Package 'babebi'

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Type Package

Title Bayesian Estimation and Validation for Small-N Designs with Rater Bias

Version 0.1.0

Description Approximate Bayesian inference and Monte Carlo validation for small-N repeated-measures designs with two time points and two raters. The package is intended for applications in which sample size is limited and the observed outcome may be affected by rater-specific bias. User-supplied data are standardised into a common long-format structure. Pre-post effects are analysed using difference scores in a linear model with a rater indicator as covariate. Posterior summaries for the regression coefficients are obtained from a large-sample normal approximation centred at the least-squares estimate with plug-in covariance under a flat improper prior. Evidence for a non-zero pre-post effect, adjusted for rater differences, is summarised using a BIC-based approximation to the Bayes factor for comparison between models with and without the pre-post effect. Monte Carlo validation uses design quantities estimated from the observed data, including sample size, mean pre-post change, and second-rater additive discrepancy, and summarises inferential performance in terms of bias, root mean squared error, credible interval coverage, posterior tail probabilities, and mean Bayes factor values. For background on the BIC approximation and Bayes factors, see Schwarz (1978) <doi:10.1214/aos/1176344136> and Kass and Raftery (1995) <doi:10.1080/01621459.1995.10476572>.

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Contents

`babebi` *Run the babebi workflow on user-supplied data*

Description

Fits the babebi model to observed data and, optionally, performs Monte Carlo validation calibrated on the observed design.

Usage

```
babebi(
  data,
  id,
  time,
  rater,
  outcome,
  time_order = NULL,
  rater_order = NULL,
  validate = TRUE,
  R = 1000,
  N = NULL,
  delta = NULL,
```

```
  bias_r2 = NULL,
  n_draws = 4000,
  seed = NULL
)
```

Arguments

data	A data frame in long format.
id	Unquoted column name identifying subjects or a character string.
time	Unquoted column name identifying time points or a character string.
rater	Unquoted column name identifying raters or a character string.
outcome	Unquoted column name containing the observed score or a character string.
time_order	Optional character vector of length 2 giving the order of the time factor: baseline first, follow-up second.
rater_order	Optional character vector of length 2 giving the order of the rater factor: reference rater first, second rater second.
validate	Logical; if TRUE, run Monte Carlo validation after model fitting.
R	Number of Monte Carlo repetitions when validate = TRUE.
N	Optional override for the sample size used in validation.
delta	Optional override for the pre-post effect used in validation.
bias_r2	Optional override for the additive bias of the second rater used in validation.
n_draws	Number of posterior draws used in model fitting.
seed	Optional integer seed for reproducibility.

Value

A named list containing:

fit A babebi_fit object returned by fit_model().

validation A babebi_validation object returned by montecarlo_from_data() when validate = TRUE, otherwise NULL.

call The original function call.

Examples

```
dat <- data.frame(
  id = rep(1:4, each = 4),
  time = rep(c("pre", "pre", "post", "post"), times = 4),
  rater = rep(c("r1", "r2"), times = 8),
  y = c(
    3.0, 3.2, 3.8, 4.0,
    2.9, 3.1, 3.5, 3.7,
    3.4, 3.6, 4.0, 4.1,
    3.1, 3.3, 3.9, 4.0
  )
)
```

```
res <- babebi(
  data = dat,
  id = id,
  time = time,
  rater = rater,
  outcome = y,
  time_order = c("pre", "post"),
  rater_order = c("r1", "r2"),
  validate = TRUE,
  R = 100,
  n_draws = 500,
  seed = 123
)

print(res$fit)
summary(res$fit)
plot(res$fit)
print(res$validation)
```

`fit_model` *Fit the babebi model to observed data*

Description

Fits the current babebi model to a fully observed 2 (time) x 2 (rater) repeated-measures dataset. Estimation is based on difference scores and a linear model including a rater indicator as covariate.

Usage

```
fit_model(
  data,
  id,
  time,
  rater,
  outcome,
  time_order = NULL,
  rater_order = NULL,
  n_draws = 4000,
  seed = NULL
)
```

Arguments

`data`	A data frame in long format.
`id`	Unquoted column name identifying subjects or a character string.
`time`	Unquoted column name identifying time points or a character string.

rater	Unquoted column name identifying raters or a character string.
outcome	Unquoted column name containing the observed score or a character string.
time_order	Optional character vector of length 2 giving the order of the time factor: baseline first, follow-up second.
rater_order	Optional character vector of length 2 giving the order of the rater factor: reference rater first, second rater second.
n_draws	Number of posterior draws used for approximation.
seed	Optional integer seed used to initialise the random-number generator for posterior sampling.

