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Description Contains functions used across packages 'DDIwR', 'QCA' and 'venn'. Interprets and translates, factorizes and negates SOP - Sum of Products expressions, for both binary and multi-value crisp sets, and extracts information (set names, set values) from those expressions. Other functions perform various other checks if possibly numeric (even if all numbers reside in a character vector) and coerce to numeric, or check if the numbers are whole. It also offers, among many others, a highly versatile recoding routine and some more flexible alternatives to the base functions 'with()' and 'within()'. SOP simplification functions in this package use related minimization from package 'QCA', which is recommended to be installed despite not being listed in the Imports field, due to circular dependency issues.

License GPL (>= 3)

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addCases *Add cases from a second data frame*

Description

Appends the rows of a second data frame, matching variables by name and filling absent variables with missing values.

Usage

```
addCases(x, y, keep = "common", exclude = NULL, add.x = NULL, add.y = NULL)
```

Arguments

x, y	Data frames. Rows from x precede rows from y.
keep	Which variables to keep: "common" (the default), "all", "x", or "y".
exclude	Variables to leave out, supplied as a comma-separated string or a character vector. NULL excludes no variables.
add.x, add.y	Additional variables unique to x or y, supplied as comma-separated strings or character vectors.

Details

"common" keeps variables present in both data frames. "all" keeps variables present in either data frame. "x" keeps the variables of x, while "y" keeps the variables of y. Variables follow the first data frame's order, except when keep = "y". With keep = "all", variables found only in y are appended in their original order. If there are no common variables, the default produces an error; choose "all", "x", or "y" to retain variables explicitly.

add.x and add.y add variables unique to their respective inputs after applying keep. They also work without common variables. Exclusions are applied last, after these additions. An excluded name must exist in at least one input. A single exclusion string matching an existing variable name is treated as that name, including any commas. Otherwise, a single string is split at commas and surrounding whitespace is removed. A character vector of length greater than one supplies exact variable names.

Missing columns use the corresponding source column's type and attributes. Shared columns are combined using rbind, including its usual type coercion and factor-level handling. Inputs must have unique, nonempty variable names, and at least one variable must be retained.

Value

A data frame containing the rows of x followed by those of y. The input data frames are unchanged.

Author(s)

Adrian Dusa

Examples

```
first <- data.frame(id = 1:2, age = c(25, 40))
second <- data.frame(score = c(8, 9), id = 3:4)

addCases(first, second)
addCases(first, second, keep = "all")
addCases(first, second, keep = "x")
addCases(first, second, keep = "y")

addCases(first, second, add.x = "age")
addCases(first, second, add.y = "score")

combined <- addCases(first, second, keep = "all", exclude = "age")
```

`admisc_package` *Adrian Dusa's Miscellaneous*

Description

Contains functions used across packages 'DDIwR', 'QCA' and 'venn'. Interprets and translates, factorizes and negates SOP - Sum of Products expressions, for both binary and multi-value crisp sets, and extracts information (set names, set values) from those expressions. Other functions perform various checks if possibly numeric (even if all numbers reside in a character vector) and coerce to numeric, or check if the numbers are whole. It also offers, among many others, a highly versatile recoding routine and some more flexible alternatives to the base functions `with()` and `within()`. SOP simplification functions in this package use related minimization from package **QCA**, which is recommended to be installed despite not being listed in the Imports field, due to circular dependency issues.

Details

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Type:	Package
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License:	GPL (>= 3)

Author(s)

Adrian Dusa

Maintainer: Adrian Dusa (dusa.adrian@unibuc.ro)

agtb *Check difference and / or (in)equality of numbers*

Description

Check if one number is greater / lower than (or equal to) another.

Usage

```
agtb(a, b, bincat)
altb(a, b, bincat)
agteb(a, b, bincat)
alteb(a, b, bincat)
aeqb(a, b, bincat)
aneqb(a, b, bincat)
```

Arguments

a	Numerical vector
b	Numerical vector
bincat	Binary categorization values, an atomic vector of length 2

Details

Not all numbers (especially the decimal ones) can be represented exactly in floating point arithmetic, and their arithmetic may not give the normal expected result.

This set of functions check for the in(equality) between two numerical vectors a and b, with the following name convention:

`gt` means "greater than"

`lt` means a "lower than" b

`gte` means a "greater than or equal to" b

`lte` means a "lower than or equal to" b

`eq` means a "equal to" b

`neq` means a "not equal to" b

The argument `values` is useful to replace the TRUE / FALSE values with custom categories.

Author(s)

Adrian Dusa

References

Goldberg, David (1991) "What Every Computer Scientist Should Know About Floating-point Arithmetic", ACM Computing Surveys vol.23, no.1, pp.5-48, doi:10.1145/103162.103163

asNumeric *Numeric vectors*

Description

Coerces objects to class "numeric", and checks if an object is numeric.

Usage

```
asNumeric(x, ...)
possibleNumeric(x, each = FALSE)
wholeNumeric(x, each = FALSE)
```

Arguments

x	A vector of values
each	Logical, return the result for each value in the vector
...	Other arguments to be passed for class based methods

Details

Unlike the function as.numeric() from the **base** package, the function asNumeric() coerces to numeric without a warning if any values are not numeric. All such values are considered NA missing.

This is a generic function, with specific class methods for factors and objects of class "declared". The usual way of coercing factors to numeric is meaningless, converting the inner storage numbers. The class method of this particular function coerces the levels to numeric, via the default activated argument levels.

For objects of class "declared", a similar argument called na_values is by default activated to coerce the declared missing values to numeric.

The function possibleNumeric() tests if the values in a vector are possibly numeric, irrespective of their storing as character or numbers. In the case of factors, it tests its levels representation.

Function wholeNumeric() tests if numbers in a vector are whole (round) numbers. Whole numbers are different from "integer" numbers (which have special memory representation), and consequently the function is.integer() tests something different, how numbers are stored in memory (see the description of function double() for more details).

The function

Author(s)

Adrian Dusa

See Also

numeric, integer, double

Examples

```
x <- c("-.1", " 2.7 ", "B")
asNumeric(x) # no warning

f <- factor(c(3, 2, "a"))

asNumeric(f)

asNumeric(f, levels = FALSE)

possibleNumeric(x) # FALSE

possibleNumeric(x, each = TRUE) # TRUE  TRUE FALSE

possibleNumeric(c("1", 2, 3)) # TRUE

is.integer(1) # FALSE

# Signaling an integer in R
is.integer(1L) # TRUE

wholeNumeric(1) # TRUE

wholeNumeric(c(1, 1.1), each = TRUE) # TRUE FALSE
```

---

asSOP *Functions to interpret and manupulate a SOP/DNF expression*

Description

These functions interpret an expression written in sum of products (SOP) or in canonical disjunctive normal form (DNF), for both crisp and multivalue notations. The function `compute()` calculates set membership scores based on a SOP expression applied to a calibrated data set (see function `calibrate()` from package **QCA**), while the function `translate()` translates a SOP expression into a matrix form.

