

# Package ‘eggCounts’

September 18, 2023

**Imports** methods, utils, rstan ( $\geq 2.26$ ), rstantools ( $\geq 2.1.1$ ), boot, coda, numbers, lattice, rootSolve

**Depends** R ( $\geq 3.4.0$ ), Rcpp ( $\geq 0.12.0$ )

**Suggests** eggCountsExtra, R.rsp, testthat

**VignetteBuilder** R.rsp

**Title** Hierarchical Modelling of Faecal Egg Counts

**Version** 2.3-4

**Date** 2023-09-07

**Maintainer** Craig Wang <craigwang247@gmail.com>

**Description** An implementation of Bayesian hierarchical models for faecal egg count data to assess anthelmintic efficacy. Bayesian inference is done via MCMC sampling using 'Stan' <<https://mc-stan.org/>>.

**SystemRequirements** GNU make

**Additional\_repositories** <https://craigwangstat.github.io/eggCountsExtra-package/>

**License** GPL ( $\geq 3$ )

**LinkingTo** rstan ( $\geq 2.18.1$ ), Rcpp ( $\geq 0.12.0$ ), BH ( $\geq 1.66.0$ ), StanHeaders ( $\geq 2.18.0$ ), RcppEigen ( $\geq 0.3.3.3.0$ ), RcppParallel ( $\geq 5.0.1$ )

**LazyLoad** yes

**LazyData** true

**ByteCompile** true

**Biarch** true

**NeedsCompilation** yes

**URL** <https://www.math.uzh.ch/pages/eggcount/>

**RcppModules** stan\_fit4paired\_mod, stan\_fit4unpaired\_mod, stan\_fit4zipaired\_mod, stan\_fit4ziunpaired\_mod, stan\_fit4nb\_mod, stan\_fit4zinb\_mod, stan\_fit4indefficacy\_mod, stan\_fit4simple\_mod

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eggCounts-package      *Hierarchical modelling of faecal egg counts*

---

## Description

This package implements Bayesian hierarchical models for the analysis of faecal egg count data. Bayesian inference is done via efficient MCMC sampling using Stan. Additional (experimental) models are available externally for handling FECs with potential outliers or bi-modality. The models are in **eggCountsExtra** package hosted on Github.

## Details

Package: eggCounts  
 Type: Package  
 Version: 2.3-4  
 Date: 2023-09-07  
 License: GPL (>= 3)  
 LazyLoad: yes

## About Stan

Stan is a probabilistic programming language for specifying Bayesian hierarchical models. It is computationally faster compared to conventional MCMC techniques. For the installation instruction and other information about Stan, please read [here](#).

## Author(s)

Craig Wang <craig.wang@math.uzh.ch>  
Michaela Paul

## Examples

```
## Not run:  
  
## Citations  
citation('eggCounts')  
  
## History of changes  
file.show(system.file("NEWS", package = "eggCounts"))  
  
## Demonstration  
demo("fecm_stan", package = "eggCounts")  
  
## Install eggCountsExtra  
devtools::install_github("CraigWangUZH/eggCountsExtra")  
  
## End(Not run)
```

---

eggs

*Faecal egg count samples (before and after treatment)*

---

## Description

This is an example dataset containing 14 eggs per gram (epg) values in sheep before and after anthelmintic treatment of benzimidazole. The correction factor of the diagnostic technique was 50.

## Usage

```
data(eggs)
```

## Format

A data.frame containing 14 observations.

## References

Craig Wang, Paul R. Torgerson, Johan Høglund, Reinhard Furrer, Zero-inflated hierarchical models for faecal egg counts to assess anthelmintic efficacy, *Veterinary Parasitology*, Volume 235, 2017, Pages 20-28.

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fecrtCI

*Compute standard FECRT according to WAAVP guidelines*

---

## Description

Computes the standard Faecal Egg Count Reduction Test together with approximate confidence interval according to the WAAVP guidelines (Coles et al., 1992, 2006). The function also returns bootstrap confidence intervals.

## Usage

```
fecrtCI(egp1, egp2, paired = FALSE, alpha = 0.05, R = 1999)
```

## Arguments

egp1	numeric vector. Faecal egg counts in untreated animals.
egp2	numeric vector. Faecal egg counts in treated animals.
paired	logical. If TRUE, indicates samples are paired. Otherwise samples are unpaired.
alpha	numeric. Confidence level of the interval.
R	numeric. Number of bootstrap replicates.

