Package 'desire'

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Title Desirability functions in R

Description Harrington and Derringer-Suich type desirability functions

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LazyData yes

NeedsCompilation yes

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R topics documented:

Chocolate *Chocolate production and quality measures*

Description

...

Usage

```
Chocolate
```

Format

A data.frame containing 13 observations

Source

C....

References

C. Alamprese, L. Datei, Q. Semeraro (2007). Optimization of processing parameters of a ball mill refiner for chocolate. *Journal of Food Engineering*, 83(4), 629–636.

compositeDF *Construct composite desirability functions*

Description

Combines a desirability function with an inner function and returns a new function object which calculates $d(f(x))$.

Usage

```
compositeDF(expr, d, ...)
```

Arguments

`expr`	any valid inner function
`d`	desirability function
`...`	additional arguments passed to function

Details

Currently specialized for expressions, functions and objects with class `lm`.

Value

A function object of a composite desirability function.

Author(s)

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References

J. Harrington (1965): The desirability function. *Industrial Quality Control*, **21**: 494-498.

G.C. Derringer, D. Suich (1980): Simultaneous optimization of several response variables. *Journal of Quality Technology* **12** (4): 214-219.

D. Steuer (2005): Statistische Eigenschaften der Multikriteriellen Optimierung mittels Wuenschbarkeiten. *Dissertation*, Dortmund University of Technology, http://hdl.handle.net/2003/20171.

H. Trautmann, C. Weihs (2006): On the Distribution of the Desirability Index using Harrington's Desirability Function. *Metrika* **63**(2): 207-213.

See Also

harrington1 and harrington2 for Harrington type desirability functions; derringerSuich for desirability functions of Derringer and Suich;

Examples

```
h <- harrington2(-1, 1, 1)
## Calculate h(x^2):
ch1 <- compositeDF(x^2, h)
ch1(0.5)
ch1(c(0.2,0.5,0.7))

## Calculate h(f(x))
f <- function(x) 2*x + 3
ch2 <- compositeDF(f, h)
ch2(0.3)
ch2(c(0.3,0.35,0.9))
```

---

ddesire *Generic Distribution functions for desirabilities*

Description

Generic density, distribution, quantile and random number generation functions for desirability functions.

Usage

```
## Default S3 method:
ddesire(x, f, mean = 0, sd = 1)
## Default S3 method:
pdesire(q, f, mean = 0, sd = 1)
## Default S3 method:
qdesire(p, f, mean = 0, sd = 1)
## Default S3 method:
rdesire(n, f, mean = 0, sd = 1)
## Default S3 method:
edesire(f, mean, sd)
## Default S3 method:
vdesire(f, mean, sd)
```

Arguments

x,q	Vector of quantiles.
p	vector of probabilies.
n	number of observations.
f	desirability function
mean	vector of means.
sd	vector of standard deviations.

Value

'ddesire' gives the density, 'pdesire' gives the distribution function, 'qdesire' gives the quantile function, and 'rdesire' generates random deviates.

'edesire' and 'vdesire' return the expectation and variance of the function.

Note

The default implementations for pdesire, qdesire, edesire and vdesire are only approximations obtained by estimating the desired property from a random sample.

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See Also

For desirability functions: harrington1 and harrington2

Examples

```
data(Chocolate)

## Fit linear model to data:
m.d90 <- lm(d90 ~ rt + as + I(rt^2) + I(as^2) + rt:as, Chocolate)
m.Fe <- lm(Fe ~ rt + as + I(rt^2) + I(as^2) + rt:as, Chocolate)

## Define desirability functions:
d.d90 <- harrington2(21, 22, 1)
d.Fe <- harrington1(22, 0.8, 28, 0.2)

## Plot density of desirability in rt=30, as=50:
df <- data.frame(rt=30, as=50)
y.Fe <- predict(m.Fe, df)
sigma.Fe <- summary(m.Fe)$sigma

y.d90 <- predict(m.d90, df)
sigma.d90 <- summary(m.d90)$sigma

## Plot curve of density function:
opar <- par(mfrow=c(2,1))
curve(ddesire(x, d.d90, y.d90, sigma.d90), 0, 1, main="d.90", n=202)
curve(ddesire(x, d.Fe, y.Fe, sigma.Fe), 0, 1, main="Fe", n=202)
par(opar)

## Integrate:
integrate(function(x) ddesire(x, d.d90, y.d90, sigma.d90), 0, 1)
integrate(function(x) ddesire(x, d.Fe, y.Fe, sigma.Fe), 0, 1)
```

