x2 = D-Input2 Desirable Input 2
y1 = D-Output1 Desirable Output 1
y2 = D-Output2 Desirable Output 2
y3 = UD-Output1 Undesirable Output 1

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolos (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benitez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)

Source

See Also

read_data, model_basic

Examples

# Example. Replication of results in Hua and Bian (2007).
data("Hua_Bian_2007")
# The third output is an undesirable output
data_example <- read_data(Hua_Bian_2007,
  ni=2,
  no=3,
  ud_outputs=3)

# Translation parameter (vtrans_o) is set to 1500
result <- model_basic(data_example,
  orientation="oo",
  rts="vrs",
  vtrans_o=1500)
eff <- efficiencies(result)
1/eff # results M5 in Table 6-5 (p.119)

is.dea dea class check.

Description

Checks whether an R object is of dea class or not.

Usage

is.dea(x)

Arguments

x Any R object.

Value

Returns TRUE if its argument is a dea object (that is, has "dea" amongst its classes) and FALSE otherwise.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)
is.deadata  
\textit{deadata class check.}

\textbf{Description}

Checks whether an \texttt{R} object is of deadata class or not.

\textbf{Usage}

\begin{verbatim}
is.deadata(x)
\end{verbatim}

\textbf{Arguments}

\begin{itemize}
  \item \texttt{x} \hspace{1cm} \texttt{Any R object.}
\end{itemize}

\textbf{Value}

Returns \texttt{TRUE} if its argument is a deadata object (that is, has "deadata" amongst its classes) and \texttt{FALSE} otherwise.

\textbf{Author(s)}

\texttt{Vicente Coll-Serrano} (<vicente.coll@uv.es>). \textit{Quantitative Methods for Measuring Culture (MC2). Applied Economics.}

\texttt{Vicente Bolós} (<vicente.bolos@uv.es>). \textit{Department of Business Mathematics}

\texttt{Rafael Benítez} (<rafael.suarez@uv.es>). \textit{Department of Business Mathematics}

University of Valencia (Spain)

---

is.deadata_fuzzy  
\textit{deadata_fuzzy class check.}

\textbf{Description}

Checks whether an \texttt{R} object is of deadata\_fuzzy class or not.

\textbf{Usage}

\begin{verbatim}
is.deadata_fuzzy(x)
\end{verbatim}

\textbf{Arguments}

\begin{itemize}
  \item \texttt{x} \hspace{1cm} \texttt{Any R object.}
\end{itemize}
is.dea_fuzzy

dea_fuzzy class check.

Description
Checks whether an R object is of dea_fuzzy class or not.

Usage

is.dea_fuzzy(x)

Arguments

x Any R object.

Value
Returns TRUE if its argument is a dea_fuzzy object (that is, has "dea_fuzzy" amongst its classes) and FALSE otherwise.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)
is.friends

Description
Checks whether a subset of DMUs is friends or not, according to Tone (2010).

Usage

```r
is.friends(datadea,
            dmu_eval = NULL,
            dmu_ref = NULL,
            rts = c("crs", "vrs", "nirs", "ndrs"),
            tol = 1e-6)
```

Arguments

datadea  The data, including n DMUs, m inputs and s outputs.
dmu_eval  A numeric vector containing the subset of DMUs to be checked. If NULL (default), all DMUs are considered.
dmu_ref  A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
rts  A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing) or "ndrs" (non-decreasing).
tol  Numeric, a tolerance margin for checking efficiency. It is 1e-6 by default.

Value
Returns TRUE if dmu_eval is friends of dmu_ref, and FALSE otherwise.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.
Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics
Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics
University of Valencia (Spain)

References

See Also

maximal_friends, model_sbmeff
Examples

data("PFT1981")
datadea <- read_data(PFT1981, ni = 5, no = 3)
subset1 <- c(15, 16, 17, 19) # Subset of DMUs to be checked
result1 <- is.friends(datadea = datadea,
                      dmu_eval = subset1,
                      dmu_ref = 1:20) # We only consider a cluster formed by the first 20 DMUs
subset2 <- c(15, 16, 17, 20) # Another subset of DMUs to be checked
result2 <- is.friends(datadea = datadea,
                      dmu_eval = subset2,
                      dmu_ref = 1:20) # We only consider a cluster formed by the first 20 DMUs

Kao_Liu_2003


Description

Data of 24 university libraries in Taiwan with one input and five outputs.

Usage

data("Kao_Liu_2003")

Format

Data frame with 24 rows and 11 columns. Definition of fuzzy inputs (X) and fuzzy outputs (Y):

x1 = Patronage It is a weighted sum of the standardized scores of faculty, graduate students, undergraduate students, and extension students in the range of 0 and 1.

y1 = Collections Books, serials, microforms, audiovisual works, and database.

y2 = Personnel Classified staff, unclassified staff, and student assistants.

y3 = Expenditures Capital expenditure, operating expenditure, and special expenditure.

y4 = Buildings Area and seats

y5 = Services Operating hours, attendance, circulation, communication channels, range of services, amount of services, etc.

beta3_l lower spread vector Expenditures
beta3_u upper spread vector Expenditures
beta5_l lower spread vector Services
beta5_u upper spread vector Services

Note

There are three observations that are missing: expenditures of Library 24 and services of Library 22 and Library 23. Kao and Liu (2000b) represent the expenditures of Library 24 by the triangular fuzzy number Y=(0.11; 0.41; 1.0). The services of Library 22 and Library 23 are expressed by a same triangular fuzzy number Y=(0.41; 0.69; 1.0).
lambdas

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source


See Also

read_data_fuzzy, model_basic

Examples

```r
# Example. Replication of results in Kao and Liu (2003, p.152)
data_example <- read_data_fuzzy(Kao_Liu_2003,
dm=1,
inputs.ML= 2,
outputs.ML= 3:7,
outputs.dL=c(NA,NA,8,NA,10),
outputs.dR=c(NA,NA,9,NA,11))

result <- modelfuzzy_kaoliu(data_example,
kaoliu_modelname = "basic",
orientation="oo",
rts="vrs",
alpha=0)

eff <- efficiencies(result)
eff
```

<table>
<thead>
<tr>
<th>lambdas</th>
<th>Lambda</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Description

Extract the lambdas of the DMUs from a dea or dea_fuzzy solution.

Usage

lambdas(deasol)

Arguments

deasol Object of class dea or dea_fuzzy obtained with some of the dea model functions.
Leon2003


Description

Data of 8 DMUs with one symmetric triangular fuzzy inputs: $X_j=(x_j,\alpha_j)$, and one symmetric triangular fuzzy outputs: $Y_j=(y_j,\beta_j)$.

Usage

data("Leon2003")

Format

Data frame with 8 rows and 5 columns. Definition of fuzzy inputs (X) and fuzzy outputs (Y):

- x1 Input 1
- alpha1 spread vector Input 1
- y1 Output 1
- beta1 spread vector Output 1

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)
Source


See Also

read_data_fuzzy, modelfuzzy_posiiblistic, cross_efficiency_fuzzy, modelfuzzy_guotanaka

Examples

# Example. Replication of results in Leon et. al (2003, p. 416)
data("Leon2003")
data_example <- read_data_fuzzy(Leon2003,
dmus = 1,
inputs.mL = 2,
inputs.dL = 3,
outputs.mL = 4,
outputs.dL = 5)
result <- modelfuzzy_possibilistic(data_example,
h = seq(0,1,by=0.1),
orientation="io",
rtl="vrs")
efficiencies(result)

Libraries

Data: Cooper, Seiford and Tone (2007).

Description

Data for 23 public libraries of the Tokyo Metropolitan Area in 1986.

Usage

data("Libraries")

Format

Data frame with 23 rows and 7 columns. Definition of inputs (X) and outputs (Y):

x1 = AREA Floor area (unit=1000 m2)
x2 = BOOKS Number of books (unit=1000)
x3 = STAFF Staff
x4 = POPULATION Population (unit=1000)
y1 = REGISTERED Registered residents (unit=1000)
y2 = BORROWED Borrowed books (unit=1000)
Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2)*. *Applied Economics*.

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source


See Also

`read_data`, `model_basic`

Examples

```r
# Example 1. Non-controllable input (POPULATION).
# Replication of results in Cooper, Seiford and Tone (2007, p.221)
data(Libraries)
# POPULATION (non-controllable input) is the forth input.
data_example <- read_data(Libraries,
  dmus=1,
  inputs=2:5,
  nc_inputs=4,
  outputs=6:7)
result <- model_basic(data_example,
  orientation="io",
  rts="crs")
efficiencies(result)
targets(result)

# Example 2. Non-discretionary input (POPULATION).
data(Libraries)
# POPULATION (non-controllable input) is the forth input.
data_example2 <- read_data(Libraries,
  dmus=1,
  inputs=2:5,
  nd_inputs=4,
  outputs=6:7)
result2 <- model_basic(data_example2,
  orientation="io",
  rts="crs")
efficiencies(result2)
targets(result2)
```
Description

Data of 37 R&D project proposal relating to the Turkish iron and steel industry. Authors consider one input and five outputs.

Usage

data("Lim_Zhu_2015")

Format

Data frame with 37 rows and 7 columns. Definition of inputs (X) and outputs (Y):

x1 = Budget  Budget
y1 = Indirect_economic  Indirect economic contribution
y2 = Direct_economic  Direct economic contribution
y3 = Technical  Technical contribution
y4 = Social  Social contribution
y5 = Scientific  Scientific contribution

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolos (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benitez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)

Source


See Also

read_data, model_multiplier, cross_efficiency
Examples

# Example. Arbitrary formulation.
# Input-oriented model under variable returns-to-scale.
data("Lim_Zhu_2015")
data_example <- read_data(Lim_Zhu_2015,
dmus=1,
ni=1,
no=5)
cross <- cross_efficiency(data_example,
epsilon = 0,
orientation = "io",
rts = "vrs",
selfapp = TRUE,
M2 = FALSE,
M3 = FALSE)
cross$Arbitrary$e

malmquist_index

Description

This function calculates the conventional input/output oriented Malmquist index under variable return-to-scale.

