

Package ‘simpowa’

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Type Package

Title Power Analysis and Sample Size Calculation for Semi-Field Vector Control Trials

Version 1.0.3

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Description Uses simulations from generalized linear mixed-effects models to incorporate random effects across multiple sources and levels of variation, and a dispersion parameter to account for overdispersion and capture unexplained variability. Covers design scenarios for both short-term and long-term trials evaluating the impact of single or combined vector control interventions. Methods build on Kipingu et al. (2025) <doi:10.1186/s12936-025-05454-y> and Johnson et al. (2015) <doi:10.1111/2041-210X.12306>.

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Imports lme4, parallel, dplyr, ggplot2, stats

Suggests rmarkdown, testthat (>= 3.0.0), waldo, devtools

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URL <https://github.com/akipingu/simpowa>

BugReports <https://github.com/akipingu/simpowa/issues>

NeedsCompilation no

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simpowa-package	<i>Power Analysis and Sample Size Calculation for Semi-Field Vector Control Trials</i>
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Description

Uses simulations from generalized linear mixed-effects models to incorporate random effects across multiple sources and levels of variation, and a dispersion parameter to account for overdispersion and capture unexplained variability. Covers design scenarios for both short-term and long-term trials evaluating the impact of single or combined vector control interventions. Methods build on Kippingu et al. (2025) <[doi:10.1186/s12936-025-05454-y](https://doi.org/10.1186/s12936-025-05454-y)> and Johnson et al. (2015) <[doi:10.1111/2041-210X.12306](https://doi.org/10.1111/2041-210X.12306)>.

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See Also

Useful links:

- <https://github.com/akipingu/simpowa>
- Report bugs at <https://github.com/akipingu/simpowa/issues>

sim.mosq.longsfecomint

*Simulate Mosquito Count Data for Long-Term Semi-Field Experiment
Testing Combined Interventions*

Description

Generates simulated mosquito count data under a short-term semi-field experimental design with fixed effects for interventions ‘intvn1’ and ‘intvn2’, random effects for chambers and sampling time points variability, and a negative binomial distributed outcomes. Uses output from ‘sim.scen.longsfecomint()’ to incorporate the table of experimental design scenarios.

Usage

```
sim.mosq.longsfecomint(  
  n.ch.per.trt,  
  exp.length,  
  sampl.freq = "weekly",  
  lambda,  
  intvn1.effect,  
  intvn2.effect,  
  ixn.effect,  
  chamber.var,  
  time.var,
```

```

    theta,
    use.random = "ALL"
  )

```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
exp.length	An integer indicating total duration of the experiment in days, e.g., 90 days.
sampl.freq	A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn1.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 1 (e.g., ITN).
intvn2.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 2 (PPFa).
ixn.effect	A numeric value representing the proportional reduction in mosquito count due to the interaction between interventions (e.g., ITN x PPFa).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
time.var	A numeric value indicating the variance between sampling time points (random effect).
theta	A numeric value quantifying overdispersion parameter for the negative binomial distribution.
use.random	A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only; If NULL, returns expected mosquito counts simulated through exponential function based on fixed effects (no sampling distribution); If "ALL", returns the full data set with all mosquito count columns based in all three options described above.

Value

A data frame with columns:

- replicates** Replicate number within each treatment group (e.g., for a total of 2 chambers per treatment means 1, 2 replicates per treatment)
- intvn1** Intervention status (e.g., 0 = control or no intervention 1 and 1 = there is intervention 1)
- intvn2** Intervention status (e.g., 0 = control or no intervention 2 and 1 = there is intervention 2)
- chamber** Unique chamber identifier as a factor (e.g., 0-0-1, 0-0-2 for the control chambers and 0-1-1, 1-0-1, 1-1-1 for intervention chambers)
- time** Time sequence scaled between 0 and 1, it is calculate by the ratio of sampling points by their total number

- timef** This is just the same as "time" but as a factor
- ixn.intvn1.time** This is the interaction between an intvn1 and time, i.e., intvn1 x time
- ixn.intvn2.time** This is the interaction between an intvn2 and time, i.e., intvn2 x time
- ixn.intvn1.intvn2.time** This is the interaction between an intvn1, intvn2 and time, i.e., intvn1 x intvn2 x time
- lin.pred.fixed** Linear predictor with fixed effects only
- lin.pred.random** Linear predictor with random chamber effects
- mosquito.count.fixed.exp** Simulated mosquito counts through exponential function from fixed effects only (no sampling)
- mosquito.count.fixed** Simulated mosquito counts through sampling distribution based on fixed effects only
- mosquito.count.random** Simulated mosquito counts through sampling distribution accounting for random effects

Examples

```
sim.mosq.longsfesinint(
  n.ch.per.trt = 2,
  exp.length = 90,
  sampl.freq = "monthly",
  lambda = 10,
  intvn1.effect = 0.7,
  intvn2.effect = 0.8,
  ixn.effect = 0.8,
  chamber.var = 0.1807,
  time.var = 0.2266,
  theta = 10,
  use.random = "ALL"
)
```

```
sim.mosq.longsfesinint
```

*Simulate Mosquito Count Data for Long-Term Semi-Field Experiment
Testing Single Intervention*

Description

Generates simulated mosquito count data under a short-term semi-field experimental design with fixed effects for intervention ('intvn'), random effects for chambers and sampling time points variability, and a negative binomial distributed outcomes. Uses output from 'sim.scen.longsfesinint()' to incorporate the table of experimental design scenarios.