`derringerSuich` *Derringer-Suich type desirability function*

Description

Returns a function evaluating a (generalized) Derringer-Suich desirability.

Usage

```
derringerSuich(y, d, beta)
```

Arguments

`y`	y
`d`	d
`beta`	beta

Details

If only `y` is provided and it is a vector of length 5, a normal $(l, t, u, \beta_1, \beta_2)$ Derringer Suich desirability is constructed. Otherwise `y`, `d` and `beta` specify a generalized Derringer Suich type desirability.

Value

derringerSuich returns a function.

Author(s)

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References

G. Derringer and R. Suich (1980), Simultaneous optimization of several response variables, *Journal of Quality Technology*, **Vol. 12, No. 4**:214-219.

D. Steuer (2005), Statistische Eigenschaften der Multikriteriellen Optimierung mittels Wuenschbarkeiten, PhD Thesis, http://hdl.handle.net/2003/20171.

See Also

harrington1 for one sided Harrington type desirabilities and harrington2 for two sided Harrington type desirabilities.

Examples

```
## Simple (l, t, u, b0, b1) Derringer-Suich desirabilities:
d1 <- derringerSuich(c(0, 1, 2, 1, 1))
d2 <- derringerSuich(c(0, 1, 2, 2, 2))
d3 <- derringerSuich(c(0, 1, 2, .5, .5))

## Comparison of their shape:
opar <- par(mfrow=c(3, 1))
plot(d1)
plot(d2)
plot(d3)
par(opar)

## d/p/q/r examples:
ddesire(.2, d1, 0, 1)
pdesire(.5, d1, 0, 1)
qdesire(.8, d1, 0, 1)
```

---

dsplot *Desirability Plot*

Description

Plot a desirability function and its relation to an arbitrary expression.

Usage

```
dsplot(expr, f, from = NULL, to = NULL, n = 101,
       show.zero = TRUE, interest = NULL,
       main = "Desirability Plot", sub = NULL, ...)
```

Arguments

expr	an expression written as a function of 'x', or alternatively the name of a function which will be plotted.
f	desirability function
from,to	the range over which the function will be plotted.
n	integer; the number of x values at which to evaluate.
show.zero	add dotted line to visualize the origin
interest	vector of interesting points
main	an overall title for the plot
sub	a subtitle for the plot
...	parameters passed to low level plot functions

Author(s)

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Examples

```
d1 <- harrington2(2, 4, 2)
dsplot(x*log(x), d1,
       from=0, to=6, n=507,
       interest=c(2, 3, 4))
```

---

geometricDI *Geometric Mean Desirability Index*

Description

Computes the weighted geometric mean of a number of desirability functions.

Usage

```
geometricDI(f, ..., weights)
```

Arguments

f, ...	desirability functions
weights	vector of weights

Details

The Desirability Index was introduced by Harrington (1965), and the concept was extended by Derringer and Suich (1980). It is a means for multicriteria (quality) optimization in industrial quality management. All desirability functions of the quality criteria are combined into a univariate global quality criterion in [0,1] which has to be optimized.

The function can be used for Harrington as well as Derringer and Suich desirability functions.

Value

`geometricDI(f, ..., weights)` returns a function object of the Geometric Mean Desirability Index.

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References

J. Harrington (1965): The desirability function. *Industrial Quality Control*, **21**: 494-498.

G.C. Derringer, D. Suich (1980): Simultaneous optimization of several response variables. *Journal of Quality Technology* **12** (4): 214-219.

