

# Package ‘BCD’

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**Type** Package

**Title** Bivariate Distributions via Conditional Specification

**Version** 0.1.1

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**Description** Implementation of bivariate binomial, geometric, and Poisson distributions based on conditional specifications. The package also includes tools for data generation and goodness-of-fit testing for these three distribution families. For methodological details, see Ghosh, Marques, and Chakraborty (2025) <doi:10.1080/03610926.2024.2315294>, Ghosh, Marques, and Chakraborty (2023) <doi:10.1080/03610918.2021.2004419>, and Ghosh, Marques, and Chakraborty (2021) <doi:10.1080/02664763.2020.1793307>.

**License** GPL (>= 2)

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**Imports** stats

**Suggests** knitr, rmarkdown

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**BugReports** <https://github.com/mnrzrad/BCD/issues>

**NeedsCompilation** no

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abortflights	<i>Aborted Flight Counts for 109 Aircrafts</i>
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### Description

This dataset records the number of aborted flights by 109 aircrafts during two consecutive periods. The counts are cross-tabulated by the number of aborted flights in each period.

### Usage

abortflights

### Format

A data frame with 109 rows and 2 variables:

**X** Number of aborted flights in Period 1.

**Y** Number of aborted flights in Period 2.

### References

Barbiero, A. (2019). A bivariate geometric distribution allowing for positive or negative correlation. *Communications in Statistics - Theory and Methods*, 48 (11), 2842—2861. doi:10.1080/03610926.2018.1473428.

Ghosh, I., Marques, F., & Chakraborty, S. (2023) A bivariate geometric distribution via conditional specification: properties and applications, *Communications in Statistics - Simulation and Computation*, 52:12, 5925–5945, doi:10.1080/03610918.2021.2004419

**Examples**

```
data(abortflights)
head(abortflights)
table(abortflights$X, abortflights$Y)
```

---

dbinomBCD	<i>Joint Probability Mass Function for a Bivariate Binomial Distribution via Conditional Specification</i>
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**Description**

Computes the probability mass function (p.m.f.) of the bivariate binomial conditionals distribution (BBCD) as defined by Ghosh, Marques, and Chakraborty (2025). The distribution is characterized by conditional binomial distributions for  $X$  and  $Y$ .

**Usage**

```
dbinomBCD(x, y, n1, n2, p1, p2, lambda)
```

**Arguments**

x	value of $X$ , must be in $\{0, 1, \dots, n_1\}$
y	value of $Y$ , must be in $\{0, 1, \dots, n_2\}$
n1	number of trials for $X$ , must be non-negative
n2	number of trials for $Y$ , must be non-negative
p1	base success probability for $X$ , in $(0, 1)$
p2	base success probability for $Y$ , in $(0, 1)$
lambda	dependence parameter, must be positive.

**Details**

The joint p.m.f. of the BBCD is

$$P(X = x, Y = y) = K_B(n_1, n_2, p_1, p_2, \lambda) \binom{n_1}{x} \binom{n_2}{y} p_1^x p_2^y (1 - p_1)^{n_1 - x} (1 - p_2)^{n_2 - y} \lambda^{xy},$$

where  $x = 0, 1, \dots, n_1$ ,  $y = 0, 1, \dots, n_2$ , and  $K_B(n_1, n_2, p_1, p_2, \lambda)$  is the normalizing constant.

**Value**

The probability  $P(X = x, Y = y)$ .

**References**

Ghosh, I., Marques, F., & Chakraborty, S. (2025). A form of bivariate binomial conditionals distributions. *Communications in Statistics - Theory and Methods*, 54(2), 534–553. doi:10.1080/03610926.2024.2315294

**See Also**

[pbinomBCD](#) [rbinomBCD](#) [MLEbinomBCD](#)

**Examples**

```
# Compute P(X = 2, Y = 1) with n1 = 5, n2 = 5, p1 = 0.5, p2 = 0.4, lambda = 0.5
dbinomBCD(x = 2, y = 1, n1 = 5, n2 = 5, p1 = 0.5, p2 = 0.4, lambda = 0.5)

# Example with independence (lambda = 1)
dbinomBCD(x = 2, y = 1, n1 = 5, n2 = 5, p1 = 0.5, p2 = 0.4, lambda = 1.0)
```

