

Package: zmctp (via r-universe)

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Type Package

Title Zero-Modified Complex 'Tri-Parametric' Pearson Distribution for Overdispersed Count Data

Version 0.1.0

Description Implements zero-modified versions of the Complex 'Tri-Parametric' Pearson distribution for overdispersed count data. The package addresses limitations of existing implementations when the parameter b approaches zero. It provides distribution functions, maximum likelihood estimation, and diagnostic tools for modeling count data with excess zeros. The methodology is based on 'Rodriguez-Avi' and coauthors (2003) <[doi:10.1007/s00362-002-0134-7](https://doi.org/10.1007/s00362-002-0134-7)>.

License GPL-3

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BugReports <https://github.com/roladoja/zmctp/issues>

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 zmctp-package

zmctp: Zero-Modified Complex Triparametric Pearson Distribution

Description

The `zmctp` package extends the Complex Triparametric Pearson (CTP) distribution with zero-modified versions for handling overdispersed count data, particularly when the parameter b approaches zero.

Details

Main functions:

- `dctp`, `pctp`, `qctp`, `rctp` - CTP distribution functions
- `dzictp`, `pzictp`, `qzictp`, `rzictp` - Zero-Modified CTP distribution functions
- `ctp.fit` - Fit CTP model
- `zictp.fit` - Fit Zero-Modified CTP model

Author(s)

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See Also

Useful links:

- <https://github.com/roladoja/zmctp>
- Report bugs at <https://github.com/roladoja/zmctp/issues>

ctp.fit

Maximum Likelihood Estimation for the CTP Distribution

Description

Fits the Complex Triparametric Pearson (CTP) distribution to count data using maximum likelihood estimation.

Usage

```
ctp.fit(  
  x,  
  a_start = NULL,  
  b_start = NULL,  
  gama_start = NULL,  
  method = "L-BFGS-B",  
  penalty = 1e+10  
)
```

Arguments

x	Numeric vector of nonnegative counts.
a_start	Optional starting value for parameter a.
b_start	Optional starting value for parameter b.
gama_start	Optional starting value for parameter gamma.
method	Optimization method (default: "L-BFGS-B").
penalty	numeric penalty added for numerical stability when $b \rightarrow 0$

Value

An object of class "ctffit" containing:

estimates	Named vector of MLEs
se	Standard errors
vcov	Variance-covariance matrix
logLik	Log-likelihood
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion

pearson_chisq	Pearson's chi-squared statistic
wald_chisq	Wald's chi-squared statistic
fitted_freq	Data frame of observed vs expected frequencies
data	Original data
converged	Convergence status

Examples

```
set.seed(123)

x <- rctp(30, a = 1, b = 0.5, gama = 5)
fit <- ctp.fit(x)
print(fit)
plot(fit)
```

dctp

Probability Mass Function of the CTP Distribution

Description

Evaluates the probability mass function of the Complex TriParametric Pearson (CTP) distribution for nonnegative integer values.

The pmf is

$$p(x) = p(0) \frac{(a + ib)_x (a - ib)_x}{(\gamma)_x x!}, \quad x = 0, 1, \dots$$

and satisfies the recurrence

$$\frac{p(x + 1)}{p(x)} = \frac{(a + x)^2 + b^2}{(\gamma + x)(x + 1)}.$$

Usage

```
dctp(x, a, b, gama, log = FALSE)
```

Arguments

x	Vector of nonnegative integers.
a	Parameter a.
b	Parameter b (must satisfy $b \geq 0$).
gama	Parameter gamma.
log	Logical; if TRUE, returns log-probabilities.

Value

A numeric vector of probabilities.

Examples

```
dctp(0:5, a = 1, b = 0.5, gama = 6)
```

 dzictp

Probability Mass Function of the ZM-CTP Distribution

Description

The Zero-Modified CTP (ZM-CTP) distribution modifies the zero probability of the baseline CTP distribution.