Usage

```

sim.mosq.longsfefe.sinint(
  n.ch.per.trt,
  exp.length,
  sampl.freq = "weekly",
  lambda,
  intvn.effect,
  chamber.var,
  time.var,
  theta,
  use.random = "ALL"
)

```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
exp.length	An integer indicating total duration of the experiment in days, e.g., 90 days.
sampl.freq	A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention (e.g., ITN).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
time.var	A numeric value indicating the variance between sampling time points (random effect).
theta	A numeric value quantifying overdispersion parameter for the negative binomial distribution.
use.random	A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only; If NULL, returns expected mosquito counts simulated through exponential function based on fixed effects (no sampling distribution); If "ALL", returns the full data set with all mosquito count columns based in all three options described above.

Value

A data frame with columns:

replicates Replicate number within each treatment group (e.g., for a total of 2 chambers per treatment means 1, 2 replicates per treatment)

intvn Intervention status (e.g., 0 = control or no intervention and 1 = there is intervention)

chamber Unique chamber identifier as a factor (e.g., 0-1, 0-2 for the control chambers and 1-1, 1-2 for intervention chambers)

time Time sequence scaled between 0 and 1, it is calculate by the ratio of sampling points by their total number

timef This is just the same as "time" but as a factor

intvn.time This is the interaction between an intervention and time, i.e., intvn x time

lin.pred.fixed Linear predictor with fixed effects only

lin.pred.random Linear predictor with random chamber effects

mosquito.count.fixed.exp Simulted mosquito counts through exponetial function from fixed effects only (no sampling)

mosquito.count.fixed Simulated mosquito counts through sampling distribution based on fixed effects only

mosquito.count.random Simulated mosquito counts through sampling distribution accounting for random effects

Examples

```
sim.mosq.longsfe.sinint(
  n.ch.per.trt = 2,
  exp.length = 90,
  sampl.freq = "monthly",
  lambda = 10,
  intvn.effect = 0.8,
  chamber.var = 0.1807,
  time.var = 0.2266,
  theta = 10,
  use.random = "ALL"
)
```

```
sim.mosq.shortsfe.comint
```

*Simulate Mosquito Count Data for Short-Term Semi-Field Experiment
Testing Combined Interventions*

Description

Generates simulated mosquito count data under a short-term semi-field experimental design with fixed effects for interventions, 'intvn1' and 'intvn2', random effects for chamber variability, and Poisson-distributed outcomes. Uses output from 'sim.scen.shortsfe.comint()' to incorporate the table of experimental design scenarios.

Usage

```
sim.mosq.shortsfe.comint(
  n.ch.per.trt,
  lambda,
  intvn1.effect,
  intvn2.effect,
  ixn.effect,
  chamber.var,
  use.random = "ALL"
)
```

Arguments

<code>n.ch.per.trt</code>	An integer specifying the number of chambers allocated per treatment group.
<code>lambda</code>	A numeric value indicating the expected mean mosquito count in control chambers.
<code>intvn1.effect</code>	A numeric value representing the proportional reduction in mosquito count due to the intervention 1 (e.g., ITN).
<code>intvn2.effect</code>	A numeric value representing the proportional reduction in mosquito count due to the intervention 2 (e.g., PPFa).
<code>ixn.effect</code>	A numeric value representing the proportional reduction in mosquito count due to the interaction (e.g., ITN x PPFa).
<code>chamber.var</code>	A numeric value specifying the variance of random chamber-level effects.
<code>use.random</code>	A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only; If NULL, returns expected mosquito counts simulated through exponential function based on fixed effects (no sampling distribution); If "ALL", returns the full data set with all mosquito count columns based in all three options described above.