Usage

malmquist_index(datadealist, 
dmu_eval = NULL, 
dmu_ref = NULL, 
orientation = c("io", "oo"), 
rts = c("crs", "vrs"), 
type1 = c("cont", "seq", "glob"), 
type2 = c("fgnz", "rd", "gl", "bias"), 
tc_vrs = FALSE)

Arguments

datadealist A list with the data at different times, including DMUs, inputs and outputs.
dmu_eval A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
dmu_ref A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
orIENTATION A string, equal to "io" (input oriented) or "oo" (output oriented).
rts A string, determining the type of returns to scale, equal to "crs" (constant) or "vrs" (variable).
type1  A string, equal to "cont" (contemporary), "seq" (sequential) or "glob" (global).

type2  A string, equal to “fgnz” (Fare et al. 1994), "rd" (Ray and Desli 1997), "gl" (generalized) or "bias" (biased).

tc_vrs  Logical. If it is FALSE, it computes the vrs bias malmquist index by using the technical change under crs (Fare and Grosskopf 1996). Otherwise, it uses the technical change under vrs.

Value

A numeric list with Malmquist index and other parameters.

Note

In the results: EC = Efficiency Change, PTEC = Pure Technical Efficiency Change, SEC = Scale Efficiency Change, TC = Technological Change, MI = Malmquist Index

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2).* Applied Economics.

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References


Examples

# Example 1. With dataset in wide format.
# Replication of results in Wang and Lan (2011, p. 2768)
data("Economy")
data_example <- read_malmquist(datadea = Economy,
                             nper = 5,
                             arrangement = "horizontal",
                             ni = 2,
                             no = 1)
result <- malmquist_index(data_example, orientation = "io")
mi <- result$mi
effch <- result$ec
tech <- result$tc

# Example 2. With dataset in long format.
# Replication of results in Wang and Lan (2011, p. 2768)
data("EconomyLong")
data_example2 <- read_malmquist(EconomyLong,
                                 percol = 2,
                                 arrangement = "vertical",
                                 inputs = 3:4,
                                 outputs = 5)
result2 <- malmquist_index(data_example2, orientation = "io")
mi2 <- result2$mi
effch2 <- result2$ec
tech2 <- result2$tc

# Example 3. Replication of results in Grifell-Tatje and Lovell (1999, p. 100).
data("Grifell_Lovell_1999")
data_example <- read_malmquist(Grifell_Lovell_1999,
                                percol = 1,
                                dmus = 2,
                                inputs = 3,
                                outputs = 4,
                                arrangement = "vertical")
result_fgnz <- malmquist_index(data_example,
                               orientation = "oo",
                               rts = "vrs",
                               type1 = "cont",
                               type2 = "fgnz")
mi_fgnz <- result_fgnz$mi

result_rd <- malmquist_index(data_example,
                               orientation = "oo",
                               rts = "vrs",
                               type1 = "cont",
                               type2 = "fgnz")
maximal_friends

Maximal friends of a set of DMUs.

Description

Finds the maximal friends subsets of a given set of DMUs, according to Tone (2010). It uses a descending algorithm in order to find directly maximal subsets.

Usage

maximal_friends(datadea,
    dmu_ref = NULL,
    rts = c("crs", "vrs", "nirs", "ndrs"),
    tol = 1e-6,
    silent = FALSE)

Arguments

datadea The data, including n DMUs, m inputs and s outputs.
dmu_ref A numeric vector containing which DMUs are the evaluation reference set, i.e. the cluster of DMUs from which we want to find maximal friends. If NULL (default), all DMUs are considered.
rtss A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing) or "ndrs" (non-decreasing).
tol Numeric, a tolerance margin for checking efficiency. It is 1e-6 by default.
silent Logical, if FALSE (default) steps are printed.

Value

A list with numeric vectors representing maximal friends subsets of DMUs.
modelfuzzy_guotanaka

Author(s)
Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*
Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*
Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*
University of Valencia (Spain)

References

See Also
is.friends, model_sbmeff

Examples
## Not run:
data("PFT1981")
datadea <- read_data(PFT1981, ni = 5, no = 3)
# We find maximal friends of a cluster formed by the first 20 DMUs
result <- maximal_friends(datadea = datadea,
                          dmu_ref = 1:20)
## End(Not run)

---

modelfuzzy_guotanaka  *Fuzzy DEA model*

Description
Solve the Fuzzy input-oriented and output-oriented DEA model proposed by Guo and Tanaka (2001) under constant returns-to-scale. In deaR is implemented the LP problem given by the model (16) in Guo and Tanaka (2001, p.155). The fuzzy efficiencies are calculated according to equations in (17) (Guo and Tanaka, 2001, p.155). The (crisp) relative efficiencies and multipliers for the case \( h = 1 \) are obtained from the CCR model (model_multiplier).

Usage
modelfuzzy_guotanaka(datadea, 
dmu_eval = NULL, 
dmu_ref = NULL, 
orientation = c("io", "oo"), 
h = 1)
Arguments

- `datadea`: The data, including DMUs, inputs and outputs.
- `dmu_eval`: A numeric vector containing which DMUs have to be evaluated. If `NULL` (default), all DMUs are considered.
- `dmu_ref`: A numeric vector containing which DMUs are the evaluation reference set. If `NULL` (default), all DMUs are considered.
- `orientation`: A string, equal to "io" (input oriented) or "oo" (output oriented).
- `h`: A numeric vector with the h-levels (in [0,1]).

Value

An object of class `deadata_fuzzy`.

Note

The optimal solution of model (16) is not unique.

Author(s)

- **Vicente Coll-Serrano** (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*
- **Vicente Bolós** (<vicente.bolos@uv.es>). *Department of Business Mathematics*
- **Rafael Benítez** (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References


See Also

`model_basic`, `model_multiplier`, `modelfuzzy_kaoliu`, `modelfuzzy_possibilistic`, `cross_efficiency_fuzzy`
Examples

# Example 1.
# Replication results in Guo and Tanaka (2001, p. 159).
# In deaR is implemented the LP problem given by the model 16 in Guo and Tanaka (2001, p. 155).
# The fuzzy efficiencies are calculated according to equations in (17) (Guo and Tanaka, 2001,p.155).
data("Guo_Tanaka_2001")
data_example <- read_data_fuzzy(Guo_Tanaka_2001,
                              inputs.mL = 2:3,
                              inputs.dL = 4:5,
                              outputs.mL = 6:7,
                              outputs.dL = 8:9)
result <- modelfuzzy_guotanaka(data_example,
                              h = c(0, 0.5, 0.75, 1),
                              orientation = "io")
efficiencies(result)

# Example 2.
data("Guo_Tanaka_2001")
data_example <- read_data_fuzzy(Guo_Tanaka_2001,
                              inputs.mL = 2:3,
                              inputs.dL = 4:5,
                              outputs.mL = 6:7,
                              outputs.dL = 8:9)
result2 <- modelfuzzy_guotanaka(data_example,
                              h = seq(0, 1, by = 0.1),
                              orientation = "io")
efficiencies(result2)

modelfuzzy_kaoliu  Fuzzy DEA model.

Description

Solve the fuzzy DEA model by Kao and Liu (2000)

Usage

modelfuzzy_kaoliu(datadea,
              dmu_eval = NULL,
              kaoliu_modelname = c("basic", "additive", "addsupereff",
                                   "deaps", "fdh", "multiplier", "nonradial",
                                   "sbmeff", "sbmsupereff", "supereff"),
              alpha = 1,
              ...)
Arguments

datadea The data, including DMUs, inputs and outputs.
dmu_eval A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
kaoliu_modelname a string containing the name of the model.
alpha A numeric vector with the alpha-cuts (in [0,1]). If alpha>1, it determines the number of alpha-cuts, equispatially distributed in [0,1].
... dmu_ref, orientation, rts and other model parameters.

Value

An object of class deadata_fuzzy.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)

References


See Also

model_basic, model_multiplier, modelfuzzy_possibilistic, modelfuzzy_guotanaka
Examples

# Example 1.
# Replication of results in Boscá, Liern, Sala and Martínez (2011, p.125)
data("Leon2003")
data_example <- read_data_fuzzy(data = Leon2003,  
  inputs.mL = 2,  
  inputs.dL = 3,  
  outputs.mL = 4,  
  outputs.dL = 5)
result <- modelfuzzy_kaoliu(data_example,  
  kaoliu_modelname = "basic",  
  alpha = seq(0, 1, by = 0.1),  
  orientation = "io",  
  rts = "vrs")
efficiencies(result)

# Example 2.
# Replication of results in Kao and Liu (2003, p.152)
data("Kao_Liu_2003")
data_example <- read_data_fuzzy(data = Kao_Liu_2003,  
  inputs.mL = 2,  
  outputs.mL = 3:7,  
  outputs.dL = c(NA, NA, 8, NA, 10),  
  outputs.dR = c(NA, NA, 9, NA, 11))
result <- modelfuzzy_kaoliu(data_example,  
  kaoliu_modelname = "basic",  
  orientation = "oo",  
  rts = "vrs",  
  alpha = 0)
sol <- efficiencies(result)
eff <- data.frame(1 / sol$Worst, 1 / sol$Best)
names(eff) <- c("eff_lower", "eff_upper")
eff

modelfuzzy_possibilistic

Possibilistic Fuzzy DEA model.

Description

Solve the possibilistic fuzzy DEA model proposed by León et. al (2003).

Usage

modelfuzzy_possibilistic(data,  
  dmu_eval = NULL,  
  poss_modelname = c("basic"),  
  h = 1,  
  ...)

modelfuzzy_possibilistic
modelfuzzy_possibilistic

Arguments

- *datadea*: The data, including DMUs, inputs and outputs.
- *dmu_eval*: A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
- *poss_modelname*: A string containing the name of the model.
- *h*: A numeric vector with the h-levels (in [0,1]).
- *...*: dmu_ref, orientation, rts and other model parameters.

