Package 'BradleyTerry'

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Title Bradley-Terry Models -- this package is now deprecated in favour of 'BradleyTerry2'

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Description Specify and fit the Bradley-Terry model and structured versions

Depends R (>= 2.10.1)

Imports brglm

License GPL (>= 2)

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R topics documented:

baseball *Baseball data from Agresti (2002)*

Description

Baseball results for games in the 1987 season between 7 teams in the Eastern Division of the American League.

Usage

```
data(baseball)
```

Format

A data frame with 98 observations on the following 4 variables.

`winner` a factor with levels `Milwaukee` `Detroit` `Toronto` `New York` `Boston` `Cleveland` `Baltimore`

`loser` a factor with levels `Milwaukee` `Detroit` `Toronto` `New York` `Boston` `Cleveland` `Baltimore`

`Freq` a numeric vector

`home.adv` a numeric vector

Details

The `home.adv` variable is `1` for games where the home team won, and `-1` for games where the away team won.

Source

page 438 of Agresti, A (2002) *Categorcal Data Analysis* (2nd Edn.). Wiley, New York.

References

Firth, D. (2005) Bradley-Terry models in R. *Journal of Statistical Software*, to appear.

See Also

`BTm`

Examples

```
data(baseball)
##  The data in collapsed tabular form as on p438 of Agresti
xtabs(Freq ~ winner + loser, baseball)
##  Simple Bradley-Terry model as in Agresti p437
print(baseballModel <- BTm(baseball ~ ..))
##  Introduce order effect as in Agresti p438
update(baseballModel, order.effect = baseball$home.adv)
```

`BTabilities` *estimated abilities in a Bradley-Terry model*

Description

Extracts the `abilities` component from a model object of class `BTm`.

Usage

```
BTabilities(model)
```

Arguments

`model`	a model object for which `inherits(model, "BTm")` is `TRUE`

Value

A two-column numeric matrix, with columns named "ability" and "se"; one row for each player.

Author(s)

David Firth

References

Firth, D. (2005) Bradley-Terry models in R. *Journal of Statistical Software*, to appear.

See Also

`BTm`, `BTresiduals`

Examples

```
data(citations)
origin <- factor(c("UK", "USA", "USA", "UK"))
citeModel2 <- BTm(citations ~ origin)
BTabilities(citeModel2)
```

BTm *Bradley-Terry model and extensions*

Description

Fits Bradley-Terry models for pair comparison data, including models with structured scores, order effect and missing covariate data. Fits by either maximum likelihood or maximum penalized likelihood (with Jeffreys-prior penalty).

Usage

```
BTm(formula, refcat = NULL, offset = NULL, contrasts = NULL,
data = NULL, subset = NULL, br = FALSE, order.effect =
NULL, ...)
```

Arguments

formula	A model formula for the Bradley-Terry "ability" parameters. Response variable should be a data frame containing contest results: columns include factors named "winner" (by default column 1) and "loser" (by default column 2), and possibly also "Freq", a numeric vector recording the frequency of each contest result (taken to be 1 if omitted). Variables on RHS have length equal to the number of players. The special RHS formula . . specifies the standard Bradley-Terry model with unstructured abilities.
refcat	Character. Which is the "reference" player? Only used with . . on the RHS of the formula (otherwise ignored if supplied). Default is the name of the alphanumerically-first player.
offset	An optional offset term in the model. A vector of length equal to the number of players.
contrasts	As for glm.
data	A data frame, in which RHS variables can be found.
subset	An optional logical or numeric vector specifying a subset of observations (ie, a subset of rows of the response dataframe) to be used in the fitting process.
br	Logical. If TRUE, fitting will be by penalized maximum likelihood as in Firth (1992, 1993), using brglm. Default is fitting by maximum likelihood.
order.effect	An optional vector, numeric, indicating an order effect to be estimated in the model (for example, a home advantage effect). Values should be 1 where contest winner has the advantage, -1 where loser has the advantage, and 0 where neither player is advantaged.
...	Other arguments for glm or brglm

Details

No allowance is made for tied contests.

Aside from the possibility of an order effect, contest-specific predictors are not catered for by BTm. However, the availability of the model and x components in objects of class BTm allows a model fitted with only player-specific predictors to be manipulated subsequently to include further terms involving contest-specific predictors.