Value

A data frame with the following columns, depending on the `use.random` option:

- replicates** Replicate number within each treatment group (e.g., for a total of 2 chambers per treatment means 1, 2 replicates per treatment)
- intvn1** Intervention status (e.g., 0 = control or no intervention 1 and 1 = there is intervention 1)
- intvn2** Intervention status (e.g., 0 = control or no intervention 2 and 1 = there is intervention 2)
- ixn** Interventions interactions status (e.g., 0 = control or no intervention and 1 = there is interaction)
- chamber** Unique chamber identifier as a factor (e.g., 0-0-1, 0-0-2 for the control chambers and 0-1-1, 1-0-1, 1-1-1 for intervention chambers)
- lin.pred.fixed** Linear predictor with fixed effects only
- lin.pred.random** Linear predictor with random chamber effects

mosquito.count.fixed.exp Simulated mosquito counts through exponential function from fixed effects only (no sampling)

mosquito.count.fixed Simulated mosquito counts through sampling distribution based on fixed effects only

mosquito.count.random Simulated mosquito counts through sampling distribution accounting for random effects

Examples

```
sim.mosq.shortsfe.comint(
  n.ch.per.trt = 2,
  lambda = 50,
  intvn1.effect = 0.7,
  intvn2.effect = 0.8,
  ixn.effect = 0.5,
  chamber.var = 0.1807,
  use.random = "ALL"
)
```

```
sim.mosq.shortsfe.sinint
```

Simulate Mosquito Count Data for Short-Term Semi-Field Experiment Testing Single Intervention

Description

Generates simulated mosquito count data under a short-term semi-field experimental design with fixed effects for intervention ('intvn'), random effects for chamber variability, and Poisson-distributed outcomes. Uses output from 'sim.scen.shortsfe.sinint()' to incorporate the table of experimental design scenarios.

Usage

```
sim.mosq.shortsfe.sinint(
  n.ch.per.trt,
  lambda,
  intvn.effect,
  chamber.var,
  use.random = "ALL"
)
```

Arguments

n.ch.per.trt An integer specifying the number of chambers allocated per treatment group.

lambda A numeric value indicating the expected mean mosquito count in control chambers.

<code>intvn.effect</code>	A numeric value representing the proportional reduction in mosquito count due to the intervention (e.g., ITN).
<code>chamber.var</code>	A numeric value specifying the variance of random chamber-level effects.
<code>use.random</code>	A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only; If NULL, returns expected mosquito counts simulated through exponential function based on fixed effects (no sampling distribution); If "ALL", returns the full data set with all mosquito count columns based in all three options described above.

Value

A data frame with the following columns, depending on the `use.random` option:

replicates Replicate number within each treatment group (e.g., for a total of 2 chambers per treatment means 1, 2 replicates per treatment)

intvn Intervention status (e.g., 0 = control or no intervention and 1 = there is intervention)

chamber Unique chamber identifier as a factor (e.g., 0-1, 0-2 for the control chambers and 1-1, 1-2 for intervention chambers)

lin.pred.fixed Linear predictor with fixed effects only

lin.pred.random Linear predictor with random chamber effects

mosquito.count.fixed.exp Simulated mosquito counts through exponential function from fixed effects only (no sampling)

mosquito.count.fixed Simulated mosquito counts through sampling distribution based on fixed effects only

mosquito.count.random Simulated mosquito counts through sampling distribution accounting for random effects

Examples

```
sim.mosq.shortsfe.sinint(
  n.ch.per.trt = 2,
  lambda = 50,
  intvn.effect = 0.8,
  chamber.var = 0.1807,
  use.random = "ALL"
)
```

 sim.plot.longsfe.comint

*Plot Mosquito Counts for Long-Term Semi-Field Experiment Testing
Combined Interventions*

Description

Generates a time series plot of mosquito counts based on either fixed effects only, random effects, or fixed effects (no sampling distribution), using data simulated by ‘sim.mosq.longsfe.comint’.

Usage

```
sim.plot.longsfe.comint(
  n.ch.per.trt,
  exp.length,
  sampl.freq = "weekly",
  lambda,
  intvn1.effect,
  intvn2.effect,
  ixn.effect,
  chamber.var,
  time.var,
  theta,
  use.random = TRUE
)
```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
exp.length	An integer indicating total duration of the experiment in days, e.g., 90 days.
sampl.freq	A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn1.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 1 (e.g., ITN).
intvn2.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 2 (PPFa).
ixn.effect	A numeric value representing the proportional reduction in mosquito count due to the interaction between interventions (e.g., ITN x PPFa).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
time.var	A numeric value indicating the variance between sampling time points (random effect).

theta	A numeric value quantifying overdispersion parameter for the negative binomial distribution.
use.random	A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only; If NULL, returns expected mosquito counts simulated through exponential function based on fixed effects (no sampling distribution);

Value

A 'ggplot' object showing mosquito counts over time by treatment group.

Examples

```
sim.plot.longsfecomint(
  n.ch.per.trt = 2,
  exp.length = 90,
  sampl.freq = "monthly",
  lambda = 10,
  intvn1.effect = 0.7,
  intvn2.effect = 0.8,
  ixn.effect = 0.8,
  chamber.var = 0.1807,
  time.var = 0.2266,
  theta = 10,
  use.random = TRUE
)
```

```
sim.plot.longsfesinint
```

*Plot Mosquito Counts for Long-Term Semi-Field Experiment Testing
Single Intervention*

Description

Generates a time series plot of mosquito counts based on use.random with either fixed effects only, random effects, or fixed effects (no sampling distribution), using data simulated by 'sim.mosq.longsfesinint'.

