Package ‘ICEinfer’

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Title Incremental Cost-Effectiveness Inference using Two Unbiased Samples
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Depends lattice
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) illustrate variation in ICE preferences by displaying potentially non-linear indifference(iso-preference) curves from an ICE map with specified values of lambda, beta and either gamma or eta parameters.
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ICEinfer-package  ICE Statistical Inference and Economic Preference Variation

Description

Functions in the ICE Statistical Inference package make head-to-head comparisons between patients in two treatment cohorts (assumed to be unbiased samples) in two distinct dimensions, cost and effectiveness.

Bootstrap resampling methods quantify the endogenous Distribution of ICE Uncertainty and define Wedge-Shaped Statistical Confidence Regions equivariant relative to exogenous choice for the numerical Shadow Price of Health, lambda.

Preference maps with (linear or nonlinear) indifference curves can be viewed or superimposed upon endogenous confidence wedges to illustrate that considerable additional, potentially self-contradictory Economic Preference Uncertainty results from deliberately varying lambda.

Details

Package:  ICEinfer
Type:  Package
Version:  1.1
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License:  GNU GENERAL PUBLIC LICENSE, Version 2, June 1991

Statistical inference using functions from the ICEinfer package usually starts 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, lfact 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 with center 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


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**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

Output list object of class ICEwedge.

**df**  Saved value of the name of the data.frame input to ICEwedge.

**lambda**  Saved positive value of lambda input to ICEwedge.

**ceunit**  Saved value of ceunit ("cost" or "effe") input to ICEwedge.

**R**  Saved positive value of lambda input to ICEwedge.

**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.

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 example, data(dulxparx) |
```

Description

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

Usage

```r
data(dpwdg)
```

Format

Output list object of class ICEwedge.

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

**lambda**  Positive value of \( \lambda \) input to ICEwedge().

**lfact**  Positive Multiplier for the \( \lambda \) value input to ICEwedge().

**ceunit**  Saved value of ceunit ("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.

**Examples**

```r
data(dpwdg)
plot(dpwdg)
```

---

**dulxparx**  Data for the High Uncertainty numerical example of Obenchain et al. (2005)

**Description**

The data are from two arms of a double-blind clinical trial in which 91 patients were randomized to the SNRI duloxetine 80 mg/d (40 mg BID) and 87 patients were randomized to the SSRI 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**

```r
data(dulxparx)
```

**Format**

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

**idb**  This measure of overall effectiveness is 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

```
data(dulxparx)
ICEScale(dulxparx, dulx, idb, ru)
```

---

**fluoxpin**

*Data from a double-blind clinical trial comparing fluoxetine plus pindolol with fluoxetine alone*

---

**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**

```
data(fluoxpin)
```
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

data(fluoxpin)
ICEScale(fluoxpin, flxpin, respond, cost)
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. Outcomes for 1242 patients treated with either fluoxetine (SSRI) or with a TCA / HCA for major depressive disorder (MDD) were discussed in Croghan et al. (1996) and Obenchain et al. (1997). All 1242 patients were continuously enrolled for at least 4 months prior to their initial antidepressant prescription and for the following 12 months.

Usage

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


ICEalice

Examples

data(fluoxtcαι)
ICEscale(fluoxtcαι, fluox, stable, cost)

Description

ICEalice() computes statistics for the VAGR Acceptability Curve and for the Buckingham ALICE curve. Plots for the resulting ICEalice object are of two types: [1] a VAGR curve where the horizontal axis is the Willingness to Pay (WTP) ICE Ratio, and [2] a monotone ALICE curve where the horizontal axis is the Absolute Value of the ICE Polar Angle, which varies from +45 degrees to +135 degrees. Printing an ICEalice object yields a 13 x 5 table (matrix) of numerical values for Absolute ICEangle, WTP, VAGR Acceptability, WTA and ALICE acceptability, respectively.

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 = WTP = 0, and rotates counter-clockwise until it becomes vertical, representing lambda = WTP = +Inf.

The Buckingham ALICE Curve assumes that 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(WTP*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 is 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.
Objects of class ICEalice contain the following output list:

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

**Author(s)**

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**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
# Read in previously computed ICEwedge output list.
data(dpwdg)
dpacc <- ICEalice(dpwdg)
# Display the ALICE curve.
plot(dpacc, show="Alice")
dpacc
```
ICEcolor  