---

dgeomBCD

*Joint Probability Mass Function for A Bivariate Geometric Distribution via Conditional Specification*

---

**Description**

Computes the joint probability mass function (p.m.f.) of a Bivariate Geometric Conditional Distributions (BGCD) based on Ghosh, Marques, and Chakraborty (2023). This distribution models paired count data with geometric conditionals, incorporating dependence between variables  $X$  and  $Y$ .

**Usage**

```
dgeomBCD(x, y, q1, q2, q3)
```

**Arguments**

<code>x</code>	value of $X$ that must be non-negative integer
<code>y</code>	value of $Y$ that must be non-negative integer
<code>q1</code>	probability parameter for $X$ , in $(0, 1]$
<code>q2</code>	probability parameter for $Y$ , in $(0, 1]$
<code>q3</code>	dependence parameter, in $(0, 1]$

**Details**

The joint p.m.f. of the BGCD is:

$$P(X = x, Y = y) = K(q_1, q_2, q_3)q_1^x q_2^y q_3^{xy},$$

where  $K(q_1, q_2, q_3)$  is the normalizing constant computed by the function `normalize_constant_BGCD`.

Note that:

- $q_3 < 1$  : indicates the negative correlation between  $X$  and  $Y$
- $q_3 = 1$  : indicates the independence between  $X$  and  $Y$

**Value**

The probability  $P(X = x, Y = y)$  for each pair of  $x$  and  $y$ .

**References**

Ghosh, I., Marques, F., & Chakraborty, S.(2023) A bivariate geometric distribution via conditional specification: properties and applications, Communications in Statistics - Simulation and Computation, 52:12, 5925–5945, doi:[10.1080/03610918.2021.2004419](https://doi.org/10.1080/03610918.2021.2004419)

**See Also**

[pgeomBCD](#) [rgeomBCD](#) [MLEgeomBCD](#)

**Examples**

```
# Compute P(X = 1, Y = 2) with q1 = 0.5, q2 = 0.6, q3 = 0.8
dgeomBCD(x = 1, y = 2, q1 = 0.5, q2 = 0.6, q3 = 0.8)

# # Compute P(X = 0, Y = 4) with q1 = 0.5, q2 = 0.6, q3 = 0.8
dgeomBCD(x = 0, y = 4, q1 = 0.5, q2 = 0.6, q3 = 0.8)
```

---

dpoisBCD

*Joint Probability Mass Function for a Bivariate Poisson Distribution via Conditional Specification*

---

**Description**

Computes the joint probability mass function (p.m.f.) of a Bivariate Poisson Conditionals distribution (BPCD) based on Ghosh, Marques, and Chakraborty (2021).

**Usage**

```
dpoisBCD(x, y, lambda1, lambda2, lambda3)
```

**Arguments**

<code>x</code>	value of $X$ that must be a non-negative integer
<code>y</code>	value of $Y$ that must be a non-negative integer
<code>lambda1</code>	rate parameter for $X$ that must be positive
<code>lambda2</code>	rate parameter for $Y$ that must be positive
<code>lambda3</code>	dependence parameter that must be $(0, 1]$

**Details**

The joint p.m.f. of the BGCD is

$$P(X = x, Y = y) = K(\lambda_1, \lambda_2, \lambda_3) \frac{\lambda_1^x \lambda_2^y \lambda_3^{xy}}{x!y!},$$

where  $x, y = 0, 1, 2, \dots$ , and  $K(\lambda_1, \lambda_2, \lambda_3)$  is the normalizing constant computed by the function `normalize_constant_BPCD`.

Key properties of the BPCD include:

- Negative correlation for  $\lambda_3 < 1$ ,
- Independence for  $\lambda_3 = 1$ .

**Value**

probability  $P(X = x, Y = y)$  for each pair of  $x$  and  $y$ .