## Value

A list with	
estimate	estimated percentage reduction in mean epg
bootCI	bootstrap confidence interval
approxCI	approximate confidence interval

## Author(s)

Michaela Paul

## References

Coles GC, Bauer C, Borgsteede FHM, Geerts S, Klei TR, Taylor MA and Waller, PJ (1992). World Association for the Advancement of Veterinary Parasitology (WAAVP) methods for the detection of anthelmintic resistance in nematodes of veterinary importance, *Veterinary Parasitology*, 44:35-44.

Coles GC, Jackson F, Pomroy WE, Prichard RK, von Samson-Himmelstjerna G, Silvestre A, Taylor MA and Vercruyse J (2006). The detection of anthelmintic resistance in nematodes of veterinary importance, *Veterinary Parasitology*, 136:167-185.

**Examples**

```
data(eggs)
fecrtCI(eggs$before, eggs$after, paired = TRUE)
```

---

fecr_probs	<i>Compute probability of the reduction parameter relative to a given threshold</i>
------------	---

---

**Description**

Computes probability of the reduction parameter's marginal posterior density relative to a threshold.

**Usage**

```
fecr_probs(stanFit, threshold = 0.95, lessthan = TRUE,
           plot = TRUE, xlab, ylab, main, verbose = TRUE, ...)
```

**Arguments**

stanFit	a <code>stanfit</code> object from the output of <code>fecr_stan()</code> .
threshold	numeric. The default threshold is 0.95 (95%).
lessthan	logical. If TRUE, the probability less than the threshold is computed. Otherwise greater or equal to the threshold is computed. Default is TRUE.
plot	logical. If TRUE, the posterior density of the reduction is plotted with region less than the threshold shaded.
xlab, ylab, main	strings. Arguments for plotting. Only used if <code>plot = TRUE</code> .
verbose	logical. If TRUE, a statement with computed probability is printed.
...	additional plotting arguments

**Value**

Returns a numeric value indicating the probability in percentage.

**Author(s)**

Craig Wang

**Examples**

```
## load sample data
data(eggs)

## apply individual efficacy model to the data vectors
model <- fecr_stan(eggs$before, eggs$after, rawCounts = FALSE, preCF = 10,
                  paired = TRUE, indEfficacy = TRUE)
fecr_probs(model$stan.samples)
```

---

fecr\_stan                      *Model the reduction of faecal egg count*

---

### Description

Models the reduction in faecal egg counts with Bayesian hierarchical models. See Details for a list of model choices.

### Usage

```
fecr_stan(preFEC, postFEC, rawCounts = FALSE, preCF = 50, postCF = preCF,
  paired = TRUE, indEfficacy = TRUE, zeroInflation = FALSE,
  muPrior, kappaPrior, deltaPrior, phiPrior, deltakappaPrior,
  nsamples = 2000, nburnin = 1000, thinning = 1, nchain = 2,
  ncore = 1, adaptDelta = 0.95, saveAll = FALSE, verbose = FALSE)
```

### Arguments

preFEC	numeric vector. Pre-treatment faecal egg counts.
postFEC	numeric vector. Post-treatment faecal egg counts.
rawCounts	logical. If TRUE, preFEC and postFEC correspond to raw counts (as counted on equipment). Otherwise they correspond to calculated eggs (raw counts times correction factor). Defaults to FALSE.
preCF	a positive integer or a vector of positive integers. Pre-treatment correction factor(s).
postCF	a positive integer or a vector of positive integers. Post-treatment correction factor(s).
paired	logical. If TRUE, uses the model for the paired design. Otherwise uses the model for the unpaired design
indEfficacy	logical. If TRUE, uses the paired model allowing for individual efficacy. Only use in combination with paired = TRUE and zeroInflation = FALSE.
zeroInflation	logical. If TRUE, uses the model with zero-inflation. Otherwise uses the model without zero-inflation.
muPrior	a named list. Prior for the group mean epg parameter $\mu$ . The default prior is <code>list(priorDist = "gamma", hyperpars = c(1, 0.001))</code> , i.e. a gamma distribution with shape 1 and rate 0.001, its 90% probability mass lies between 51 and 2996.
kappaPrior	a named list. Prior for the group dispersion parameter $\kappa$ . The default prior is <code>list(priorDist = "gamma", hyperpars = c(1, 0.7))</code> , i.e. a gamma distribution with shape 1 and rate 0.7, its 90% probability mass lies between 0.1 and 4.3 with a median of 1.
deltaPrior	a named list. Prior for the reduction parameter $\delta$ . The default prior is <code>list(priorDist = "beta", hyperpars = c(1, 1))</code> , i.e. a uniform prior between 0 and 1.