D. Steuer (2005): Statistische Eigenschaften der Multikriteriellen Optimierung mittels Wuenschbarkeiten. *Dissertation*, Dortmund University of Technology, http://hdl.handle.net/2003/20171.

H. Trautmann, C. Weihs (2006): On the Distribution of the Desirability Index using Harrington's Desirability Function. *Metrika* **63**(2): 207-213.

See Also

`harrington1` and `harrington2` for Harrington type desirability functions; `derringerSuich` for desirability functions of Derringer and Suich; `minimumDI`,`meanDI` for other types of Desirability indices.

Examples

```
h1 <- harrington1(-2, .9, 2, .1)
h2 <- harrington2(0, 2, 2)

di <- geometricDI(h1, h2, weights=c(1/3, 2/3))
di(c(0, 1))

## Desirability Index of vector input:
h <- harrington2(3,7,1)
g <- harrington1(-2, .1, 2, .9)

d <- geometricDI(h, g, weights=c(0.5, 0.5))

m <- matrix(c(seq(2, 8, 0.1), seq(-2, 4, 0.1)), ncol=2, byrow=FALSE)
apply(m, 1, d)
```

harrington1 *One-sided Harrington type desirability function*

Description

Returns a one-sided desirability function of the Harrington type. Density, distribution function, quantile function and random number generation for the distribution of the one-sided Harrington desirability function are computed given a normally distributed variable Y with expected value equal to mean and standard deviation equal to sd.

Usage

```
harrington1(y1, d1, y2, d2)
## S3 method for class 'harrington1'
ddesire(x, f, mean, sd)
## S3 method for class 'harrington1'
pdesire(q, f, mean, sd)
## S3 method for class 'harrington1'
qdesire(p, f, mean, sd)
## S3 method for class 'harrington1'
edesire(f, mean, sd)
## S3 method for class 'harrington1'
vdesire(f, mean, sd)
dharrington1(x, y1, d1, y2, d2, mean, sd)
pharrington1(q, y1, d1, y2, d2, mean, sd)
qharrington1(p, y1, d1, y2, d2, mean, sd)
rharrington1(n, y1, d1, y2, d2, mean, sd)
eharrington1(y1, d1, y2, d2, mean, sd)
vharrington1(y1, d1, y2, d2, mean, sd)
```

Arguments

x,q	vector of quantiles.
p	vector of probabilies.
n	number of observations.
f	one-sided Harrington type desirability function.
y1,d1,y2,d2	Two values y1 and y2 of variable Y with respective desirability values d1 and d2 determine the shape of the desirability function.
mean	vector of expected values of normal distributions.
sd	vector of standard deviations of normal distributions.

Details

harrington1(y1, d1, y2, d2) is the one-sided desirability function of Harrington type (Harrington (1965)). It aims at the specification of desired values of a variable Y which has to be minimized or maximized. Y is transformed onto a unitless scale to the interval [0,1].

Harrington's one-sided desirability function d given a normally distributed variable Y with $E(Y) =$ mean and $sd(Y) =$sd has the Double Lognormal Distribution (Holland and Ahsanullah (1989)).

Value

harrington1(y1, d1, y2, d2) returns a function object of the one-sided desirability function of the Harrington type (see example below). Values b_0 and b_1 of the desirability function formula are determined.

ddesire /dharrington1 give the density, pdesire / pharrington1 give the distribution function, qdesire / qharrington1 give the quantile function, and rdesire / rharrington1 generate random deviates. edesire / eharrington1 and vdesire / vharrington1 compute the expected value and the variance of the desirability function for a normally distributed random variable Y with $E(Y) =$mean and $sd(Y) =$sd.

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References

J. Harrington (1965): The desirability function. *Industrial Quality Control*, **21**: 494-498.

B. Holland, M. Ahsanullah (1989): Further Results on the Distribution of Meinhold and Singpurwalla. *The American Statistician* **43** (4): 216-219.

