The ICEinfer Package

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Title Incremental Cost-Effectiveness (ICE) Statistical Inference (from Two Unbiased Samples)

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Depends R (>= 2.5.0)

Description Given two unbiased samples of patient level data on cost and effectiveness for a pair of treatments, make head-to-head treatment comparisons by (i) generating the bivariate bootstrap resampling distribution of ICE uncertainty for a specified value of the shadow price of health, lambda, (ii) form the wedge-shaped ICE confidence region with specified confidence fraction within [0.50, 0.99] that is equivariant with respect to changes in lambda, (iii) color the bootstrap outcomes within the above confidence wedge with economic preferences from an ICE map with specified values of lambda, beta and gamma parameters, (iv) display VAGR and ALICE acceptability curves, and (v) display indifference (iso-preference) curves from an ICE map with specified values of lambda, beta and gamma or eta parameters.

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ICEalice

Functions to compute and display ICE Acceptability Curves.

Description

ICEalice() computes statistics for the VAGR Acceptability Curve and for the Buckingham ALICE curve. plot.ICEalice() plots the VAGR curve versus Willingness to Pay (WTP) ICE Ratios followed by the ALICE curve versus the range of Absolute ICE Angles from 45 degrees to 135 degrees. print.ICEalice() displays the 13 x 5 matrix of values for Absolute ICEangle, WTP, VAGR Acceptability, WTA and ALICE statistics.

Usage

ICEalice(ICEw)

Arguments

ICEw

An object of class ICEwedge.

Details

The VAGR Acceptability Curve displays the fraction of outcomes within the Bootstrap distribution of ICE Uncertainty that lie below and/or to the right of a rotating straight line through the origin of the ICE plane. This straight line starts out horizontal, representing \( \lambda = \text{WTP} = 0 \), and rotates counter-clockwise until it becomes vertical, representing \( \lambda = \text{WTP} = +\infty \).

The Buckingham ALICE Curve assumes the \( \lambda \) is held fixed. It displays the fraction of outcomes within the Bootstrap distribution of ICE Uncertainty that lie on or between a pair of rotating ICE rays (eminating from the ICE origin) with slopes representing KINKed values of WTP < WTA that always satisfy Obenchain’s LINK function, \( \lambda = \sqrt{\text{WTP} \times \text{WTA}} \), with \( \lambda \) held fixed. The right-hand ray for WTP starts out horizontal and pointing to the right, then rotates counter-clockwise until it becomes vertical, as in a VAGR curve. The left-hand ray for WTA starts out vertical and pointing downwards, then rotates clockwise until it is horizontal. Since \( \lambda \) is held fixed, the slopes of the rotating rays corresponding to decreasing WTA as WTP increases. The starting point of an ALICE curve at an Absolute ICE Angle of 45 degrees always represents the fraction of outcomes in the Bootstrap Distribution of ICE Uncertainty for which the new treatment is both less costly AND more effective than the std treatment. The ending point of an ALICE curve at an Absolute ICE Angle of 135 degrees always represents the fraction of outcomes in the Bootstrap Distribution of ICE Uncertainty for which the new treatment is either less costly OR more effective...
than the std treatment. The middle point of an ALICE curve at an Absolute ICE Angle of 90 degrees represents the fraction of outcomes in the Bootstrap Distribution of ICE Uncertainty falling below and/or to the right of the straight line through the ICE origin of slope lambda = WTP = WTA.

Value

Objects of class ICEalice contain the following output list:

- **lambda**: Positive numerical value for the Shadow Price of Health, lambda
- **unit**: Common unit of measurement of either cost or effect.
- **ia**: R x 1 Vector of Sorted ICE Angles. Default value of R = 25000.
- **acc**: 13 x 5 Matrix of Absolute ICE Angle, WTP, VAGR Acceptability, WTA and AL-ICE statistics.

Author(s)

Bob Obenchain <softrx@iquest.net>

References


Buckingham K. Personal communications including a draft manuscript entitled Representing the cumulative probability of Acceptability Levels In Cost Effectiveness (ALICE curve) 2003.


See Also

*ICEwedge* and *ICEcolor*

Examples

```r
data(dpwdg)
dpacc <- ICEalice(dpwdg)
dpacc
plot(dpacc)
```
ICEcolor

**Compute Preferences for Outcomes in a Bootstrap ICE Distribution that are within a Confidence Wedge**

**Description**

Assuming ICEw is an object of class ICEwedge, ICEcolor uses the value of lambda given by lfact * (ICEw item lambda) and the ICE Preference Map with parameters beta and gamma to compute the Economic Preference value for each point within the Bootstrap Distribution of ICE Uncertainty that also lies within the ICEwedge.

**Usage**

```
ICEcolor(ICEw, lfact = 1, beta = 1, gamma = 3 + 2 * sqrt(2))
```

**Arguments**

- **ICEw**
  Required; Existing ICEwedge object.
- **lfact**
  Required; Strictly positive multiplier for ICEw item lambda.
- **beta**
  Required; Strictly positive Returns-to-Scale power parameter for the ICE Preference Map. beta = 1 implies linear (constant) Returns to Scale. beta > 0 and < 1 implies diminishing Returns to Scale. beta > 1 implies increasing Returns to Scale.
- **gamma**
  Required; Strictly positive Directional power parameter. The smallest reasonable value for gamma is usually gamma = beta, which yields a (generalized) linear map. The largest reasonable value for gamma is usually gamma = beta*(3+2*sqrt(2)), which yields a map that satisfies the Cartesian Monotonicity Axiom and also yields finite WTP and WTA values greater than or equat to 0 but less than +Inf.

