Package ‘nnet’

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**class.ind**

*Generates Class Indicator Matrix from a Factor*

**Description**

Generates a class indicator function from a given factor.

**Usage**

```r
class.ind(cl)
```

**Arguments**

- `cl` factor or vector of classes for cases.

**Value**

A matrix which is zero except for the column corresponding to the class.

**References**


**Examples**

```r
# The function is currently defined as
class.ind <- function(cl) {
  n <- length(cl)
cl <- as.factor(cl)x <- matrix(0, n, length(levels(cl)))x[(1:n) + n*(unclass(cl)-1)] <- 1
dimnames(x) <- list(names(cl), levels(cl))
x
}
```

---

**multinom**

*Fit Multinomial Log-linear Models*

**Description**

Fits multinomial log-linear models via neural networks.

**Usage**

```r
multinom(formula, data, weights, subset, na.action,
  contrasts = NULL, Hess = FALSE, summ = 0, censored = FALSE,
  model = FALSE, ...)
```
**Arguments**

formula  a formula expression as for regression models, of the form `response ~ predictors`. The response should be a factor or a matrix with K columns, which will be interpreted as counts for each of K classes. A log-linear model is fitted, with coefficients zero for the first class. An offset can be included: it should be a numeric matrix with K columns if the response is either a matrix with K columns or a factor with K >= 2 classes, or a numeric vector for a response factor with 2 levels. See the documentation of `formula()` for other details.

data  an optional data frame in which to interpret the variables occurring in `formula`.

weights  optional case weights in fitting.

subset  expression saying which subset of the rows of the data should be used in the fit. All observations are included by default.

na.action  a function to filter missing data.

contrasts  a list of contrasts to be used for some or all of the factors appearing as variables in the model formula.

Hess  logical for whether the Hessian (the observed/expected information matrix) should be returned.

summ  integer; if non-zero summarize by deleting duplicate rows and adjust weights. Methods 1 and 2 differ in speed (2 uses C); method 3 also combines rows with the same X and different Y, which changes the baseline for the deviance.

censored  If Y is a matrix with K columns, interpret the entries as one for possible classes, zero for impossible classes, rather than as counts.

model  logical. If true, the model frame is saved as component `model` of the returned object.

...  additional arguments for `nnet`

**Details**

`multinom` calls `nnet`. The variables on the rhs of the formula should be roughly scaled to [0,1] or the fit will be slow or may not converge at all.

**Value**

A `nnet` object with additional components:

- deviance  the residual deviance, compared to the full saturated model (that explains individual observations exactly). Also, minus twice log-likelihood.

- edf  the (effective) number of degrees of freedom used by the model

- AIC  the AIC for this fit.

- Hessian  (if Hess is true).

- model  (if model is true).

**References**

nnet

Fit Neural Networks

Description

Fit single-hidden-layer neural network, possibly with skip-layer connections.

Usage

nnet(x, ...)

## S3 method for class 'formula'
nnet(formula, data, weights, ..., 
    subset, na.action, contrasts = NULL)

## Default S3 method: 
nnet(x, y, weights, size, Wts, mask, 
    linout = FALSE, entropy = FALSE, softmax = FALSE, 
    censored = FALSE, skip = FALSE, rang = 0.7, decay = 0, 
    maxit = 100, Hess = FALSE, trace = TRUE, MaxNWts = 1000, 
    abstol = 1e-4, reltol = 1e-8, ...)

Arguments

formula A formula of the form class ~ x1 + x2 + ...

x matrix or data frame of x values for examples.

y matrix or data frame of target values for examples.

weights (case) weights for each example – if missing defaults to 1.

size number of units in the hidden layer. Can be zero if there are skip-layer units.

data Data frame from which variables specified in formula are preferentially to be taken.

subset An index vector specifying the cases to be used in the training sample. (NOTE: 
If given, this argument must be named.)

See Also

nnet

Examples

options(contrasts = c("contr.treatment", "contr.poly"))
library(MASS)
example(birthwt)
(bwt.mu <- multinom(low ~ ., bwt))
**na.action** A function to specify the action to be taken if NAs are found. The default action is for the procedure to fail. An alternative is na.omit, which leads to rejection of cases with missing values on any required variable. (NOTE: If given, this argument must be named.)

**contrasts** a list of contrasts to be used for some or all of the factors appearing as variables in the model formula.

**wts** initial parameter vector. If missing chosen at random.

**mask** logical vector indicating which parameters should be optimized (default all).

**linout** switch for linear output units. Default logistic output units.

**entropy** switch for entropy (= maximum conditional likelihood) fitting. Default by least-squares.

**softmax** switch for softmax (log-linear model) and maximum conditional likelihood fitting. linout, entropy, softmax and censored are mutually exclusive.

**censored** A variant on softmax, in which non-zero targets mean possible classes. Thus for softmax a row of \( \begin{pmatrix} 0, & 1, & 1 \end{pmatrix} \) means one example each of classes 2 and 3, but for censored it means one example whose class is only known to be 2 or 3.