**References**

Ghosh, I., Marques, F., & Chakraborty, S. (2021). A new bivariate Poisson distribution via conditional specification: properties and applications. *Journal of Applied Statistics*, 48(16), 3025-3047. [doi:10.1080/02664763.2020.1793307](https://doi.org/10.1080/02664763.2020.1793307)

**See Also**

[rpoisBCD](#), [ppoisBCD](#)

**Examples**

```
# Compute P(X = 1, Y = 2) with lambda1 = 0.5, lambda2 = 0.5, lambda3 = 0.5
dpoisBCD(x = 1, y = 2, lambda1 = 0.5, lambda2 = 0.5, lambda3 = 0.5)

# Compute P(X = 0, Y = 1) with lambda1 = 0.5, lambda2 = 0.5, lambda3 = 0.5
dpoisBCD(x = 0, y = 1, lambda1 = 0.5, lambda2 = 0.5, lambda3 = 0.5)
```

---

eplSeasonGoals

*English Premier League Goals (2014–2019)*

---

**Description**

A list of data frames for five consecutive seasons (2014/15 to 2018/19) from the English Premier League. Each data frame contains the number of full-time home ('X') and away ('Y') goals scored in each match of the season.

**Usage**

```
data(eplSeasonGoals)
```

**Format**

A named list of 5 data frames:

**1415** 380 rows, variables: X (home goals), Y (away goals)

**1516** 380 rows, variables: X (home goals), Y (away goals)

**1617** 380 rows, variables: X (home goals), Y (away goals)

**1718** 380 rows, variables: X (home goals), Y (away goals)

**1819** 380 rows, variables: X (home goals), Y (away goals)

**1920** 380 rows, variables: X (home goals), Y (away goals)

**2021** 380 rows, variables: X (home goals), Y (away goals)

**2122** 380 rows, variables: X (home goals), Y (away goals)

**2223** 380 rows, variables: X (home goals), Y (away goals)

**2324** 380 rows, variables: X (home goals), Y (away goals)

**2525** 380 rows, variables: X (home goals), Y (away goals)

**Details**

Data source: English Premier League match results from <https://football-data.co.uk/> (formerly hosted on datahub.io).

**References**

Ghosh, I., Marques, F., & Chakraborty, S. (2021). A new bivariate Poisson distribution via conditional specification: properties and applications. *Journal of Applied Statistics*, 48(16), 3025-3047. doi:10.1080/02664763.2020.1793307

**Examples**

```
data/eplSeasonGoals)
head/eplSeasonGoals[["1415"]]
head/eplSeasonGoals[["2425"]]
```

---

FTtest

*Freeman–Tukey Test for Bivariate Distributions via Conditional Specification*

---

**Description**

Performs a goodness-of-fit test using the Freeman–Tukey (F–T) statistic for a given dataset and a specified bivariate distribution via Conditional Specification.

**Usage**

```
FTtest(data, distribution, params, num_params)
```

**Arguments**

<code>data</code>	a dataset or matrix with two columns.
<code>distribution</code>	a string specifying the theoretical distribution ("BBCD", "BBPD", or "BBGD").
<code>params</code>	a named list of parameters required by the specified distribution.
<code>num_params</code>	an integer specifying the number of parameters that were estimated

**Details**

The Freeman–Tukey (F–T) statistic is used to assess the goodness of fit in contingency tables. It is defined as:

$$T^2 = 4 \sum_{i=1}^r \sum_{j=1}^c \left( \sqrt{O_{ij}} - \sqrt{E_{ij}} \right)^2$$

where  $O_{ij}$  and  $E_{ij}$  are the observed and expected frequencies, respectively.

The statistic  $T^2$  asymptotically follows a chi-squared distribution with  $(r \cdot c - 1)$  degrees of freedom, where  $r$  is the number of rows and  $c$  is the number of columns in the contingency table.