**Details**

Multiple calls to ICEcolor() are usually made for different lfact multipliers of x item lambda as well as different choices for the ICE Preference power parameters, beta and gamma. Calls to plot(x, alibi) for these alternative ICEcolor x-objects can be used to illustrate that Economic Uncertainty can literally SWAMP the Statistical Uncertainty within patient level data on the relative cost and effectiveness of two treatments.

**Value**

Object of class ICEcolor containing an output list with the following items:

- **df**
  Saved value of the name of the data.frame input to ICEcolor.
- **lambda**
  Saved positive value of lambda input to ICEcolor.
- **unit**
  Saved value of unit, cost or effe, input to ICEcolor.
- **R**
  Saved integer value for number of bootstrap replications input to ICEcolor.
- **trtm**
  Saved name of the treatment indicator within the df data.frame.
ICEepmap

**Description**

ICEepmap() and ICEomega() define ICE Preference Map Parameter Values by defining an object, pm, of class ICEepmap for display using print(pm) or plot(pm, xygrid).

**Usage**

    ICEepmap(lambda = 1, beta = 1, gamma = 3 + 2 * sqrt(2))
    ICEomega(lambda = 1, beta = 1, eta = 3 + 2 * sqrt(2))

---

**xeffe**  
Saved name of the treatment effectiveness variable within the df data.frame.

**ycost**  
Saved name of the treatment cost variable within the df data.frame.

**effcst**  
Saved value of the sorted 3-variable (trtm, effe, cost) data.frame.

**t1**  
Observed value of (DeltaEffe, DeltaCost) when each patient is sampled exactly once.

**t**  
R x 2 matrix of values of (DeltaEffe, DeltaCost) computed from bootstrap re-samples.

**seed**  
Saved value of the seed used to start pseudo random number generation.

**Author(s)**

Bob Obenchain <softrx@iquest.net>

**References**


**See Also**

ICEwedge, plot.ICEcolor and print.ICEcolor

**Examples**

```r
data(dpwdg)
dpcol <- ICEcolor(dpwdg)
dpcol
plot(dpcol)
dpcolX <- ICEcolor(dpwdg, lfact=10)
dpcolX
plot(dpcolX)
```
Arguments

**lambda**  
Optional; Positive value for the Shadow Price of Health.

**beta**  
Optional; Positive Returns-to-Scale Power parameter for the ICE Preference Map. beta = 1 implies linear (constant) Returns to Scale. A beta > 0 and < 1 implies diminishing Returns to Scale. A beta > 1 implies increasing Returns to Scale.

**gamma**  
Optional for ICEepmap(); Positive Directional Power parameter. The smallest reasonable value for gamma is usually gamma = beta, which yields a (generalized) linear map. The largest reasonable value for gamma is usually gamma = beta*(3+2*sqrt(2)), which yields a map that satisfies Cartesian Monotonicity and also yields WTP and WTA values within [0, +Inf).

**eta**  
Optional for ICEomega(); Positive Power Parameter Ratio. Generalized linear maps result when eta = 1. The eta for the more realistic Nonlinear maps is greater than one, but not greater than the Omega limit of (3+2*sqrt(2)), which is approximately 5.828. This upper limit on eta is required for Cartesian Monotonicity to hold.

Details

The ICEepmap() and ICEomega() functions specify numerical values for the Shadow Price of Health Parameter, lambda, for the Returns to Scale Power Parameter, beta, and for either the Directional Power Parameter, gamma, or else the Power Parameter Ratio, eta = gamma / beta.

Value

Object of class ICEepmap containing an output list with the following items:

**lambda**  
Saved positive value of Shadow Price of Health, lambda, read by the print and plot methods for objects of class ICEepmap.

**beta**  
Saved Positive Returns-to-Scale Power parameter, beta, read by the print and plot methods for objects of class ICEepmap.

**gamma**  
Saved Positive Directional Power parameter, gamma, read by the print and plot methods for objects of class ICEepmap.

**Author(s)**

Bob Obenchain <softrx@iquest.net>

References


ICEinfer-package

See Also

plot.ICEepmap and print.ICEepmap

Examples

pm <- ICEomega(beta=0.8)
require(lattice)
plot(pm)


Description

ICE Statistical Inference makes head-to-head comparisons between two treatments in two dimensions, cost and effectiveness. Bootstrap resampling from unbiased, patient level data quantifies the Distribution of ICE Uncertainty and defines Wedge-Shaped Statistical Confidence Regions equivariant relative to choice for the numerical Shadow Price of Health, lambda. Preference maps with (linear or nonlinear) indifference curves then illustrate that considerable additional Economic Preference Uncertainty can result from deliberately varying lambda.

Details

Package:  ICEinfer
Type:  Package
Version:  0.1
Date:  2007-07-13
License:  GNU GENERAL PUBLIC LICENSE, Version 2, June 1991

Statistical inference using functions from the ICEinfer package usually start with (possibly multiple) invocations of ICEscale() to help determine a reasonable value for the Shadow Price of Health, lambda. This is invariably followed by a single call to ICEuncrt to generate the Bootstrap Distribution of ICE Uncertainty corresponding to the chosen value of lambda. However, the print() and plot() functions for objects of type ICEuncrt do have optional arguments, ifact and swu, to help the user quantify and visualize the consequences of changing lambda and switching between cost and effe units.