Usage

```
asSOP(expression = "", snames = "", noflevels = NULL)

compute(expression = "", data = NULL, separate = FALSE, ...)

expand(expression = "", snames = "", noflevels = NULL, partial = FALSE,
      implicants = FALSE, ...)

mvSOP(expression = "", snames = "", data = NULL, keep.tilde = TRUE, ...)

simplify(expression = "", snames = "", noflevels = NULL, ...)

translate(expression = "", snames = "", noflevels = NULL, data = NULL, ...)
```

Arguments

expression	String, a SOP expression.
data	A dataset with binary cs, mv and fs data.
separate	Logical, perform computations on individual, separate paths.
snames	A string containing the sets' names, separated by commas.
noflevels	Numerical vector containing the number of levels for each set.
partial	Logical, perform a partial Quine expansion.
implicants	Logical, return an expanded matrix in the implicants space.
keep.tilde	Logical, preserves the tilde sign when coercing a factor level
...	Other arguments, mainly for backwards compatibility.

Details

An expression written in sum of products (SOP), is a "union of intersections", for example `A*B + B*~C`. The disjunctive normal form (DNF) is also a sum of products, with the restriction that each product has to contain all literals. The equivalent DNF expression is: `A*B*~C + A*B*C + ~A*B*~C`

The same expression can be written in multivalue notation: `A[1]*B[1] + B[1]*C[0]`.

Expressions can contain multiple values for the same condition, separated by a comma. If B was a multivalue causal condition, an expression could be: `A[1] + B[1,2]*C[0]`.

Whether crisp or multivalue, expressions are treated as Boolean. In this last example, all values in B equal to either 1 or 2 will be converted to 1, and the rest of the (multi)values will be converted to 0.

Negating a multivalue condition requires a known number of levels (see examples below). Intersections between multiple levels of the same condition are possible. For a causal condition with 3 levels (0, 1 and 2) the following expression `~A[0,2]*A[1,2]` is equivalent with `A[1]`, while `A[0]*A[1]` results in the empty set.

The number of levels, as well as the set names can be automatically detected from a dataset via the argument `data`. When specified, arguments `snames` and `noflevels` have precedence over `data`.

The product operator `*` should always be used, but it can be omitted when the data is multivalue (where product terms are separated by curly brackets), and/or when the set names are single letters (for example `AD + B~C`), and/or when the set names are provided via the argument `snames`.

When expressions are simplified, their simplest equivalent can result in the empty set, if the conditions cancel each other out.

The function `mvSOP()` assumes binary crisp conditions in the expression, except for categorical data used as multi-value conditions. The factor levels are read directly from the data, and they should be unique accross all conditions.

Value

For the function `compute()`, a vector of set membership values.

For function `simplify()`, a character expression.

For the function `translate()`, a matrix containing the implicants on the rows and the set names on the columns, with the following codes:

0	absence of a causal condition
1	presence of a causal condition
-1	causal condition was eliminated

The matrix was also assigned a class "translate", to avoid printing the -1 codes when signaling a minimized condition. The mode of this matrix is character, to allow printing multiple levels in the same cell, such as "1,2".

For function `expand()`, a character expression or a matrix of implicants.

Author(s)

Adrian Dusa

References

Ragin, C.C. (1987) *The Comparative Method: Moving beyond Qualitative and Quantitative Strategies*. Berkeley: University of California Press.

Examples

```
## Not run:
# make sure the package QCA is loaded

# -----
# for compute()
library(QCA)
compute(DEV*~IND + URB*STB, data = LF)

# calculating individual paths
compute(DEV*~IND + URB*STB, data = LF, separate = TRUE)

## End(Not run)


# -----
# for simplify() also make sure the package QCA is installed
simplify(asSOP("(A + B)(A + ~B)")) # result is "A"

# works even without the quotes
simplify(asSOP((A + B)(A + ~B))) # result is "A"

# but to avoid confusion POS expressions are more clear when quoted
# to force a certain order of the set names
simplify("(URB + LIT*~DEV)(~LIT + ~DEV)", snames = c(DEV, URB, LIT))

# multilevel conditions can also be specified (and negated)
simplify("(A[1] + ~B[0])(B[1] + C[0])", snames = c(A, B, C), noflevels = c(2, 3, 2))


# Ragin's (1987) book presents the equation E = SG + LW as the result
# of the Boolean minimization for the ethnic political mobilization.
```

```
# intersecting the reactive ethnicity perspective (R = ~L~W)
# with the equation E (page 144)

simplify("~L~W(SG + LW)", snames = c(S, L, W, G))

# [1] "S~L~WG"


# resources for size and wealth (C = SW) with E (page 145)
simplify("SW(SG + LW)", snames = c(S, L, W, G))

# [1] "SWG + SLW"


# and factorized
factorize(simplify("SW(SG + LW)", snames = c(S, L, W, G)))

# F1: SW(G + L)


# developmental perspective (D = Lg) and E (page 146)
simplify("L~G(SG + LW)", snames = c(S, L, W, G))

# [1] "LW~G"

# subnations that exhibit ethnic political mobilization (E) but were
# not hypothesized by any of the three theories (page 147)
# ~H = ~(~L~W + SW + L~G) = GL~S + GL~W + G~SW + ~L~SW

simplify("(GL~S + GL~W + G~SW + ~L~SW)(SG + LW)", snames = c(S, L, W, G))


# -----
# for translate()
translate(A + B*C)

# same thing in multivalue notation
translate(A[1] + B[1]*C[1])

# tilde as a standard negation (note the condition "b"!)
translate(~A + b*C)

# and even for multivalue variables
# in multivalue notation, the product sign * is redundant
translate(C[1] + T[2] + T[1]*V[0] + C[0])

# negation of multivalue sets requires the number of levels
translate(~A[1] + ~B[0]*C[1], snames = c(A, B, C), noflevels = c(2, 2, 2))

# multiple values can be specified
translate(C[1] + T[1,2] + T[1]*V[0] + C[0])
```

```
# or even negated
translate(C[1] + ~T[1,2] + T[1]*V[0] + C[0], snames = c(C, T, V), noflevels = c(2,3,2))

# if the expression does not contain the product sign *
# snames are required to complete the translation
translate(AaBb + ~CcDd, snames = c(Aa, Bb, Cc, Dd))

# to print _all_ codes from the standard output matrix
(obj <- translate(A + ~B*C))
print(obj, original = TRUE) # also prints the -1 code


# -----
# for expand()
expand(~AB + B~C)

# S1: ~AB~C + ~ABC + AB~C

expand(~AB + B~C, snames = c(A, B, C, D))

# S1: ~AB~C~D + ~AB~CD + ~ABC~D + ~ABCD + AB~C~D + AB~CD

# In implicants form:
expand(~AB + B~C, snames = c(A, B, C, D), implicants = TRUE)

#      A B C D
# [1,] 1 2 1 1    ~AB~C~D
# [2,] 1 2 1 2    ~AB~CD
# [3,] 1 2 2 1    ~ABC~D
# [4,] 1 2 2 2    ~ABCD
# [5,] 2 2 1 1    AB~C~D
# [6,] 2 2 1 2    AB~CD
```

---

betweenBrackets *Extract information from a multi-value SOP/DNF expression*

Description

Functions to extract information from an expression written in SOP, or in the canonical DNF, for multi-value causal conditions. They extract either the values within brackets, or the causal condition names outside the brackets.