Compute Preference Colors for Outcomes within a Bootstrap Confidence Wedge

Description

Assuming the input ICEw object is of class ICEwedge, ICEcolor uses \( \text{lambda} = \text{lfact} \times \text{ICEw$\lambda} \) to define an ICE Preference Map with specified parameters (lfact, beta, gamma) to compute Economic Preference values. Only the Bootstrap re-sampled points within the ICE confidence wedge are used. Thus, assuming that the overall level of confidence (statistical size of the wedge) is held fixed, the points to be colored are always the very same points for all choices of lambda. However, the numerical value of preference (and thus the color) of each such point as well as the overall symmetry or asymmetry in the resulting ICE map can depend greatly upon lambda.

Usage

\[
\text{ICEcolor(ICEw, lfact = 1, beta = 1, gamma = 3+2*sqrt(2))}
\]

Arguments

<table>
<thead>
<tr>
<th>name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICEw</td>
<td>Existing ICEwedge object.</td>
</tr>
<tr>
<td>lfact</td>
<td>Strictly positive multiplier for ICEw$\lambda$.</td>
</tr>
<tr>
<td>beta</td>
<td>Strictly positive Returns-to-Scale power parameter for the ICE Preference Map. beta = 1 implies linear (constant) Returns to Scale. beta &gt; 0 and &lt; 1 implies diminishing Returns to Scale. beta &gt; 1 implies increasing Returns to Scale.</td>
</tr>
<tr>
<td>gamma</td>
<td>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 admits all possible finite values for WTP and WTA, i.e. all values greater than or equal to 0 but less than +( \infty ).</td>
</tr>
</tbody>
</table>

Details

Multiple calls to ICEcolor() are usually made for different lfact multipliers of ICEw$\lambda$ item 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 exogenous Economic Uncertainty can literally SWAMP the Statistical Uncertainty endogenous to 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:

<table>
<thead>
<tr>
<th>name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
<td>Saved value of the name of the data.frame input to ICEcolor.</td>
</tr>
<tr>
<td>lambda</td>
<td>Saved positive value of lambda input to ICEcolor.</td>
</tr>
</tbody>
</table>
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.
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 <wizbob@att.net>

References


See Also

ICEwedge, plot.ICEcolor and print.ICEcolor

Examples

# Read in previously computed ICEwedge output list.
data(dpwdg)
dpcol <- ICEcolor(dpwdg)
# Display preference coloring for the stored value of lambda.
plot(dpcol, show="RBOW")
dpcolx <- ICEcolor(dpwdg, lfact=10)
# Display preference coloring when lambda is increased by a factor of 10.
plot(dpcolx, show="RBOW")
**ICEepmap**

*Set Parameter Values defining ICE Economic Preference Maps*

**Description**

ICEepmap() and ICEomega() set numerical values for lambda (the full, fair shadow price of health) and for the two so-called power-parameters of a parametric ICE Preference Map. These functions return a value, epm, that is an output list object of class ICEepmap for display using print(epm) or plot(epm, xygrid). The primary purpose of such plots is to allow the user to more easily visualize the profound effects that changing numerical values for lambda, beta and either gamma or eta = gamma / beta can have on the iso-preference contours (level curves) of an ICE map.

From the statistical perspective championed here, lambda is little more than a nusiance parameter. For example, the wedge-shaped ICE confidence regions formed by ICEwedge() are equivariant under changes in lambda. Unfortunately, the resulting economic preferences that can be visualized using ICEcolor() can change drastically with changes in lambda.

