Package ‘bellreg’

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Title Count Regression Models Based on the Bell Distribution

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The 'bellreg' package.

Description

Bell Regression models for count data with overdispersion. The implemented models account for ordinary and zero-inflated regression models under both frequentist and Bayesian approaches. Theoretical details regarding the models implemented in the package can be found in (Castellares et al. 2018) and (Lemonte et al. 2020).

References


Bell

Probability function, distribution function, quantile function and random generation for the Bell distribution with parameter theta.

Description

Probability function, distribution function, quantile function and random generation for the Bell distribution with parameter theta.

Usage

dbell(x, theta, log = FALSE)
pbell(q, theta, lower.tail = TRUE, log.p = FALSE)
qbell(p, theta, log.p = FALSE)
rbell(n, theta)

Arguments

x vector of (non-negative integer) quantiles.
theta parameter of the Bell distribution (theta > 0).
log, log.p logical; if TRUE, probabilities p are given as log(p).
q vector of quantiles.
lower.tail logical; if TRUE (default), probabilities are \( P[X \leq x] \); otherwise, \( P[X > x] \).
p vector of probabilities.
n number of random values to return.

Details

Probability mass function

\[
f(x) = \frac{\theta^x e^{\theta} + 1}{x!} B_x,
\]

where \( B_x \) is the Bell number, and \( x = 0, 1, \ldots \).

Value

dbell gives the (log) probability function, pbell gives the (log) distribution function, qbell gives the quantile function, and rbell generates random deviates.
bellreg

Bell regression model

Description
Fits the Bell regression model to overdispersed count data.

Usage
bellreg(
  formula,
  data,
  approach = c("mle", "bayes"),
  hessian = TRUE,
  hyperpars = list(mu_beta = 0, sigma_beta = 10),
  ...
)

Arguments
formula an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data an optional data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model. If not found in data, the variables are taken from environment(formula), typically the environment from which ypbp is called.
approach approach to be used to fit the model (mle: maximum likelihood; bayes: Bayesian approach).
hessian hessian logical; If TRUE (default), the hessian matrix is returned when approach="mle".
hyperpars a list containing the hyperparameters associated with the prior distribution of the regression coefficients; if not specified then default choice is hyperpars = c(mu_beta = 0, sigma_beta = 10).
... further arguments passed to either 'rstan::optimizing' or 'rstan::sampling'.

Value
bellreg returns an object of class "bellreg" containing the fitted model.

Examples

# ML approach:
ml <- bellreg(nf ~ lroll, data = faults, approach = "mle")
summary(ml)
# Bayesian approach:
bayes <- bellreg(nf ~ lroll, data = faults, approach = "bayes")
summary(bayes)

---

**cells**

**Cells data set**

### Description

Data set taken from (Crawley 2012) and posteriorly analyzed by (Lemonte et al. 2020). The data includes the count of infected blood cells per square millimetre on microscope slides prepared from \( n = 511 \) randomly selected individuals.

### Format

A data frame with 511 rows and 5 variables:

- **cells**: count of infected blood cells per square millimetre on microscope slides
- **smoker**: smoking status of the subject (0: smoker; 1: non smoker)
- **gender**: subject’s gender (1: male; 0: female).
- **age**: subject’s age categorized into three levels: young (\( \leq 20 \)), mid (21 to 59), and old (\( \geq 60 \)).
- **weight**: body mass score categorized into three levels: normal, overweight, obese.

### References


---

**coef.bellreg**

**Estimated regression coefficients for the bellreg model**

### Description

Estimated regression coefficients for the bellreg model

### Usage

```r
## S3 method for class 'bellreg'
coef(object, ...)
```
Arguments

object  an object of the class bellreg.
...

Value

a vector with the estimated regression coefficients.

Examples

```r
fit <- bellreg(nf ~ lroll, data=faults)
coef(fit)
```

---

**Description**

Estimated regression coefficients for zibellreg model

**Usage**

```r
## S3 method for class 'zibellreg'
coef(object, ...)
```

Arguments

object  an object of the class bellreg
...

Value

a list containing the the estimated regression coefficients associated with the degenerated and Bell count distributions, respectively.

Examples

```r
fit <- zibellreg(cells ~ smoker + gender|smoker + gender, data = cells)
coef(fit)
```
**confint**

*Generic S3 method confint*

**Description**

Generic S3 method confint

**Usage**

`confint(object, ...)`

**Arguments**

- `object`: a fitted model object
- `...`: further arguments passed to or from other methods.