Next, a single call to ICEwedge() yields the equivariant, wedge-shaped region of specified statistical confidence within [.50, .99] by computing ICE Angle Order Statistics around a circle centered at the ICE Origin, (DeltaEff, DeltaCost) = (0, 0).

Researchers wishing to view alternative ICE Acceptability Curves would then invoke ICEalice().

Finally, multiple calls to ICEcolor for different values of lambda and/or different forms of (linear or nonlinear) ICE Preference Maps are typically used to illustrate the considerable additional Economic Preference Uncertainty that can be introduced. This Economic Uncertainty is superimposed
on top of the inherent Statistical Uncertainty contained in unbiased, patient level data on the relative cost and effectiveness of two treatments for the same disease / condition.

Author(s)

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References


Examples

```r
data(dulxparx)
ICEscale(dulxparx, dulx, idb, ru)
ICEscale(dulxparx, dulx, idb, ru, lambda=0.26)
dpunc <- ICEuncrt(dulxparx, dulx, idb, ru, lambda=0.26)
dpwdg <- ICEwedge(dpunc)
plot(dpwdg)
dpacc <- ICEalice(dpwdg)
plot(dpacc)
dpcol <- ICEcolor(dpwdg)
dpcol
plot(dpcol)
dpcolX <- ICEcolor(dpwdg, lfact=10)
dpcolX
plot(dpcolX, alibi=TRUE)
```

**ICEscale**

*ICEscale()* functions compute or print ICE Statistical Inference Summary Statistics relative to choice for the numerical value of the Shadow Price of Health, lambda.
Description

ICEscale() computes Summary Statistics for 2-sample, 2-variable inference where one variable is a measure of effectiveness (higher values are better) and the other variable is a measure of cost (lower values are better). The 2 samples are of patients receiving only 1 of the 2 possible treatments. The treatment called new is the one with the higher numerical level for the specified treatment indicator variable, while the treatment called std corresponds to the lower numerical level. The pivotal statistic for inference is (ΔEff, ΔCost), which are the head-to-head mean differences for new treatment minus std treatment. Each sample is assumed to provide unbiased estimates of the overall expected effectiveness and cost for that treatment.

Usage

ICEscale(df, trtm, xeffe, ycost, lambda = 1, unit = cost)

Arguments

df Required; Existing data.frame object containing the trtm, xeffe and ycost variables.
trtm Required; Name of the treatment indicator variable contained within the df data.frame that assumes one of only two different numerical values for each patient.
xeffe Required; Name of the treatment effectiveness variable within the df data.frame.
ycost Required; Name of the treatment cost variable within the df data.frame.
lambda Optional; lambda strictly positive value for the Shadow Price of Health.
unit Optional; unit character string containing either cost (default) or effe.

Details

After an initial call with the default value of lambda = 1, multiple additional calls to ICEscale() with different numerical values for lambda are usually made at the very beginning of analyses using other functions from the ICEinfer package. For example, the statistical choice for lambda assures that the ΔEff and ΔCost mean treatment differences (new minus std) will have approximately equal variability when expressed in either cost or effe units. The power of ten value of lambda that is closest to the statistical value for lambda assures use of units that, except for the position of the decimal point, are identical to the cost/effectiveness ratio implied by the scales in which data values are stored within the input data.frame.

Value

Object of class ICEscale containing an output list with the following items:

trtm Saved name of the treatment indicator within the input data.frame.
xeffe Saved name of the treatment effectiveness variable within the input data.frame.
ycost Saved name of the treatment cost variable within the input data.frame.
effcst Saved value of the sorted 3-variable (trtm,effe,cost) data.frame.
lambda Value for the Shadow Price of Health, lambda, input to ICEscals().
t1  Observed values of (DeltaEffe, DeltaCost) when each distinct patient is sampled exactly once.

s1  Observed values for the standard deviations of (DeltaEffe, DeltaCost) when each distinct patient is sampled exactly once.

slam  Statistical Shadow Price computed as s1[2]/s1[1] and rounded to digits = 3.

potlam  Power-of-Ten Shadow Price computed as 10(as.integer(log10(slam))).

Author(s)
Bob Obenchain <softrx@iquest.net>

References


See Also
ICEscale, plot.ICEuncrt and print.ICEuncrt

Examples
```r
data(dulxparx)
ICEscale(dulxparx, dulx, idb, ru)
```

ICEuncrt  
Compute the Bootstrap Distribution of ICE Uncertainty for a specified value of the Shadow Price of Health, lambda.

Description
ICEuncrt() uses bootstrap resampling (with replacement) to compute the distribution of uncertainty for 2-sample, 2-variable statistical inference. The 2 variables must be measures of effectiveness (higher values are better) and cost (lower values are better). The 2 samples are of patients receiving only 1 of the 2 possible treatments. The treatment called new is the one with the higher numerical level for the specified treatment indicator variable, while the treatment called std corresponds to the lower numerical level. The pivotal statistic for inference is (DeltaEffe, DeltaCost), which are the head-to-head mean differences for new treatment minus std treatment. Each sample is assumed to provide unbiased estimates of the overall expected effectiveness and cost for that treatment.
Usage

ICEuncrt(df, trtm, xeffe, ycost, lambda = 1, unit = cost, R = 25000, seed = 0)

Arguments

df
  Required; Existing data.frame object containing the trtm, xeffe and ycost variables.

trtm
  Required; Name of the treatment indicator variable contained within the df data.frame that assumes one of only two different numerical values for each patient.

xeffe
  Required; Name of the treatment effectiveness variable within the df data.frame.

ycost
  Required; Name of the treatment cost variable within the df data.frame.

lambda
  Optional; lambda strictly positive value for the Shadow Price of Health.

unit
  Optional; unit character string containing either cost (default) or effe.