**skip** switch to add skip-layer connections from input to output.

**rang** Initial random weights on \([-\text{rang}, \text{rang}]\). Value about 0.5 unless the inputs are large, in which case it should be chosen so that \( \text{rang} \times \max(|x|) \) is about 1.

**decay** parameter for weight decay. Default 0.

**maxit** maximum number of iterations. Default 100.

**Hess** If true, the Hessian of the measure of fit at the best set of weights found is returned as component Hessian.

**trace** switch for tracing optimization. Default TRUE.

**MaxNWts** The maximum allowable number of weights. There is no intrinsic limit in the code, but increasing MaxNWts will probably allow fits that are very slow and time-consuming.

**abstol** Stop if the fit criterion falls below abstol, indicating an essentially perfect fit.

**reltol** Stop if the optimizer is unable to reduce the fit criterion by a factor of at least \( 1 - \text{reltol} \).

... arguments passed to or from other methods.

### Details

If the response in `formula` is a factor, an appropriate classification network is constructed; this has one output and entropy fit if the number of levels is two, and a number of outputs equal to the number of classes and a softmax output stage for more levels. If the response is not a factor, it is passed on unchanged to `nnet.default`.

Optimization is done via the BFGS method of `optim`. 
Value

object of class "nnet" or "nnet.formula". Mostly internal structure, but has components

wts the best set of weights found
value value of fitting criterion plus weight decay term.
fitted.values the fitted values for the training data.
residuals the residuals for the training data.
convergence 1 if the maximum number of iterations was reached, otherwise 0.

References


See Also

`predict.nnet`, `nnetHess`

Examples

# use half the iris data
ir <- rbind(iris3[,1], iris3[,2], iris3[,3])
targets <- class.ind(c(rep("s", 50), rep("c", 50), rep("v", 50)))
samp <- c(sample(1:50, 25), sample(51:100, 25), sample(101:150, 25))
ir1 <- nnet(ir[,1], targets[1:100], size = 2, rang = 0.1,
decay = 5e-4, maxit = 200)
test.cl <- function(true, pred) {
  true <- max.col(true)
  cres <- max.col(pred)
  table(true, cres)
}
test.cl(targets[-samp,], predict(ir1, ir[-samp,]))

# or
ird <- data.frame(rbind(iris3[,1], iris3[,2], iris3[,3]),
  species = factor(c(rep("s", 50), rep("c", 50), rep("v", 50))))
ir.nn2 <- nnet(species ~ ., data = ird, subset = samp, size = 2, rang = 0.1,
decay = 5e-4, maxit = 200)
table(ird$species[-samp,], predict(ir.nn2, ird[-samp,], type = "class"))
nnetHess

Evaluates Hessian for a Neural Network

Description

Evaluates the Hessian (matrix of second derivatives) of the specified neural network. Normally called via argument Hess=TRUE to nnet or via vcov.multinom.

Usage

nnetHess(net, x, y, weights)

Arguments

- **net**: object of class nnet as returned by nnet.
- **x**: training data.
- **y**: classes for training data.
- **weights**: the (case) weights used in the nnet fit.

Value

square symmetric matrix of the Hessian evaluated at the weights stored in the net.

References


See Also

nnet, predict.nnet

Examples

# use half the iris data
ir <- rbind(iris3[,1], iris3[,2], iris3[,3])
targets <- matrix(c(rep(c(1,0,0),50), rep(c(0,1,0),50), rep(c(0,0,1),50)),
                  150, 3, byrow=TRUE)
samp <- c(sample(1:50,25), sample(51:100,25), sample(101:150,25))
ir1 <- nnet(ir[samp,], targets[samp,], size=2, rang=0.1, decay=5e-4, maxit=200)
eigen(nnetHess(ir1, ir[samp,], targets[samp,], TRUE)$values
predict.nnet

Predict New Examples by a Trained Neural Net

Description

Predict new examples by a trained neural net.

Usage

## S3 method for class 'nnet'
predict(object, newdata, type = c("raw","class"), ...)

Arguments

- **object**: an object of class nnet as returned by nnet.
- **newdata**: matrix or data frame of test examples. A vector is considered to be a row vector comprising a single case.
- **type**: Type of output
- **...**: arguments passed to or from other methods.

Details

This function is a method for the generic function predict() for class "nnet". It can be invoked by calling predict(x) for an object x of the appropriate class, or directly by calling predict.nnet(x) regardless of the class of the object.

Value

If type = "raw", the matrix of values returned by the trained network; if type = "class", the corresponding class (which is probably only useful if the net was generated by nnet.formula).

References


See Also

nnet, which.is.max
which.is.max

Find Maximum Position in Vector

Description

Find the maximum position in a vector, breaking ties at random.

Usage

which.is.max(x)

Arguments

x

a vector

Details

Ties are broken at random.

Value

index of a maximal value.

References

See Also

max.col, which.max which takes the first of ties.

Examples

```r
## Not run: ## this is incomplete
pred <- predict(nnet, test)
table(true, apply(pred, 1, which.is.max))

## End(Not run)
```
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