Usage

```
sim.plot.longsfesinint(
  n.ch.per.trt,
  exp.length,
  sampl.freq = "weekly",
  lambda,
```

```

    intvn.effect,
    chamber.var,
    time.var,
    theta,
    use.random = TRUE
  )

```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
exp.length	An integer indicating total duration of the experiment in days, e.g., 90 days.
sampl.freq	A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention (e.g., ITN).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
time.var	A numeric value indicating the variance between sampling time points (random effect).
theta	A numeric value quantifying overdispersion parameter for the negative binomial distribution.
use.random	A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only; If NULL, returns expected mosquito counts simulated through exponential function based on fixed effects (no sampling distribution);

Value

A 'ggplot' object showing mosquito counts over time by treatment group.

Examples

```

sim.plot.longsfe.sinint(
  n.ch.per.trt = 2,
  exp.length = 90,
  sampl.freq = "monthly",
  lambda = 10,
  intvn.effect = 0.8,
  chamber.var = 0.1807,
  time.var = 0.2266,
  theta = 10,
  use.random = TRUE
)

```

```
sim.plot.shortsfe.comint
```

*Plot Mosquito Counts for Short-Term Semi-Field Experiment Testing
Combined Interventions*

Description

Generates a boxplot of simulated mosquito counts grouped by intervention combinations. Uses output from 'sim.mosq.shortsfe.comint()' and overlays jittered points to show chamber-level variation.

Usage

```
sim.plot.shortsfe.comint(  
  n.ch.per.trt,  
  lambda,  
  intvn1.effect,  
  intvn2.effect,  
  ixn.effect,  
  chamber.var,  
  use.random = TRUE,  
  jitter = TRUE  
)
```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn1.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 1 (e.g., ITN).
intvn2.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 2 (e.g., PPFa).
ixn.effect	A numeric value representing the proportional reduction in mosquito count due to the interaction (e.g., ITN x PPFa).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
use.random	A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only; If NULL, returns expected mosquito counts simulated through exponential function based on fixed effects (no sampling distribution);
jitter	A logical value indicating whether to overlay individual chamber-level points. If TRUE, overlays individual chamber-level points. If FALSE, do not overlay individual chamber-level points.

Value

A ‘ggplot’ object showing expected mosquito counts by treatment group.

Examples

```
sim.plot.shortsfe.comint(
  n.ch.per.trt = 2,
  lambda = 50,
  intvn1.effect = 0.7,
  intvn2.effect = 0.8,
  ixn.effect = 0.5,
  chamber.var = 0.1807,
  use.random = TRUE,
  jitter = TRUE
)
```

```
sim.plot.shortsfe.sinint
```

Plot Mosquito Counts from Short-Term Semi-Field Experiment Testing Single Intervention

Description

Generates a boxplot of simulated mosquito counts grouped by intervention status (Control vs Intervention). Uses output from ‘sim.mosq.shortsfe.sinint()’ and can overlay jittered points to show chamber-level variation.

Usage

```
sim.plot.shortsfe.sinint(
  n.ch.per.trt,
  lambda,
  intvn.effect,
  chamber.var,
  use.random = TRUE,
  jitter = TRUE
)
```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention (e.g., ITN).
chamber.var	A numeric value specifying the variance of random chamber-level effects.

use.random	A logical value indicating whether to plot mosquito counts simulated using a sampling distribution (with random or fixed effects) or exponential function (fixed effect) If TRUE, plots expected mosquito counts simulated using sampling distribution with random effects; If FALSE, plots expected counts using sampling distribution based on fixed effects only; If NULL, plots expected counts simulated using exponential function with fixed effects only (no sampling).
jitter	A logical value indicating whether to overlay individual chamber-level points If TRUE, overlays individual chamber-level points. If FALSE, do not overlay individual chamber-level points.

Value

A ‘ggplot’ object showing expected mosquito counts by treatment group.

Examples

```
sim.plot.shortsfe.sinint(
  n.ch.per.trt = 2,
  lambda = 50,
  intvn.effect = 0.8,
  chamber.var = 0.1807,
  use.random = TRUE,
  jitter = TRUE
)
```

```
sim.power.longsfecomint
```

Estimate Empirical Power for Long-Term Semi-Field Experiment Testing Combined Interventions

Description

Runs repeated simulations and negative binomial GLMM fits to estimate empirical power as the proportion of simulations with p-values below 0.05. These p-values are generated using the function called ‘sim.pval.longsfecomint()’.