phiPrior	a named list. Prior for the zero-inflation parameter $\phi$ . The default prior is <code>list(priorDist = "beta", hyperpars = c(1,1))</code> , i.e. a uniform prior between 0 and 1.
deltakappaPrior	a named list. Prior information for the shape parameter of reduction $\delta_\kappa$ . The default prior is <code>list(priorDist = "normal", hyperpars=c(2,1))</code> . Only used if <code>indEfficacy = TRUE</code> .
nsamples	a positive integer. Number of samples for each chain (including burn-in samples).
nburnin	a positive integer. Number of burn-in samples.
thinning	a positive integer. Thinning parameter, i.e. the period for saving samples.
nchain	a positive integer. Number of chains.
ncore	a positive integer. Number of cores to use when executing the chains in parallel.
adaptDelta	numeric. The target acceptance rate, a numeric value between 0 and 1.
saveAll	logical. If TRUE, posterior samples for all parameters are saved in the <code>stanfit</code> object. If FALSE, only samples for $\delta$ , $\mu$ , $\kappa$ and $\phi$ are saved. Default to FALSE.
verbose	logical. If TRUE, prints progress and debugging information.

## Details

### List of built-in models:

- unpaired without zero-inflation: `set paired = FALSE, indEfficacy = FALSE, zeroInflation = FALSE`
- unpaired with zero-inflation: `set paired = FALSE, indEfficacy = FALSE, zeroInflation = TRUE`
- paired without zero-inflation: `set paired = TRUE, indEfficacy = FALSE, zeroInflation = FALSE`
- paired with zero-inflation: `set paired = TRUE, indEfficacy = FALSE, zeroInflation = TRUE`
- paired with individual efficacy: `set paired = TRUE, indEfficacy = TRUE, zeroInflation = FALSE`

### Prior choice:

Consider using non-default prior for  $\delta$  when,

- there is on average an increase in egg counts after treatment
- there are divergent-sample warnings
- there are non-convergence warnings

Two examples of useful non-default priors include:

1. `list(priorDist = "normal", hyperpars = c(1, 5))` for stabilizing the reduction parameter without being informative.
2. `list(priorDist = "beta", hyperpars = c(0, 5))` for allowing up to 4-fold increase of egg count after treatment.

**Other information:** The first time each model with non-default priors is applied, it can take up to 20 seconds to compile the model. Currently the function only support prior distributions with two parameters. For a complete list of supported priors and their parameterization, please consult the list of distributions in [Stan User Guide](#).

The default number of samples per chain is 2000, with 1000 burn-in samples. Normally this is sufficient in Stan. If the chains do not converge, one should tune the MCMC parameters until convergence is reached to ensure reliable results.

## Value

Prints out the posterior summary of FECR as the reduction, `meanEPG.untreated` as the mean pre-treatment `epg`, and `meanEPG.treated` as the mean after-treatment `epg`. The posterior summary contains the mean, standard deviation (`sd`), 2.5%, 50% and 97.5% percentiles, the 95% highest posterior density interval (`HPDLow95` and `HPDHigh95`) and the posterior mode.

NOTE: Based on our simulation studies, we recommend to use (2.5%, 97.5%) as the 95% credible interval and the median as summary statistics of reduction for the individual efficacy model. For all other models, we recommend to use the 95% HPD interval and the mode.

The returned value is a list that consists of:

```
stan.samples    an object of S4 class stanfit representing the fitted results
posterior.summary
                 a data.frame that is the same as the printed posterior summary
```

## Author(s)

Craig Wang

## References

**Individual efficacy models:** Craig Wang, Paul R. Torgerson, Ray M. Kaplan, Melissa M. George, Reinhard Furrer. (2018) Modelling anthelmintic resistance by extending `eggCounts` package to allow individual efficacy, *International Journal for Parasitology: Drugs and Drug Resistance*, Volume 8, Pages 386-393. <[doi:10.1016/j.ijpddr.2018.07.003](https://doi.org/10.1016/j.ijpddr.2018.07.003)>

**Zero-inflation models:** Craig Wang, Paul R. Torgerson, Johan Hoglund, Reinhard Furrer. (2017) Zero-inflated hierarchical models for faecal egg counts to assess anthelmintic efficacy, *Veterinary Parasitology*, Volume 235, Pages 20-28. <[doi:10.1016/j.vetpar.2016.12.007](https://doi.org/10.1016/j.vetpar.2016.12.007)>