R
  Optional; R positive integer value for the number of Bootstrap Replications desired. Minimum allowed value is 50; default value is 25000.

seed
  Optional; seed is an integer between 0 and 25000. A seed value of 0 causes a random integer seed between 1 and 25000 to be generated. To reproduce results from a previous invocation of ICEuncrt(), use the seed value saved in its output list object.

Details

A single call to ICEuncrt() is usually made for a particular value of the Shadow Price of Health, lambda. Alternative statistical choices for lambda can be suggested by making calls to ICEscale() with different values for lambda. Because the bootstrap distribution of ICE uncertainty is equivariant under changes in lambda, it is much faster to transform an existing bootstrap distribution than to generate a new one for a different value of lambda. The print.ICEuncrt() and plot.ICEuncrt() functions thus have 2 special parameters, lfact and swa, that can change lambda and switch the units of measurement, respectively, without actually generating a new bootstrap distribution via a call to ICEuncrt().

Value

Object of class ICEuncrt containing an output list with the following items:

df
  Saved value of the name of the data.frame input to ICEuncrt.

lambda
  Saved positive value of lambda input to ICEuncrt.

unit
  Saved value of unit, cost or effe, input to ICEuncrt.

R
  Saved integer value for number of bootstrap replications input to ICEuncrt.

trtm
  Saved name of the treatment indicator within the df data.frame.

xeffe
  Saved name of the treatment effectiveness variable within the df data.frame.

ycost
  Saved name of the treatment cost variable within the df data.frame.

effcst
  Saved value of the sorted 3-variable (trtm,effe,cost) data.frame.
**ICEwedge**

- **t1**: Observed value of (\(\Delta E_{\text{ffe}}, \Delta C_{\text{ost}}\)) when each patient is included exactly once.
- **t**: \(R \times 2\) matrix of values of \((\Delta E_{\text{ffe}}, \Delta C_{\text{ost}})\) computed from bootstrap resamples.
- **seed**: Saved value of the seed used to start pseudo random number generation.

**Author(s)**

Bob Obenchain <softrx@iquest.net>

**References**


**See Also**

*ICEscale*, *plot.ICEuncrt* and *print.ICEuncrt*

**Examples**

```r
data(dulxparx)
# Generating a bootstrap ICE uncertainty distribution is time consuming.
dpunc <- ICEuncrt(dulxparx, dulx, idb, ru, lambda=0.26)
dpunc
plot(dpunc)
# Transforming an existing bootstrap ICE uncertainty distribution is fast.
dpuncX <- plot(dpunc, lfact=10)
```

**Description**

*ICEwedge()* functions calculate and display an Equivariant Wedge-Shaped Confidence Region with stated Statistical Confidence Level in the range: 0.50 \(\leq\)conf \(\leq\) 0.99.

*ICEwedge()* uses the Bootstrap Distribution of ICE Uncertainty generated by *ICEuncrt()* to calculate and sort ICE Angle Order Statistics around a circle. *ICEwedge()* then counts outwards the same number of ICE Angle Order Statistics, floor\(R^*\text{conf/2}\), both Counter-Clockwise and Clockwise from the center Order Statistic (nearest the Observed ICE Ratio) to define a pair of ICE Ray Endpoints at Order Statistics jlo and kup that subtend an ICE Polar Angle of subangle degrees.
Usage

ICEwedge(ICEu, lfact = 1, conf = 0.95)

Arguments

- **ICEu**: Required; Output list object of class ICEuncrt.
- **lfact**: Optional; Either a strictly positive multiplicative factor for ICEu item lambda or else 0 to cause ICEwedge to compute the positive lfact and lambda values which transforms the alibi display so that it has an alias interpretation.
- **conf**: Optional; Statistical Confidence Level within [0.50, 0.99].

Details

The plot() of an object of class ICEwedge displays the Bootstrap Distribution of ICE Uncertainty with a small, circular, colored dot (pch = 20). Outcomes outside the Wedge are displayed in black, while outcomes inside the Wedge are displayed in cyan. Upper and lower ICE Ray Limits are displayed as solid black lines, and the ICE Ray through the center ICE Angle Order Statistic is shown as a dashed black line.