Usage

```
sim.power.longsfecomint(
  n.ch.per.trt,
  exp.length,
  sampl.freq,
  lambda,
  intvn1.effect,
  intvn2.effect,
  ixn.effect,
  chamber.var,
```

```

    time.var,
    theta,
    nsim = 100,
    n.cores = 1,
    use.random = TRUE
  )

```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
exp.length	An integer indicating total duration of the experiment in days, e.g., 90 days.
sampl.freq	A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn1.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 1 (e.g., ITN).
intvn2.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 2 (PPFa).
ixn.effect	A numeric value representing the proportional reduction in mosquito count due to the interaction between interventions (e.g., ITN x PPFa).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
time.var	A numeric value indicating the variance between sampling time points (random effect).
theta	A numeric value quantifying overdispersion parameter for the negative binomial distribution.
nsim	An integer indicating the total number of simulations.
n.cores	An integer the number of cores to use for parallel processing.
use.random	A logical value indicating whether to plot mosquito counts simulated using a sampling distribution (with random or fixed effects). If TRUE, returns power for expected mosquito counts simulated using sampling distribution with random effects; If FALSE, returns power for expected counts using sampling distribution based on fixed effects only.

Value

A named numeric vector:

power Estimated empirical power (rounded to two decimal places)

ci.lower Lower bound of 95% confidence interval

ci.upper Upper bound of 95% confidence interval

Note

Parallel execution is supported via 'n.cores', but examples default to 'n.cores = 1' for reproducibility and package checks.

Examples

```
# For a realistic SFE design, nsim should be at least 1000.
```

```
sim.power.longsfecomint(
  n.ch.per.trt = 2,
  exp.length = 90,
  sampl.freq = "monthly",
  lambda = 10,
  intvn1.effect = 0.7,
  intvn2.effect = 0.8,
  ixn.effect = 0.8,
  chamber.var = 0.1807,
  time.var = 0.2266,
  theta = 10,
  nsim = 2,
  n.cores = 1,
  use.random = TRUE
)
```

```
sim.power.longsfesinint
```

Estimate Empirical Power for Long-Term Semi-Field Experiment Testing Single Intervention

Description

Runs repeated simulations and negative binomial GLMM fits to estimate empirical power as the proportion of simulations with p-values below 0.05. These p-values are generated using the function called 'sim.pval.longsfesinint()'.

Usage

```
sim.power.longsfesinint(
  n.ch.per.trt,
  exp.length,
  sampl.freq,
  lambda,
  intvn.effect,
  chamber.var,
  time.var,
  theta,
  nsim = 100,
  n.cores = 1,
  use.random = TRUE
)
```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
exp.length	An integer indicating total duration of the experiment in days, e.g., 90 days.
sampl.freq	A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention (e.g., ITN).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
time.var	A numeric value indicating the variance between sampling time points (random effect).
theta	A numeric value quantifying overdispersion parameter for the negative binomial distribution.
nsim	An integer indicating the total number of simulations.
n.cores	An integer the number of cores to use for parallel processing.
use.random	A logical value indicating whether to plot mosquito counts simulated using a sampling distribution (with random or fixed effects). If TRUE, returns power for expected mosquito counts simulated using sampling distribution with random effects; If FALSE, returns power for expected counts using sampling distribution based on fixed effects only.

Value

A named numeric vector:

power Estimated empirical power (rounded to two decimal places)

ci.lower Lower bound of 95% confidence interval

ci.upper Upper bound of 95% confidence interval

Note

Parallel execution is supported via 'n.cores', but examples default to 'n.cores = 1' for reproducibility and package checks.

Examples

```
# For a realistic SFE design, nsim should be at least 1000.
```

```
sim.power.longsfesinint(
  n.ch.per.trt = 2,
  exp.length = 90,
  sampl.freq = "monthly",
  lambda = 10,
  intvn.effect = 0.8,
```

```

chamber.var = 0.1807,
time.var = 0.2266,
theta = 10,
nsim = 2,
n.cores = 1,
use.random = TRUE
)

```

```
sim.power.shortsfe.comint
```

Estimate Empirical Power for Short-Term Semi-Field Experiment Testing Combined Intervention

Description

Runs repeated simulations and Poisson GLMM fits to estimate empirical power as the proportion of simulations with p-values below 0.05. These p-values are generated using the function called 'sim.pval.shortsfe.comint()'.

Usage

```

sim.power.shortsfe.comint(
  n.ch.per.trt,
  lambda,
  intvn1.effect,
  intvn2.effect,
  ixn.effect,
  chamber.var,
  nsim,
  n.cores = 1,
  use.random = TRUE
)

```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn1.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 1 (e.g., ITN).
intvn2.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 2 (e.g., PPFa).
ixn.effect	A numeric value representing the proportional reduction in mosquito count due to the interaction (e.g., ITN x PPFa).
chamber.var	A numeric value specifying the variance of random chamber-level effects.

nsim	An integer indicating the total number of simulations.
n.cores	An integer the number of cores to use for parallel processing.
use.random	A logical value indicating whether to plot mosquito counts simulated using a sampling distribution (with random or fixed effects). If TRUE, returns power for expected mosquito counts simulated using sampling distribution with random effects; If FALSE, returns power for expected counts using sampling distribution based on fixed effects only.