**Other models:** Paul R. Torgerson, Michaela Paul, Reinhard Furrer. (2014) Evaluating faecal egg count reduction using a specifically designed package 'eggCounts' in R and a user friendly web interface, *International Journal for Parasitology*, Volume 44, Pages 299-303. <[doi:10.1016/j.ijpara.2014.01.005](https://doi.org/10.1016/j.ijpara.2014.01.005)>

## See Also

[simData2s](#) for simulating faecal egg counts data with two samples



## Examples

```
## load sample data
data(eggs)

## apply individual efficacy model to the data vectors
model <- fecr_stan(eggs$before, eggs$after, rawCounts = FALSE, preCF = 50,
                  paired = TRUE, indEfficacy = TRUE)
## convert to MCMC object and inspect the summary
samples <- stan2mcmc(model$stan.samples)
summary(samples)
```

---

fecr\_stanExtra

*Model the reduction of faecal egg count using custom models*

---

## Description

Models the reduction in faecal egg counts with custom model formulation using Stan modelling language (for advanced users).

## Usage

```
fecr_stanExtra(preFEC, postFEC, rawCounts = FALSE, preCF = 50, postCF = preCF,
              modelName = NULL, modelCode = NULL, modelFile = NULL, modelData = NULL,
              nsamples = 2000, nburnin = 1000, thinning = 1, nchain = 2,
              ncore = 1, adaptDelta = 0.95, verbose = FALSE)
```

## Arguments

preFEC	numeric vector. Pre-treatment faecal egg counts. Not required if modelData is supplied.
postFEC	numeric vector. Post-treatment faecal egg counts. Not required if modelData is supplied.
rawCounts	logical. If TRUE, preFEC and postFEC correspond to raw counts (as counted on equipment). Otherwise they correspond to calculated eggs (raw counts times correction factor). Defaults to FALSE. Not required if modelCode or modelFile is supplied.
preCF	a positive integer or a vector of positive integers. Pre-treatment correction factor(s). Not required if modelCode or modelFile is supplied.
postCF	a positive integer or a vector of positive integers. Post-treatment correction factor(s). Not required if modelCode or modelFile is supplied.
modelName	string. One of four available models ("Po", "UPo", "ZIPo", "ZIUPo") from <b>eggCountsExtra</b> package, which corresponds to outlier-adjusted version of paired, unpaired, paired with zero inflation and unpaired with zero inflation models. Not required if modelCode or modelFile is supplied.
modelCode	stan model code. Not required when modelName or modelFile is supplied.

<code>modelFile</code>	stan model file with file extension <code>*.stan</code> . Not required when <code>modelName</code> or <code>modelCode</code> is supplied.
<code>modelData</code>	stan data list. A named list or environment providing the data for the model, or a character vector for all the names of objects in the current environment used as data. Not required when <code>modelName</code> is supplied.
<code>nsamples</code>	a positive integer. Number of samples for each chain (including burn-in samples).
<code>nburnin</code>	a positive integer. Number of burn-in samples.
<code>thinning</code>	a positive integer. Thinning parameter, i.e. the period for saving samples.
<code>nchain</code>	a positive integer. Number of chains.
<code>ncore</code>	a positive integer. Number of cores to use when executing the chains in parallel.
<code>adaptDelta</code>	numeric. The target acceptance rate, a numeric value between 0 and 1.
<code>verbose</code>	logical. If TRUE, prints progress and debugging information.

### Details

If `modelName` is one of `c("Po", "UPo", "ZIPo", "ZIUPo")`, then outlier-adjusted models are used.

- In paired models, outliers are those counts with `postFEC > preFEC`. Outlier weights are assigned as the inverse of `postFEC/preFEC`,
- In unpaired models, outliers are those counts with `postFEC` greater than the 95th percentile of a Poisson distribution, where the Poisson mean is computed based on the mean of `postFEC` excluding `postFEC > Q3 + 1.5*IQR`. `Q3` is the 75th percentile and `IQR` is the interquartile range. The lowest outlier weight is assigned as 0.01, and other outliers assigned proportionally.
- In both cases, non-outliers are assigned with outlier weight = 1.

The first time each model is applied, it can take up to 20 seconds for Stan to compile the model.

The default number of samples per chain is 2000, with 1000 burn-in samples. Normally this is sufficient in Stan. If the chains do not converge, one should tune the MCMC parameters until convergence is reached to ensure reliable results.

### Value

Prints out the posterior summary of FECR as the reduction, `meanEPG.untreated` as the mean pre-treatment `epg`, and `meanEPG.treated` as the mean after-treatment `epg`. The posterior summary contains the mean, standard deviation (`sd`), 2.5%, 50% and 97.5% percentiles, the 95% highest posterior density interval (`HPDLow95` and `HPDHigh95`) and the posterior mode.