Value

An object of class ICEwedge with the following output list:

- **ICEinp**: Name of the ICEuncrt object input to ICEwedge().
- **lambda**: Positive value of lfact * ICEu item lambda
- **lfact**: Positive Multiplier for the ICEu item lambda value input to ICEwedge().
- **unit**: Saved value of unit, cost or effe, input to ICEuncrt.
- **conf**: Statistical Confidence Level within [0.50, 0.99] input to ICEwedge.
- **R**: Saved integer value for number of bootstrap replications input to ICEuncrt.
- **axys**: R x 4 data.frame with ICE Angle in column 1, bootstrap resampled values of (DeltaEffe, DeltaCost) in columns 2 and 3, and the binary flag with 0 => outcome outSide the Confidence Wedge and 1 => outcome inSide the Confidence Wedge in column 4.
- **t1**: Observed value of (DeltaEffe, DeltaCost) when each patient is sampled exactly once.
- **ia1**: The center ICE Angle closest to the Oberved ICE Ratio.
- **center**: The largest value of j such that axys[j, 1] < ia1 <= axys[j+1, 1].
- **jlo**: Number of the ICE Angle Order Statistic defining the Clockwise or lower ICE Ray boundary of the Confidence Wedge.
- **kup**: Number of the ICE Angle Order Statistic defining the Counter-Clockwise or upper ICE Ray boundary of the Confidence Wedge.
- **subangle**: Subtended Polar ICE Angle between Order Statistics jlo and kup.
- **xmax**: Alias plots of ICEwedge have horizontal range [-xmax, +xmax].
- **ymax**: Alias plots of ICEwedge have vertical range [-ymax, +ymax].
- **ab**: ICE angle computation perspective of alibi or alias.
Author(s)

Bob Obenchain <softrx@iquest.net>

References


See Also

ICEuncrt and ICEcolor

Examples

```r
data(dpunc)
# ICEwedge() calculations are rather slow
dpwdg <- ICEwedge(dpunc)
dpwdg
plot(dpwdg)
# ICE Angle computations using the alibi axes with an alias interpretation
dpwdg0 <- ICEwedge(dpunc, lfact=0)
dpwdg0
plot(dpwdg0)
```

---

**dpunc**

*Output list object of class ICEuncrt for the High Uncertainty numerical example in the ICEinfer package, data(dulxparx).*

Description

dpunc is the output list object of class ICEuncrt resulting from the following time consuming computation: dpunc <- ICEuncrt(dulxparx, dulx, idb, ru, lambda=0.26)

Usage

data(dpunc)
Format

- **df** Saved value of the name of the data.frame input to ICEuncrt.
- **lambda** Saved positive value of lambda input to ICEuncrt.
- **unit** Saved value of unit, cost or effe, input to ICEuncrt.
- **R** Saved integer value for number of bootstrap replications input to ICEuncrt.
- **trtm** Saved name of the treatment indicator within the df data.frame.
- **xeffe** Saved name of the treatment effectiveness variable within the df data.frame.
- **ycost** Saved name of the treatment cost variable within the df data.frame.
- **effcst** Saved value of the sorted 3-variable (trtm, effe, cost) data.frame.
- **t1** Observed value of (DeltaEffe, DeltaCost) when each patient is included exactly once.
- **t** R x 2 matrix of values of (DeltaEffe, DeltaCost) computed from bootstrap resamples.
- **seed** Saved value of the seed used to start pseudo random number generation.

References


Examples

```r
# Intermediate ICEinfer Output List for the dulxparx dataset...
data(dpunc)
plot(dpunc)
```

---

**dpwdg**  
*Output list object of class ICEwedge for the High Uncertainty numerical example in the ICEinfer package, data(dulxparx)*

Description

dpwdg is the output list object of class ICEwedge resulting from the following time consuming computation: dpwdg <- ICEwedge(dpunc)

Usage

data(dpwdg)
Format

Output list object of class ICEwedge.

ICEinp Name of the ICEuncrt object input to ICEwedge().

lambda Positive value of lfact * ICEu$lambda

lfact Positive Multiplier for the ICEu$lambda value input to ICEwedge().

unit Saved value of unit, cost or effe, input to ICEuncrt.

conf Statistical Confidence Level within [0.50, 0.99] input to ICEwedge.

R Saved integer value for number of bootstrap replications input to ICEuncrt.

axys R x 4 data.frame with ICE Angle in column 1, bootstrap resampled values of (DeltaEffe, DeltaCost) in columns 2 and 3, and the binary flag with 0 => outcome outSide the Confidence Wedge and 1 => outcome inSide the Confidence Wedge in column 4.

t1 Observed value of (DeltaEffe, DeltaCost) when each patient is sampled exactly once.

ia1 The ICE Angle corresponding to the Observed ICE Ratio.

center The largest value of j such that axys[j, 1] < ia1 <= axys[j+1, 1].

jlo Number of the ICE Angle Order Statistic defining the Clockwise or lower ICE Ray boundary of the Confidence Wedge.

kup Number of the ICE Angle Order Statistic defining the Counter-Clockwise or upper ICE Ray boundary of the Confidence Wedge.

subangle Subtended Polar ICE Angle between Order Statistics jlo and kup.

xmax Alias plots of ICEwedge have horizontal range [-xmax, +xmax].

ymax Alias plots of ICEwedge have vertical range [-ymax, +ymax].

ab ICE angle computation perspective of alibi or alias.

References


Examples

# Intermediate ICEinfer Output List for the dulxparx dataset...
data(dpwdg)
plot(dpwdg)
Data for the High Uncertainty numerical example of Obenchain et al. (2005) from a double-blind clinical trial comparing duloxetine (an SNRI) with paroxetine (an SSRI) described in Goldstein et al. (2004).

Description

The data are from two arms of a double-blind clinical trial in which 91 patients were randomized to duloxetine 80 mg/d (40 mg BID) and 87 patients were randomized to paroxetine 20 mg/d for treatment of major depressive disorder (MDD). Missing-data-imputation and sensitivity-analyses were needed to make meaningful cost-effectiveness comparisons in this study.

Usage

data(dulxparx)

Format

A data frame of 3 variables on 178 patients; no NAs.