A standardized ICE map results when the specified value of lambda is used to assure that the x effe difference and the y cost difference are both expressed in the same units (i.e. both in cost units or else both in effe units.) Unfortunately, the only way to assure display of this particular sort of rescaling in ICE plane depictions is to use alibi = TRUE in plot.ICEnocr(). Both plot.ICEwedge() and plot.ICEcolor() always default to alias axis scaling. Thus the equivariance property of the ICE confidence wedge is depicted as if the rays determining its upper and lower limits are invariant under changes in lambda.

The easy way to visualize a standardized ICE map is to always use the default value of lambda = 1 in ICEepmap() and ICEomega(). A standardized ICE map always has the following two characteristics: [i] it always assigns a zero overall preference to all (x, y) outcomes everywhere along the x = y ICE diagonal, and [ii] its iso-preference contours are always exactly symmetric about the x = -y (upper-left to lower-right) ICE diagonal.

**Usage**

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

**Arguments**

- **lambda**: Positive value for the fair, full-retail Shadow Price of Health.
- **beta**: 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**: Positive Directional Power parameter for ICEepmap(). 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 Positive Power Parameter Ratio for ICEomega(). Generalized linear maps result when eta = 1. The eta for the more realistic Nonlinear maps is greater than one, but not greater than the ICE Omega limit of (3+2*sqrt(2)), which is approximately 5.828. This upper limit on eta is required to assure that Cartesian Monotonicity of preferences holds.

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 <wizbob@att.net>

References


See Also

plot.ICEepmap and print.ICEepmap

Examples

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

ICEscale(df, trtm, xeffe, ycost, lambda = 1, ceunit = "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.
ceunit Optional; ceunit 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 DeltaEffe and DeltaCost mean treatment differences (new minus std) will have approximately equal variability when expressed in either cost or effe ceunits. The power of ten value of lambda that is closest to the statistical value for lambda assures use of ceunits 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.
- **xeff**: 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 (DeltaEff, DeltaCost) when each distinct patient is sampled exactly once.
- **s1**: Observed values for the standard deviations of (DeltaEff, 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 <wizbob@att.net>

References


See Also

ICEscale, plot.ICEuncrt and print.ICEuncrt

Examples

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

ICEuncrt

*Compute Bootstrap Distribution of ICE Uncertainty for given Shadow Price of Health, lambda*
ICEuncrt

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 (DeltaEff, 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 = 1L, ceunit = "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.
ceunit Optional; ceunit 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 ceunit 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.
ceunit      Saved value of ceunit (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.
effecest     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.

Author(s)

Bob Obenchain <wizbob@att.net>

References


See Also

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

Examples

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

Equivariant Wedge-Shaped ICE Region with Confidence Level from 0.50 to 0.99

Description

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*conf/2), both Counter-Clockwise and Clockwise from the so-called "center" Order Statistic (the one nearest to the Observed ICE Ratio) to define a pair of ICE Ray Endpoints at ICE Angle Order Statistics (reported as numbers jlo and kup, respectively) that subtend an ICE Polar Angle reported in degrees.

Usage

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

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICEu</td>
<td>Output list object of class ICEuncrt.</td>
</tr>
<tr>
<td>lfact</td>
<td>Either a strictly positive multiplicative factor for ICEu item lambda or else 0 to cause ICEwedge to compute the positive lfact and lambda values that transform the alibi display to have an alias interpretation.</td>
</tr>
<tr>
<td>conf</td>
<td>Statistical Confidence Level within [0.50, 0.99].</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICEinp</td>
<td>Name of the ICEuncrt object input to ICEwedge().</td>
</tr>
<tr>
<td>lambda</td>
<td>Positive value of lfact * ICEu item lambda</td>
</tr>
<tr>
<td>lfact</td>
<td>Positive Multiplier for the ICEu item lambda value input to ICEwedge().</td>
</tr>
<tr>
<td>unit</td>
<td>Saved value of unit, cost or effe, input to ICEuncrt.</td>
</tr>
<tr>
<td>conf</td>
<td>Statistical Confidence Level within [0.50, 0.99] input to ICEwedge.</td>
</tr>
<tr>
<td>R</td>
<td>Saved integer value for number of bootstrap replications input to ICEuncrt.</td>
</tr>
</tbody>
</table>
axys  R x 4 data.frame with ICE Angle in column 1, bootstrap resampled values of (DeltaEff, 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 (DeltaEff, DeltaCost) when each patient is sampled exactly once.