The returned value is a list that consists of:

<code>stan.model</code>	an object of class <code>stanmodel-class</code> that was used
<code>stan.samples</code>	an object of S4 class <code>stanfit</code> representing the fitted results
<code>posterior.summary</code>	a data.frame that is the same as the printed posterior summary. Not available for custom models.

**Author(s)**

Craig Wang

**Examples**

```
## Not run:
library(eggCountsExtra)
data(eggs) ## load sample data

## apply paired model with outliers
model1 <- fecr_stanExtra(eggs$before, eggs$after, rawCounts=FALSE,
  preCF=10, modelName = "Po")
samples <- stan2mcmc(model1$stan.samples)
fecr_probs(model1$stan.samples, threshold = 0.99)

## apply a simple custom model
code <- "data{
  int J; // number of animals
  int y_before[J]; // after treatment McMaster count
  int y_after[J]; // before treatment McMaster count
}
parameters{
  real<lower=0> mu;
  real<lower=0,upper=1> delta;
}
model{
  mu ~ gamma(1,0.001);
  delta ~ beta(1,1);
  y_before ~ poisson(mu);
  y_after ~ poisson(mu*delta);
}"

dat <- list(J = nrow(eggs), y_before = eggs$before,
  y_after = eggs$after)
model2 <- fecr_stanExtra(modelCode = code, modelData = dat)

## End(Not run)
```

fecr\_stanSimple

*Model the reduction of faecal egg count using a simple Bayesian model***Description**

Models the reduction in faecal egg counts with a simple Bayesian model formulation. The model is for paired design only, and it assumes Poisson distribution for the observed egg counts.

**Usage**

```
fecr_stanSimple(preFEC, postFEC, rawCounts = FALSE,
  preCF = 50, postCF = preCF, muPrior, deltaPrior,
  nsamples = 2000, nburnin = 1000, thinning = 1, nchain = 2,
  ncore = 1, adaptDelta = 0.95, saveAll = FALSE, verbose = FALSE)
```

**Arguments**

preFEC	numeric vector. Pre-treatment faecal egg counts.
postFEC	numeric vector. Post-treatment faecal egg counts.
rawCounts	logical. If TRUE, preFEC and postFEC correspond to raw counts (as counted on equipment). Otherwise they correspond to calculated eggs (raw counts times correction factor). Defaults to FALSE.
preCF	positive integer or vector of positive integers. Pre-treatment correction factor(s).
postCF	positive integer or vector of positive integers. Post-treatment correction factor(s).
muPrior	named list. Prior for the group mean epg parameter $\mu$ . The default prior is <code>list(priorDist = "gamma", hyperpars=c(1, 0.001))</code> , i.e. a gamma distribution with shape 1 and rate 0.001, its 90% probability mass lies between 51 and 2996.
deltaPrior	named list. Prior for the reduction parameter $\delta$ . The default prior is <code>list(priorDist = "beta", hyperpars=c(1, 1))</code> , i.e. a uniform prior between 0 and 1.
nsamples	a positive integer. Number of samples for each chain (including burn-in samples).
nburnin	a positive integer. Number of burn-in samples.
thinning	a positive integer. Thinning parameter, i.e. the period for saving samples.
nchain	a positive integer. Number of chains.
ncore	a positive integer. Number of cores to use when executing the chains in parallel.
adaptDelta	numeric. The target acceptance rate, a numeric value between 0 and 1.
saveAll	logical. If TRUE, posterior samples for all parameters are saved in the <code>stanfit</code> object. Otherwise only samples for $\delta$ and $\mu$ are saved. Default to FALSE.
verbose	logical. If TRUE, prints progress and debugging information.

**Details**

The first time each model with non-default priors is applied, it can take up to 20 seconds to compile the model. Currently the function only support prior distributions with two parameters. For a complete list of supported priors and their parameterization, please consult the list of distributions in [Stan User Guide](#).

The default number of samples per chain is 2000, with 1000 burn-in samples. Normally this is sufficient in Stan. If the chains do not converge, one should tune the MCMC parameters until convergence is reached to ensure reliable results.

**Value**

Prints out the posterior summary of FECR as the reduction, meanEPG.untreated as the mean pre-treatment epg, and meanEPG.treated as the mean after-treatment epg. The posterior summary contains the mean, standard deviation (sd), 2.5%, 50% and 97.5% percentiles, the 95% highest posterior density interval (HPDLow95 and HPDHigh95) and the posterior mode.