Value

An object of class deadata_fuzzy.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2)*. Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References


See Also

- model_basic, modelfuzzy_kaoliu, modelfuzzy_guotanaka

Examples

# Replication of results in Leon et. al (2003, p. 416)
data("Leon2003")
data_example <- read_data_fuzzy(Leon2003,inputs.mL = 2,inputs.dL = 3,outputs.mL = 4,outputs.dL = 5)result <- modelfuzzy_possibilistic(data_example,
h = seq(0, 1, by = 0.1),
orientation = "io",
rts = "vrs")

efficiencies(result)

Description
Solve the additive model of Charnes et. al (1985). With the current version of deaR, it is possible to solve input-oriented, output-oriented, and non-oriented additive dea model under constant and non-constant returns-to-scale.

Besides, the user can set weights for the input slacks and/or output slacks. So, it is also possible to solve weighted additive models. For example: Measure of Inefficiency Proportions (MIP), Range Adjusted Measure (RAM), etc.

Usage
model_additive(datadea,
    dmu_eval = NULL,
    dmu_ref = NULL,
    orientation = NULL,
    weight_slack_i = 1,
    weight_slack_o = 1,
    rts = c("crs", "vrs", "nirs", "ndrs", "grs"),
    L = 1,
    U = 1,
    compute_target = TRUE,
    returnlp = FALSE,
    ...
)

Arguments

datadea: The data, including \(n\) DMUs, \(m\) inputs and \(s\) outputs.
dmu_eval: A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
dmu_ref: A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
orIENTATION: This parameter is either NULL (default) or a string, equal to "io" (input-oriented) or "oo" (output-oriented). It is used to modify the weight slacks. If input-oriented, weight_slack_o are taken 0. If output-oriented, weight_slack_i are taken 0.
weight_slack_i: A value, vector of length \(m\), or matrix \(m \times ne\) (where \(ne\) is the length of dmu_eval) with the weights of the input slacks. If 0, output-oriented.
weight_slack_o  A value, vector of length s, or matrix s x ne (where ne is the length of dmu_eval) with the weights of the output slacks. If 0, input-oriented.

rts        A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).

L          Lower bound for the generalized returns to scale (grs).

U          Upper bound for the generalized returns to scale (grs).

compute_target Logical. If it is TRUE, it computes targets.

returnlp   Logical. If it is TRUE, it returns the linear problems (objective function and constraints).

...        Ignored, for compatibility issues.

Note

In this model, the efficiency score is the sum of the slacks. Therefore, a DMU is efficient when the objective value (objval) is zero.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)

References


See Also

model_addsupereff
Examples

# Example 1.
# Replication of results in Charnes et. al (1994, p. 27)
x <- c(2, 3, 6, 9, 5, 4, 10)
y <- c(2, 5, 7, 8, 3, 1, 7)
data_example <- data.frame(dmus = letters[1:7], x, y)
data_example <- read_data(data_example, 
                         ni = 1,
                         no = 1)
result <- model_additive(data_example, 
                         rts = "vrs")
efficiencies(result)
slacks(result)
lambdas(result)

# Example 2.
# Measure of Inefficiency Proportions (MIP).
x <- c(2, 3, 6, 9, 5, 4, 10)
y <- c(2, 5, 7, 8, 3, 1, 7)
data_example <- data.frame(dmus = letters[1:7], x, y)
data_example <- read_data(data_example, ni = 1, no = 1)
result2 <- model_additive(data_example, rts = "vrs",
                          weight_slack_i = 1 / data_example["input"],
                          weight_slack_o = 1 / data_example["output"])
slacks(result2)

# Example 3.
# Range Adjusted Measure of Inefficiencies (RAM).
x <- c(2, 3, 6, 9, 5, 4, 10)
y <- c(2, 5, 7, 8, 3, 1, 7)
data_example <- data.frame(dmus = letters[1:7], x, y)
data_example <- read_data(data_example, ni = 1, no = 1)
range_i <- apply(data_example["input"], 1, max) - apply(data_example["input"], 1, min)
range_o <- apply(data_example["output"], 1, max) - apply(data_example["output"], 1, min)
w_range_i <- 1 / (range_i * (dim(data_example["input"])[1] + dim(data_example["output"])[1]))
w_range_o <- 1 / (range_o * (dim(data_example["output"])[1] + dim(data_example["output"])[1]))
result3 <- model_additive(data_example, rts = "vrs",
                          weight_slack_i = w_range_i,
                          weight_slack_o = w_range_o)
slacks(result3)

model_addsupereff Additive super-efficiency DEA model.

Description

Solve the additive super-efficiency model proposed by Du, Liang and Zhu (2010). It is an extension of the SBM super-efficiency to the additive DEA model.
Usage

```r
model_addsupereff(datadea,
dmu_eval = NULL,
dmu_ref = NULL,
orientation = NULL,
weight_slack_i = NULL,
weight_slack_o = NULL,
rts = c("crs", "vrs", "nirs", "ndrs", "grs"),
L = 1,
U = 1,
compute_target = TRUE,
returnlp = FALSE,
...)
```

Arguments

**datadea**  
The data, including \( n \) DMUs, \( m \) inputs and \( s \) outputs.

**dmu_eval**  
A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.

**dmu_ref**  
A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.

**orientation**  
This parameter is either NULL (default) or a string, equal to "io" (input-oriented) or "oo" (output-oriented). It is used to modify the weight slacks. If input-oriented, \( \text{weight\_slack\_i} \) are taken 0. If output-oriented, \( \text{weight\_slack\_o} \) are taken 0.

**weight_slack_i**  
A value, vector of length \( m \), or matrix \( m \times ne \) (where \( ne \) is the length of \( \text{dmu\_eval} \)) with the weights of the input superslacks (\( t_{\text{input}} \)). If 0, output-oriented. If \( \text{weight\_slack\_i} \) is the matrix of the inverses of inputs (of DMUS in \( \text{dmu\_eval} \)), the model is unit invariant.

**weight_slack_o**  
A value, vector of length \( s \), or matrix \( s \times ne \) (where \( ne \) is the length of \( \text{dmu\_eval} \)) with the weights of the output superslacks (\( t_{\text{output}} \)). If 0, input-oriented. If \( \text{weight\_slack\_o} \) is the matrix of the inverses of outputs (of DMUS in \( \text{dmu\_eval} \)), the model is unit invariant.

**rts**  
A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).

**L**  
Lower bound for the generalized returns to scale (grs).

**U**  
Upper bound for the generalized returns to scale (grs).

**compute_target**  
Logical. If it is TRUE, it computes targets, projections and slacks.

**returnlp**  
Logical. If it is TRUE, it returns the linear problems (objective function and constraints).

...  
Ignored, for compatibility issues.
Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2).* Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References


See Also

`model_additive, model_supereff, model_sbmsupereff`

Examples

```r
# Replication of results in Du, Liang and Zhu (2010, Table 6, p.696)
data("Power_plants")
Power_plants <- read_data(Power_plants, ni = 4, no = 2)
result <- model_addsupereff(Power_plants, rts = "crs")
efficiencies(result)
```

| model_basic | Basic (radial) DEA model. |

Description

Solve input and output oriented basic DEA models (envelopment form) under constant (CCR DEA model), variable (BCC DEA model), non-increasing, non-decreasing or generalized returns to scale. By default, models are solved in a two-stage process (DEA slacks are maximized).

The `model_basic` function allows to treat with non-discretional, uncontrollable and undesirable inputs/outputs.

Finally, you can use the `model_basic` function to solve directional DEA models by choosing `orientation = "dir"`. 

Usage

```r
model_basic(datadea,
  dmu_eval = NULL,
  dmu_ref = NULL,
  orientation = c("io", "oo", "dir"),
  dir_input = NULL,
  dir_output = NULL,
  rts = c("crs", "vrs", "nirs", "ndrs", "grs"),
  L = 1,
  U = 1,
  maxslack = TRUE,
  weight_slack_i = 1,
  weight_slack_o = 1,
  vtrans_i = NULL,
  vtrans_o = NULL,
  compute_target = TRUE,
  compute_multiplier = FALSE,
  returnlp = FALSE,
  ...
)
```

Arguments

datadea  The data, including n DMUs, m inputs and s outputs.
dmu_eval  A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
dmu_ref  A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
orientation  A string, equal to "io" (input oriented), "oo" (output oriented), or "dir" (directional).
dir_input  A value, vector of length m, or matrix m x ne (where ne is the length of dmu_eval) with the input directions. If dir_input == input matrix (of DMUS in dmu_eval) and dir_output == 0, it is equivalent to input oriented (beta = 1 - efficiency). If dir_input is omitted, input matrix (of DMUS in dmu_eval) is assigned.
dir_output  A value, vector of length s, or matrix s x ne (where ne is the length of dmu_eval) with the output directions. If dir_input == 0 and dir_output == output matrix (of DMUS in dmu_eval), it is equivalent to output oriented (beta = efficiency - 1). If dir_output is omitted, output matrix (of DMUS in dmu_eval) is assigned.
rts  A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).
L  Lower bound for the generalized returns to scale (grs).
U  Upper bound for the generalized returns to scale (grs).
maxslack  Logical. If it is TRUE, it computes the max slack solution.
weight_slack_i  A value, vector of length m, or matrix m x ne (where ne is the length of dmu_eval) with the weights of the input slacks for the max slack solution.
weight_slack_o  A value, vector of length s, or matrix s x ne (where ne is the length of dmu_eval) with the weights of the output slacks for the max slack solution.

vtrans_i  Numeric vector of translation for undesirable inputs with non-directional orientation. If vtrans_i[i] is NA, then it applies the "max + 1" translation to the i-th undesirable input. If vtrans_i is a constant, then it applies the same translation to all undesirable inputs. If vtrans_i is NULL, then it applies the "max + 1" translation to all undesirable inputs.

vtrans_o  Numeric vector of translation for undesirable outputs with non-directional orientation, analogous to vtrans_i, but applied to outputs.

compute_target  Logical. If it is TRUE, it computes targets of the max slack solution.

compute_multiplier  Logical. If it is TRUE, it computes multipliers (dual solution) when orientation is "io" or "oo".

returnlp  Logical. If it is TRUE, it returns the linear problems (objective function and constraints) of stage 1.