**Value**

A list with components:

**observed** Observed frequency table

**expected** Expected frequency table under the specified distribution

**test** Result of the Freeman–Tukey test, a list with test statistic and p-value

**Examples**

```
samples <- rgeomBCD(n = 20, q1 = 0.5, q2 = 0.5, q3 = 0.1, seed = 123)
params <- MLEgeomBCD(samples)
result_bgcd <- FTtest(samples, "BGCD", params, num_params = 3)
result_bgcd
```

```
samples <- rpoisBCD(20, lambda1=.5, lambda2=.5, lambda3=.5)
params <- MLEpoisBCD(samples)
result_bpcd <- FTtest(samples, "BPCD", params, num_params = 3)
result_bpcd
```



---

lensfaults

*Surface and Interior Faults in 100 Lenses*


---

**Description**

This dataset records counts of surface faults ( $X$ ) and interior faults ( $Y$ ) observed in 100 optical lenses

**Usage**

```
lensfaults
```

**Format**

A data frame with 100 rows and 2 variables:

**X** Number of surface faults in a lens.

**Y** Number of interior faults in the same lens.

**References**

Aitchison, J., & Ho, C. H. (1989). The multivariate Poisson-log normal distribution. *Biometrika*, 76(4), 643–653.

Ghosh, I., Marques, F., & Chakraborty, S. (2021). A new bivariate Poisson distribution via conditional specification: properties and applications. *Journal of Applied Statistics*, 48(16), 3025-3047. [doi:10.1080/02664763.2020.1793307](https://doi.org/10.1080/02664763.2020.1793307)

---

MLEbinomBCD

*Maximum Likelihood Estimation for a Bivariate Binomial Distribution via Conditional Specification*


---

**Description**

Estimates the parameters of a Bivariate Binomial Conditionals via Conditional Specification using maximum likelihood.

**Usage**

```
MLEbinomBCD(data, fixed_n1 = NULL, fixed_n2 = NULL, verbose = TRUE)
```

**Arguments**

data	A data frame or matrix with columns ‘X’ and ‘Y’
fixed_n1	known value of ‘n1’ (NULL to estimate)
fixed_n2	known value of ‘n2’ (NULL to estimate)
verbose	logical; print progress

**Value**

A list of class "MLEpoisBCD" containing:

n1 estimated n1

n2 estimated n2

p1 estimated p1

p2 estimated p2

lambda estimated lambda

logLik Maximum log-likelihood achieved.

AIC Akaike Information Criterion.

BIC Bayesian Information Criterion.

convergence Convergence status from the optimizer (0 means successful).

**Examples**

```
data <- rbinomBCD(n = 10, n1 = 5, n2 = 3, p1 = 0.6, p2 = 0.4, lambda = 1.2)
MLEbinomBCD(data)
MLEbinomBCD(data, fixed_n1 = 5, fixed_n2 = 3)
```

---

MLEgeomBCD

*Maximum Likelihood Estimation for a Bivariate Geometric Distribution via Conditional Specification*

---

**Description**

Estimates the parameters of a bivariate geometric distribution via Conditional Specification using maximum likelihood.

**Usage**

```
MLEgeomBCD(data, initial_values = c(0.5, 0.5, 0.5))
```

**Arguments**

**data** data frame or matrix with two columns, representing paired observations of count variables  $(X, Y)$ .

**initial\_values** numeric vector of length 3 with initial values for the parameters  $q_1, q_2$ , and  $q_3$ . Must be strictly between 0 and 1. Default is  $c(0.5, 0.5, 0.5)$ .

**Details**

The model estimates parameters from a joint distribution for  $(X, Y)$  with the form:

$$P(X = x, Y = y) = K(q_1, q_2, q_3) q_1^x q_2^y q_3^{xy},$$

where  $K(q_1, q_2, q_3)$  is the normalizing constant.

**Value**

A list containing:

q1 estimated q1.

q2 estimated q2.

q3 estimated q3.

logLik Maximum log-likelihood achieved.

AIC Akaike Information Criterion.

BIC Bayesian Information Criterion.

convergence Convergence status from the optimizer (0 means successful).