Usage

```
betweenBrackets(x, type = "[", invert = FALSE, regexp = NULL)
outsideBrackets(x, type = "[", regexp = NULL)
curlyBrackets(x, outside = FALSE, regexp = NULL)
squareBrackets(x, outside = FALSE, regexp = NULL)
roundBrackets(x, outside = FALSE, regexp = NULL)
```

Arguments

x	A DNF/SOP expression.
type	Brackets type: curly, round or square.
invert	Logical, if activated returns whatever is not within the brackets.
outside	Logical, if activated returns the condition names outside the brackets.
regexp	Optional regular expression to extract information with.

Details

Expressions written in SOP are used in Boolean logic, signaling a disjunction of conjunctions.

These expressions are useful in Qualitative Comparative Analysis, a social science methodology used to search for causal configurations associated with a certain outcome.

They are also used to draw Venn diagrams with package venn, which draws any kind of set intersection based on a custom SOP expression.

`curlyBrackets()`, `squareBrackets()` and `roundBrackets()` are special cases of `betweenBrackets()` and `outsideBrackets()`, using curly, square or round brackets through the `type` argument.

`outsideBrackets()` can also be seen as a special case of `betweenBrackets(invert = TRUE)`.

SOP expressions are usually written using curly brackets for multi-value conditions but, to allow evaluation of unquoted expressions through R's parser, unquoted expressions should use square brackets and conjunctions should always use the product * sign.

Sufficiency is recognized as `"=>"` in quoted expressions but this does not pass over R's parsing system in unquoted expressions. To overcome this problem, it is best to use the single arrow `"->"` notation. Necessity is recognized as either `"<="` or `"<-"`, both being valid in quoted and unquoted expressions.

Author(s)

Adrian Dusa

Examples

```
sop <- "A[1] + B[2]*C[0]"

betweenBrackets(sop)
betweenBrackets(sop, invert = TRUE)

# unquoted (valid) SOP expressions are allowed, same result
betweenBrackets(A[1] + B[2]*C[0])

# curly brackets are also valid in quoted expressions
betweenBrackets("A{1} + B{2}*C{0}", type = "{")
curlyBrackets("A{1} + B{2}*C{0}")
curlyBrackets("A{1} + B{2}*C{0}", outside = TRUE)

squareBrackets(A[1] + B[2]*C[0])
squareBrackets(A[1] + B[2]*C[0], outside = TRUE)
```

betweenQuotes — *Extract information between quotes in a string*

Description

Functions to extract the between the (escaped) quotes, in a string.

Usage

```
betweenQuotes(x)
```

Arguments

x	A string.

Author(s)

Adrian Dusa

Examples

```
x <- "An example of \"quoted\" text."

betweenQuotes(x)
```

change — *Generic function to change the structure of an object, function of the (changed) parameters used to create it.*

Description

A generic function that applies different altering methods for different types of objects (of certain classes).

Usage

```
change(x, ...)
```

Arguments

x	An object of a particular class.
...	Arguments to be passed to a specific method.

Details

For the time being, this function is designed to change truth table objects (only). Future versions will likely add class methods for different other objects.

Value

The changed object.

Author(s)

Adrian Dusa

Examples

```
## Not run:
# An example to change a QCA truth table
library(QCA)

ttLF <- truthTable(LF, outcome = SURV, incl.cut = 0.8)
minimize(ttLF, include = "?")

# excluding contradictory simplifying assumptions
minimize(
    change(ttLF, exclude = findRows(type = 2)),
    include = "?"
)

## End(Not run)
```

---

coerceMode *Coerce an atomic vector to numeric or integer, if possible*

Description

This function verifies if an R vector is possibly numeric, and further if the numbers inside are whole numbers.

Usage

```
coerceMode(x)
```

Arguments

x	An atomic R vector

Value

An R vector of coerced mode.

Author(s)

Adrian Dusa

Examples

```
obj <- c("1.0", 2:5)

is.integer(coerceMode(obj))
```

---

combnk *Generate all combinations of n numbers, taken k at a time*

Description

A fast function to generate all possible combinations of n numbers, taken k at a time, starting from the first k numbers or starting from a combination that contain a certain number.

Usage

```
combnk(n, k, ogte = 0, zerobased = FALSE)
```

Arguments

n	Vector of any kind, or a numerical scalar.
k	Numeric scalar.
ogte	At least one value greater than or equal to this number.
zerobased	Logical, zero or one based.

Details

When a scalar, argument n should be numeric, otherwise when a vector its length should not be less than k.

When the argument ogte is specified, the combinations will sequentially be incremented from those which contain a certain number, or a certain position from n when specified as a vector.

Value

A matrix with k rows and choose(n, k) columns.

Author(s)

Adrian Dusa

Examples

```
combnk(5, 2)

combnk(5, 2, ogte = 3)

combnk(letters[1:5], 2)
```

`export` *Export an object to a file or a connection*

Description

This is a generic function, usually a wrapper to `write.table()`.

Usage

```
export(what, ...)
```

Arguments

`what`	The object to be written (matrix or dataframe)
`...`	Specific arguments to class functions.

Details

The default convention for `write.table()` is to add a blank column name for the row names, but (despite it is a standard used for CSV files) that doesn't work with all spreadsheets or other programs that attempt to import the result of `write.table()`.

This function acts as if `write.table()` was called, with only one difference: if row names are present in the dataframe (i.e. any of them should be different from the default row numbers), the final result will display a new column called `cases` in the first position, except the situation that another column called `cases` already exists in the data, when the row names will be completely ignored.

If not otherwise specified, an argument `sep = ","` is added by default.

The argument `row.names` is always set to FALSE, a new column being added anyways (if possible).

Since this function pipes everything to `write.table()`, the argument `file` can also be a connection open for writing, and `""` indicates output to the console.

Author(s)

Adrian Dusa

See Also

The "R Data Import/Export" manual.