- **idb**: This measure of overall effectiveness is \textit{integrated decrease in HAMD-17 score from baseline to endpoint}, Hamilton (1967). This is a (signed) area-under-the-curve measure with larger values more favorable. Missing values were imputed via the MMRM models reported in Goldstein et al. (2004).

- **ru**: Patient self-reported health-care resource utilization above and beyond that provided within study protocol was collected using the Resource Utilization Survey, Copley-Merriman et al. (1992), with published 1998 dollars-per-unit costs, Schoenbaum et al. (2001), rounded to the nearest 50 dollars. Dollars/week were then calculated by multiplying (total accumulated cost) for a patient by 7 and dividing by the (total days of cost accumulation) for that patient. For patients who discontinued early, this is Average-Value-Carried-Forward imputation.

- **dulx**: Treatment indicator variable. dulx = 1 implies receipt of duloxetine 80 mg/d (40 mg BID). dulx = 0 implies receipt of paroxetine 20 mg/d.

References


Examples

```r
# Demo of ICEinfer functionality on the dulxparx dataset...
demo(dulxparx)
```

<table>
<thead>
<tr>
<th>fluoxpin</th>
<th>Data from a double-blind clinical trial comparing fluoxetine augmented with pindolol with fluoxetine plus placebo.</th>
</tr>
</thead>
</table>

Description

These data are from a Spanish double-blind clinical trial in which 55 patients were randomized to fluoxetine (an SSRI) plus pindolol (a Beta Blocker) and 56 patients were randomized to fluoxetine plus placebo for treatment of major depressive disorder (MDD), Sacristan et al. (2000).

Usage

```r
data(fluoxpin)
```

Format

A data frame of 3 variables on 111 patients; no NAs.

- **respond** Patients are considered to have responded to treatment when a 50% or greater decrease in HAMD-17 total score occurred between baseline and end-point (at day 42), with no more than 10% additional variation between intermediate visits.

- **cost** Resource utilization was prospectively collected alongside the clinical trial. Patients and caregivers were interviewed by the researcher concerning all resources consumed during the study period. Resources dictated by the protocol were not counted. Costs are expressed in Pesetas (Pts.) at 1996 prices (1 Dollar = 145 Pts.) Observed differences in average direct medical costs were mainly due to hospitalizations within the FlxPin = 0 group.

- **flxpin** Treatment indicator variable. FlxPin = 1 implies receipt of fluoxetine 20 mg/day plus pindolol 7.5 mg/day (2.5 mg tid). FlxPin = 0 implies receipt of fluoxetine 20 mg/day plus placebo (tid).

Details

Since both samples are rather small (55 and 56 patients) here and the Effectiveness variable, respond, is binary, this example illustrates how the Law of Large Numbers can fail to apply to ICE inferences. Specifically, the bootstrap distribution of sample differences between AVERAGES appears to be quite different from bivariate normal in three ways: (i) The Bootstrap Distribution of ICE Uncertainty appears to consist of vertical stripes because the horizontal variable is discrete here while the vertical variable is continuous. (ii) The Bootstrap Distribution of cost differences appears
to end somewhat abruptly near the horizontal axis at DeltaCost = 0, rather than have a long upwards tail like its downwards tail. (iii) The equal density contours of the bivariate Bootstrap Distribution appear to NOT be elliptical. This third point can be dramatically illustrated by computing the Owen Empirical Likelihood contour that passes through the origin of the ICE plane.

References


Examples

```r
# Demo of ICEinfer functionality on the fluoxpin dataset...
demo(fluoxpin)
```

**fluoxtca**

*Cost-Effectiveness data from the Marketscan(SM) claims database comparing 1242 patients treated with either fluoxetine (SSRI) or with a TCA / HCA for major depressive disorder (MDD), Croghan et al. (1996) and Obenchain et al. (1997).*

**Description**

In 1990-1992, the Marketscan(SM) database included medical and pharmacy claims for approximately 700,000 individuals whose health insurance was provided by large corporations throughout the United States. All 1242 patients were continuously enrolled for at least 4 months prior to their initial antidepressant prescription and for the following 12 months.

**Usage**

```r
data(fluoxtca)
```
Format

A data frame of 3 variables on 1242 patients; no NAs.

stable  stable = 1 indicates that the patient remained on his/her initial antidepressant medication for at least six consecutive months.

cost  cost is the Marketscan(SM) 12 month total annual charge for a patient.

fluox  Treatment indicator variable; fluox = 1 indicates receipt of fluoxetine 20 mg/d by 799 patients. fluox = 0 implies receipt of either a tricyclic (TCA) or a heterocyclic (HCA) by 443 patients.

Details

This dataset contains measures of cost and effectiveness for 799 patients treated with fluoxetine (a Selective Serotonin Reuptake Inhibitor or SSRI), 104 patients treated with a first generation tricyclic, TCA (amitriptyline or imipramine), 250 patients treated with a second generation TCA (desipramine or nortriptyline), and 89 patients treated with trazodone (a heterocyclic, HCA).

References


Obenchain RL. ICEplane: a windows application for incremental cost-effectiveness (ICE) statistical inference. Copyright(c) Pharmaceutical Research and Manufacturers of America (PhRMA.) [http://www.math.iupui.edu/ indyasa/ bobodown.htm](http://www.math.iupui.edu/ indyasa/ bobodown.htm) Revised 1997–2007.