Value

A named numeric vector:

power Estimated empirical power (rounded to two decimal places)

ci.lower Lower bound of 95% confidence interval

ci.upper Upper bound of 95% confidence interval

Note

Parallel execution is supported via 'n.cores', but examples default to 'n.cores = 1' for reproducibility and package checks.

Examples

```
# For a realistic SFE design, nsim should be at least 1000.
```

```
sim.power.shortsfe.comint(
  n.ch.per.trt = 2,
  lambda = 50,
  intvn1.effect = 0.7,
  intvn2.effect = 0.8,
  ixn.effect = 0.5,
  chamber.var = 0.1807,
  nsim = 2,
  n.cores = 1,
  use.random = TRUE
)
```

```
sim.power.shortsfe.sinint
```

Estimate Empirical Power for Short-Term Semi-Field Experiment Testing Single Intervention

Description

Runs repeated simulations and Poisson GLMM fits to estimate empirical power as the proportion of simulations with p-values below 0.05. These p-values are generated using the function called 'sim.pval.shortsfe.sinint()'.

Usage

```
sim.power.shortsfe.sinint(
  n.ch.per.trt,
  lambda,
  intvn.effect,
  chamber.var,
  nsim,
  n.cores = 1,
  use.random = TRUE
)
```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention (e.g., ITN).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
nsim	An integer indicating the total number of simulations.
n.cores	An integer the number of cores to use for parallel processing.
use.random	A logical value indicating whether to plot mosquito counts simulated using a sampling distribution (with random or fixed effects). If TRUE, returns power for expected mosquito counts simulated using sampling distribution with random effects; If FALSE, returns power for expected counts using sampling distribution based on fixed effects only.

Value

A named numeric vector:

power Estimated empirical power (rounded to two decimal places)

ci.lower Lower bound of 95% confidence interval

ci.upper Upper bound of 95% confidence interval

Note

Parallel execution is supported via ‘n.cores’, but examples default to ‘n.cores = 1’ for reproducibility and package checks.

Examples

```
# For a realistic SFE design, nsim should be at least 1000.
```

```
sim.power.shortsfe.sinint(
  n.ch.per.trt = 2,
  lambda = 50,
```

```

    intvn.effect = 0.8,
    chamber.var = 0.1807,
    nsim = 2,
    n.cores = 1,
    use.random = TRUE
)

```

```
sim.pval.longsfecomint
```

Extract p-value from Simulated GLMM for Long-Term Semi-Field Experiment Testing Combined Interventions

Description

Returns the p-value by fitting a negative binomial GLMM to simulated mosquito count data. Uses simulated mosquito counts data from 'sim.mosq.longsfecomint()' and fits a negative binomial GLMM to extract the p-value associated with the intvn effect.

Usage

```

sim.pval.longsfecomint(
  n.ch.per.trt,
  exp.length,
  sampl.freq = "weekly",
  lambda,
  intvn1.effect,
  intvn2.effect,
  ixn.effect,
  chamber.var,
  time.var,
  theta,
  use.random = TRUE
)

```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
exp.length	An integer indicating total duration of the experiment in days, e.g., 90 days.
sampl.freq	A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn1.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 1 (e.g., ITN).

intvn2.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 2 (PPFa).
ixn.effect	A numeric value representing the proportional reduction in mosquito count due to the interaction between interventions (e.g., ITN x PPFa).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
time.var	A numeric value indicating the variance between sampling time points (random effect).
theta	A numeric value quantifying overdispersion parameter for the negative binomial distribution.
use.random	A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only;

Value

A named numeric vector:

pvalue A p-value from likelihood ratio test comparing models with and without the interaction term

Examples

```
# For a realistic SFE design, nsim should be at least 1000
sim.pval.longsfefe.comint(
  n.ch.per.trt = 2,
  exp.length = 90,
  sampl.freq = "monthly",
  lambda = 10,
  intvn1.effect = 0.7,
  intvn2.effect = 0.8,
  ixn.effect = 0.8,
  chamber.var = 0.1807,
  time.var = 0.2266,
  theta = 10,
  use.random = TRUE
)
```

```
sim.pval.longsfefe.sinint
```

Extract p-value from Simulated GLMM for Long-Term Semi-Field Experiment Testing Single Intervention

Description

Returns the p-value by fitting a negative binomial GLMM to simulated mosquito count data. Uses simulated mosquito counts data from 'sim.mosq.longsfefe.sinint()' and fits a negative binomial GLMM to extract the p-value associated with the intvn effect.