`write.table`

`factorize` *Factorize Boolean expressions*

Description

This function finds all combinations of common factors in a Boolean expression written in SOP - sum of products. It makes use of the function `simplify()`, which uses the function `minimize()` from package **QCA**). Users are highly encouraged to install and load that package, despite not being present in the Imports field (due to circular dependency issues).

Usage

```
factorize(input, snames = "", noflevels = NULL, pos = FALSE, ...)
```

Arguments

`input`	A string representing a SOP expression, or a minimization object of class `"qca"`.
`snames`	A string containing the sets' names, separated by commas.
`noflevels`	Numerical vector containing the number of levels for each set.
`pos`	Logical, if possible factorize using product(s) of sums.
`...`	Other arguments (mainly for backwards compatibility).

Details

Factorization is a process of finding common factors in a Boolean expression, written in SOP - sum of products. Whenever possible, the factorization can also be performed in a POS - product of sums form.

Conjunctions should preferably be indicated with a star `*` sign, but this is not necessary when conditions have single letters or when the expression is expressed in multi-value notation.

The argument `snames` is only needed when conjunctions are not indicated by any sign, and the set names have more than one letter each (see function `translate()` for more details).

The number of levels in `noflevels` is needed only when negating multivalue conditions, and it should complement the `snames` argument.

If `input` is an object of class `"qca"` (the result of the function `minimize()` from package **QCA**), a factorization is performed for each of the minimized solutions.

Value

A named list, each component containing all possible factorizations of the input expression(s), found in the name(s).

Author(s)

Adrian Dusa

References

Ragin, C.C. (1987) *The Comparative Method. Moving beyond qualitative and quantitative strategies*, Berkeley: University of California Press

See Also

translate

Examples

```
# typical example with redundant conditions
factorize(a~b~cd + a~bc~d + a~bcd + abc~d)

# results presented in alphabetical order
factorize(~one*two*~four + ~one*three + three*~four)

# to preserve a certain order of the set names
factorize(~one*two*~four + ~one*three + three*~four,
          snames = c(one, two, three, four))

# using pos - products of sums
factorize(~a~c + ~ad + ~b~c + ~bd, pos = TRUE)

## Not run:
# make sure the package QCA is loaded
library(QCA)

# using an object of class "qca" produced with function minimize()
# in package QCA

pCVF <- minimize(CVF, outcome = "PROTEST", incl.cut = 0.8,
                 include = "?", use.letters = TRUE)

factorize(pCVF)

# using an object of class "deMorgan" produced with negate()
factorize(negate(pCVF))

## End(Not run)
```

---

frelevel *Modified* relevel() *function*

Description

The base function relevel() accepts a single argument "ref", which can only be a scalar and not a vector of values. frelevel() accepts more (even all) levels and reorders them.

Usage

```
frelevel(variable, levels)
```

Arguments

variable	The categorical variable of interest
levels	One or more levels of the factor, in the desired order

Value

A factor of the same length as the initial one.

Author(s)

Adrian Dusa

See Also

relevel

Examples

```
words <- c("ini", "mini", "miny", "moe")
variable <- factor(words, levels = words)

# modify the order of the levels, keeping the order of the values
frelevel(variable, c("moe", "ini", "miny", "mini"))
```

---

frev *Inverts the values of a factor*

Description

Provides a reversed version of the values from a factor, for instance a Likert type response scale.

Usage

```
frev(x, labels = FALSE)
```

Arguments

x	A factor
labels	Logical, invert the labels as well

Details

The argument labels can also be used for the levels of a factor.

Value

A factor of the same length as the original one.

Author(s)

Adrian Dusa

Examples

```
words <- c("ini", "mini", "miny", "moe")
variable <- factor(words, labels = words)

# inverts the values, preserving the labels' order
frev(variable)

# inverts both values and labels
frev(variable, labels = TRUE)
```

---

getName *Get the name of the object being used in a function call*

Description

This is a utility to be used inside a function.

Usage

```
getName(x, object = FALSE)
```

Arguments

x	String, expression to be evaluated
object	Logical, return the object's name

Details

Within a function, the argument x can be anything and it is usually evaluated as an object.

This function should be used in conjunction with the base match.call(), to obtain the original name of the object being served as an input, regardless of how it is being served.

A particular use case of this function relates to the cases when a variable within a data.frame is used. The overall name of the object (the data frame) is irrelevant, as the real object of interest is the variable.

Value

A character vector of length 1.

Author(s)

Adrian Dusa

Examples

```
foo <- function(x) {
    funargs <- sapply(match.call(), deparse)[-1]
    return(getName(funargs[1]))
}

dd <- data.frame(X = 1:5, Y = 1:5, Z = 1:5)

foo(dd)
# dd

foo(dd$X)
# X

foo(dd[["X"]])
# X

foo(dd[[c("X", "Y")]])
# X Y

foo(dd[, 1])
# X

foo(dd[, 2:3])
# Y Z
```

---

hastilde *Tilde operations*

Description

Checks and changes expressions containing set negations using a tilde.

Usage

```
hastilde(x)
notilde(x)
tilde1st(x)
```

Arguments

x	A vector of values

Details

Boolean expressions can be negated in various ways. For binary crisp and fuzzy sets, one of the most straightforward ways to invert the set membership scores is to subtract them from 1. This is both possible using R vectors and also often used to signal a negation in SOP (sum of products) expressions.

Some other times, SOP expressions can signal a set negation (also known as the absence of a causal condition) by using lower case letters, while upper case letters are used to signal the presence of a causal condition. SOP expressions also use a tilde to signal a set negation, immediately preceding the set name.

This set of functions detect when and if a set present in a SOP expression contains a tilde (function `hastilde`), whether the entire expression begins with a tilde (function `tilde1st`).

Author(s)

Adrian Dusa

Examples

```
hastilde("~A")
```

`hclr` *Colors from the HCL spectrum*

Description

Produces colors from the HCL (Hue Chroma Luminance) spectrum, based on the number of levels from a factor.

Usage

```
hclr(x, starth = 25, c = 50, l = 75, alpha = 1, fixup = TRUE)
```

Arguments

`x`	Number of factor levels, or the factor itself, or a frequency distribution from a factor
`starth`	Starting point for the hue (in the interval 0 - 360)
`c`	chroma - color purity, small values produce dark and high values produce bright colors
`l`	color luminance - a number between 0 and 100
`alpha`	color transparency, where 0 is a completely transparent color, up to 1
`fixup`	logical, corrects the RGB values foto produce a realistic color

Details

Any value of h outside the interval 0 - 360 is constrained to this interval using modulo values. For instance, 410 is constrained to 50 = 410

Value

The RBG code for the corresponding HCL colors.