Examples

```r
# Demo of ICEinfer functionality on the fluoxtca dataset...

demo(fluoxtca)
```

Description

Internal method functions for the ICEinfer package. The plot() and print() functions also accept optional ...arguments documented elsewhere.
Author(s)
Bob Obenchain <softrx@iquest.net>

plot.ICEcolor

Add Economic Preference Colors to Outcomes in the Bootstrap ICE Distribution of Uncertainty that also lie within an ICE Statistical Confidence Wedge

Description
Assuming x is an object of class ICEcolor, the default invocation of plot(x) recolors the default alias display of the points within the bootstrap distribution of ICE uncertainty that are within its statistical confidence wedge. An invocation of the form plot(x, alibi=TRUE) recolors the alibi display. When ready, click within this graphics window to display a Histogram of all the Economic Preference values falling within the ICE Statistical Confidence Wedge.

Usage

## S3 method for class 'ICEcolor':
plot(x, alibi = FALSE, ...)

Arguments

x
Required; Output list object of class ICEcolor.

alibi
Optional; Logical value of TRUE or FALSE to control scaling of axes. alibi = FALSE produces the default alias graphic in which points in the bootstrap uncertainty scatter are held fixed in space, and changes in lambda change the scaling (tick marks) along either the horizontal axis of a cost unit display or else along the vertical axis of an effe unit display. alibi = TRUE produces an alibi graphic in which the scaling (and range) is the same along both axes, and changes in lambda cause the points in the bootstrap uncertainty scatter to move either left or right in a cost unit display or else up or down in an effe unit display.

... 
Optional; Argument(s) passed on to plot().

Details
To illustrate the sensitivity of Economic Preferences to choice of lambda, multiple calls are usually made to ICEcolor() for different values of lambda as well as for different choices of the beta and gamma parameters that determine the shape of and spacing between the Indifference Curves of an ICE Preference Map.

The plot() of an object of class ICEcolor displays the Bootstrap Distribution of ICE Uncertainty using small, circular, colored dots (pch = 20). Outcomes outside the Confidence Wedge are displayed in black, while outcomes inside the Wedge are displayed in a rainbow of colors (within the red-tan-yellow-green range) that represent Economic Preferences.

Upper and lower ICE Ray Limits are again displayed as solid black lines, while the Straight Line through the ICE origin that represents lambda is shown as a dashed black line. In an Alias graphic,
the slope of this dashed, black line will always be one; however, this dashed line usually does not appear to bisect the North-East and South-West ICE quadrants because DIFFERENT SCALINGS are being used along the horizontal and vertical axes. In an Alibi graphic where the scaling along both axes is the SAME, the slope of this dashed, black line will always be lambda; this dashed line will thus not bisect the North-East and South-West ICE quadrants unless lambda = 1.

Value

NULL

Author(s)

Bob Obenchain <softrx@iquest.net>

References


See Also

*ICEcolor, ICEscale* and *ICEwedge*.

Examples

```r
data(dpwdg)
dpcol <- ICEcolor(dpwdg)
dpcol
plot(dpcol)
plot(dpcol, alibi=TRUE)
```

---

**plot.ICEepmap**

*Display the Indifference Curves of an ICE Economic Preference Map*

**Description**

Display plots of the Indifference Curves of an ICE Economic Preference Map using the contourplot() and expand.grid() functions from the *lattice* package.

**Usage**

```r
## S3 method for class 'ICEepmap':
plot(x, xygrid = FALSE, ...)
```
Arguments

x                   Required; Output list object from either ICEepmap or ICEomega.
xygrid             Optional; Either FALSE or a grid object for a lattice of (x, y) plotting positions.
...                Optional; Argument(s) passed on to contourplot().

Details

If xygrid == FALSE, the default xygrid will be a 201 x 201 lattice of equally spaced plotting positions covering the x=DeltaEffé and y=DeltaCost ranges [-10,+10]. This default is: x <- seq(-10, +10, length = 201); y <- x; xygrid <- expand.grid(x = x, y = y)

Value

NULL

Author(s)

Bob Obenchain <sofrx@iquest.net>

References


See Also

ICEepmap and ICEomega

Examples

```r
epm <- ICEomega(beta=0.8)
require(lattice)
plot(epm)
```
**plot.ICEuncrt**

*Display Scatter for a possibly Transformed Bootstrap Distribution of ICE Uncertainty*

**Description**

Assuming x is an output list object of class ICEuncrt, the default invocation of plot(x) graphically displays the bootstrap distrib of ICE uncertainty currently stored in x. An invocation of the form x10 <- plot(x, lfact=10) increases the value of x item lambda by a factor of 10, displays that transformed bootstrap distribution, and stores it in object x10. When x item unit is cost, an invocation of the form xs <- plot(x, swu=TRUE) displays the bootstrap distribution stored in x using effe units and stores the transformed distribution in object xs.

**Usage**

```r
## S3 method for class 'ICEuncrt':
plot(x, lfact = 1, swu = FALSE, alibi = FALSE, ...)
```

**Arguments**

- **x**
  - Required; Output list object of class ICEuncrt.
- **lfact**
  - Optional; Positive factor multiplying the stored value of x item lambda.
- **swu**
  - Optional; Logical value of TRUE or FALSE to control switching the stored value of x item unit between the 2 possibilities, cost and effe.
- **alibi**
  - Optional; Logical value of TRUE or FALSE to control scaling of axes. alibi = FALSE produces the default alias graphic in which points in the bootstrap uncertainty scatter are held fixed in space, and changes in lambda change the scaling (tick marks) along either the horizontal axis of a cost unit display or else along the vertical axis of an effe unit display. alibi = TRUE produces an alibi graphic in which the scaling (and range) is the same along both axes, and changes in lambda cause the points in the bootstrap uncertainty scatter to move either left or right in a cost unit display or else up or down in an effe unit display.
- **...**
  - Optional; Argument(s) passed on to plot().

