Package ‘nnet’

September 28, 2022

Priority recommended
Version 7.3-18
Date 2022-09-28
Depends R (>= 3.0.0), stats, utils
Suggests MASS
Description Software for feed-forward neural networks with a single hidden layer, and for multinomial log-linear models.
Title Feed-Forward Neural Networks and Multinomial Log-Linear Models
ByteCompile yes
License GPL-2 | GPL-3
URL http://www.stats.ox.ac.uk/pub/MASS4/
NeedsCompilation yes
Author Brian Ripley [aut, cre, cph], William Venables [cph]
Maintainer Brian Ripley <ripley@stats.ox.ac.uk>
Repository CRAN
Date/Publication 2022-09-28 12:57:31 UTC

R topics documented:

  class.ind ....................................................... 2
  multinom ....................................................... 2
  nnet ........................................................... 4
  nnetHess ....................................................... 7
  predict.nnet .................................................. 8
  which.is.max ............................................... 9

Index 11
class.ind  
*Generates Class Indicator Matrix from a Factor*

**Description**
Generates a class indicator function from a given factor.

**Usage**
```
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**
```
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**

See Also

nnet

Examples

oc <- options(contrasts = c("contr.treatment", "contr.poly"))
library(MASS)
example(birthwt)
(bwt.mu <- multinom(low ~ ., bwt))
options(oc)

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 = 1.0e-4, reltol = 1.0e-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.)
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 (0, 1, 1) 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 [-rang, rang]. Value about 0.5 unless the inputs are large, in which case it should be chosen so that rang * 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 - 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[samp,], targets[samp,], 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 New Examples by a Trained Neural Net**

**Description**

Predict new examples by a trained neural net.

**Usage**

```r
## 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`
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[samp,], targets[samp,], 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"))

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

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

## End(Not run)
Index

* models
  multinom, 2
* multiple logistic
  multinom, 2
* neural
  class.ind, 2
  multinom, 2
  nnet, 4
  nnetHess, 7
  predict.nnet, 8
* utilities
  class.ind, 2
  which.is.max, 9

add.net (nnet), 4
add1.multinom (multinom), 2
anova.multinom (multinom), 2

class.ind, 2
coeff.multinom (multinom), 2
coeff.nnet (nnet), 4
drop1.multinom (multinom), 2
eval.nn (nnet), 4
extractAIC.multinom (multinom), 2

formula, 3
logLik.multinom (multinom), 2

max.col, 10
model.frame.multinom (multinom), 2
multinom, 2

nnet, 3, 4, 4, 7, 8
nnetHess, 6, 7
norm.net (nnet), 4
optim, 5
predict.multinom (multinom), 2

predict.nnet, 6, 7, 8
print.multinom (multinom), 2
print.nnet (nnet), 4
print.summary.multinom (multinom), 2
print.summary.nnet (nnet), 4
summary.multinom (multinom), 2
summary.nnet (nnet), 4
vcov.multinom (multinom), 2

which.is.max, 8, 9
which.max, 10