Author(s)

Adrian Dusa

Examples

```
aa <- sample(letters[1:5], 100, replace = TRUE)

hclr(aa)

# same with
hclr(5)

# or
hclr(table(aa))
```

---

inside *Modify variables by name*

Description

Similar to the base function `within()`, this function lets you refer to variables by name and saves your changes in the supplied object.

Usage

```
inside(data, expr, ...)

## S3 method for class 'list'
inside(data, expr, keepAttrs = TRUE, ...)
```

Arguments

data	A data frame (including a tibble or a `data.table`), a matrix with named columns, a named list, a named atomic vector, or an environment.
expr	An R expression, or several expressions enclosed in braces.
keepAttrs	For a list, keep its attributes and the original order of its elements. If these are unimportant, `keepAttrs = FALSE` is more efficient.
...	A single assignment can also be written as a named argument, for example `inside(DF, total = men + women)`.

Details

For a data frame DF, writing inside(DF, total <- men + women) adds the column total to DF. It can also be used to change an existing column, or to remove one with rm(). The data frame can itself be part of another object, for instance inside(obj$DF, rm(total)). To calculate a result for use elsewhere, see using().

The same syntax works for a tibble. Even if the tibble is grouped, an expression such as mean(Age) gives the mean for the whole column. For a data.table, the function updates a copy and assigns it back to the supplied name. A key or secondary index is kept if its columns still contain the same values in the same order.

For a matrix, the column names can be used just as in a data frame. A new column can have one value for each row, or a single value for all rows. The result is still a matrix, with the same row names, even with only one column left or with no columns at all. Adding a character column to a numeric matrix makes the whole matrix character.

For a named vector, each name refers to one value. An assignment can change that value or add a new element at the end. Both rm(x) and x <- NULL remove the element called x. The other elements keep their order. If a name occurs more than once, the first occurrence is used. Elements with empty or missing names are kept. The usual R rules for replacement apply, including those for factor levels.

For an environment, the expression is evaluated directly there. R looks for names in that environment and then in its parents. An assignment such as x <- NULL gives x the value NULL. To remove x altogether, use rm(x). Changes are visible through any other name for the same environment, including changes already made if a later expression gives an error.

Value

The updated object, returned invisibly. For an environment, this is the supplied environment itself.

Author(s)

Adrian Dusa

Examples

```
mt <- mtcars
inside(mt, hwratio <- hp/wt)

dim(mtcars)

dim(mt)

# add a total for each row of a matrix
m <- cbind(men = c(12, 9), women = c(15, 11))
inside(m, total <- men + women)
m

# same calculation for a single area, this time using a named vector
counts <- c(men = 12, women = 15)
inside(counts, total <- men + women)
counts
```

```
# keep just the total
inside(counts, rm(men, women))
counts

# two names for the same environment
e <- new.env()
other <- e
inside(e, {
    men <- 12
    women <- 15
    total <- men + women
    rm(men, women)
})
other$total
```

`intersection` *Intersect expressions*

Description

This function takes two or more SOP expressions (combinations of conjunctions and disjunctions) or even entire minimization objects, and finds their intersection.

Usage

```
intersection(..., snames = "", noflevels)
```

Arguments

`...`	One or more expressions, combined with / or minimization objects of class `"QCA_min"`.
`snames`	A string containing the sets' names, separated by commas.
`noflevels`	Numerical vector containing the number of levels for each set.

Details

The initial aim of this function was to provide a software implementation of the intersection examples presented by Ragin (1987: 144-147). That type of example can also be performed with the function `simplify()`, while this function is now mainly used in conjunction with the `modelFit()` function from package **QCA**, to assess the intersection between theory and a QCA model.

Irrespective of the input type (character expressions and / or minimiation objects), this function is now a wrapper to the main `simplify()` function (which only accepts character expressions).

It can deal with any kind of expressions, but multivalent crisp conditions need additional information about their number of levels, via the argument `noflevels`.

The expressions can be formulated in terms of either lower case - upper case notation for the absence and the presence of the causal condition, or use the tilde notation (see examples below). Usage of either of these is automatically detected, as long as all expressions use the same notation.

If the snames argument is provided, the result is sorted according to the order of the causal conditions (set names) in the original dataset, otherwise it sorts the causal conditions in alphabetical order.

For minimzation objects of class "QCA_min", the number of levels, and the set names are automatically detected.

Author(s)

Adrian Dusa

References

Ragin, Charles C. 1987. *The Comparative Method: Moving beyond Qualitative and Quantitative Strategies*. Berkeley: University of California Press.

Examples

```
# using minimization objects
## Not run:
library(QCA) # if not already loaded
ttLF <- truthTable(LF, outcome = "SURV", incl.cut = 0.8)
pLF <- minimize(ttLF, include = "?")


# for example the intersection between the parsimonious model and
# a theoretical expectation
intersection(pLF, DEV*STB)


# negating the model
intersection(negate(pLF), DEV*STB)

## End(Not run)


# -----
# in Ragin's (1987) book, the equation E = SG + LW is the result
# of the Boolean minimization for the ethnic political mobilization.

# intersecting the reactive ethnicity perspective (R = lw)
# with the equation E (page 144)
intersection(~L~W, SG + LW, snames = c(S, L, W, G))


# resources for size and wealth (C = SW) with E (page 145)
intersection(SW, SG + LW, snames = c(S, L, W, G))


# and factorized
factorize(intersection(SW, SG + LW, snames = c(S, L, W, G)))
```

```
# developmental perspective (D = L~G) and E (page 146)
intersection(L~G, SG + LW, snames = c(S, L, W, G))


# subnations that exhibit ethic political mobilization (E) but were
# not hypothesized by any of the three theories (page 147)
# ~H = ~(~L~W + SW + L~G)
intersection(negate(~L~W + SW + L~G), SG + LW, snames = c(S, L, W, G))
```

`invert` *Negate Boolean expressions*

Description

Functions to negate a DNF/SOP expression, or to invert a SOP to a negated POS or a POS to a negated SOP.

Usage

```
invert(input, snames = "", noflevels, simplify = TRUE, ...)

sopos(input, snames = "", noflevels)
```

Arguments

`input`	A string representing a SOP expression, or a minimization object of class `"QCA_min"`.
`snames`	A string containing the sets' names, separated by commas.
`noflevels`	Numerical vector containing the number of levels for each set.
`simplify`	Logical, allow users to choose between the raw negation or its simplest form.
`...`	Other arguments (mainly for backwards compatibility).

Details

In Boolean algebra, there are two transformation rules named after the British mathematician Augustus De Morgan. These rules state that:

1. The complement of the union of two sets is the intersection of their complements.

2. The complement of the intersection of two sets is the union of their complements.

In "normal" language, these would be written as:

1. `not (A and B) = (not A) or (not B)`

2. `not (A or B) = (not A) and (not B)`

Based on these two laws, any Boolean expression written in disjunctive normal form can be transformed into its negation.