NOTE: we recommend to use the 95% HPD interval and the mode for further statistical analysis.

The returned value is a list that consists of:

```
stan.samples    an object of S4 class stanfit representing the fitted results
posterior.summary
                A data.frame that is the same as the printed posterior summary
```

**Author(s)**

Tea Isler  
Craig Wang

**See Also**

[simData2s](#) for simulating faecal egg counts data with two samples

**Examples**

```
## load sample data
data(eggs)

## apply paired model with individual efficacy
model <- fecr_stanSimple(eggs$before, eggs$after,
                       rawCounts = FALSE, preCF = 10)
samples <- stan2mcmc(model$stan.samples)
```

---

fec\_stan

*Modelling of faecal egg count data (one-sample case)*

---

**Description**

Models the mean of faecal egg counts with Bayesian hierarchical models. See Details for a list of model choices.

**Usage**

```
fec_stan(fec, rawCounts = FALSE, CF = 50, zeroInflation = TRUE,
         muPrior, kappaPrior, phiPrior, nsamples = 2000, nburnin = 1000,
         thinning = 1, nchain = 2, ncore = 1, adaptDelta = 0.95,
         saveAll = FALSE, verbose = FALSE)
```

**Arguments**

fec	numeric vector. Faecal egg counts.
rawCounts	logical. If TRUE, preFEC and postFEC correspond to raw counts (as counted on equipment). Otherwise they correspond to calculated eggs (raw counts times correction factor). Defaults to FALSE.
CF	a positive integer or a vector of positive integers. Correction factor(s).
zeroInflation	logical. If true, uses the model with zero-inflation. Otherwise uses the model without zero-inflation
muPrior	named list. Prior for the group mean epg parameter $\mu$ . The default prior is <code>list(priorDist = "gamma", hyperpars=c(1, 0.001))</code> , i.e. a gamma distribution with shape 1 and rate 0.001, its 90% probability mass lies between 51 and 2996.
kappaPrior	named list. Prior for the group dispersion parameter $\kappa$ . The default prior is <code>list(priorDist = "gamma", hyperpars=c(1, 0.7))</code> , i.e. a gamma distribution with shape 1 and rate 0.7, its 90% probability mass lies between 0.1 and 4.3 with a median of 1.
phiPrior	named list. Prior for the zero-inflation parameter $\phi$ . The default prior is <code>list(priorDist = "beta", hyperpars=c(1, 1))</code> , i.e. a uniform prior between 0 and 1.
nsamples	a positive integer. Number of samples for each chain (including burn-in samples).
nburnin	a positive integer. Number of burn-in samples.
thinning	a positive integer. Thinning parameter, i.e. the period for saving samples.
nchain	a positive integer. Number of chains.
ncore	a positive integer. Number of cores to use when executing the chains in parallel.
adaptDelta	numeric. The target acceptance rate, a numeric value between 0 and 1.
saveAll	logical. If TRUE, posterior samples for all parameters are saved in the stanfit object. If FALSE, only samples for $\mu$ , $\kappa$ and $\phi$ are saved. Default to FALSE.
verbose	logical. If true, prints progress and debugging information.

**Details****List of built-in models:**

- without zero-inflation: set `zeroInflation = FALSE`
- with zero-inflation: set `zeroInflation = TRUE`

Note that this function only models the mean of egg counts, see `fecr_stan()` for modelling the reduction.

**Other information:** The first time each model with non-default priors is applied, it can take up to 20 seconds to compile the model. Currently the function only support prior distributions with two parameters. For a complete list of supported priors and their parameterization, please consult the list of distributions in [Stan User Guide](#).

The default number of samples per chain is 2000, with 1000 burn-in samples. Normally this is sufficient in Stan. If the chains do not converge, one should tune the MCMC parameters until convergence is reached to ensure reliable results.

**Value**

Prints out summary of meanEPG as the posterior mean epg. The posterior summary contains the mean, standard deviation (sd), 2.5%, 50% and 97.5% percentiles, the 95% highest posterior density interval (HPDLow95 and HPDHigh95) and the posterior mode. NOTE: we recommend to use the 95% HPD interval and the mode for further statistical analysis.

The returned value is a list that consists of:

```
stan.samples    an object of S4 class stanfit representing the fitted results
posterior.summary
                 a data.frame that is the same as the printed posterior summary
```

**Author(s)**

Craig Wang

**See Also**

[simData1s](#) for simulating faecal egg count data with one sample

**Examples**

```
## load the sample data
data(eggs)

## apply zero-inflation model
model <- fec_stan(eggs$before, rawCounts = FALSE, CF = 50)
```

---

<code>getPrior_delta</code>	<i>Get prior parameters from Beta distribution</i>
-----------------------------	--

---

**Description**

Compute the shape parameters from a Beta distribution for  $\delta$  based on some prior belief.

