Package ‘Formula’

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Description Infrastructure for extended formulas with multiple parts on the right-hand side and/or multiple responses on the left-hand side (see <doi:10.18637/jss.v034.i01>).
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Description

The new class Formula extends the base class formula by allowing for multiple responses and multiple parts of regressors.
Usage

Formula(object)

## S3 method for class 'Formula'
formula(x, lhs = NULL, rhs = NULL,
    collapse = FALSE, update = FALSE, drop = TRUE, ...)

as.Formula(x, ...)

is.Formula(object)

Arguments

object, x  an object. For Formula it needs to be a formula object.
lhs, rhs  indexes specifying which elements of the left- and right-hand side, respectively, should be employed. NULL corresponds to all parts, 0 to none.
collapse  logical. Should multiple parts (if any) be collapsed to a single part (essentially by replacing the | operator by +)? collapse can be a vector of length 2, corresponding for different handling of left- and right-hand side respectively.
update  logical. Only used if all(collapse). Should the resulting formula be updated to remove possibly redundant terms occurring in multiple terms?
drop  logical. Should the Formula class be dropped? If TRUE (the default) a formula is returned, if FALSE the corresponding Formula is returned.
...
  further arguments.

Details

Formula objects extend the basic formula objects. These extensions include multi-part formulas such as y ~ x1 + x2 | u1 + u2 + u3 | v1 + v2, multiple response formulas y1 + y2 ~ x1 + x2 + x3, multi-part responses such as y1 | y2 + y3 ~ x, and combinations of these.

The Formula creates a Formula object from a formula which can have the | operator on the left- and/or right-hand side (LHS and/or RHS). Essentially, it stores the original formula along with attribute lists containing the decomposed parts for the LHS and RHS, respectively.

The main motivation for providing the Formula class is to be able to conveniently compute model frames and model matrices or extract selected responses based on an extended formula language. This functionality is provided by methods to the generics model.frame, and model.matrix. For details and examples, see their manual page: model.frame.Formula.

In addition to these workhorses, a few further methods and functions are provided. By default, the formula() method switches back to the original formula. Additionally, it allows selection of subsets of the LHS and/or RHS (via lhs, and rhs) and collapsing multiple parts on the LHS and/or RHS into a single part (via collapse).

is.Formula checks whether the argument inherits from the Formula class.

as.Formula is a generic for coercing to Formula, the default method first coerces to formula and then calls Formula. The default and formula method also take an optional env argument, specifying the environment of the resulting Formula. In the latter case, this defaults to the environment of the formula supplied.
Methods to further standard generics `print`, `update`, and `length` are provided for `Formula` objects. The latter reports the number of parts on the LHS and RHS, respectively.

**Value**

`Formula` returns an object of class `Formula` which inherits from `formula`. It is the original formula plus two attributes "lhs" and "rhs" that contain the parts of the decomposed left- and right-hand side, respectively.

**References**


**See Also**

`model.frame.Formula`

**Examples**

```r
## create a simple Formula with one response and two regressor parts
f1 <- y ~ x1 + x2 | z1 + z2 + z3
F1 <- Formula(f1)
class(F1)
length(F1)
## switch back to original formula
formula(F1)
## create formula with various transformations
formula(F1, rhs = 1)
formula(F1, collapse = TRUE)
formula(F1, lhs = 0, rhs = 2)
## put it together from its parts
as.Formula(y ~ x1 + x2, ~ z1 + z2 + z3)
## update the formula
update(F1, . ~ . + I(x1^2) | . - z2 - z3)
update(F1, . | y2 + y3 ~ .)
# create a multi-response multi-part formula
f2 <- y1 | y2 + y3 ~ x1 + I(x2^2) | 0 + log(x1) | x3 / x4
F2 <- Formula(f2)
length(F2)
## obtain various subsets using standard indexing
## no lhs, first/second rhs
formula(F2, lhs = 0, rhs = 1:2)
formula(F2, lhs = 0, rhs = -3)
formula(F2, lhs = 0, rhs = c(TRUE, TRUE, FALSE))
## first lhs, third rhs
```

model.frame.Formula

Model Frame/Matrix/Response Construction for Extended Formulas

Description

Computation of model frames, model matrices, and model responses for extended formulas of class Formula.

Usage

```r
## S3 method for class 'Formula'
model.frame(formula, data = NULL, ..., 
  lhs = NULL, rhs = NULL, dot = "separate")
## S3 method for class 'Formula'
model.matrix(object, data = environment(object), ..., 
  lhs = NULL, rhs = 1, dot = "separate")
## S3 method for class 'Formula'
terms(x, ..., 
  lhs = NULL, rhs = NULL, dot = "separate")
model.part(object, ...) 
## S3 method for class 'Formula'
model.part(object, data, lhs = 0, rhs = 0, 
  drop = FALSE, terms = FALSE, dot = NULL, ...)
```

Arguments

- `formula, object, x`
  - An object of class Formula.
- `data`
  - A data.frame, list or environment containing the variables in formula. For `model.part` it needs to be the `model.frame`.
- `lhs, rhs`
  - Indexes specifying which elements of the left- and right-hand side, respectively, should be employed. `NULL` corresponds to all parts, 0 to none. At least one lhs or one rhs has to be specified.
- `dot`
  - Character specifying how to process formula parts with a dot (.) on the right-hand side. This can be "separate" so that each formula part is expanded separately. "sequential" so that the parts are expanded sequentially conditional on all prior parts. "previous" so the part is expanded to the previous part.
- `drop`
  - Logical. Should the data.frame be dropped for single column data frames?
- `terms`
  - Logical. Should the "terms" attribute (corresponding to the `model.part` extracted) be added?
- `...`
  - Further arguments passed to the respective `formula` methods.
Details

All three model computations leverage the corresponding standard methods. Additionally, they allow specification of the part(s) of the left- and right-hand side (LHS and RHS) that should be included in the computation.