Usage

```
sim.pval.longsfe.sinint(
  n.ch.per.trt,
  exp.length,
  sampl.freq = "weekly",
  lambda,
  intvn.effect,
  chamber.var,
  time.var,
  theta,
  use.random = TRUE
)
```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
exp.length	An integer indicating total duration of the experiment in days, e.g., 90 days.
sampl.freq	A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention (e.g., ITN).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
time.var	A numeric value indicating the variance between sampling time points (random effect).
theta	A numeric value quantifying overdispersion parameter for the negative binomial distribution.
use.random	A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only;

Value

A named numeric vector:

pvalue A p-value from likelihood ratio test comparing models with and without the interaction term

Examples

```
sim.pval.longsfe.sinint(
  n.ch.per.trt = 2,
  exp.length = 90,
```

```

    sampl.freq = "monthly",
    lambda = 10,
    intvn.effect = 0.8,
    chamber.var = 0.1807,
    time.var = 0.2266,
    theta = 10,
    use.random = TRUE
  )

```

```
sim.pval.shortsfe.comint
```

Extract p-value from Simulated GLMM for Short-Term Semi-Field Experiment Testing Combined Interventions

Description

Returns the p-value by fitting a Poisson GLMM to simulated mosquito count data. Uses simulated mosquito counts data from ‘sim.mosq.shortsfe.comint()’ and fits a Poisson GLMM to extract the p-value associated with the intvn effect.

Usage

```

sim.pval.shortsfe.comint(
  n.ch.per.trt,
  lambda,
  intvn1.effect,
  intvn2.effect,
  ixn.effect,
  chamber.var,
  use.random = TRUE
)

```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn1.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 1 (e.g., ITN).
intvn2.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention 2 (e.g., PPFa).
ixn.effect	A numeric value representing the proportional reduction in mosquito count due to the interaction (e.g., ITN x PPFa).
chamber.var	A numeric value specifying the variance of random chamber-level effects.

`use.random` A logical value indicating whether to return mosquito counts simulated through a sampling distribution (with random or fixed chamber effects) or all. If TRUE, returns expected mosquito counts simulated through sampling distribution with random effects; If FALSE, returns expected mosquito counts simulated through sampling distribution based on fixed effects only;

Value

A named numeric vector:

pvalue A p-value from likelihood ratio test comparing models with and without the interaction term

Examples

```
sim.pval.shortsfe.comint(
  n.ch.per.trt = 2,
  lambda = 50,
  intvn1.effect = 0.7,
  intvn2.effect = 0.8,
  ixn.effect = 0.5,
  chamber.var = 0.1807,
  use.random = TRUE
)
```

sim.pval.shortsfe.sinint

Extract p-values from Simulated GLMM for Short-Term Semi-Field Experiment Testing Single Intervention

Description

Returns the p-value by fitting a Poisson GLMM to simulated mosquito count data. Uses simulated mosquito counts data from 'sim.mosq.shortsfe.sinint()' and fits a Poisson GLMM to extract the p-value associated with the intvn effect.

Usage

```
sim.pval.shortsfe.sinint(
  n.ch.per.trt,
  lambda,
  intvn.effect,
  chamber.var,
  use.random = TRUE
)
```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
lambda	A numeric value indicating the expected mean mosquito count in control chambers.
intvn.effect	A numeric value representing the proportional reduction in mosquito count due to the intervention (e.g., ITN).
chamber.var	A numeric value specifying the variance of random chamber-level effects.
use.random	A logical value indicating whether to plot mosquito counts simulated using a sampling distribution (with random or fixed effects) or exponential function (fixed effect) If TRUE, returns p-value for GLMM fitted to expected mosquito counts simulated using sampling distribution with random effects; If FALSE, returns p-value for GLMM fitted to mosquito counts simulated using sampling distribution based on fixed effects only.

Value

A named numeric vector:

pvalue A p-value for the intervention effect from the GLMM

Examples

```
sim.pval.shortsfe.sinint(
  n.ch.per.trt = 2,
  lambda = 50,
  intvn.effect = 0.8,
  chamber.var = 0.1807,
  use.random = TRUE
)
```

```
sim.scen.longsfefe.comint
```

*Simulate Design Scenarios for Long-Term Semi-Filed Experiment
Testing Combined Interventions*

Description

Constructs a data frame representing the factorial design of semi-field experiments testing combined interventions. Each chamber is uniquely identified and assigned treatments combinations, including interaction terms. The intervention here are shortly named as 'intvn1' and 'intvn2'.

Usage

```
sim.scen.longsfefe.comint(n.ch.per.trt, exp.length, sampl.freq = "weekly")
```

Arguments

n.ch.per.trt	An integer specifying the number of chambers allocated per treatment group.
exp.length	An integer indicating total duration of the experiment in days, e.g., 90 days.
sampl.freq	A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.