**Usage**

```
getPrior_delta(lower, upper, p = 0.7, mode, conc, plot = TRUE)
```

**Arguments**

<code>lower, upper, p</code>	numeric. Prior belief about the reduction. There is $p$ probability that the reduction is between <code>lower</code> and <code>upper</code> . Not used if <code>mode</code> and <code>conc</code> are supplied.
<code>mode, conc</code>	numeric. Prior belief about the reduction. The mode and concentration parameters of a beta distribution. Higher concentration indicates smaller variance. Not used if <code>lower</code> and <code>upper</code> thresholds are supplied.
<code>plot</code>	logical. If TRUE, the prior distribution is plotted after parameters are found.

**Details**

The `multiroot` function from **rootSolve** package is used to compute the parameters.

**Value**

Returns Beta prior parameters for  $\delta$  and the printed argument to use in a `fecr_stan()` or a `fec_stan()` function call.

**Author(s)**

Tea Isler  
Craig Wang

**Examples**

```
# there is 80% probability that the reduction is between 60% and 90%
getPrior_delta(lower = 0.6, upper = 0.9, p = 0.8)
```

---

getPrior\_mu

*Get prior parameters from Gamma distribution*

---

**Description**

Compute the shape and rate parameters from a Gamma distribution for  $\mu$  based on some prior belief about its cumulative distribution function.

**Usage**

```
getPrior_mu(x, px, y, py, s1 = 1, s2 = 0.001, plot = TRUE)
```

**Arguments**

<code>x, px, y, py</code>	numeric. Threshold of some prior belief about true epg. There is <code>px</code> probability that the true epg is below <code>x</code> , and there is <code>py</code> probability that the true epg is below <code>y</code> .
<code>s1, s2</code>	numeric. Starting values.
<code>plot</code>	logical. If TRUE, the prior distribution is plotted after parameters are found.

**Details**

`multiroot` function from **rootSolve** package is used to compute the parameters.

**Value**

Returns Gamma prior parameters for  $\mu$  and the printed argument to use in a `fecr_stan()` or a `fec_stan()` function call.



**Author(s)**

Tea Isler  
Craig Wang

**Examples**

```
# there is 30% probability that the mean epg is less than 200
# and 80% probability that the mean epg is less than 500
getPrior_mu(x = 200, px = 0.3, y = 500, py = 0.8)
```

---

plotCounts	<i>Plot faecal egg count data</i>
------------	-----------------------------------

---

**Description**

Plot egg count data to reflect changes between before and after treatment.

**Usage**

```
plotCounts(data, paired = TRUE, points = TRUE,
           points.method = "jitter", xlabel = "",
           ylabel = "Faecal egg counts [epg]", ...)
```

**Arguments**

data	a data.frame with two columns, the first column is before treatment counts, the second column is after treatment counts.
paired	logical. If TRUE, uses the plot for the paired design. Otherwise uses the plot for the unpaired design.
points	logical. If TRUE, add individual points for unpaired plot. Not used if paired = TRUE.
points.method	string. It is used to separate coincident points if points = TRUE. One of "jitter", "stack" or "overplot".
xlabel	string. Label of x-axis.
ylabel	String. Label of y-axis.
...	Additional arguments for function <a href="#">xyplot</a> if paired is TRUE, for function <a href="#">boxplot</a> otherwise.

**Details**

For paired data, a xyplot is used. For unpaired data, a grouped boxplot is used.

**Value**

A plot is drawn.

**Author(s)**

Craig Wang

**Examples**

```
data(eggs)
plotCounts(eggs[,c("before", "after")], paired = TRUE)
```

---

simData1s

*Simulate faecal egg count data (1-sample situation)*


---

**Description**

Simulates (zero-inflated) egg count data

**Usage**

```
simData1s(n = 10, mean = 500, kappa = 0.5, phi = 1,
          f = 50, rounding = TRUE, seed = NULL)
```

**Arguments**

n	positive integer. Sample size.
mean	numeric. True number of eggs per gram (epg).
kappa	numeric. Overdispersion parameter, $\kappa \rightarrow \infty$ corresponds to Poisson distribution.
phi	numeric. Prevalence, i.e. proportion of infected animals, between 0 and 1.
f	positive integer. Correction factor of the egg counting technique, either an integer or a vector of integers with length n.
rounding	logical. If TRUE, the Poisson mean for the raw counts is rounded. The rounding applies since the mean epg is frequently reported as an integer value. For more information, see Details.
seed	integer. Random seed.