Usage

```
dzictp(x, a, b, gama, omega, log = FALSE)
```

Arguments

x	Vector of nonnegative integers.
a	Parameter a.
b	Parameter b.
gama	Parameter gamma.
omega	Zero-modification parameter, with $0 < \omega < 1$.
log	Logical; if TRUE, returns log-probabilities.

Value

Numeric vector of probabilities.

Examples

```
dzictp(0:5, a = 1, b = 0.5, gama = 6, omega = 0.3)
```

 pctp

Cumulative Distribution Function of the CTP Distribution

Description

Cumulative Distribution Function of the CTP Distribution

Usage

```
pctp(q, a, b, gama, lower.tail = TRUE, log.p = FALSE)
```

Arguments

q	Vector of quantiles.
a	Parameter a.
b	Parameter b.
gama	Parameter gamma.
lower.tail	Logical; if TRUE, probabilities are $P(X \leq q)$, otherwise $P(X > q)$.
log.p	Logical; if TRUE, probabilities are given on the log scale.

Value

Numeric vector of cumulative probabilities.

Examples

```
pctp(0:5, a = 1, b = 0.5, gama = 6)
```

plot.ctpfit

Plot method for ctpfit objects

Description

Plot method for ctpfit objects

Usage

```
## S3 method for class 'ctpfit'  
plot(x, type = c("frequency", "cdf", "qq"), ...)
```

Arguments

x	A ctpfit object
type	Type of plot: "frequency", "cdf", or "qq"
...	Additional graphical parameters

Value

No return value. Called for its side effect of producing a plot.

plot.zictpfit	<i>Plot method for zictpfit objects</i>
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Description

Creates diagnostic plots for Zero-Modified CTP distribution fits, including frequency comparisons, CDF plots, and Q-Q plots.

Usage

```
## S3 method for class 'zictpfit'  
plot(x, type = c("frequency", "cdf", "qq"), ...)
```

Arguments

x	A zictpfit object from zictp.fit()
type	Type of plot: "frequency", "cdf", or "qq"
...	Additional graphical parameters

Value

No return value. Called for its side effect of producing a plot.

print.ctpfit	<i>Print method for ctpfit objects</i>
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Description

Print method for ctpfit objects

Usage

```
## S3 method for class 'ctpfit'  
print(x, ...)
```

Arguments

x	A ctpfit object
...	Additional arguments (ignored)

Value

Invisibly returns the original fitted model object. The function is called for its side effect of printing a model summary.

<code>print.zictpfit</code>	<i>Print method for zictpfit objects</i>
-----------------------------	--

Description

Print method for zictpfit objects

Usage

```
## S3 method for class 'zictpfit'
print(x, ...)
```

Arguments

<code>x</code>	A zictpfit object
<code>...</code>	Additional arguments (ignored)

Value

Invisibly returns the original fitted model object. The function is called for its side effect of printing a model summary.

<code>pzictp</code>	<i>Cumulative Distribution Function of the ZM-CTP Distribution</i>
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Description

Cumulative Distribution Function of the ZM-CTP Distribution

Usage

```
pzictp(q, a, b, gama, omega, lower.tail = TRUE, log.p = FALSE)
```

Arguments

<code>q</code>	Vector of quantiles.
<code>a</code>	Parameter a.
<code>b</code>	Parameter b.
<code>gama</code>	Parameter gamma.
<code>omega</code>	Zero-modification parameter.
<code>lower.tail</code>	Logical.
<code>log.p</code>	Logical.

Value

Numeric vector of cumulative probabilities.

Examples

```
pzictp(0:5, a = 1, b = 0.5, gama = 6, omega = 0.3)
```

qctp

Quantile Function of the CTP Distribution

Description

Quantile Function of the CTP Distribution

Usage

```
qctp(p, a, b, gama, lower.tail = TRUE, log.p = FALSE, max_q = 1000)
```

Arguments

p	Vector of probabilities.
a	Parameter a.
b	Parameter b.
gama	Parameter gamma.
lower.tail	Logical.
log.p	Logical.
max_q	Maximum x to search.