H. Trautmann, C. Weihs (2006): On the Distribution of the Desirability Index using Harrington's Desirability Function. *Metrika* **63**(2): 207-213.

See Also

harrington2 for two sided Harrington type desirabilities

Examples

```
##Assigning the function object to h:
h <- harrington1(-2, .1, 2, .9)

## Plot of desirability function:
plot(h)

## Desirability function of a vector:
h(seq(-2,2,0.1))

## d/p/q/r/e/v examples:
ddesire(.8, h, 0, 1)
 dharrington1(.8, -2, .1, 2, .9, 0, 1)

ddesire(.8, h, c(0,0.5), c(1,1.5))

pdesire(.8, h, 0, 1)
pharrington1(.8, -2, .1, 2, .9, 0, 1)
```

```
qdesire(.8, h, 0, 1)
qharrington1(.8, -2, .1, 2, .9, 0, 1)

rdesire(1e6, h, 0, 1)
rharrington1(1e6, -2, .1, 2, .9, 0, 1)

edesire(h,3,0.5)
eharrington1(-2, .1, 2, .9,3,0.5)

vdesire(h,3,0.5)
vharrington1(-2, .1, 2, .9,3,0.5)

## b_0 and b_1 values:
environment(h)$b0
environment(h)$b1
```

---

harrington2 *Two-sided Harrington type desirability function*

Description

Returns a two sided desirability function of the Harrington type. Density, distribution function, quantile function and random number generation for the distribution of the two-sided Harrington desirability function are computed given a normally distributed variable Y with expected value equal to mean and standard deviation equal to sd.

Usage

```
harrington2(LSL, USL, n)
## S3 method for class 'harrington2'
ddesire(x, f, mean, sd)
## S3 method for class 'harrington2'
pdesire(q, f, mean, sd)
## S3 method for class 'harrington2'
qdesire(p, f, mean, sd)
dharrington2(x, LSL, USL, n, mean, sd)
pharrington2(q, LSL, USL, n, mean, sd)
qharrington2(p, LSL, USL, n, mean, sd)
rharrington2(ns, LSL, USL, n, mean, sd)
eharrington2(LSL, USL, n, mean, sd)
vharrington2(LSL, USL, n, mean, sd)
```

Arguments

x,q	vector of quantiles.
p	vector of probabilies.
ns	number of observations.

f	two-sided Harrington type desirability function.
LSL	Lower Specification Limit of Y.
USL	Upper Specification Limit of Y.
n	Kurtosis parameter of desirability function. Values > 1 result in smoother shapes around the target value $T = (LSL+USL)/2$. Values < 1 already penalize small target deviations.
mean	vector of means.
sd	vector of standard deviations.

Details

harrington2(LSL, USL, n) is the two-sided desirability function of Harrington type (Harrington (1965)). It aims at the specification of desired values of a variable Y which has to be optimized regarding a target value T. Y is transformed onto a unitless scale to the interval [0,1]. LSL and USL are associated with a desirability of $1/e \approx 0.37$. LSL and USL have to be chosen symmetrically around the target value T.

The density and distribution functions of Harrington's two-sided desirability function d given a normally distributed variable Y with $E(Y) =$ mean and $sd(Y) =$sd can be determined analytically, see Trautmann and Weihs (2006).

Value

harrington2(LSL, USL, n) returns a function object of the two-sided desirability function of the Harrington type (see example below).

ddesire / dharrington2 give the density, pdesire / pharrington2 give the distribution function, qdesire / qharrington2 give the quantile function, and rdesire / rharrington2 generate random deviates. edesire / eharrington2 and vdesire / vharrington2 compute the expected value and the variance of the desirability function for a normally distributed random variable Y with $E(Y) =$mean and $sd(Y) =$sd.

Author(s)

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References

J. Harrington (1965): The desirability function. *Industrial Quality Control*, **21**:494-498.

H. Trautmann, C. Weihs (2006): On the Distribution of the Desirability Index using Harrington's Desirability Function. *Metrika* **63**(2): 207-213.