It is also possible to negate all models and solutions from the result of a Boolean minimization from function `minimize()` in package `QCA`. The resulting object, of class `"qca"`, is automatically recognised by this function.

In a SOP expression, the products should normally be split by using a star * sign, otherwise the sets' names will be considered the individual letters in alphabetical order, unless they are specified via snames.

To negate multilevel expressions, the argument noflevels is required.

It is entirely possible to obtain multiple negations of a single expression, since the result of the negation is passed to function simplify().

Function sopos() simply transforms an expression from a sum of products (SOP) to a negated product of sums (POS), and the other way round.

Value

A character vector when the input is a SOP expresison, or a named list for minimization input objects, each component containing all possible negations of the model(s).

Author(s)

Adrian Dusa

References

Ragin, Charles C. 1987. *The Comparative Method: Moving beyond Qualitative and Quantitative Strategies*. Berkeley: University of California Press.

See Also

minimize, simplify

Examples

```
# example from Ragin (1987, p.99)
invert(AC + B~C, simplify = FALSE)

# the simplified, logically equivalent negation
invert(AC + B~C)

# with different intersection operators
invert(AB*EF + ~CD*EF)

# invert to POS
invert(a*b + ~c*d)

## Not run:
# using an object of class "qca" produced with minimize()
# from package QCA
library(QCA)
cLC <- minimize(LC, outcome = SURV)

invert(cLC)
```

```
# parsimonious solution
pLC <- minimize(LC, outcome = SURV, include = "?")

invert(pLC)

## End(Not run)
```

`listRDA` *Load and list objects from an .rda file*

Description

Utility functions to read the names and load the objects from an .rda file, into an R list.

Usage

```
listRDA(.filename)

objRDA(.filename)
```

Arguments

`.filename`	The path to the file where the R object is saved.

Details

Files with the extension .rda are routinely created using the base function `save()`.

The function `listRDA()` loads the object(s) from the .rda file into a list, preserving the object names in the list components.

The .rda file can naturally be loaded with the base `load()` function, but in doing so the containing objects will overwrite any existing objects with the same names.

The function `objRDA()` returns the names of the objects from the .rda file.

Value

A list, containing the objects from the loaded .rda file.

Author(s)

Adrian Dusa

numdec *Count number of decimals*

Description

Calculates the (maximum) number of decimals in a possibly numeric vector.

Usage

```
numdec(x, each = FALSE, na.rm = TRUE, maxdec = 15)
```

Arguments

x	A vector of values
each	Logical, return the result for each value in the vector
na.rm	Logical, ignore missing values
maxdec	Maximal number of decimals to count

Author(s)

Adrian Dusa

Examples

```
x <- c(12, 12.3, 12.34)

numdec(x) # 2

numdec(x, each = TRUE) # 0, 1, 2

x <- c("-.1", " 2.75 ", "12", "B", NA)

numdec(x) # 2

numdec(x, each = TRUE) # 1, 2, 0, NA, NA
```

overwrite *Overwrite an object in a given environment.*

Description

Utility function to overwrite an object, and bypass the assignment operator.

Usage

```
overwrite(objname, content, environment)
```

Arguments

objname	Character, the name of the object to overwrite.
content	An R object
environment	The environment where to perform the overwrite procedure.

Details

assign() is sufficient when objname is a simple object name, such as "bar". It is not sufficient when the target is an expression, such as "bar$A". A call such as assign(bar$A, 1, envir = parent.frame()) fails because assign() expects its first argument to evaluate to a character string. If that expression is first deparsed, for instance to "bar$A", then assign() would create an object literally named "bar$A" in the target environment rather than replacing component A inside bar.

This function handles both situations. For simple names, it overwrites the object directly in the target environment. For expressions, it reconstructs and evaluates the corresponding assignment call in that environment.

Value

This function does not return anything.

Author(s)

Adrian Dusa

Examples

```
foo <- function(object, x) {
    objname <- deparse(substitute(object))
    overwrite(objname, x, parent.frame())
}


bar <- 1
foo(bar, 2)

bar
# [1] 2

bar <- list(A = bar)
foo(bar$A, 3)

bar
# $A
# [1] 3


foo_assign <- function(object, x) {
    objname <- deparse(substitute(object))
    assign(objname, x, envir = parent.frame())
```

```
}

bar <- list(A = 1)
try(assign(bar$A, 3, envir = parent.frame()))

bar <- 1
foo_assign(bar, 2)

bar
# [1] 2

bar <- list(A = 1)
foo_assign(bar$A, 3)

bar
# $A
# [1] 1

`bar$A`
# [1] 3
```

`permutations` *Calculates the permutations of a vector*

Description

Generates all possible permutations of elements from a vector.

Usage

```
permutations(x)
```

Arguments

x	Any kind of vector.

Author(s)

Adrian Dusa

Examples

```
permutations(1:3)
```

recode *Recode a variable*

Description

Recodes a vector (numeric, character or factor) according to a set of rules. It is similar to the function recode() from package **car**, but more flexible. It also has similarities with the function findInterval() from package **base**.

Usage

```
recode(x, rules = NULL, cut = NULL, values = NULL, ...)
```

Arguments

x	A vector of mode numeric, character or factor.
rules	Character string or a vector of character strings for recoding specifications.
cut	A vector of one or more unique cut points.
values	A vector of output values.
...	Other parameters, for compatibility with other functions such as recode() in package **car** but also factor() in package **base**

Details

Similar to the recode() function in package **car**, the recoding rules are separated by semicolons, of the form input = output, and allow for:

a single value	1 = 0
a range of values	2:5 = 1
a set of values	c(6,7,10) = 2
else	everything that is not covered by the previously specified rules

Contrary to the recode() function in package **car**, this function allows the : sequence operator (even for factors), so that a rule such as c(1,3,5:7), or c(a,d,f:h) would be valid.

Actually, since all rules are specified in a string, it really doesn't matter if the c() function is used or not. For compatibility reasons it accepts it, but a more simple way to specify a set of rules is "1,3,5:7=A; else=B"

Special values lo and hi may also appear in the range of values, while else can be used with else=copy to copy all values which were not specified in the recoding rules.

In the package **car**, a character output would have to be quoted, like "1:2='A'" but that is not mandatory in this function, "1:2=A" would do just as well. Output values such as "NA" or "missing" are converted to NA.

Another difference from the **car** package: the output is **not** automatically converted to a factor even if the original variable is a factor. That option is left to the user's decision to specify as.factor.result, defaulted to FALSE.

A capital difference is the treatment of the values not present in the recoding rules. By default, package **car** copies all those values in the new object, whereas in this package the default values are NA and new values are added only if they are found in the rules. Users can choose to copy all other values not present in the recoding rules, by specifically adding `else=copy` in the rules.