Value

An object of class c("BTm", "glm", "lm"), or of class c("BTm", "brglm", "glm", "lm") if br = TRUE. Components are as for glm or brglm, with additionally

x0	Model matrix for the formula as supplied (rather than the model matrix actually used in the subsidiary call to glm or brglm, which is included as component x if the call includes x = TRUE). One row for each player.
offset0	The supplied offset vector, if any was specified. One element for each player. (The offset vector actually used in the subsidiary call to glm or brglm is included as component offset.)
y0	The data frame of contest winners and losers, containing only those rows actually used in fitting the model.
order.effect	The values of order.effect, if specified.
abilities	A two-column matrix of estimated abilities, with the ability for refcat set to zero if refcat is specified (otherwise the first player has zero ability). First column is estimated ability, second column is the standard error for that estimate. One row for each player.

Note

Methods specific to the BTm class of models are

- add1.BTm
- drop1.BTm
- terms.BTm
- formula.BTm

Others are inherited from glm or lm.

Author(s)

David Firth

References

Agresti, A (2002) *Categorical Data Analysis* (2nd ed). New York: Wiley.

Firth, D. (1992) Bias reduction, the Jeffreys prior and GLIM. In *Advances in GLIM and Statistical Modelling*, Eds. L Fahrmeir, B J Francis, R Gilchrist and G Tutz, pp91–100. New York: Springer.

Firth, D. (1993) Bias reduction of maximum likelihood estimates. *Biometrika* **80**, 27–38.

Firth, D. (2005) Bradley-Terry models in R. *Journal of Statistical Software*, to appear.

Stigler, S. (1994) Citation patterns in the journals of statistics and probability. *Statistical Science* **9**, 94–108.

See Also

BTresiduals, BTabilities

Examples

```
##
##  Statistics journal citation data from Stigler (1994)
##  -- see also Agresti (2002, p448)
data(citations)

##  First fit the "standard" Bradley-Terry model
print(citeModel <- BTm(citations ~ ..))

##  Now the same thing with a different "reference" journal
update(citeModel, . ~ ., refcat = "JASA")

##  Is the "citeability" of a journal predicted by its country of origin?
origin <- factor(c("UK", "USA", "USA", "UK"))
print(citeModel2 <- BTm(citations ~ origin))

##  Hmm... not so sure about the origin of "Comm Statist" ...
is.na(origin[2]) <- TRUE
citeModel2 <- update(citeModel2, . ~ .)

##  Now an example with an order effect -- see Agresti (2002) p438
data(baseball)

##  Simple Bradley-Terry model as in Agresti p437
print(baseballModel <- BTm(baseball ~ ..))

##  Introduce order effect as in Agresti p438
update(baseballModel, order.effect = baseball$home.adv)
```

BTresiduals *player-specific residuals from a Bradley-Terry model*

Description

Computes player-specific residuals from a model object of class BTm, suitable for diagnostic checking of a predictor involving player-level covariates.

Usage

```
BTresiduals(model)
```

Arguments

model	a model object for which `inherits(model, "BTm")` is `TRUE`

Details

The residuals returned by `BTresiduals` are weighted means of working residuals, with weights equal to the binomial denominators in the fitted model. These are suitable for diagnostic model checking, for example plotting against candidate predictors.

Value

A numeric vector of length equal to the number of players, with a "weights" attribute.

Author(s)

David Firth

References

Firth, D. (2005) Bradley-Terry models in R. *Journal of Statistical Software*, to appear.

See Also

`BTm`, `BTabilities`

Examples

```
data(citations)
origin <- factor(c("UK", "USA", "USA", "UK"))
citeModel2 <- BTm(citations ~ origin)
BTresiduals(citeModel2)
```

---

citations *Statistics journal citation data from Stigler (1994)*

Description

Extracted from a larger table in Stigler (1994). Inter-journal citation counts for four journals, "Biometrika", "Comm Statist.", "JASA" and "JRSS-B", as used on p448 of Agresti (2002).

Usage

```
data(citations)
```

Format

A data frame with 16 observations on the following 3 variables.

`winner` a factor with levels `Biometrika` `Comm Statist` `JASA` `JRSS-B`

`loser` a factor with levels `Biometrika` `Comm Statist` `JASA` `JRSS-B`

`Freq` a numeric vector

Details

"winner" is the cited journal, "loser" the one doing the citing.