See Also

harrington1 for one sided Harrington type desirabilities

Examples

```
##Assigning the function object to h:
h <- harrington2(3,7,1)

## Plot of desirability function:
plot(h)

## Desirability function of a vector:
h(seq(2,8,0.1))

## d/p/q/r/e/v examples:
ddesire(4, h, 0, 1)
dharrington2(4, 3, 7, 1, 0, 1)

ddesire(4, h, c(0,0.5),c(1,1.5))

pdesire(4, h, 0, 1)
pharrington2(4, 3, 7, 1, 0, 1)

qdesire(0.8, h, 0, 1)
qharrington2(0.8, 3, 7, 1, 0, 1)

rdesire(1e6, h, 0, 1)
rharrington2(1e6, 3, 7, 1, 0, 1)

edesire(h,3,0.5)

vdesire(h,3,0.5)
```

`Internal functions` *Internal functions*

Description

Functions not exported and not intended for general use.

Usage

```
h1.solve.params(y1, d1, y2, d2)
```

Arguments

y1	y1
d1	d1
y2	y2
d2	d2

meanDI *Weighted Mean Desirability Index*

Description

Computes the weighted mean of a number of desirability functions.

Usage

```
meanDI(f, ..., weights = 1)
```

Arguments

f,...	desirability functions.
weights	vector of weights. Weights do not need to sum to one.

Details

The Desirability Index was introduced by Harrington (1965), and the concept was extended by Derringer and Suich (1980). It is a means for multicriteria (quality) optimization in industrial quality management. All desirability functions of the quality criteria are combined into a univariate global quality criterion which has to be optimized. The Weighted Mean Desirability Index is related to the concept of utility functions.

The function can be used for Harrington as well as Derringer and Suich desirability functions.

Value

`meanDI(f, ..., weights)` returns a function object of the Weighted Mean Desirability Index.

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References

J. Harrington (1965): The desirability function. *Industrial Quality Control*, **21**: 494-498.

G.C. Derringer, D. Suich (1980): Simultaneous optimization of several response variables. *Journal of Quality Technology* **12** (4): 214-219.

See Also

`harrington1` and `harrington2` for Harrington type desirability functions; `derringerSuich` for desirability functions of Derringer and Suich; `geometricDI`,`minimumDI` for other types of Desirability indices.

Examples

```
h1 <- harrington1(-2, .9, 2, .1)
h2 <- harrington2(0, 2, 2)

di <- meanDI(h1, h2,weights=c(0.2,0.8))
di(c(0, 1))

## Desirability Index of vector input:
h <- harrington2(3,7,1)
g <- harrington1(-2, .1, 2, .9)

d <- meanDI(h, g,weights=c(0.3,0.7))

m <- matrix(c(seq(2, 8, 0.1), seq(-2, 4, 0.1)), ncol=2, byrow=FALSE)
apply(m, 1, d)
```

`minimumDI` *Minimum Desirability Index*

Description

Computes the minimum of a number of desirability functions.

Usage

```
minimumDI(f, ...)
```

Arguments

`f,...`	desirability functions

Details

The Desirability Index was introduced by Harrington (1965), and the concept was extended by Derringer and Suich (1980). It is a means for multicriteria (quality) optimization in industrial quality management. All desirability functions of the quality criteria are combined into a univariate global quality criterion in [0,1] which has to be optimized.

The function can be used for Harrington as well as Derringer and Suich desirability functions.

Value

`minimumDI(f, ...)` returns a function object of the Minimum Desirability Index.

Author(s)

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References

J. Harrington (1965): The desirability function. *Industrial Quality Control*, **21**: 494-498.

G.C. Derringer, D. Suich (1980): Simultaneous optimization of several response variables. *Journal of Quality Technology* **12** (4): 214-219.

D. Steuer (2005): Statistische Eigenschaften der Multikriteriellen Optimierung mittels Wuenschbarkeiten. *Dissertation*, Dortmund University of Technology, http://hdl.handle.net/2003/20171.