...  Ignored, for compatibility issues.

Note

(1) With undesirable inputs/outputs and non-directional orientation, you should select "vrs" returns to scale (BCC model) in order to maintain translation invariance (Seiford and Zhu, 2002). If deaR detects that you are not specifying rts = "vrs", it makes the change to "vrs" automatically.

(2) With undesirable inputs and non-directional orientation use input-oriented BCC model, and with undesirable outputs and non-directional orientation use output-oriented BCC model. Alternatively, you can also treat the undesirable outputs as inputs and then apply the input-oriented BCC model (similarly with undesirable inputs).

(3) With orientation = "dir" (directional distance function model), efficient DMUs are those for which beta = 0.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References


Undesirable inputs/outputs:

Non-discretionary/Non-controllable inputs/outputs:

Directional DEA model:

See Also

model_multiplier, model_supereff

Examples

# Example 1. Basic DEA model with desirable inputs/outputs.
# Replication of results in Charnes, Cooper and Rhodes (1981).
data("PFT1981")
# Selecting DMUs in Program Follow Through (PFT)
PFT <- PFT1981[1:49, ]
PFT <- read_data(PFT,
   inputs = 2:6,
   outputs = 7:9 )
eval_pft <- model_basic(PFT,
   orientation = "io",
   rts = "crs")
eff <- efficiencies(eval_pft)
s <- slacks(eval_pft)
lamb <- lambdas(eval_pft)
tar <- targets(eval_pft)
ref <- references(eval_pft)
returns <- rts(eval_pft)
model_deaps

Preference Structure DEA model.

Description

With this non-radial DEA model (Zhu, 1996), the user can specify the preference input (or output) weights that reflect the relative degree of desirability of the adjustments of the current input (or output) levels.

Usage

model_deaps(data,  
  dmu_eval = NULL,  
  dmu_ref = NULL,  
  weight_eff = 1,  
  orientation = c("io", "oo"),  
  rts = c("crs", "vrs", "nirs", "ndrs", "grs"),  
  L = 1,  
  U = 1,
model_deaps

... = FALSE,
  ...)  

Arguments

data_dea The data, including n DMUs, m inputs and s outputs.
dmu_eval A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
dmu_ref A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
weight_eff Preference weights. If input-oriented, it is a value, vector of length m, or matrix m x ne (where ne is the length of dmu_eval) with the weights applied to the input efficiencies. If output-oriented, it is a value, vector of length s, or matrix s x ne with the weights applied to the output efficiencies.
orientation A string, equal to "io" (input-oriented) or "oo" (output-oriented).
rts A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).
L Lower bound for the generalized returns to scale (grs).
U Upper bound for the generalized returns to scale (grs).
restricted_eff Logical. If it is TRUE, the efficiencies are restricted to be <=1 (input-oriented) or >=1 (output-oriented).
maxslack Logical. If it is TRUE, it computes the max slack solution.
weight_slack If input-oriented, it is a value, vector of length s, or matrix s x ne with the weights of the output slacks for the max slack solution. If output-oriented, it is a value, vector of length m, or matrix m x ne with the weights of the input slacks for the max slack solution.
compute_target Logical. If it is TRUE, it computes targets of the max slack solution.
returnlp Logical. If it is TRUE, it returns the linear problems (objective function and constraints) of stage 1.
... Ignored, for compatibility issues.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)
References


See Also

model_nonradial, model_profit, model_sbmeff

Examples

data("Fortune500")
data_deaps <- read_data(datadea = Fortune500, 
ni = 3,
no = 2)
result <- model_deaps(data_deaps, 
weight_eff = c(1, 2, 3),
orientation = "io",
rts = "vrs")
efficiencies(result)

model_fdh

Free disposal hull (FDH) model.

Description

FDH model allows the free disposability to construct the production possibility set. The central feature of the FDH model is the lack of convexity for its production possibility set (Thrall, 1999).

Usage

model_fdh(datadea, 
fdh_modelname = c("basic"),
...)

Arguments

datadea The data, including DMUs, inputs and outputs.
fdh_modelname A string containing the name of the model to apply FDH.
... dmu_eval, dmu_ref, orientation and other model parameters.
Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References


Examples

```r
# Example 1. FDH input-oriented.
# Replication of results in Sanei and Mamizadeh Chatghayeb (2013)
data("Supply_Chain")
data_fdh1 <- read_data(Supply_Chain,
                         inputs = 2:4,
                         outputs = 5:6)
result <- model_fdh(data_fdh1) # by default orientation = "io"
efficiencies(result)

# Example 2. FDH output-oriented.
# Replication of results in Sanei and Mamizadeh Chatghayeb (2013)
data("Supply_Chain")
data_fdh2 <- read_data(Supply_Chain,
                         inputs = 5:6,
                         outputs = 7:8)
result2 <- model_fdh(data_fdh2,
                     orientation = "oo")
efficiencies(result2)
```

model_multiplier

*Multiplier DEA model*
Description

Solve input-oriented and output-oriented basic DEA models (multiplicative form) under constant (CCR DEA model), variable (BCC DEA model), non-increasing, non-decreasing or generalized returns to scale. It does not take into account uncontrollable, non-discretionary or undesirable inputs/outputs.

Usage

```r
model_multiplier(datadea,
                   dmu_eval = NULL,
                   dmu_ref = NULL,
                   epsilon = 0,
                   orientation = c("io", "oo"),
                   rts = c("crs", "vrs", "nirs", "ndrs", "grs"),
                   L = 1,
                   U = 1,
                   returnlp = FALSE,
                   compute_lambda = TRUE,
                   ...)
```

Arguments

dataea The data, including DMUs, inputs and outputs.
dmu_eval A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
dmu_ref A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
epsilon Numeric, multipliers must be \( \geq \) epsilon.
orIENTATION A string, equal to "io" (input-oriented) or "oo" (output-oriented).
rts A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).
L Lower bound for the generalized returns to scale (grs).
U Upper bound for the generalized returns to scale (grs).
returnlp Logical. If it is TRUE, it returns the linear problems (objective function and constraints).
compute_lambda Logical. If it is TRUE, it computes the dual problem and lambdas.
... Ignored, for compatibility issues.

Note

(1) Very important with the multiplier model: "The optimal weights for an efficient DMU need not be unique" (Cooper, Seiford and Tone, 2007:31). "Usually, the optimal weights for inefficient DMUs are unique, the exception being when the line of the DMU is parallel to one of the boundaries of the feasible region" (Cooper, Seiford and Tone, 2007:32).
(2) The measure of technical input (or output) efficiency obtained by using multiplier DEA models is better the smaller the value of epsilon.

(3) Epsilon is usually set equal to $10^{-6}$. However, if epsilon is not set correctly, the multiplier model can be infeasible (Zhu, 2014:49).

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References


See Also

model_basic, cross_efficiency

Examples

# Example 1.
# Replication of results in Golany and Roll (1989).
data("Golany_Roll_1989")
data_example <- read_data(datadea = Golany_Roll_1989[1:10, ],
                          inputs = 2:4,
                          outputs = 5:6)
result <- model_multiplier(data_example,
                          epsilon = 0,
                          orientation = "io",
                          rts = "crs")
model_nonradial

Non-radial DEA model.

Description

Non-radial DEA model allows for non-proportional reductions in each input or augmentations in each output.

Usage

```r
model_nonradial(datadea, 
dmu_eval = NULL, 
dmu_ref = NULL, 
orientation = c("io", "oo"), 
rts = c("crs", "vrs", "nirs", "ndrs", "grs"), 
L = 1, 
U = 1, 
maxslack = TRUE, 
weight_slack = 1, 
compute_target = TRUE, 
returnlp = FALSE, 
...)
```

Arguments

datadea The data, including n DMUs, n inputs and s outputs.
dmu_eval A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
### model_nonradial

- **dmu_ref**: A numeric vector containing which DMUs are the evaluation reference set. If `NULL` (default), all DMUs are considered.
- **orientation**: A string, equal to "io" (input-oriented) or "oo" (output-oriented).
- **rts**: A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).
- **L**: Lower bound for the generalized returns to scale (grs).
- **U**: Upper bound for the generalized returns to scale (grs).
- **maxslack**: Logical. If it is `TRUE`, it computes the max slack solution.
- **weight_slack**: If input-oriented, it is a value, vector of length `s`, or matrix `s x ne` (where `ne` is the length of `dmu_eval`) with the weights of the output slacks for the max slack solution. If output-oriented, it is a value, vector of length `m`, or matrix `m x ne` with the weights of the input slacks for the max slack solution.
- **compute_target**: Logical. If it is `TRUE`, it computes targets of the max slack solution.
- **returnlp**: Logical. If it is `TRUE`, it returns the linear problems (objective function and constraints) of stage 1.

... Ignored, for compatibility issues.

### Author(s)

- **Vicente Coll-Serrano** (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*
- **Vicente Bolós** (<vicente.bolos@uv.es>). *Department of Business Mathematics*
- **Rafael Benítez** (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

### References


### See Also

- `model_deaps`, `model_profit`, `model_sbmeff`
Examples

# Replication of results in Wu, Tsai and Zhou (2011)
data("Hotels")
data_hotels <- read_data(Hotels,
  inputs = 2:5,
  outputs = 6:8)
result <- model_nonradial(data_hotels,
  orientation = "oo",
  rts = "vrs")
efficiencies(result)

model_profit

Profit efficiency DEA model.

Description

Cost, revenue and profit efficiency DEA models.