ia1  The center ICE Angle closest 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 numbers 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 <wizbob@att.net>

**References**


**See Also**

ICEuncrt and ICEcolor

**Examples**

data(dpunc)

# ICEwedge() calculations may take more than 5 seconds...
dpwdg <- ICEwedge(dpunc)
plot(dpwdg)

# ICEwedge() computations from an alias (rather than alibi) perspective...
dpwdg0 <- ICEwedge(dpunc, lfact=0)
plot(dpwdg0)
plot.ICEcolor

Display Economic Preferences for ICE Outcomes within a Bootstrap Confidence Wedge

Description

Assuming x is an object of class ICEcolor, the default invocation of plot(x) first displays a Histogram depicting the Distribution of Economic Preferences within an ICE Confidence Wedge then applies a rainbow of colors to these same points on a display of the ICE Bootstrap re-sampling Scatter. An invocation of the form plot(x, alibi=TRUE) uses alibi (rather than alias) scaling when displaying the Bootstrap Scatter plot. When ready, the user should press the ENTER Key to overwrite the Histogram display with the Scatter plot.

Usage

```r
## S3 method for class 'ICEcolor'
plot(x, alibi = FALSE, show = "Both", ...)
```

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.

- `show`  
  Optional; Character string of "Hist", "RBOW" or "Both". show = "Hist" displays a Histogram depicting the distribution of Economic Preferences within the ICE Wedge, while show = "RBOW" applies a rainbow of colors (Red–Tan–Yellow–Green) to depict the Economic Preference level associated with each re-sampled point within the ICE Wedge. show = "Both" is the default; it requires the user to press the ENTER key when ready to overwrite the initial "Hist" display with the corresponding "RBOW" 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) Indifference Curves on an ICE Economic Preference Map.
plot.ICEcolor

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 Confidence Limits are again displayed as Solid black Rays. The Dashed black LINE trough the ICE Origin, (0,0), has slope 1, indicating the ZERO Preference boundary that literally bisects the North-East and South-West ICE Quadrants. This Dashed Line may not "appear" to have slope 1, but that happens only when the horizontal and vertical RANGES displayed are quite different.

Value

NULL

Author(s)

Bob Obenchain <wizbob@att.net>

References


See Also

ICEcolor, ICEscale and ICEwedge.

Examples

data(dpwdg)
dpcol <- ICEcolor(dpwdg)
plot(dpcol, show="RBOW")
plot(dpcol, alibi=TRUE, show="RBOW")
plot.ICEepmap

Display Indifference Curves on a standardized 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 R-package.

Usage

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

Arguments

- `x` Output list object from either ICEepmap or ICEomega.
- `xygrid` 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=DeltaEffe 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 <wizbob@att.net>

References


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 the 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

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

Arguments

x Output list object of class ICEuncrt.
lfact Positive factor multiplying the stored value of x item lambda.
swu Logical value of TRUE or FALSE to control switching the stored value of x item unit between the 2 possibilities, cost and effe.
alibi 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 merely 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 literally 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 economic 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 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

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

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 common display unit (`cost` or `effe`), multiple `print()` and/or `plot()` calls 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 `swu`, 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 \((lfact \times \text{item lambda})\).
- **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 \((\text{trtm}, \text{effe}, \text{cost})\) data.frame.
- **t1**: Observed value of \((\Delta\text{Effe}, \Delta\text{Cost})\) when each patient is included exactly once.
- **tb**: \(R \times 2\) matrix of values of \((\Delta\text{Effe}, \Delta\text{Cost})\) computed by transformation.
- **seed**: Saved value of the seed used to start pseudo random number generation.

Author(s)

Bob Obenchain <wizbob@att.net>

References


See Also

ICEuncrt, ICEscale and ICEwedge.

Examples

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