H. Trautmann, C. Weihs (2006): On the Distribution of the Desirability Index using Harrington's Desirability Function. *Metrika* **63**(2): 207-213.

See Also

harrington1 and harrington2 for Harrington type desirability functions; derringerSuich for desirability functions of Derringer and Suich; geometricDI,meanDI for other types of Desirability indices.

Examples

```
h1 <- harrington1(-2, .9, 2, .1)
h2 <- harrington2(0, 2, 2)

di <- minimumDI(h1, h2)
di(c(0, 1))

## Desirability Index of vector input:
h <- harrington2(3,7,1)
g <- harrington1(-2, .1, 2, .9)

d <- minimumDI(h, g)

m <- matrix(c(seq(2, 8, 0.1), seq(-2, 4, 0.1)), ncol=2, byrow=FALSE)
apply(m, 1, d)
```

---

normMax *Normal Distribution based desirability functions.*

Description

Desirability functions based on the normal distribution. These where developed by XXX in order to improve YYY.

Usage

```
normMax(LSL, USL)
normMin(LSL, USL)
normTarget(LSL, T, USL)
```

Arguments

LSL	Lower specification limit
T	Target value
USL	Upper specification limit

Value

normMin and normMax return functions implementing the specified minimzation or maximizing desirability. normTarget returns a function implementing the specified target desirability.

Author(s)

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References

XXX Technical Report ZZZ

See Also

harrington1 for one sided Harrington type desirabilities, harrington2 for two sided Harrington type desirabilities and derringerSuich for Derringer-Suich type desirabilities.

Examples

```
## Create desirability functions:
d1 <- normMin(-1, 1)
d2 <- normMax(-1, 1)
d3 <- normTarget(-1, 0, 1)

## Show shape of desirability function:
opar <- par(mfrow=c(3,1))
plot(d1)
plot(d2)
plot(d3)
par(opar)

## Show
dsplot(log(x), d1, .5, 2)
dsplot(sin(x), d2, -pi, pi)
dsplot(cos(x), d3, 0, 2*pi)
```

plot.desire.function *Plot curve of desirability function*

Description

Plot a desirability function.

Usage

```
## S3 method for class 'desire.function'
plot(x, n = 600, xlim = NULL, ylim = c(0, 1),
              xlab = "Value", ylab = "Desirability", ..., main)
```

Arguments

x	desirability function
n	the number of x values at which to evaluate.
xlim	numeric of length 2; if specified, it serves as the default for the range of x values.
ylim	numeric of length 2; if specified, it serves as the default for the range of y values.
xlab	x axes label
ylab	y axes label
...	arguments passed to lines.
main	main title of plot

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plot.harrington2 *Plot of two-sided Harrington type desirability function*

Description

Plots a two-sided desirability function of the Harrington type.

Usage

```
## S3 method for class 'harrington2'
plot(x, ...)
```

Arguments

x	two-sided Harrington desirability function.
...	additional parameters passed to plot.

Details

Lower Specification Limit (LSL) and Upper Specification Limit (USL) are visualized. The default range of the x-axis is selected automatically.

Value

R-graphics plot object of two-sided Harrington desirability function.

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References

J. Harrington (1965): The desirability function. *Industrial Quality Control*, **21**: 494-498.

See Also

harrington2 for two sided Harrington type desirabilities, plot

Examples

```
##Assigning a function object to h:
h <- harrington2(3,7,1)

## Plot of desirability function:
plot(h)

plot(harrington2(4,8,1.5))
```

---

realisticDF *Realistic desirability functions*

Description

Convert a desirability into a realistic desirability.

Usage

```
realisticDF(f, ...)
## S3 method for class 'desire.function'
realisticDF(f, ...)
```

Arguments

f	desirability function
...	...

Details

To construct a composite realistic desirability, first create a realistic desirability and then compose it. Doing the opposite is currently unsupported. This allows the composition to possibly pass a standard deviation which can be deduced from the inner function (eg. if the inner function is an object of class lm).

Value

A function with the same arguments as x and sd, which returns the realistic desirability.

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See Also

minimumDI

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