Usage

model_profit(datadea,
  dmu_eval = NULL,
  dmu_ref = NULL,
  price_input = NULL,
  price_output = NULL,
  rts = c("crs", "vrs", "nirs", "ndrs", "grs"),
  L = 1,
  U = 1,
  restricted_optimal = TRUE,
  returnlp = FALSE,
  ...)

Arguments

datadea The data, including n DMUs, m inputs and s outputs.
dmu_eval A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
dmu_ref A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
price_input Unit prices of inputs for cost or profit efficiency models. It is a value, vector of length m, or matrix m x ne (where ne is the length of dmu_eval).
price_output Unit prices of outputs for revenue or profit efficiency models. It is a value, vector of length s, or matrix s x ne.
rt A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).
model_profit

L 
Upper bound for the generalized returns to scale (grs).

U 
Lower bound for the generalized returns to scale (grs).

restricted_optimal
Logical. If it is TRUE, the optimal inputs are restricted to be <= inputs (for cost efficiency models) or the optimal outputs are restricted to be >= outputs (for revenue efficiency models).

returnlp
Logical. If it is TRUE, it returns the linear problems (objective function and constraints) of stage 1.

... Ignored, for compatibility issues.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)

References


See Also

model_deaps, model_nonradial, model_sbmeff

Examples

# Example 1. Replication of results in Coelli et al. (1998, p.166).
# Cost efficiency model.
data("Coelli_1998")
# Selection of prices: input_prices is the transpose where the prices for inputs are.
input_prices <- t(Coelli_1998[, 5:6])
data_example1 <- read_data(Coelli_1998, ni = 2, no = 1)
result1 <- model_profit(data_example1, price_input = input_prices, rts = "crs", restricted_optimal = FALSE)
# notice that the option by default is restricted_optimal = TRUE
efficiencies(result1)

# Example 2. Revenue efficiency model.
# Selection of prices for output: output_prices is the transpose where the prices for outputs are.
output_prices <- t(Coelli_1998[, 7])
data_example2 <- read_data(Coelli_1998,
    ni = 2,
    no = 1)
result2 <- model_profit(data_example2,
    price_output = output_prices,
    rts = "crs",
    restricted_optimal = FALSE)
# notice that the option by default is restricted_optimal = TRUE
efficiencies(result2)

# Example 3. Profit efficiency model.
data("Coelli_1998")
# Selection of prices for inputs and outputs: input_prices and output_prices are the transpose where the prices (for inputs and outputs) are.
input_prices <- t(Coelli_1998[, 5:6])
output_prices <- t(Coelli_1998[, 7])
data_example3 <- read_data(Coelli_1998,
    ni = 2,
    no = 1)
result3 <- model_profit(data_example3,
    price_input = input_prices,
    price_output = output_prices,
    rts = "crs",
    restricted_optimal = FALSE)
# notice that the option by default is restricted_optimal = TRUE
efficiencies(result3)

---

**model_rdm**

Range directional model.

**Description**

Range directional model from Portela et al. (2004).

**Usage**

```r
model_rdm(datadea,
    dmu_eval = NULL,
    dmu_ref = NULL,
    orientation = c("no", "io", "oo"),
    irdm = FALSE,
    maxslack = TRUE,
    weight_slack_i = 1,
    weight_slack_o = 1,
    compute_target = TRUE,
    returnlp = FALSE,
    ...)
```
Arguments

datadea The data, including \(n\) DMUs, \(m\) inputs and \(s\) outputs.
dmu_eval A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
dmu_ref A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
orientation A string, equal to "no" (non-oriented), "io" (input oriented), or "oo" (output oriented).
irdm Logical. If it is TRUE, it applies the IRDM (inverse range directional model).
maxslack Logical. If it is TRUE, it computes the max slack solution.
weight_slack_i A value, vector of length \(m\), or matrix \(m \times ne\) (where \(ne\) is the length of \(dmu_eval\)) with the weights of the input slacks for the max slack solution.
weight_slack_o A value, vector of length \(s\), or matrix \(s \times ne\) (where \(ne\) is the length of \(dmu_eval\)) with the weights of the output slacks for the max slack solution.
compute_target Logical. If it is TRUE, it computes targets of the max slack solution.
returnlp Logical. If it is TRUE, it returns the linear problems (objective function and constraints) of stage 1.
...
Ignored, for compatibility issues.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)

References


---

`model_sbmeff` Slack based measure (SBM) of efficiency model.

Description

Calculate the SBM model proposed by Tone (2001).
Usage

model_sbmeff(datadea,
    dmu_eval = NULL,
    dmu_ref = NULL,
    weight_input = 1,
    weight_output = 1,
    orientation = c("no", "io", "oo"),
    rts = c("crs", "vrs", "nirs", "ndrs", "grs"),
    L = 1,
    U = 1,
    kaizen = FALSE,
    maxfr = NULL,
    tol = 1e-6,
    silent = FALSE,
    compute_target = TRUE,
    returnlp = FALSE,
    ...
)

Arguments

datadea
The data, including n DMUs, m inputs and s outputs.
dmu_eval
A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
dmu_ref
A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
weight_input
A value, vector of length m, or matrix m x ne (where ne is the length of dmu_eval) with weights to inputs corresponding to the relative importance of items.
weight_output
A value, vector of length m, or matrix m x ne (where ne is the length of dmu_eval) with weights to outputs corresponding to the relative importance of items.
orientation
A string, equal to "no" (non-oriented), "io" (input-oriented) or "oo" (output-oriented).
rtt
A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).
L
Lower bound for the generalized returns to scale (grs).
U
Upper bound for the generalized returns to scale (grs).
kaizen
Logical. If TRUE, the kaizen version of SBM (Tone 2010), also known as SBM-Max, is computed.
maxfr
A list with the maximal friends sets, as it is returned by function maximal_friends. If NULL (default) this list is computed internally.
tol
Numeric, a tolerance margin for checking efficiency (only for the kaizen version).
silent
Logical. If FALSE (default) it prints all the messages from function maximal_friends.
compute_target
Logical. If it is TRUE, it computes targets.
model_sbmeff

returnlp Logical. If it is TRUE, it returns the linear problems (objective function and constraints). If kaizen is TRUE it is ignored.

... Other options (currently not implemented)

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)

References


See Also

model_nonradial, model_deaps, model_profit, model_sbmsupereff

Examples

# Replication of results in Tone (2001, p.505)
data("Tone2001")
data_example <- read_data(Tone2001,
ni = 2,
no = 2)
result_SBM <- model_sbmeff(data_example,
orientation = "no",
rts = "crs")
result_CCR <- model_basic(data_example,
orientation = "io",
rts = "crs")
efficiencies(result_SBM)
efficiencies(result_CCR)
slacks(result_SBM)
slacks(result_CCR)

data("Tone2003")
data_example <- read_data(Tone2003,
ni = 1,
no = 2,
model_sbmsupereff

Slack based measure of superefficiency model

Description
Slack based measure of superefficiency model (Tone 2002) with n DMUs, m inputs, s outputs...

Usage
model_sbmsupereff(datadea, 
dmu_eval = NULL, 
dmu_ref = NULL, 
weight_input = 1, 
weight_output = 1, 
orientation = c("no", "io", "oo"), 
rts = c("crs", "vrs", "nirs", "ndrs", "grs"), 
L = 1, 
U = 1, 
compute_target = TRUE, 
compute_rho = FALSE, 
kaizen = FALSE, 
silent = FALSE, 
returnlp = FALSE)

Arguments

datadea The data, including DMUs, inputs and outputs.
dmu_eval A numeric vector containing which DMUs have to be evaluated. If NULL (default), all DMUs are considered.
dmu_ref A numeric vector containing which DMUs are the evaluation reference set. If NULL (default), all DMUs are considered.
weight_input A value, vector of length m, or matrix m x ne (where ne is the length of dmu_eval) with weights to inputs corresponding to the relative importance of items.
weight_output A value, vector of length m, or matrix m x ne (where ne is the length of dmu_eval) with weights to outputs corresponding to the relative importance of items.
orientation A string, equal to "no" (non-oriented), "io" (input-oriented) or "oo" (output-oriented).
model_sbmsupereff

**rts**
A string, determining the type of returns to scale, equal to "crs" (constant), "vrs" (variable), "nirs" (non-increasing), "ndrs" (non-decreasing) or "grs" (generalized).

**L**
Lower bound for the generalized returns to scale (grs).

**U**
Upper bound for the generalized returns to scale (grs).

**compute_target**
Logical. If it is TRUE, it computes targets, superslacks (t_input and t_output) and slacks.

**compute_rho**
Logical. If it is TRUE, it computes the SBM efficiency score (applying model_sbmeff) of the DMU (project_input, project_output).

**kaizen**
Logical. If TRUE, the kaizen version of SBM (Tone 2010), also known as SBM-Max, is computed for the efficiency score of the DMU (project_input, project_output).

**silent**
Logical. If FALSE (default) it prints all the messages from function maximal_friends.

**returnlp**
Logical. If it is TRUE, it returns the linear problems (objective function and constraints).

**Author(s)**

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

**References**


**See Also**

model_sbmeff, model_supereff, model_addsupereff

**Examples**

```r
# Replication of results in Tone(2002, p.39)
data("Power_plants")
data_example <- read_data(Power_plants, 
n1 = 4,
no = 2)
result <- model_sbmsupereff(data_example, 
   orientation = "io",
   rts = "grs",
   L = 1,
   U = 2,
   compute_target = TRUE,
   compute_rho = TRUE,
   kaizen = TRUE,
   silent = FALSE,
   returnlp = TRUE)
```
Description

Solve Andersen and Petersen radial Super-efficiency DEA model.