**References**

Ghosh, I., Marques, F., & Chakraborty, S. (2023) A bivariate geometric distribution via conditional specification: properties and applications, *Communications in Statistics - Simulation and Computation*, 52:12, 5925–5945, doi:[10.1080/03610918.2021.2004419](https://doi.org/10.1080/03610918.2021.2004419)

**See Also**

[dgeomBCD](#) [pgeomBCD](#) [rgeomBCD](#)

**Examples**

```
# Simulate data
samples <- rgeomBCD(n = 50, q1 = 0.2, q2 = 0.2, q3 = 0.5)
result <- MLEgeomBCD(samples)
print(result)
# For better estimation accuracy and stability, consider increasing the sample size (n = 1000)

data(abortflights)
MLEgeomBCD(abortflights)
```

---

MLEpoisBCD

*Maximum Likelihood Estimation for a Bivariate Poisson Distribution via Conditional Specification*

---

**Description**

Estimates the parameters of a bivariate Poisson distribution via Conditional Specification using maximum likelihood.

**Usage**

```
MLEpoisBCD(data, initial_values = NULL)
```

**Arguments**

- `data` data frame or matrix with two columns, representing paired observations of count variables  $(X, Y)$ .
- `initial_values` optional named list with initial values for the parameters: `lambda1`, `lambda2`, and `lambda3`. If not provided, the function computes heuristic starting values.

**Details**

The model estimates parameters from a joint distribution for  $(X, Y)$  with the form:

$$P(X = x, Y = y) = K(\lambda_1, \lambda_2, \lambda_3) \frac{\lambda_1^x \lambda_2^y \lambda_3^{xy}}{x!y!},$$

where  $x, y = 0, 1, 2, \dots$ , and  $K(\lambda_1, \lambda_2, \lambda_3)$  is the normalizing constant.

**Value**

A list of class "MLEpoisBCD" containing:

`lambda1` estimated `lambda1`.

`lambda2` estimated `lambda2`.

`lambda3` estimated dependence parameter (must be in  $(0, 1]$ ).

`logLik` Maximum log-likelihood achieved.

`AIC` Akaike Information Criterion.

`BIC` Bayesian Information Criterion.

`convergence` Convergence status from the optimizer (0 means successful).

**See Also**

[dpoisBCD](#) [ppoisBCD](#) [rpoisBCD](#)

**Examples**

```
# Simulate data
data <- rpoisBCD(n = 50, lambda1 = 3, lambda2 = 5, lambda3 = 1)
result <- MLEpoisBCD(data)
print(result)

data(eplSeasonGoals)
MLEpoisBCD(eplSeasonGoals[["1819"]])

data(lensfaults)
MLEpoisBCD(lensfaults)
```

pbinomBCD

*Cumulative Distribution Function for a Bivariate Binomial Distribution via Conditional Specification*

### Description

Computes the cumulative distribution function (c.d.f.) of a bivariate binomial conditionals distribution (BBCD) as defined by Ghosh, Marques, and Chakraborty (2025).

### Usage

```
pbinomBCD(x, y, n1, n2, p1, p2, lambda)
```

### Arguments

x	value at which the c.d.f. is evaluated
y	value at which the c.d.f. is evaluated
n1	number of trials for $X$ , must be non-negative.
n2	number of trials for $Y$ , must be non-negative.
p1	base success probability for $X$ , in $(0, 1)$ .
p2	base success probability for $Y$ , in $(0, 1)$ .
lambda	dependence parameter, must be positive.

### Value

The probability  $P(X \leq x, Y \leq y)$ .

### References

Ghosh, I., Marques, F., & Chakraborty, S. (2025). A form of bivariate binomial conditionals distributions. *Communications in Statistics - Theory and Methods* 54(2), 534–553. doi:10.1080/03610926.2024.2315294

### See Also

[dbinomBCD](#) [rbinomBCD](#)

### Examples

```
# Compute P(X \le 2, Y \le 1) with n1 = 5, n2 = 5, p1 = 0.5, p2 = 0.4, lambda = 0.5
pbinomBCD(x = 2, y = 1, n1 = 5, n2 = 5, p1 = 0.5, p2 = 0.4, lambda = 0.5)

# Example with independence (lambda = 1)
pbinomBCD(x = 1, y = 1, n1 = 10, n2 = 10, p1 = 0.3, p2 = 0.6, lambda = 1)
```

pgeomBCD

*Cumulative Distribution Function for a Bivariate Geometric Distribution via Conditional Specification*

### Description

Computes the cumulative distribution function (c.d.f.) of a bivariate geometric conditionals distribution (BGCD) based on Ghosh, Marques, and Chakraborty (2023).

