Package 'zmctp'

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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>.

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URL https://github.com/roladoja/zmctp

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

Maintainer Rasheedat Oladoja <roladoja@ttu.edu>

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Author Rasheedat Oladoja [aut, cre] (ORCID: <https://orcid.org/0009-0001-5883-8039>)

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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)

Maintainer: Rasheedat Oladoja <roladoja@ttu.edu> (ORCID)

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 "ctpfit" 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

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

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 >= 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 $0 < \text{omega} < 1$.
`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 <= 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 *Plot method for zictpfit objects*

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 *Print method for ctpfit objects*

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.

print.zictpfit *Print method for zictpfit objects*

Description

Print method for zictpfit objects

Usage

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

Arguments

x	A zictpfit 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.

pzictp *Cumulative Distribution Function of the ZM-CTP Distribution*

Description

Cumulative Distribution Function of the ZM-CTP Distribution

Usage

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

Arguments

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

p	Vector of probabilities.
a	Parameter a.
b	Parameter b.
gama	Parameter gamma.
omega	Zero-modification parameter.
lower.tail	Logical.
log.p	Logical.
max_q	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 *Summary method for ctpfit objects*

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 *Summary method for zictpfit objects*

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` *Maximum Likelihood Estimation for the Zero-Modified CTP Distribution*

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 gama = 2*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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