Usage

```r
def model_supereff(datadea, 
dmu_eval = NULL, 
dmu_ref = NULL, 
supereff_modelname = c("basic"), 
..., orientation, rts and other model parameters.
```
multipliers

References


See Also

model_basic, model_sbmsupereff, model_addsupereff

Examples

# Example 1.
# Replication of results in Tone (2002, p.38)
data("Power_plants")
data_example <- read_data(Power_plants,
n1 = 4,
no = 2)
result <- model_supereff(data_example,
orientation = "io",
rts = "crs")

eff <- efficiencies(result)

# Example 2.
# Results of Super-efficiency with vrs returns to scale show infeasibility solutions
# for DMUs D4 and D6 (these DMUs are not shown in deaR results).
data("Power_plants")
data_example2 <- read_data(Power_plants,
n1 = 4,
no = 2)
result2 <- model_supereff(data_example2,
orientation = "io",
rts = "vrs")
eff2 <- efficiencies(result2)

multipliers

<table>
<thead>
<tr>
<th>Multipliers</th>
</tr>
</thead>
</table>

Description

Extract the multipliers of the DMUs from a dea or dea_fuzzy solution.

Usage

multipliers(deasol)
Arguments

deaol Object of class dea or dea_fuzzy obtained with some of the dea model functions.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.
Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics
Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics
University of Valencia (Spain)

Examples

data("Coll_Blasco_2006")
data_example <- read_data(Coll_Blasco_2006,
ni = 2,
no = 2)
result <- model_multiplier(data_example,
orientation = "io",
rts = "crs")
multipliers(result)

Description

Data from Project Follow Through (PTF) in public school education. There are 49 DMUs (school sites) in PFT and 21 DMUs in Non-Follow Through (NFT). Authors consider 3 outputs (Y) and 5 inputs (X).

Usage

data("PFT1981")

Format

Data frame with 70 rows and 10 columns. Definition of inputs (X) and outputs (Y):

Y1 = Reading Total Reading Scores (as measured by the Metropolitan Achievement Test).
Y2 = Math Total Math Scores (total mathematics score by the Metropolitan Achievement Test.
Y3 = Coopersmith Total Coopersmith Scores (Coopersmith self-esteem inventory, intended as a measure of self-esteem).
X1 = Education Education level of mother (as measured in terms of percentage of high school graduates among female parents).
X2 = Occupation  Occupation Index (highest occupation of a family member according to a pre-arranged rating scale).
X3 = Parental  Parental Visit Index (representing the number of visits to the school site).
X4 = Counseling  Counseling Index (parent counselling index calculated from data on time spent with child on school-related topics such as reading together, etc.).
X5 = Teachers  Number of Teachers (number of teachers at a given site).
Program  PFT or NFT.

Author(s)
Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.
Vicente Bolos (<vicente.bolos@uv.es>). Department of Business Mathematics
Rafael Benitez (<rafael.suarez@uv.es>). Department of Business Mathematics
University of Valencia (Spain)

Source

See Also
read_data, model_basic

Examples
# Example 1. Replication of results in Charnes, Cooper and Rhodes (1981)
data("PFT1981")
# selecting DMUs in Project Follow Through (PFT)
PFT <- PFT1981[1:49,]
PFT <- read_data(PFT, 
dmus=1,
   inputs=2:6,
   outputs=7:9 )
eval_pft <- model_basic(PFT, 
   orientation="io",
   rts="crs")
eff_pft <- efficiencies(eval_pft)

# Example 2. Replication of results in Charnes, Cooper and Rhodes (1981)
data("PFT1981")
# selecting DMUs in Non-Follow Through (NFT)
NFT <- PFT1981[50:70,]
NFT <- read_data(NFT, 
   dmus=1,
   inputs=2:6,
   outputs=7:9 )
plot.dea <- model_basic(NFT, 
  orientation="io",
  rts="crs")

eff_nft <- efficiencies(eval_nft)

---

describe.plot.dea

**Plot for DEA models.**

**Description**

Plot some attribute of a DEA model (conventional, fuzzy or Malmquist).

**Usage**

```
## S3 method for class 'dea'
plot(x, showPlots = TRUE, ...)
```

**Arguments**

- `x`: An object of class "dea" obtained by a dea model function.
- `showPlots`: Logical. When TRUE (default) the plots are shown one by one. When it is FALSE the plots are not shown and are returned by the function (invisibly) as a list.
- `...`: Ignored, for compatibility issues.

**Value**

Depending on the model it returns a single data.frame containing: efficiencies, slacks, lambdas, targets, references or a list of data.frames with the cross-efficiencies computed with different methods (Arbitrary, Method II or Method III (see CITA)) or, in case the model is a malmquist index, a single data.frame with the coefficients for the different periods.

**Author(s)**

- **Vicente Coll-Serrano** (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*
- **Vicente Bolós** (<vicente.bolos@uv.es>). *Department of Business Mathematics*
- **Rafael Benítez** (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

**References**

Examples

```r
data_example <- read_data(datadea = Fortune500,
                          inputs = 2:4,
                          outputs = 5:6)
result <- model_basic(data_example)
plot(result)
```

Description

Plot some attribute of a Fuzzy DEA model (Guo-Tanaka and Kao-Liu models).

Usage

```r
## S3 method for class 'dea_fuzzy'
plot(x, showPlots = TRUE, ...)
```

Arguments

- **x**: An object of class "dea_fuzzy" obtained by a fuzzy dea model function.
- **showPlots**: Logical. When TRUE (default) the plots are shown one by one. When it is FALSE the plots are not shown and are returned by the function (invisibly) as a list.
- **...**: Ignored, for compatibility issues.

Value

Depending on the model it returns ...

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References

Power_plants

Data: Tone (2002).

Description

This dataset consists of six power plants with 4 inputs (X) and 2 outputs (Y).

Usage

data("Power_plants")

Format

Data frame with 15 rows and 7 columns. Definition of inputs (X) and outputs (Y):

- **x1** Manpower required
- **x2** Construction costs in millions of dollars
- **x3** Annual maintenance costs in millions of dollars
- **x4** Number of villages to be evacuated
- **y1** Power generated in megawatts
- **y2** Safety level

Author(s)

**Vicente Coll-Serrano** (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

**Vicente Bolos** (<vicente.bolos@uv.es>). *Department of Business Mathematics*

**Rafael Benitez** (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Source


See Also

read_data, model_supereff, model_sbmsupereff
Examples

# Example 1. Radial super-efficiency model.
# Replication of results in Tone (2002)
data("Power_plants")
data_example <- read_data(Power_plants,
  ni = 4,
  no = 2)
result <- model_supereff(data_example,
  orientation="io",
  rts="crs")
eff <- efficiencies(result)
eff

# Example 2. SBM super-efficiency model.
data("Power_plants")
data_example <- read_data(Power_plants,
  ni = 4,
  no = 2)
result2 <- model_sbmsupereff(data_example,
  orientation="io",
  rts="crs")
efficiencies(result2)
slacks(result2)$input
references(result2)

Description

This function creates, from a data frame, a deadata structure, which is as list with fields input, output, dmunames, nc_inputs, nc_outputs, nd_inputs, nd_outputs.

Usage

read_data(datadea = NULL,
  ni = NULL,
  no = NULL,
  dmus = 1,
  inputs = NULL,
  outputs = NULL,
  nc_inputs = NULL,
  nc_outputs = NULL,
  nd_inputs = NULL,
  nd_outputs = NULL,
  ud_inputs = NULL,
  ud_outputs = NULL)
Arguments

datadea Data frame with DEA data.
ni Number of inputs, if inputs are in columns 2:(ni + 1) (if DMUs are in the first column) or 1:ni (no DMUs column).
no Number of outputs, if outputs are in columns (ni + 2):(ni + no + 1) (if DMUs are in the first column) or (ni + 1):(ni + no) (no DMUs column). If not specified, DMUs are in the first column.
dmus Column (number or name) of DMUs (optional). By default, it is the first column. If there is not any DMU column, then it must be NULL.
inputs Columns (numbers or names) of inputs (optional). It prevails over ni. Alternatively to datadea, it can be a matrix with the inputs (DMUs in columns). In this case, DMUs names are taken from the columns names.
outputs Columns (numbers or names) of outputs (optional). It prevails over no. Alternatively to datadea, it can be a matrix with the outputs (DMUs in columns).
nc_inputs A numeric vector containing the indices of non-controllable inputs.
nc_outputs A numeric vector containing the indices of non-controllable outputs.
nd_inputs A numeric vector containing the indices of non-discretionary inputs.
nd_outputs A numeric vector containing the indices of non-discretionary outputs.
ud_inputs A numeric vector containing the indices of undesirable (good) inputs.
ud_outputs A numeric vector containing the indices of undesirable (bad) outputs.

Value

An object of class deadata

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)

Examples

data("Coll_Blasco_2006")
data_example <- read_data(datadea = Coll_Blasco_2006,
ni = 2,
no = 2)

# This is the same as:
data_example <- read_data(Coll_Blasco_2006,
inputs = 2:3,
outputs = 4:5)

# And the same as:
dmunames <- c("A", "B", "C", "D", "E", "F")
```r
nd <- length(dmunames) # Number of DMUs
inputnames <- c("Employees", "Capital")
i <- length(inputnames) # Number of Inputs
outputnames <- c("Vehicles", "Orders")
o <- length(outputnames) # Number of Outputs
inputs <- matrix(c(8, 8, 11, 15, 14, 12, 13, 11, 18, 18, 20),
                 nrow = i, ncol = nd, dimnames = list(inputnames, dmunames))
outputs <- matrix(c(14, 20, 25, 42, 8, 30, 25, 8, 40, 22, 24, 30),
                  nrow = o, ncol = nd, dimnames = list(outputnames, dmunames))
data_example <- read_data(inputs = inputs,
                        outputs = outputs)
# If the first input is a non-controllable input:
data_example <- read_data(Coll_Blasco_2006,
                        inputs = 2:3,
                        outputs = 4:5,
                        nc_inputs = 1)
# If the second output is a non-discretionary output:
data_example <- read_data(Coll_Blasco_2006,
                        inputs = 2:3,
                        outputs = 4:5,
                        nd_outputs = 2)
# If the second input is a non-discretionary input and the second output is an undesirable:
data_example <- read_data(Coll_Blasco_2006,
                        inputs = 2:3,
                        outputs = 4:5,
                        nd_inputs = 2,
                        ud_outputs = 2)
```

---

**read_data_fuzzy**

**Description**

This function creates, from a data frame, a `deadata_fuzzy` structure, which is a list with fields `input`, `output` and `dmunames`. At the same time, `input` and `output` are lists with fields `mL`, `mR`, `dL` and `dR`.