The idea underlying all three model computations is to extract a suitable formula from the more general Formula and then calling the standard model.frame, model.matrix, and terms methods.

More specifically, if the formula has multiple parts on the RHS, they are collapsed, essentially replacing | by +. If there is only a single response on the LHS, then it is kept on the LHS. Otherwise all parts of the formula are collapsed on the RHS (because formula objects can not have multiple responses). Hence, for multi-response Formula objects, the (non-generic) model.response does not give the correct results. To avoid confusion a new generic model.part with suitable formula method is provided which can always be used instead of model.response. Note, however, that it has a different syntax: It requires the Formula object in addition to the readily processed model.frame supplied in data (and optionally the lhs). Also, it returns either a data.frame with multiple columns or a single column (dropping the data.frame property) depending on whether multiple responses are employed or not.

If the the formula contains one or more dots (.), some care has to be taken to process these correctly, especially if the LHS contains transformations (such as log, sqrt, cbind, Surv, etc.). Calling the terms method with the original data (untransformed, if any) resolves all dots (by default separately for each part, otherwise sequentially) and also includes the original and updated formula as part of the terms. When calling model.part either the original untransformed data should be provided along with a dot specification or the transformed model.frame from the same formula without another dot specification (in which case the dot is inferred from the terms of the model.frame).

References


See Also

Formula, model.frame, model.matrix, terms, model.response

Examples

```r
## artificial example data
set.seed(1090)
dat <- as.data.frame(matrix(round(runif(21), digits = 2), ncol = 7))
colnames(dat) <- c("y1", "y2", "y3", "x1", "x2", "x3", "x4")
for(i in c(2, 6:7)) dat[[i]] <- factor(dat[[i]] > 0.5, labels = c("a", "b"))
dat$y2[1] <- NA
dat

# artificial example data
set.seed(1090)
dat <- as.data.frame(matrix(round(runif(21), digits = 2), ncol = 7))
colnames(dat) <- c("y1", "y2", "y3", "x1", "x2", "x3", "x4")
for(i in c(2, 6:7)) dat[[i]] <- factor(dat[[i]] > 0.5, labels = c("a", "b"))
dat$y2[1] <- NA
dat
```

```r
## single response and two-part RHS ##

```
```r
## single response with two-part RHS
F1 <- Formula(log(y1) ~ x1 + x2 | I(x1^2))
```
## set up model frame
mf1 <- model.frame(F1, data = dat)
mf1

## extract single response
model.part(F1, data = mf1, lhs = 1, drop = TRUE)
model.response(mf1)

## model.response() works as usual

## extract model matrices
model.matrix(F1, data = mf1, rhs = 1)
model.matrix(F1, data = mf1, rhs = 2)

# multiple responses and multiple RHS

## set up Formula
F2 <- Formula(y1 + y2 | log(y3) ~ x1 + I(x2^2) | 0 + log(x1) | x3 / x4)

## set up full model frame
mf2 <- model.frame(F2, data = dat)
mf2

## extract responses
model.part(F2, data = mf2, lhs = 1)
model.part(F2, data = mf2, lhs = 2)

## model.response(mf2) does not give correct results!

## extract model matrices
model.matrix(F2, data = mf2, rhs = 1)
model.matrix(F2, data = mf2, rhs = 2)
model.matrix(F2, data = mf2, rhs = 3)

# Formulas with '.'

## set up Formula with a single '.'
F3 <- Formula(y1 | y2 - .)
mf3 <- model.frame(F3, data = dat)

## without y1 or y2
model.matrix(F3, data = mf3)

## without y1 but with y2
model.matrix(F3, data = mf3, lhs = 1)

## without y2 but with y1
model.matrix(F3, data = mf3, lhs = 2)

## set up Formula with multiple '.'
F3 <- Formula(y1 | y2 | log(y3) ~ . - x3 - x4 | .)
## Process both '.' separately (default)
mf3 <- model.frame(F3, data = dat, dot = "separate")
## only x1-x2
model.part(F3, data = mf3, rhs = 1)
## all x1-x4
model.part(F3, data = mf3, rhs = 2)

## process the '.' sequentially, i.e., the second RHS conditional on the first
mf3 <- model.frame(F3, data = dat, dot = "sequential")
## only x1-x2
model.part(F3, data = mf3, rhs = 1)
## only x3-x4
model.part(F3, data = mf3, rhs = 2)

## process the second '.' using the previous RHS element
mf3 <- model.frame(F3, data = dat, dot = "previous")
## only x1-x2
model.part(F3, data = mf3, rhs = 1)
## x1-x2 again
model.part(F3, data = mf3, rhs = 2)

##############################
## Process multiple offsets ##
##############################

## set up Formula
F4 <- Formula(y1 ~ x3 + offset(x1) | x4 + offset(log(x2)))
mf4 <- model.frame(F4, data = dat)
## model.part can be applied as above and includes offset!
model.part(F4, data = mf4, rhs = 1)
## additionally, the corresponding corresponding terms can be included
model.part(F4, data = mf4, rhs = 1, terms = TRUE)
## hence model.offset() can be applied to extract offsets
model.offset(model.part(F4, data = mf4, rhs = 1, terms = TRUE))
model.offset(model.part(F4, data = mf4, rhs = 2, terms = TRUE))
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