**Details**

After a single call to ICEuncrt() for an initial value of the Shadow Price of Health, lambda, and an initial choice of display unit, cost or effe, multiple calls to plot.ICEuncrt() are usually made. Alternative statistical choices for lambda can be suggested by making calls to ICEscale() with different values for lambda. Because the Bootstrap Distribution of ICE Uncertainty is equivariant under changes in lambda, it is much faster to transform an existing bootstrap distribution than to generate a new one for a different value of lambda. The print.ICEuncrt() and plot.ICEuncrt() functions thus have 2 special parameters, lfact and swu, that can change lambda and switch the units of measurement, respectively, without actually regenerating the bootstrap distribution via a call to ICEuncrt().
Value

Object of class ICEuncrt containing a possibly TRANSFORMED output list with items:

- **df**: Saved value of the name of the data.frame in the original call to ICEuncrt().
- **lambda**: Possibly changed, positive value of lfact * (x item lambda).
- **unit**: Possibly switched value of x item unit, cost or effe.
- **R**: Saved integer value for number of bootstrap replications input to ICEuncrt.
- **trtm**: Saved name of the treatment indicator within the df data.frame.
- **xeffe**: Saved name of the treatment effectiveness variable within the df data.frame.
- **ycost**: Saved name of the treatment cost variable within the df data.frame.
- **effcst**: Saved value of the sorted 3-variable (trtm, effe, cost) data.frame.
- **t1**: Observed value of (DeltaEffe, DeltaCost) when each patient is included exactly once.
- **tb**: R x 2 matrix of values of (DeltaEffe, DeltaCost) computed by transformation.
- **seed**: Saved value of the seed used to start pseudo random number generation.

Author(s)

Bob Obenchain <softrx@iquest.net>

References


See Also

ICEuncrt, ICEscale and ICEwedge.

Examples

data(dpunc)
dpunc
# Transformation of a bootstrap distribution is fast.
dpuncs <- plot(dpunc, swu=TRUE)
print.ICEuncrt

Summary Statistics for a possibly Transformed Bootstrap Distribution of ICE Uncertainty

Description

Assuming x is an output list object of class ICEuncrt, the default invocations of x or print(x) describe the bootstrap distribution of ICE uncertainty currently stored in x. An invocation of the form x10 <- print(x, lfact=10) increases the value of x item lambda by a factor of 10, describes that transformed bootstrap distribution, and stores it in object x10. When x item unit is cost, an invocation of the form xs <- print(x, swu=TRUE) describes the bootstrap distribution stored in x using effe units and stores the transformed distribution in object xs.

Usage

```r
## S3 method for class 'ICEuncrt':
print(x, lfact = 1, swu = FALSE, ...)
```

Arguments

- **x**: Required; Output list object of class ICEuncrt.
- **lfact**: Optional; Positive factor multiplying the stored value of x item lambda.
- **swu**: Optional; Logical value of TRUE or FALSE to control switching the stored value of x item unit between the 2 possibilities, cost and effe.
- **...**: Optional; argument(s) passed on to plot().

Details

After a single call to ICEuncrt() for an initial value of the Shadow Price of Health, lambda, and an initial choice of display unit, cost or effe, multiple calls to print.ICEuncrt() or plot.ICEuncrt() are usually made. Because the bootstrap distribution of ICE uncertainty is equivariant under changes in lambda, it is much faster to transform an existing Bootstrap ICE Uncertainty Distribution than to generate a new one for a different value of lambda. The print.ICEuncrt() and plot.ICEuncrt() functions thus have 2 special parameters, lfact and swa, that can change lambda and switch the units of measurement, respectively, without actually regenerating the bootstrap distribution via a new call to ICEuncrt().

Value

Object of class ICEuncrt containing a possibly TRANSFORMED output list with items:

- **df**: Saved value of the name of the data.frame in the original call to ICEuncrt().
- **lambda**: Possibly changed, positive value of (lfact * x item lambda).
- **unit**: Possibly switched value of x item unit, cost or effe.
- **R**: Saved integer value for number of bootstrap replications input to ICEuncrt.
- **trtm**: Saved name of the treatment indicator within the df data.frame.
print.ICEuncrt

xeffe  Saved name of the treatment effectiveness variable within the df data.frame.
ycost  Saved name of the treatment cost variable within the df data.frame.
effcst Saved value of the sorted 3-variable (trtm,effe,cost) data.frame.
t1  Observed value of (DeltaEffe, DeltaCost) when each patient is included exactly once.
tb  R x 2 matrix of values of (DeltaEffe, DeltaCost) computed by transformation.
seed  Saved value of the seed used to start pseudo random number generation.

Author(s)

Bob Obenchain <softrx@iquest.net>

References


See Also

ICEuncrt, ICEscale and ICEwedge.

Examples

data(dpunc)
dpunc

# Transformation of bootstrap distributions is fast.
dpuncX <- print(dpunc, lfact=10)
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