**Usage**

```r
read_data_fuzzy(datadea,
                dmus = 1,
                inputs.mL = NULL,
                inputs.mR = NULL,
                inputs.dL = NULL,
                inputs.dR = NULL,
                outputs.mL = NULL,
                outputs.mR = NULL,
                outputs.dL = NULL,
                outputs.dR = NULL,
```
read_data_fuzzy

outputs.dR = NULL,
nc_inputs = NULL,
nc_outputs = NULL,
nd_inputs = NULL,
nd_outputs = NULL,
ud_inputs = NULL,
ud_outputs = NULL)

Arguments

dataede

Data frame with DEA data.
dmus

Column (number or name) of DMUs (optional). By default, it is the first column. If there is not any DMU column, then it must be NULL.

inputs.mL

Where are (columns) the mL (left centers) of trapezoidal fuzzy inputs in dataede. If an input is triangular or crisp, we put the column where the centers or the crisp values are, respectively. Alternatively to dataede, inputs.mL can be a matrix of size (number of inputs x number of DMUs) with the mL of trapezoidal fuzzy inputs, the centers of triangular inputs, and the crisp values of crisp inputs. In this case, DMUs names are taken from the columns names.

inputs.mR

Where are (columns) the mR (right centers) of trapezoidal fuzzy inputs in dataede. If an input is triangular or crisp, we put NA. Alternatively to dataede, inputs.mR can be a matrix of size (number of inputs x number of DMUs) with the mR of trapezoidal fuzzy inputs, the centers of triangular inputs, and the crisp values of crisp inputs. If all inputs are triangular or crisp, then inputs.mR must be NULL (default) or equal to inputs.mL.

inputs.dL

Where are (columns) the dL (left radii) of trapezoidal and triangular fuzzy inputs in dataede. If an input is symmetric, we put the column where the radii are. If an input is rectangular or crisp, we put NA. Alternatively to dataede, inputs.dL can be a matrix of size (number of inputs x number of DMUs) with the dL of trapezoidal and triangular fuzzy inputs. If an input is rectangular or crisp, its radius is zero. If all inputs are rectangular or crisp, then inputs.dL must be NULL (default) or a zero matrix.

inputs.dR

Where are (columns) the dR (right radii) of trapezoidal and triangular fuzzy inputs in dataede. If an input is symmetric, rectangular or crisp, we put NA. Alternatively to dataede, inputs.dR can be a matrix of size (number of inputs x number of DMUs) with the dR of trapezoidal and triangular fuzzy inputs. If an input is rectangular or crisp, its radius is zero. If all inputs are symmetric, rectangular or crisp, then inputs.dR must be NULL (default) or equal to inputs.dL.

outputs.mL

Analogous to inputs.mL, but relating to outputs.

outputs.mR

Analogous to inputs.mR, but relating to outputs.

outputs.dL

Analogous to inputs.dL, but relating to outputs.

outputs.dR

Analogous to inputs.dR, but relating to outputs.

nc_inputs

A numeric vector containing the indices of non-controllable inputs.
nc_outputs  A numeric vector containing the indices of non-controllable outputs.
ndInputs  A numeric vector containing the indices of non-discretionary inputs.
nd_outputs  A numeric vector containing the indices of non-discretionary outputs.
ud_inputs  A numeric vector containing the indices of undesirable (good) inputs.
ud_outputs  A numeric vector containing the indices of undesirable (bad) outputs.

Value

An object of class deadata_fuzzy.

Examples

# Example 1. If inputs and/or outputs are symmetric triangular fuzzy numbers
data("Leon2003")
data_example <- read_data_fuzzy(datadea = Leon2003,
   inputs.mL = 2,
   inputs.dL = 3,
   outputs.mL = 4,
   outputs.dL = 5)

# Example 2. If inputs and/or outputs are non-symmetric triangular fuzzy numbers
data("Kao_Liu_2003")
data_example <- read_data_fuzzy(Kao_Liu_2003,
   inputs.mL = 2,
   outputs.mL = 3:7,
   outputs.dL = c(NA, NA, 8, NA, 10),
   outputs.dR = c(NA, NA, 9, NA, 11))

Description

This function creates, from a data frame, a list deadata.

Usage

read_malmquist(datadea,
   nper = NULL,
   percol = NULL,
   arrangement = c("horizontal", "vertical"),
   ...)
Arguments

- `datadea`: Dataframe with DEA data.
- `nper`: Number of time periods (with dataset in wide format).
- `percol`: Column of time period (with dataset in long format).
- `arrangement`: Horizontal with data in wide format. Vertical with data in long format.
- ...: Other options to be passed to the `read_data` function

Value

An object of class `deadata`

Author(s)

- **Vicente Coll-Serrano** (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*
- **Vicente Bolós** (<vicente.bolos@uv.es>). *Department of Business Mathematics*
- **Rafael Benítez** (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Examples

```r
# Example 1. If you have a dataset in wide format.
data("Economy")
data_example <- read_malmquist(datadea = Economy, 
nper = 5, 
arrangement = "horizontal", 
ni = 2, 
no = 1)

# This is the same as:
data_example <- read_malmquist(datadea = Economy, 
nper = 5, 
arrangement = "horizontal", 
inputs = 2:3, 
outputs = 4)

# Example 2. If you have a dataset in long format.
data("EconomyLong")
data_example2 <- read_malmquist(EconomyLong, 
percol = 2, 
arrangement = "vertical", 
inputs = 3:4, 
outputs = 5)
```
Description

Extract the reference set for each DMU (inefficient DMUs and efficient DMUs that are combination of other efficient DMUs) from a DEA model solution.

Usage

```r
references(deasol,
            thr = 1e-4)
```

Arguments

deaol Object of class dea obtained with some of the DEA model functions.

thr Tolerance threshold (for avoiding misidentification of efficient DMUs due to round-off errors)

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2).* Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Examples

```r
# Replication results model DEA1 in Tomkins and Green (1988).
data("Departments")
# Calculate Total income
Departments$Total_income <- Departments[, 5] + Departments[, 6]+Departments[, 7]
data_DEA1 <- read_data(Departments,
                       inputs = 9,
                       outputs = c(2, 3, 4, 12))
result <- model_basic(data_DEA1,
                      orientation = "io",
                      rts = "crs")
references(result) # Table 3 (p.157)
```
## Description

Extract the returns to scale.

## Usage

```r
rts(deamodel, thr = 1e-4)
```

## Arguments

- `deamodel` Object of class dea obtained with some of the dea functions.
- `thr` Threshold for the tolerance for considering something = 1. Default to 1e-4.

## Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2)*. *Applied Economics.*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

## Examples

```r
data("Coll_Blasco_2006")
data_example <- read_data(Coll_Blasco_2006, ni = 2, no = 2)
result <- model_basic(data_example, orientation = "io", rts ="crs")
rts(result)
```
Data: Ruggiero (2007).

Description
Simulated data of 35 DMUs with two inputs and one output.

Usage
data("Ruggiero2007")

Format
Data frame with 35 rows and 4 columns. Definition of inputs (X) and outputs (Y):

- x1  Input 1
- x2  Input 2
- y1  Output 1

Author(s)
Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.
Vicente Bolos (<vicente.bolos@uv.es>). Department of Business Mathematics
Rafael Benitez (<rafael.suarez@uv.es>). Department of Business Mathematics
University of Valencia (Spain)

Source

See Also
read_data, model_basic

Examples
# Example. Replication of results in Ruggiero (2007).
data("Ruggiero2007")
# the second input is a non-discretionary input
datadea <- read_data(Ruggiero2007,
ni=2,
no=1,
nd_inputs=2)
result <- model_basic(datadea,
slacks

Description

Extract the slacks of the DMUs from a dea or dea_fuzzy solution.

Usage

slacks(deasol)

Arguments

deasol Object of class dea or dea_fuzzy obtained with some of the DEA model functions.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Examples

data("Coll_Blasco_2006")
data_example <- read_data(Coll_Blasco_2006,
  ni = 2,
  no = 2)
result <- model_multiplier(data_example,
  orientation = "io",
  rts = "crs")
slacks(result)
Summary conventional DEA models.

Description

Summary of the results obtained by a conventional DEA model.

Usage

```r
## S3 method for class 'dea'
summary(object, exportExcel = TRUE, filename = NULL, returnList = FALSE, ...)
```

Arguments

- `object`: An object of class "dea" obtained by a dea model function.
- `exportExcel`: Logical value. If TRUE (default) the results are also exported to an Excel file.
- `filename`: Character string. Absolute filename (including path) of the exported Excel file. If NULL, then the name of the file will be "ResultsDEA"+timestamp.xlsx.
- `returnList`: Logical value. If TRUE then the results are given as a list of data frames. If FALSE (default) all the data frames are merged into a single data frame.
- `...`: Ignored. Used for compatibility issues.

Value

Depending on the model it returns a single data.frame containing: efficiencies, slacks, lambdas, targets, references or a list of data.frames with the cross-efficiencies computed with different methods (Arbitrary, Method II or Method III (see CITA)) or, in case the model is a malmquist index, a single data.frame with the coefficients for the different periods.

Author(s)

- **Vicente Coll-Serrano** (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*
- **Vicente Bolós** (<vicente.bolos@uv.es>). *Department of Business Mathematics*
- **Rafael Benítez** (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References

Examples

data("PFT1981")
# Selecting DMUs in Program Follow Through (PFT)
PFT <- PFT1981[1:49,]
PFT <- read_data(PFT,
    inputs = 2:6,
    outputs = 7:9 )
eval_pft <- model_basic(PFT,
    orientation = "io",
    rts = "crs")
summary(eval_pft, exportExcel = FALSE)

summary.dea_fuzzy  

Summary Fuzzy DEA models.