Since the two functions have the same name, it is possible that users loading both packages to use one instead of the other (depending which package is loaded first). In order to preserve functionality and minimize possible namespace collisions with package **car**, special efforts have been invested to ensure perfect compatibility with the other `recode()` function (plus more).

The argument `...` allows for more arguments specific to the **car** package, such as `as.factor.result`, `as.numeric.result`. In addition, it also accepts `levels`, `labels` and `ordered` specific to function `factor()` in package **base**. When using the arguments `levels` and / or `labels`, the output will automatically be coerced to a factor, unless the argument `values` is used, as indicated below.

Blank spaces outside category labels are ignored, see the last example.

It is possible to use `recode()` in a similar way to function `cut()`, by specifying a vector of cut points. For any number of such `c` cut ploints, there should be `c + 1` values. If not otherwise specified, the argument `values` is automatically constructed as a sequence of numbers from 1 to `c + 1`.

Unlike the function `cut()`, arguments such as `include.lowest` or `right` are not necessary because the final outcome can be changed by tweaking the cut values.

If both arguments `values` and `labels` are provided, the labels are going to be stored as an attribute.

Author(s)

Adrian Dusa

Examples

```
x <- rep(1:3, 3)
#  [1] 1 2 3 1 2 3 1 2 3

recode(x, "1:2 = A; else = B")
#  [1] "A" "A" "B" "A" "A" "B" "A" "A" "B"

recode(x, "1:2 = 0; else = copy")
#  [1] 0 0 3 0 0 3 0 0 3


set.seed(1234)
x <- sample(18:90, 20, replace = TRUE)
#  [1] 45 39 26 22 55 33 21 87 31 73 79 21 21 38 57 73 84 22 83 64

recode(x, cut = "35, 55")
#  [1] 2 2 1 1 2 1 1 3 1 3 3 1 1 2 3 3 3 1 3 3

set.seed(1234)
x <- factor(sample(letters[1:10], 20, replace = TRUE),
          levels = letters[1:10])
#  [1] j f e i e f d b g f j f d h d d e h d h
# Levels: a b c d e f g h i j
```

```
recode(x, "b:d = 1; g:hi = 2; else = NA") # note the "hi" special value
#  [1]  2 NA NA  2 NA NA  1  1  2 NA  2 NA  1  2  1  1 NA  2  1  2

recode(x, "a, c:f = A; g:hi = B; else = C", labels = "A, B, C")
#  [1] B A A B A A A C B A B A A B A A A B A B
# Levels: A B C

recode(x, "a, c:f = 1; g:hi = 2; else = 3",
       labels = c("one", "two", "three"), ordered = TRUE)
#  [1] two   one   one   two   one   one   one   three two   one
# [11] two   one   one   two   one   one   one   two   one   two
# Levels: one < two < three

set.seed(1234)
categories <- c("An", "example", "that has", "spaces")
x <- factor(sample(categories, 20, replace = TRUE),
            levels = categories, ordered = TRUE)
sort(x)
#  [1] An       An       An       example  example  example  example
#  [8] example  example  example  example  that has that has that has
# [15] spaces   spaces   spaces   spaces   spaces   spaces
# Levels: An < example < that has < spaces

recode(sort(x), "An : that has = 1; spaces = 2")
#  [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2

# single quotes work, but are not necessary
recode(sort(x), "An : 'that has' = 1; spaces = 2")
#  [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2

# same using cut values
recode(sort(x), cut = "that has")
#  [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2

# modifying the output values
recode(sort(x), cut = "that has", values = 0:1)
#  [1] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1

# more treatment of "else" values
x <- 10:20

# recoding rules don't overlap all existing values, the rest are empty
recode(x, "8:15 = 1")
#  [1]  1  1  1  1  1  1 NA NA NA NA NA

# all other values copied
recode(x, "8:15 = 1; else = copy")
#  [1]  1  1  1  1  1  1 16 17 18 19 20
```

---

recreate *Facilitate expression substitution*

Description

Utility function based on `substitute()`, to recover an unquoted input.

Usage

```
recreate(x, snames = NULL, ...)
```

Arguments

`x`	A substituted input.
`snames`	A character string containing set names.
`...`	Other arguments, mainly for internal use.

Details

This function is especially useful when users have to provide lots of quoted inputs, such as the name of the columns from a data frame to be considered for a particular function.

This is actually one of the main uses of the base function `substitute()`, but here it can be employed to also detect SOP (sum of products) expressions, explained for instance in function `translate()`.

Such SOP expressions are usually used in contexts of sufficieny and necessity, which are indicated with the usual signs `->` and `<-`. These are both allowed by the R parser, indicating standard assignment. Due to the R's internal parsing system, a sufficient expression using `->` is automatically flipped to a necessity statement `<-` with reversed LHS to RHS, but this function is able to determine what is the expression and what is the output.

The other necessity code `<=` is also recognized, but the equivalent sufficiency code `=>` is not allowed in unquoted expressions.

Value

A quoted, equivalent expression or a substituted object.

Author(s)

Adrian Dusa

See Also

`substitute`, `simplify`

Examples

```
recreate(substitute(A + ~B*C))

foo <- function(x, ...) recreate(substitute(list(...)))

foo(arg1 = 3, arg2 = A + ~B*C)

df <- data.frame(A = 1, B = 2, C = 3, Y = 4)
```

```
# substitute from the global environment
# the result is the builtin C() function
res <- recreate(substitute(C))

is.function(res) # TRUE

# search first within the column name space from df
recreate(substitute(C), colnames(df))
# "C"

# necessity well recognized
recreate(substitute(A <- B))

# but sufficiency is flipped
recreate(substitute(A -> B))

# more complex SOP expressions are still recovered
recreate(substitute(A + ~B*C -> Y))
```

`replaceText` *Replace text in a string*

Description

Provides an improved method to replace strings, compared to function gsub() in package **base**.

Usage

```
replaceText(
    expression = "", target = "", replacement = "", protect = "",
    boolean = FALSE, ...)
```

Arguments

`expression`	Character string, usually a SOP - sum of products expression.
`target`	Character vector or a string containing the text to be replaced.
`replacement`	Character vector or a string containing the text to replace with.
`protect`	Character vector or a string containing the text to protect.
`boolean`	Treat characters in a boolean way, using upper and lower case letters.
`...`	Other arguments, from and to other functions.

Details

If the input expression is "J*JSR", and the task is to replace "J" with "A" and "JSR" with "B", function gsub() is not very useful since the letter "J" is found in multiple places, including the second target.

This function finds the exact location(s) of each target in the input string, starting with those having the largest number of characters, making sure the locations are unique. For instance, the target "JSR" is found on the location from 3 to 5, while the target "J" is is found on two locations 1 and 3, but 3 was already identified in the previously found location for the larger target.