### Usage

```
pgeomBCD(x, y, q1, q2, q3)
```

### Arguments

x	value at which the c.d.f. is evaluated
y	value at which the c.d.f. is evaluated
q1	probability parameter for $X$ , in $(0, 1]$
q2	probability parameter for $Y$ , in $(0, 1]$
q3	dependence parameter, in $(0, 1]$

### Value

The probability  $P(X \leq x, Y \leq y)$ .

### References

Ghosh, I., Marques, F., & Chakraborty, S. (2023) A bivariate geometric distribution via conditional specification: properties and applications, *Communications in Statistics - Simulation and Computation*, 52:12, 5925–5945, doi:[10.1080/03610918.2021.2004419](https://doi.org/10.1080/03610918.2021.2004419)

### See Also

[dgeomBCD](#) [rgeomBCD](#)

### Examples

```
# Compute P(X \le 1, Y \le 2) with q1 = 0.5, q2 = 0.6, q3 = 0.8
pgeomBCD(x = 1, y = 2, q1 = 0.5, q2 = 0.6, q3 = 0.8)

# Example with small values
pgeomBCD(x = 0, y = 0, q1 = 0.4, q2 = 0.3, q3 = 0.9)
```

ppoisBCD

*Cumulative Distribution Function for a Bivariate Poisson Distribution via Conditional Specification*

### Description

Computes the cumulative distribution function (c.d.f.) of a bivariate Poisson distribution (BPD) with conditional specification, as described by Ghosh, Marques, and Chakraborty (2021).

### Usage

```
ppoisBCD(x, y, lambda1, lambda2, lambda3)
```

### Arguments

x	value at which the c.d.f. is evaluated
y	value at which the c.d.f. is evaluated
lambda1	rate parameter for $X$ that must be positive
lambda2	rate parameter for $Y$ that must be positive
lambda3	dependence parameter that must be $(0, 1]$

### Value

The probability  $P(X \leq x, Y \leq y)$ .

### References

Ghosh, I., Marques, F., & Chakraborty, S. (2021). A new bivariate Poisson distribution via conditional specification: properties and applications. *Journal of Applied Statistics*, 48(16), 3025-3047. doi:[10.1080/02664763.2020.1793307](https://doi.org/10.1080/02664763.2020.1793307)

### See Also

[dpoisBCD](#) [rpoisBCD](#)

### Examples

```
# Compute P(X \le 1, Y \le 1) with lambda1 = 0.5, lambda2 = 0.5, lambda3 = 0.5
ppoisBCD(x = 1, y = 1, lambda1 = 0.5, lambda2 = 0.5, lambda3 = 0.5)

# Example with larger values
ppoisBCD(x = 2, y = 2, lambda1 = 1.0, lambda2 = 1.0, lambda3 = 0.8)
```

---

rbinomBCD	<i>Random Sampling from a Bivariate Binomial Distribution via Conditional Specification</i>
-----------	---

---

**Description**

Generates random samples from a bivariate binomial conditionals distribution (BBCD).

**Usage**

```
rbinomBCD(n, n1, n2, p1, p2, lambda, seed = 123, verbose = TRUE)
```

**Arguments**

n	number of samples to generate.
n1	number of trials for $X$ , must be non-negative.
n2	number of trials for $Y$ , must be non-negative.
p1	base success probability for $X$ , in $(0, 1)$ .
p2	base success probability for $Y$ , in $(0, 1)$ .
lambda	dependence parameter, must be positive.
seed	seed for random number generation (default = 123).
verbose	logical; if TRUE (default), prints progress updates and a summary.

**Value**

A data frame with columns 'X' and 'Y', containing the sampled values.