Description

Summary of the results obtained by a fuzzy DEA model.

Usage

## S3 method for class 'dea_fuzzy'
summary(object, ..., exportExcel = TRUE, filename = NULL, returnList = FALSE)

Arguments

object  
An object of class "dea_fuzzy" obtained with a fuzzy dea model function
        (modelfuzzy_guotanaka, modelfuzzy_kaoliu, modelfuzzy_possibilistic).
...
Extra options
exportExcel  Logical value. If TRUE (default) the results are also exported to an Excel file
filename  Character string. Absolute filename (including path) of the exported Excel file.
        If NULL, then the name of the file will be "ResultsDEA"+timestamp.xlsx.
returnList  Logical value. If TRUE then the results are given as a list of data frames. If
        FALSE (default) all the data frames are merged into a single data frame.

Value

If the model is that from Guo and Tanaka (modelfuzzy_guotanaka), it returns a data.frame with
columns: DMU, alpha cuts and efficiencies. For the possibilistic model (modelfuzzy_possibilistic)
it returns a data.frame with columns: DMU, alpha-cuts, efficiencies and the corresponding lambda
values. For the Kao and Liu model (modelfuzzy_kaoliu), the result may depend on the crisp sub-
model used. It will contain a data.frame with the efficiencies (if any), the slacks and superslacks (if
any), the lambda values and the targets.

If exportExcel is TRUE, then an Excel file will be created containing as many sheets as necessary
depending on the variables returned.
Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

References


Examples

data("Leon2003")
data_example <- read_data_fuzzy(Leon2003, 
  inputs.mL = 2, 
  inputs.dL = 3, 
  outputs.mL = 4, 
  outputs.dL = 5)
result <- modelfuzzy_possibilistic(data_example, 
  h = seq(0, 1, by = 0.1), 
  orientation = "io", 
  rts = "vrs")
summary(result, exportExcel = FALSE)

Supply_Chain

*Data: Sanei and Mamizadeh Chatghayeb (2013).*

Description

Data of 17 supply chain (buyer-supplier relationship in manufacturing).

Usage

data("Supply_Chain")

Format

Data frame with 17 rows and 8 columns. Definition of inputs (X) and outputs (Y):

X1 to X3 Inputs of buyers
I1 to I2 Outputs of buyers, Inputs of suppliers
Y1 to Y2 Outputs of suppliers
targets

Description

Extract the targets of the DMUs from a dea or dea_fuzzy solution.

Usage

targets(deasol)

Arguments

deasol Object of class dea or dea_fuzzy obtained with some of the DEA model functions.
Examples

data("Coll_Blasco_2006")
data_example <- read_data(Coll_Blasco_2006,
  ni = 2,
  no = 2)
result <- model_multiplier(data_example,
  orientation = "io",
  rts = "crs")
targets(result)

---

Data: Tone (2001).

Description

Data of 5 DMUs producing 2 outputs by using 2 inputs

Usage

data("Tone2001")

Format

Data frame with 5 rows and 5 columns. Definition of inputs (X) and outputs (Y):

<table>
<thead>
<tr>
<th>x1</th>
<th>Input1</th>
</tr>
</thead>
<tbody>
<tr>
<td>x2</td>
<td>Input2</td>
</tr>
<tr>
<td>y1</td>
<td>Output1</td>
</tr>
<tr>
<td>y2</td>
<td>Output2</td>
</tr>
</tbody>
</table>

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). Quantitative Methods for Measuring Culture (MC2). Applied Economics.

Vicente Bolós (<vicente.bolos@uv.es>). Department of Business Mathematics

Rafael Benítez (<rafael.suarez@uv.es>). Department of Business Mathematics

University of Valencia (Spain)
Source

See Also
read_data, model_sbmeff

Examples

```r
# Example. Replication of results in Tone (2001, p. 505)
data("Tone2001")
data_example <- read_data(Tone2001,
  ni = 2,
  no = 2)
result <- model_sbmeff(data_example,
  orientation = "no",
  rts = "crs"
) efficiencies(result)
slacks(result)
```

Description
Data of 9 DMUs producing 2 outputs, being second output undesirable, by using 1 input.

Usage
data("Tone2003")

Format
Data frame with 9 rows and 4 columns. Definition of inputs (X) and outputs (Y):

- **x** Input
- **yg** Output1 ("good" output)
- **yb** Output2 (undesirable "bad" output)

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2). Applied Economics.*

Vicente Bolos (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benitez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)
undesirable_basic

Source


See Also

read_data, model_sbmeff

Examples

# Example. Replication of results in Tone (2003), pp 10-11.
data("Tone2003")
data_example <- read_data(Tone2003,
    ni = 1,
    no = 2,
    ud_outputs = 2)
result <- model_sbmeff(data_example,
    rts = "vrs")
efficiencies(result)
targets(result)

undesirable_basic  Undesirable inputs and outputs for basic DEA model.

Description

This function transforms a deadata or deadata_fuzzy class with inputs and outputs into a deadata or deadata_fuzzy class with good inputs and/or outputs, and bad (undesirable) inputs and/or outputs. Onwards, it is recommended to use a dea model with variable returns to scale (vrs).

Usage

undesirable_basic(datadea,
    vtrans_i = NULL,
    vtrans_o = NULL)

Arguments

datadea  The data, including DMUs, inputs and outputs.

vtrans_i  Numeric vector of translation for undesirable inputs. If vtrans_i[i] is NA, then it applies the "max + 1" translation to the i-th undesirable input. If vtrans_i is a constant, then it applies the same translation to all undesirable inputs. If vtrans_i is NULL, then it applies the "max + 1" translation to all undesirable inputs.

vtrans_o  Numeric vector of translation for undesirable outputs, analogous to vtrans_i, but applied to outputs.
Value

An object of class `deadata` or `deadata_fuzzy`.

Author(s)

Vicente Coll-Serrano (<vicente.coll@uv.es>). *Quantitative Methods for Measuring Culture (MC2)*. *Applied Economics*.

Vicente Bolós (<vicente.bolos@uv.es>). *Department of Business Mathematics*

Rafael Benítez (<rafael.suarez@uv.es>). *Department of Business Mathematics*

University of Valencia (Spain)

Examples

data("Hua_Bian_2007")
# The third output is an undesirable output.
data_example <- read_data(Hua_Bian_2007,
    ni = 2,
    no = 3,
    ud_outputs = 3)
# rts must be "vrs" for undesirable inputs/outputs:
# Translation parameter is set to (max + 1)
result <- model_basic(data_example,
    orientation = "oo",
    rts = "vrs")
Index

* datasets
  Coelli_1998, 5
  Coll_Blasco_2006, 6
  Departments, 11
  Doyle_Green_1994, 13
  Economy, 14
  EconomyLong, 15
  Electric_plants, 19
  Fortune500, 20
  Fried1993, 21
  Golany_Roll_1989, 22
  Grifell_Lovell_1999, 23
  Guo_Tanaka_2001, 24
  Hotels, 26
  Hua_Bian_2007, 27
  Kao_Liu_2003, 32
  Leon2003, 34
  Libraries, 35
  Lim_Zhu_2015, 37
  PFT1981, 74
  Power_plants, 78
  Ruggiero2007, 87
  Supply_Chain, 91
  Tone2001, 93
  Tone2003, 94

  bootstrap_basic, 3
  Coelli_1998, 5
  Coll_Blasco_2006, 6
cross_efficiency, 7, 13, 23, 37, 61
cross_efficiency_fuzzy, 9, 10, 25, 35, 43

  Departments, 11
  Doyle_Green_1994, 13

  Economy, 14
  EconomyLong, 15
  efficiencies, 16
  efficiencies.dea, 17
  efficiencies.dea_fuzzy, 18
  Electric_plants, 19
  Fortune500, 20
  Fried1993, 21
  Golany_Roll_1989, 22
  Grifell_Lovell_1999, 23
  Guo_Tanaka_2001, 24
  Hotels, 26
  Hua_Bian_2007, 27
  is.dea, 28
  is.dea_fuzzy, 30
  is.deadata, 29
  is.deadata_fuzzy, 29
  is.friends, 31, 42
  Kao_Liu_2003, 32
  lambdas, 33
  Leon2003, 34
  Libraries, 35
  Lim_Zhu_2015, 37
  malmquist_index, 15, 16, 24, 38
  maximal_friends, 31, 41
  model_additive, 48, 52
  model_addsupereff, 49, 50, 71, 73
  model_basic, 12, 19, 22, 28, 33, 36, 43, 45, 47, 52, 61, 73, 75, 87
  model_deaps, 56, 63, 65, 69
  model_fdh, 58, 92
  model_multiplier, 9, 13, 21, 23, 37, 43, 45, 55, 59
  model_nonradial, 26, 58, 62, 65, 69
  model_profit, 58, 63, 64, 69
  model_rdm, 66
  model_sbmeff, 31, 42, 58, 63, 65, 67, 71, 94, 95
model_sbmsupereff, 52, 69, 70, 73, 78
model_supereff, 52, 55, 71, 72, 78
modelfuzzy_guotanaka, 25, 35, 42, 45, 47
modelfuzzy_kaoiliu, 43, 44, 47
modelfuzzy_posssibilistic, 35, 43, 45, 46
multipliers, 73
PFT1981, 74
plot.dea, 76
plot.dea_fuzzy, 77
Power_plants, 78
read_data, 5, 7, 12, 13, 19, 21–23, 26, 28, 36, 37, 75, 78, 79, 87, 92, 94, 95
read_data_fuzzy, 25, 33, 35, 81
read_malmquist, 15, 16, 24, 83
references, 85
rts, 86
Ruggiero2007, 87
slacks, 88
summary.dea, 89
summary.dea_fuzzy, 90
Supply_Chain, 91
targets, 92
Tone2001, 93
Tone2003, 94
undesirable_basic, 95