Value

A data frame with columns:

replicates	Replicate number within each treatment group (e.g., for a total of 2 chambers per treatment means 1, 2 replicates per treatment)
intvn1	Intervention status (e.g., 0 = control or no intervention 1 and 1 = there is intervention 1)
intvn2	Intervention status (e.g., 0 = control or no intervention 2 and 1 = there is intervention 2)
chamber	Unique chamber identifier as a factor (e.g., 0-0-1, 0-0-2 for the control chambers and 0-1-1, 1-0-1, 1-1-1 for intervention chambers)
time	Time sequence scaled between 0 and 1, it is calculate by the ratio of sampling points by their total number
timef	This is just the same as "time" but as a factor
ixn.intvn1.time	This is the interaction between an intvn1 and time, i.e., intvn1 x time
ixn.intvn2.time	This is the interaction between an intvn2 and time, i.e., intvn2 x time
ixn.intvn1.intvn2.time	This is the interaction between an intvn1, intvn2 and time, i.e., intvn1 x intvn2 x time

Examples

```
sim.scen.longsfefe.comint(
  n.ch.per.trt = 2,
  exp.length = 90,
  sampl.freq = "monthly"
)
```

```
sim.scen.longsfefe.sinint
```

*Simulate Design Scenarios for Long-Term Semi-Field Experiment
Testing Single Intervention*

Description

Constructs a design scenario table representing a short-term semi-field experiment with two treatment levels (or intervention status), i.e., control (no intervention) and intervention, and a specified number of chambers or compartment per treatment. Each chamber is uniquely identified by a treatment level and a replicate combination. An intervention here is shortly named as 'intvn'.

Usage

```
sim.scen.longsfe.sinint(n.ch.per.trt, exp.length, sampl.freq = "weekly")
```

Arguments

n.ch.per.trt An integer specifying the number of chambers allocated per treatment group.

exp.length An integer indicating total duration of the experiment in days, e.g., 90 days.

sampl.freq A character for a sampling frequency label. Example, for 90 days experiment; "daily" means 90 sampling points, "weekly" means 12 sampling points, "bi-weekly" means 6 sampling points, or "monthly" means 3 sampling points.

Value

A data frame with columns:

replicates Replicate number within each treatment group (e.g., for a total of 2 chambers per treatment means 1, 2 replicates per treatment)

intvn Intervention status (e.g., 0 = control or no intervention and 1 = there is intervention)

chamber Unique chamber identifier as a factor (e.g., 0-1, 0-2 for the control chambers and 1-1, 1-2 for intervention chambers)

time Time sequence scaled between 0 and 1, it is calculate by the ratio of sampling points by their total number

timef This is just the same as "time" but as a factor

intvn.time This is the interaction between an intervention and time, i.e., intvn x time

Examples

```
sim.scen.longsfe.sinint(
  n.ch.per.trt = 2,
  exp.length = 90,
  sampl.freq = "monthly"
)
```

```
sim.scen.shortsfe.comint
```

*Simulate Design Scenarios for Short-Term Semi-Field Experiment
Testing Combined Interventions*

Description

Constructs a data frame representing the factorial design of semi-field experiments testing combined interventions. Each chamber is uniquely identified and assigned treatments combinations, including interaction terms. The intervention here are shortly named as 'intvn1' and 'intvn2'.

Usage

```
sim.scen.shortsfe.comint(n.ch.per.trt)
```

Arguments

`n.ch.per.trt` An integer specifying the number of chambers allocated per treatment group.

Value

A data frame with columns:

replicates Replicate number within each treatment group (e.g., for a total of 2 chambers per treatment means 1, 2 replicates per treatment)

intvn1 Intervention status (e.g., 0 = control or no intervention 1 and 1 = there is intervention 1)

intvn2 Intervention status (e.g., 0 = control or no intervention 2 and 1 = there is intervention 2)

ixn Interventions interactions status (e.g., 0 = control or no intervention and 1 = there is interaction)

chamber Unique chamber identifier as a factor (e.g., 0-0-1, 0-0-2 for the control chambers and 0-1-1, 1-0-1, 1-1-1 for intervention chambers)

Examples

```
sim.scen.shortsfe.comint(n.ch.per.trt = 2)
```

```
sim.scen.shortsfe.sinint
```

*Simulate Design Scenarios for Short-Term Semi-Field Experiment
Testing Single Intervention*

Description

Constructs a design scenario table representing a short-term semi-field experiment with two treatment levels (or intervention status), i.e., control (no intervention) and intervention, and a specified number of chambers or compartment per treatment. Each chamber is uniquely identified by a treatment level and a replicate combination. An intervention here is shortly named as 'intvn'.

Usage

```
sim.scen.shortsfe.sinint(n.ch.per.trt)
```

Arguments

`n.ch.per.trt` An integer specifying the number of chambers allocated per treatment group.

Details

This function considers a single design parameter, which is the total number of chambers or compartments per treatment ('n.ch.per.trt'), e.g., 4. The 'n.ch.per.trt' indicates how many chambers known as 'replicates' are present per treatment.

Value

A data frame with columns:

replicates Replicate number within each treatment group (e.g., for a total of 2 chambers per treatment means 1, 2 replicates per treatment)

intvn Intervention status (e.g., 0 = control or no intervention and 1 = there is intervention)

chamber Unique chamber identifier as a factor (e.g., 0-1, 0-2 for the control chambers and 1-1, 1-2 for intervention chambers)

Examples

```
sim.scen.shortsfe.sinint(n.ch.per.trt = 2)
```

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