**Value**

the estimated regression coefficients

---

**confint.bellreg**

*Confidence intervals for the regression coefficients*

**Description**

Confidence intervals for the regression coefficients

**Usage**

```
## S3 method for class 'bellreg'
confint(object, level = 0.95, ...)
```

**Arguments**

- `object`: an object of the class bellreg
- `level`: the confidence level required
- `...`: further arguments passed to or from other methods

**Value**

`100(1-alpha)`
Examples

```r
fit <- bellreg(nf ~ lroll, data = faults)
confint(fit)
```

---

**confint.zibellreg**  
*Confidence intervals for the regression coefficients*

**Description**

Confidence intervals for the regression coefficients

**Usage**

```r
## S3 method for class 'zibellreg'
confint(object, level = 0.95, ...)
```

**Arguments**

- `object`  
  an object of the class zibellreg
- `level`  
  the confidence level required
- `...`  
  further arguments passed to or from other methods

**Value**

100(1-alpha)

**Examples**

```r
fit <- zibellreg(cells ~ smoker+gender|smoker+gender, data = cells, approach = "mle")
confint(fit)
```
Faults data set

Description

Data set taken from ( ) and posteriorly analyzed by (Castellares et al. 2018). The data contains the number of faults in rolls of fabric of different lengths.

Format

A data frame with 32 rows and 2 variables:

- nf: number of faults in rolls of fabric of different lengths.
- lroll: length of the roll.

References


print.summary.bellreg

Print the summary.bellreg output

Description

Print the summary.bellreg output

Usage

## S3 method for class 'summary.bellreg'
print(x, ...)

Arguments

x an object of the class summary.bellreg.

... further arguments passed to or from other methods.

Value

a summary of the fitted model.
print.summary.zibellreg

Print the summary.zibellreg output

Description

Print the summary.zibellreg output

Usage

## S3 method for class 'summary.zibellreg'
print(x, ...)

Arguments

x
   an object of the class summary.zibellreg.
...
   further arguments passed to or from other methods.

Value

a summary of the fitted model.

summary.bellreg

Summary for the bellreg model

Description

Summary for the bellreg model

Usage

## S3 method for class 'bellreg'
summary(object, ...)

Arguments

object
   an object of the class 'bellreg'.
...
   further arguments passed to or from other methods.
Summary for the zibellreg model

Description
Summary for the zibellreg model

Usage

## S3 method for class 'zibellreg'
summary(object, ...)

Arguments

object
an object of the class 'zibellreg'.

... further arguments passed to or from other methods.

Value

the variance-covariance matrix associated with the regression coefficients.

Examples

fit <- bellreg(nf ~ lroll, data = faults)
v cov(fit)

Variance-covariance matrix for a bellreg model

Description
This function extracts and returns the variance-covariance matrix associated with the regression coefficients when the maximum likelihood estimation approach is used in the model fitting.

Usage

## S3 method for class 'bellreg'
v cov(object, ...)

Arguments

object
an object of the class bellreg.

... further arguments passed to or from other methods.

Value

the variance-covariance matrix associated with the regression coefficients.
### vcov.zibellreg

*Covariance of the regression coefficients*

#### Description

Covariance of the regression coefficients

#### Usage

```r
## S3 method for class 'zibellreg'
vcov(object, ...)  
```

#### Arguments

- `object`: an object of the class `bellreg`
- `...`: further arguments passed to or from other methods.

#### Value

the variance-covariance matrix associated with the regression coefficients.

#### Examples

```r
fit <- zibellreg(cells ~ smoker + gender|smoker + gender, data = cells)
vcov(fit)
```

---

### zibellreg

*ZiBell regression model*

#### Description

Fits the Bell regression model to overdispersed count data.

#### Usage

```r
zibellreg(
  formula,
  data,
  approach = c("mle", "bayes"),
  hessian = TRUE,
  hyperpars = list(mu.psi = 0, sigma.psi = 10, mu.beta = 0, sigma.beta = 10),
  ...
)
```
Arguments

- **formula**: an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
- **data**: an optional data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model. If not found in data, the variables are taken from environment(formula), typically the environment from which ypbp is called.
- **approach**: approach to be used to fit the model (mle: maximum likelihood; bayes: Bayesian approach).
- **hessian**: hessian logical; If TRUE (default), the hessian matrix is returned when approach="mle".
- **hyperpars**: a list containing the hyperparameters associated with the prior distribution of the regression coefficients; if not specified then default choice is hyperpars = c(mu_psi = 0, sigma_psi = 10, mu_beta = 0, sigma_beta = 10).
- **...**: further arguments passed to either 'rstan::optimizing' or 'rstan::sampling'.

Value

zibellreg returns an object of class "zibellreg" containing the fitted model.

Examples

```r
# ML approach:
mle <- zibellreg(cells ~ smoker+gender|smoker+gender, data = cells, approach = "mle")
summary(mle)

# Bayesian approach:
bayes <- zibellreg(cells ~ 1|smoker+gender, data = cells, approach = "bayes")
summary(bayes)
```
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