In addition, this function can also deal with target strings containing spaces.

Value

The original string, replacing the target text with its replacement.

Author(s)

Adrian Dusa

Examples

```
replaceText("J*JSR", "J, JSR", "A, B")

# same output, on input expresions containing spaces
replaceText("J*JS R", "J, JS R", "A, B")

# works even with Boolean expressions, where lower case
# letters signal the absence of the causal condition
replaceText("DEV + urb*LIT", "DEV, URB, LIT", "A, B, C", boolean = TRUE)
```

---

scan.clipboard *Cross platform scan/write clipboard*

Description

Functions to read and write to the system's clipboard, for copy/paste operations.

Usage

```
scan.clipboard(...)
write.clipboard(x)
```

Arguments

x	Object to be written to the clipboard
...	Same arguments that are used in the base function scan

Author(s)

Adrian Dusa

setColnames *Set matrix row or column names*

Description

Set matrix row or column names without copying, especially useful for (very) large matrices.

Usage

```
setColnames(matrix, colnames)
setRownames(matrix, rownames)
setDimnames(matrix, nameslist)
```

Arguments

matrix	An R matrix
colnames	Character vector of column names
rownames	Character vector of row names
nameslist	A two-component list containing rownames and colnames

Author(s)

Adrian Dusa

Examples

```
mat <- matrix(1:9, nrow = 3)
setDimnames(mat, list(LETTERS[1:3], letters[1:3]))
```

tryCatchWEM *Try functions to capture warnings, errors and messages.*

Description

This function combines the base functions `tryCatch()` and `withCallingHandlers()` for the specific purpose of capturing not only errors and warnings but messages as well.

Usage

```
tryCatchWEM(expr, capture = FALSE)
```

Arguments

expr	Expression to be evaluated.
capture	Logical, capture the visible output.

Details

In some situations it might be important not only to test a function, but also to capture everything that is written in the R console, be it an error, a warning or simply a message.

For instance package **QCA** (version 3.4) has a Graphical User Interface that simulates an R console embedded into a web based **shiny** app.

It is not intended to replace function `tryCatch()` in any way, especially not evaluating an expression before returning or exiting, it simply captures everything that is printed on the console (the visible output).

Value

A list, if anything would be printed on the screen, or an empty (NULL) object otherwise.

Author(s)

Adrian Dusa

`using` *Evaluate an expression in a data environment*

Description

Similar to the base function `with()`, this function evaluates an expression using the names in the supplied data. It can also evaluate the same expression separately for each group.

Usage

```
using(data, expr, split.by = NULL, ..., .simplify = TRUE)
```

Arguments

`data`	A data frame (including a tibble or a `data.table`), a matrix, a named list, a named atomic vector, or an environment.
`expr`	An R expression, for instance `mean(Age)`.
`split.by`	One or more grouping variables. For instance, use `Area` for a single variable, or `Area & Gender` for both. A character vector of column names also works. A grouping variable supplied separately must have one value per row. Use a factor for a grouping variable supplied as character values.
`...`	A single assignment can also be written as a named argument, for example `using(DF, total = men + women)`.
`.simplify`	If possible, collect the group results in a matrix. Set this to `FALSE` to keep a list with one result per group.

Details

Given a data frame `DF`, the call `using(DF, mean(Age))` is another way to write `mean(DF$Age)`. If there is also a variable called `Age` outside the data frame, the column in `DF` takes precedence. The same idea applies to the columns of a matrix and the elements of a named list or vector. Other names are looked up where the function was called. Warnings, messages and interrupts are handled as usual.

For instance, if `counts <- c(men = 12, women = 15)`, the call `using(counts, men + women)` returns 27. If a name occurs more than once, the first occurrence is used. Elements with empty or missing names are skipped when looking up a name. An assignment made with `<-` is local to this calculation. To save a change in the vector, use `inside()`. For an environment, the expression runs directly in that environment, so assignments made there persist.

With `split.by = Area`, the mean age is calculated separately for each area. Groups follow the order of the factor levels. Within each group, the rows keep their original order. Only groups present in the data are used. Cases with missing values on a grouping variable are excluded, including values or ranges declared as missing. A list can be split if its columns have distinct, nonempty names and the same number of rows. Named atomic vectors and environments are evaluated as a whole.

When working with a data frame, `.data` refers to the whole data frame, or to the rows of the current group when using `split.by`. For instance, a model can be fitted with `data = .data`. This also works for a list split into groups. If a column is itself called `.data`, it can be selected with `.data[[".data"]]`.

For a direct call to `lm()` or `glm()` with a stored formula, each model uses the rows of its group. With a formula such as `Age ~ .`, the dot leaves out the grouping variables, which are constant within the group. A grouping variable can still be included by name. An explicit `data` argument always takes precedence.

Value

The value of the expression. With `split.by`, the result is a matrix if each group returns a compatible vector of the same length. For example, `mean(Age)` gives one row per group and one column of means. If the vectors have names, their elements are matched by name.

Other results, such as frequency tables, fitted models and `NULL`, are collected in a list. The grouping values are available in `attr(result, "group.keys")`, with one row per group. Numeric summaries are rounded for printing.

Author(s)

Adrian Dusa

Examples

```
# calculate the total for one area
counts <- c(men = 12, women = 15)
using(counts, men + women)

# same calculation for each row of a matrix
m <- cbind(men = c(12, 9), women = c(15, 11))
using(m, men + women)
```

```
# same with the two counts stored in an environment
e <- list2env(as.list(counts))
using(e, men + women)

set.seed(123)
DF <- data.frame(
    Area = factor(sample(c("Rural", "Urban"), 123, replace = TRUE)),
    Gender = factor(sample(c("Female", "Male"), 123, replace = TRUE)),
    Age = sample(18:90, 123, replace = TRUE),
    Children = sample(0:5, 123, replace = TRUE)
)


# table of frequencies for Gender
table(DF$Gender)

# same with
using(DF, table(Gender))

# same, but split by Area
using(DF, table(Gender), split.by = Area)

# calculate the mean age by gender
using(DF, mean(Age), split.by = Gender)

# same, but select cases from the urban area
using(subset(DF, Area == "Urban"), mean(Age), split.by = Gender)

# mean age by gender and area
using(DF, mean(Age), split.by = Area & Gender)

# same with
using(DF, mean(Age), split.by = c(Area, Gender))

# average number of children by Area
using(DF, mean(Children), split.by = Area)

# one fitted model per area, using the current group's data
fits <- using(DF, lm(Age ~ Children, data = .data), split.by = "Area")
lapply(fits, coef)

# frequency tables by Area
using(DF, table(Children), split.by = Area)
```

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