**Examples**

```
samples <- rbinomBCD(n = 100, n1 = 10, n2 = 10, p1 = 0.5, p2 = 0.4, lambda = 1.2)
head(samples)
```

---

rgeomBCD	<i>Random Sampling from a Bivariate Geometric Distribution via Conditional Specification</i>
----------	--

---

**Description**

Generates random samples from a bivariate geometric distribution (BGCD)

**Usage**

```
rgeomBCD(n, q1, q2, q3, seed = 123)
```



**Arguments**

n	number of samples to generate
q1	probability parameter for $X$ , in $(0, 1]$
q2	probability parameter for $Y$ , in $(0, 1]$
q3	dependence parameter, in $(0, 1]$
seed	seed for random number generation (default = 123)

**Value**

A data frame with two columns: 'X' and 'Y', containing the sampled values.

**Examples**

```
# Generate 100 samples
samples <- rgeomBCD(n = 100, q1 = 0.5, q2 = 0.5, q3 = 0.00001)
head(samples)
cor(samples$X, samples$Y) # Should be negative
```

---

rpoisBCD	<i>Random Sampling from a Bivariate Poisson Distribution via Conditional Specification</i>
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---

**Description**

Generates random samples from a bivariate Poisson distribution (BPD).

**Usage**

```
rpoisBCD(n, lambda1, lambda2, lambda3, seed = 123)
```

**Arguments**

n	number of samples to generate
lambda1	rate parameter for $X$ that must be positive
lambda2	rate parameter for $Y$ that must be positive
lambda3	dependence parameter that must be $(0, 1]$
seed	seed for random number generation (default = 123)

**Value**

A data frame with columns 'X' and 'Y', containing the sampled values.

**Examples**

```
samples <- rpoisBCD(n = 100, lambda1 = 0.5, lambda2 = 0.5, lambda3 = 0.5)
cor(samples$X, samples$Y) # Should be negative
```

---

seedplant

*Seed and Plant Count Data*

---

### Description

This dataset records the number of seeds sown and the number of resulting plants grown over plots of fixed area (5 square feet).

### Usage

seedplant

### Format

A data frame with  $n$  rows and 2 variables:

**X** Number of seeds sown.

**Y** Number of plants grown.

#' @references Lakshminarayana, J., S. N. N. Pandit, and K. Srinivasa Rao. 1999. On a bivariate poisson distribution. *Communications in Statistics - Theory and Methods*, 28 (2), 267–276. doi:10.1080/03610929908832297

Ghosh, I., Marques, F., & Chakraborty, S. (2025). A form of bivariate binomial conditionals distributions. *Communications in Statistics - Theory and Methods*, 54(2), 534–553. doi:10.1080/03610926.2024.2315294

### Examples

```
data(seedplant)
head(seedplant)
plot(seedplant$X, seedplant$Y,
      xlab = "Seeds Sown",
      ylab = "Plants Grown",
      main = "Seed vs. Plant Count per Plot")
```

---

shacc

*Railway Shunter Accident Data (1937–1947)*

---

### Description

Accident records for 122 experienced railway shunters across two historical periods.

### Usage

shacc

**Format**

A data frame with 122 rows and 2 variables:

**X** Number of accidents during the 6-year period from 1937 to 1942.

**Y** Number of accidents during the 5-year period from 1943 to 1947.

This dataset is useful for analyzing accident rates before and after possible policy or operational changes.

**References**

Arbous, A. G., & Kerrich, J. E. (1951). Accident statistics and the concept of accident-proneness. *Biometrics*, 7(4), 340. doi:[10.2307/3001656](https://doi.org/10.2307/3001656)

Ghosh, I., Marques, F., & Chakraborty, S. (2025). A form of bivariate binomial conditionals distributions. *Communications in Statistics - Theory and Methods*, 54(2), 534–553. doi:[10.1080/03610926.2024.2315294](https://doi.org/10.1080/03610926.2024.2315294)

**Examples**

```
data(shacc)
head(shacc)
plot(shacc$X, shacc$Y, xlab = "Accidents 1937-42", ylab = "Accidents 1943-47")
```

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