Value

Numeric vector of quantiles.

Examples

```
qctp(c(0.25, 0.5, 0.75), a = 1, b = 0.5, gama = 6)
```

`qzictp`*Quantile Function of the ZM-CTP Distribution*

Description

Quantile Function of the ZM-CTP Distribution

Usage

```
qzictp(p, a, b, gama, omega, lower.tail = TRUE, log.p = FALSE, max_q = 1000)
```

Arguments

<code>p</code>	Vector of probabilities.
<code>a</code>	Parameter a.
<code>b</code>	Parameter b.
<code>gama</code>	Parameter gamma.
<code>omega</code>	Zero-modification parameter.
<code>lower.tail</code>	Logical.
<code>log.p</code>	Logical.
<code>max_q</code>	Maximum x to search.

Value

Numeric vector of quantiles.

Examples

```
qzictp(c(0.25, 0.5, 0.75), a = 1, b = 0.5, gama = 6, omega = 0.3)
```

`rctp`*Random Generation from the CTP Distribution*

Description

Random Generation from the CTP Distribution

Usage

```
rctp(n, a, b, gama)
```

Arguments

n	Number of observations.
a	Parameter a.
b	Parameter b.
gama	Parameter gamma.

Value

Integer vector of random draws.

Examples

```
set.seed(123)
rctp(10, a = 1, b = 0.5, gama = 6)
```

rzictp

Random Generation from the ZM-CTP Distribution

Description

Random Generation from the ZM-CTP Distribution

Usage

```
rzictp(n, a, b, gama, omega)
```

Arguments

n	Number of observations.
a	Parameter a.
b	Parameter b.
gama	Parameter gamma.
omega	Zero-modification parameter.

Value

Integer vector of random draws.

Examples

```
set.seed(123)
rzictp(10, a = 1, b = 0.5, gama = 6, omega = 0.3)
```

summary.ctpfit	<i>Summary method for ctpfit objects</i>
----------------	--

Description

Summary method for ctpfit objects

Usage

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

Arguments

object	A ctpfit object
...	Additional arguments (ignored)

Value

Invisibly returns the original fitted model object. The function is called for its side effects, producing a formatted summary of parameter estimates, moments, and goodness-of-fit diagnostics.

summary.zictpfit	<i>Summary method for zictpfit objects</i>
------------------	--

Description

Summary method for zictpfit objects

Usage

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

Arguments

object	A zictpfit object
...	Additional arguments (ignored)

Value

Invisibly returns the original fitted model object. The function is called for its side effects, producing a formatted summary of parameter estimates, moments, and goodness-of-fit diagnostics.

zictp.fit	<i>Maximum Likelihood Estimation for the Zero-Modified CTP Distribution</i>
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Description

Fits the Zero-Modified Complex TriParametric Pearson (ZM-CTP) distribution to count data using maximum likelihood estimation.

A logit reparameterization is used for omega to ensure $0 < \omega < 1$, and a log reparameterization is used for gamma so that $\text{gama} = 2 \cdot a + 2 + \exp(\eta)$, which guarantees variance existence throughout optimization.

Usage

```
zictp.fit(  
  x,  
  a_start = NULL,  
  b_start = NULL,  
  gama_start = NULL,  
  omega_start = NULL,  
  method = "BFGS"  
)
```

Arguments

x	Numeric vector of nonnegative counts.
a_start	Optional starting value for parameter a.
b_start	Optional starting value for parameter b.
gama_start	Optional starting value for parameter gamma.
omega_start	Optional starting value for omega ($0 < \omega < 1$).
method	Optimization method (default: "BFGS").

Value

An object of class "zictpfit".

Examples

```
set.seed(123)  
x <- rzictp(30, a = 1, b = 0.5, gama = 5, omega = 0.3)  
fit <- zictp.fit(x)  
fit$estimates
```

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