Source

Agresti, A (2002) *Categorical Data Analysis* (2nd ed). New York: Wiley.

References

Firth, D. (2005) Bradley-Terry models in R. *Journal of Statistical Software*, to appear.

Stigler, S. (1994) Citation patterns in the journals of statistics and probability. *Statistical Science* **9**, 94–108.

See Also

`BTm`

Examples

```
data(citations)
##  Data as a square table, as in Agresti p448
xtabs(Freq ~ ., citations)
## Standard Bradley-Terry model fitted to these data
BTm(citations ~ ..)
```

---

flatlizards *Augrabies Male Flat Lizards: Contest Results and Predictor Variables*

Description

Data collected at Augrabies Falls National Park (South Africa) in September-October 2002, on the contest performance and background attributes of 77 male flat lizards (*Platysaurus broadleyi*). The results of exactly 100 contests were recorded, along with various measurements made on each lizard. Full details of the study are in Whiting et al. (2006).

Usage

```
data(flatlizards)
```

Format

This dataset is a list containing two data frames: `flatlizards$contests` and `flatlizards$predictors`.

The `flatlizards$contests` data frame has 100 observations on the following 2 variables:

`winner` a factor with 77 levels `lizard003` ... `lizard189`

`loser` a factor with the same 77 levels `lizard003` ... `lizard189`

The `flatlizards$predictors` data frame has 77 observations (one for each of the 77 lizards) on the following 18 variables:

`id` an integer identifier for each lizard

`throat.PC1` numeric, the first principal component of the throat spectrum

`throat.PC2` numeric, the second principal component of the throat spectrum

`throat.PC3` numeric, the third principal component of the throat spectrum

`frontleg.PC1` numeric, the first principal component of the front-leg spectrum

`frontleg.PC2` numeric, the second principal component of the front-leg spectrum

`frontleg.PC3` numeric, the third principal component of the front-leg spectrum

`badge.PC1` numeric, the first principal component of the ventral colour patch spectrum

`badge.PC2` numeric, the second principal component of the ventral colour patch spectrum

`badge.PC3` numeric, the third principal component of the ventral colour patch spectrum

`badge.size` numeric, a measure of the area of the ventral colour patch

`testosterone` numeric, a measure of blood testosterone concentration

`SVL` numeric, the snout-vent length of the lizard

`head.length` numeric, head length

`head.width` numeric, head width

`head.height` numeric, head height

`condition` numeric, a measure of body condition

`repro.tactic` a factor indicating reproductive tactic; levels are `resident` and `floater`

Details

There were no duplicate contests (no pair of lizards was seen fighting more than once), and there were no tied contests (the result of each contest was clear).

The variables `head.length`, `head.width`, `head.height` and `condition` were all computed as residuals (of directly measured head length, head width, head height and body mass index, respectively) from simple least-squares regressions on `SVL`.

Values of some predictors are missing (`NA`) for some lizards, 'at random', because of instrument problems unconnected with the value of the measurement being made.

Source

The data were collected by Dr Martin Whiting, University of the Witwatersrand, http://web.wits.ac.za/Academic/Science/APES/Research/MWLab/People/, and they appear here with his kind permission.

References

Whiting, M.J., Stuart-Fox, D.M., O'Connor, D., Firth, D., Bennett, N.C. and Blomberg, S.P. (2006). Ultraviolet signals ultra-aggression in a lizard. *Animal Behaviour* **72**, 353-363. (http://dx.doi.org/10.1016/j.anbehav.2005.10.018)

Examples

```
library(BradleyTerry)
data(flatlizards)
##
##  Fit the standard Bradley-Terry model, using the bias-reduced
##  maximum likelihood method:
##
BTmodel <- BTm(flatlizards$contests ~ .., br = TRUE)
summary(BTmodel)
##
##  That's fairly useless, though, because of the rather small
##  amount of data on each lizard.  And really the scientific
##  interest is not in the abilities of these particular 77
##  lizards, but in the relationship between ability and the
##  measured predictor variables.
##
##  So next fit (by maximum likelihood) a "structured" B-T model in
##  which abilities are determined by a linear predictor.  This
##  reproduces results reported in Table 1 of Whiting et al. (2006).
##
BTmodel2 <- BTm(flatlizards$contests ~ throat.PC1 + throat.PC3 +
  head.length + SVL, data = flatlizards$predictors)
summary(BTmodel2)
```

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