**Details**

In the simulation of raw (master) counts, it follows a Poisson distribution with some mean. The mean is frequently rounded down if it has a very low value and `rounding = TRUE`, hence there expects to be a bias overall when  $\mu < 150$ . Set `rounding = FALSE` for not to have any bias in the simulated counts.

**Value**

A data.frame with three columns, namely the observed epg (obs), actual number of eggs counted (master) and true epg in the sample (true).

**Author(s)**

Craig Wang  
Michaela Paul

**See Also**

[fec\\_stan](#) for analyzing faecal egg count data with one sample

**Examples**

```
fec <- simData1s(n = 10, mean = 500,
                kappa = 0.5, phi = 0.7)
```

---

 simData2s

---

*Simulate faecal egg count data (2-sample situation)*


---

**Description**

Generates two samples of (zero-inflated) egg count data

**Usage**

```
simData2s(n = 10, preMean = 500, delta = 0.1, kappa = 0.5,
          deltaShape = NULL, phiPre = 1, phiPost = phiPre, f = 50,
          paired = TRUE, rounding = TRUE, seed = NULL)
```

**Arguments**

n	positive integer. Sample size.
preMean	numeric. True pre-treatment epg.
delta	numeric. Proportion of epg left after treatment, between 0 and 1. $1 - \delta$ is reduction in mean after treatment, $\delta = 0.1$ indicates a 90% reduction.
kappa	numeric. Overdispersion parameter, $\kappa \rightarrow \infty$ corresponds to Poisson distribution.
deltaShape	numeric. Shape parameter for the distribution of reductions. If NULL, the same reduction is applied to the latent true epg of each animal.
phiPre	numeric. Pre-treatment prevalence (i.e. proportion of infected animals), between 0 and 1.
phiPost	numeric. Post-treatment prevalence, between 0 and 1.
f	integer or vector of integers. Correction factor of the egg counting technique
paired	logical. If TRUE, paired samples are simulated. Otherwise unpaired samples are simulated.
rounding	logical. If TRUE, the Poisson mean for the raw counts is rounded. The rounding applies since the mean epg is frequently reported as an integer value. For more information, see Details.
seed	an integer that will be used in a call to <code>set.seed</code> before simulation. If NULL, a random seed is allocated.

**Details**

In the simulation of raw (master) counts, it follows a Poisson distribution with some mean. The mean is frequently rounded down if it has a very low value and `rounding = TRUE`, there expects to be some bias in the mean reduction when  $\mu < 150$  and  $\delta < 0.1$ . Set `rounding = FALSE` for not to have any bias.

**Value**

A data.frame with six columns, namely the observed egg (obs), actual number of eggs counted (master) and true epg in the sample (true) for both pre- and post- treatment.

**Author(s)**

Craig Wang  
Michaela Paul

**See Also**

[fecr\\_stan](#) for analyzing faecal egg count data with two samples

**Examples**

```
fec <- simData2s(n = 10, preMean = 500, delta = 0.1, kappa = 0.5)

## show the bias when the true reduction should be 95%
fec <- simData2s(n = 1e5, preMean = 150, delta = 0.05,
  kappa = 0.5, seed = 1)
1 - mean(fec$masterPost)/mean(fec$masterPre)
## without bias
fec <- simData2s(n = 1e5, preMean = 150, delta = 0.05,
  kappa = 0.5, seed = 1, rounding = FALSE)
1 - mean(fec$masterPost)/mean(fec$masterPre)
```

---

 stan2mcmc

---

*Convert a Stanfit object to a MCMC object*


---

**Description**

Converts a stanfit object into a mcmc object for easier analysis.

**Usage**

```
stan2mcmc(stanFit)
```

**Arguments**

stanFit            a [stanfit](#) object from the output of either `fecr_stan()` or `fec_stan()`

**Details**

The output can be analyzed as a mcmc object with the functions from the coda package. NOTE: The resulting MCMC object does not contain warm-up samples and is already thinned.

**Value**

A MCMC object with a list of relevant parameters.

**Author(s)**

Craig Wang

**Examples**

```
data(eggs)

## apply zero-inflation model for the paired design
model <- fecr_stan(eggs$before, eggs$after, rawCounts = FALSE,
                  indEfficacy = FALSE, preCF = 10,
                  paired = TRUE, zeroInflation = TRUE)
samples <- stan2mcmc(model$stan.samples)
summary(samples)
plot(samples)
```

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