Details

Posterior draws are obtained from a large-sample normal approximation to the posterior of the regression coefficients under an improper flat prior.

Value

A named list of class `babebi_fit`.

Examples

```
dat <- data.frame(
  id = rep(1:4, each = 4),
  time = rep(c("pre", "pre", "post", "post"), times = 4),
  rater = rep(c("r1", "r2"), times = 8),
  y = c(
    3.0, 3.2, 3.8, 4.0,
    2.9, 3.1, 3.5, 3.7,
    3.4, 3.6, 4.0, 4.1,
    3.1, 3.3, 3.9, 4.0
  )
)

fit <- fit_model(
  data = dat,
  id = id,
  time = time,
  rater = rater,
  outcome = y,
  time_order = c("pre", "post"),
  rater_order = c("r1", "r2"),
  n_draws = 500,
  seed = 123
)

print(fit)
summary(fit)
plot(fit)
```

`montecarlo_from_data` *Run Monte Carlo calibration from user-supplied data*

Description

Uses observed data to estimate the sample size, mean pre-post change, and mean additive discrepancy of the second rater for the Monte Carlo engine, then runs a single Monte Carlo validation cell.

Usage

```
montecarlo_from_data(
  data,
  id,
  time,
  rater,
  outcome,
  time_order = NULL,
  rater_order = NULL,
  R = 1000,
  N = NULL,
  delta = NULL,
  bias_r2 = NULL,
  seed = NULL
)
```

Arguments

`data`	A data frame in long format.
`id`	Unquoted column name identifying subjects or a character string.
`time`	Unquoted column name identifying time points or a character string.
`rater`	Unquoted column name identifying raters or a character string.
`outcome`	Unquoted column name containing the observed score or a character string.
`time_order`	Optional character vector of length 2 giving the order of the time factor: baseline first, follow-up second.
`rater_order`	Optional character vector of length 2 giving the order of the rater factor: reference rater first, second rater second.
`R`	Number of Monte Carlo repetitions.
`N`	Optional override for the sample size used in the simulation. Defaults to the observed number of subjects.
`delta`	Optional override for the pre-post effect used in the simulation. Defaults to the value estimated from the data.
`bias_r2`	Optional override for the additive bias of the second rater. Defaults to the value estimated from the data.
`seed`	Optional integer seed used to initialise the random-number generator for simulation.

Value

A one-row data frame of class `babebi_validation` with Monte Carlo performance summaries. The attributes `calibrated_design` and `call` store the design estimated from the observed data and the original call.

Examples

```
dat <- data.frame(
  id = rep(1:4, each = 4),
  time = rep(c("pre", "pre", "post", "post"), times = 4),
  rater = rep(c("r1", "r2"), times = 8),
  y = c(
    3.0, 3.2, 3.8, 4.0,
    2.9, 3.1, 3.5, 3.7,
    3.4, 3.6, 4.0, 4.1,
    3.1, 3.3, 3.9, 4.0
  )
)

mc <- montecarlo_from_data(
  data = dat,
  id = id,
  time = time,
  rater = rater,
  outcome = y,
  time_order = c("pre", "post"),
  rater_order = c("r1", "r2"),
  R = 100,
  seed = 123
)

print(mc)
```

`plot.babebi_fit` *Plot a babebi fit object*

Description

Plot a babebi fit object

Usage

```
## S3 method for class 'babebi_fit'
plot(x, ...)
```

Arguments

`x`	An object of class `babebi_fit`.
`...`	Further arguments passed to or from other methods.

Value

No return value, called for its side effects.

---

print.babebi_fit *Print a babebi fit object*

Description

Print a babebi fit object

Usage

```
## S3 method for class 'babebi_fit'
print(x, digits = 3, ...)
```

Arguments

x	An object of class babebi_fit.
digits	Number of digits to print.
...	Further arguments passed to or from other methods.

Value

The input object, invisibly.

---

print.babebi_validation *Print a babebi validation object*

Description

Print a babebi validation object

Usage

```
## S3 method for class 'babebi_validation'
print(x, digits = 3, ...)
```

Arguments

x	An object of class babebi_validation.
digits	Number of digits to print.
...	Further arguments passed to or from other methods.

Value

The input object, invisibly.

print.summary.babebi_fit *Print a summary of a babebi fit object*

Description

Print a summary of a babebi fit object

Usage

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

Arguments

x	An object of class summary.babebi_fit.
...	Further arguments passed to or from other methods.

Value

The input object, invisibly.

summary.babebi_fit *Summarise a babebi fit object*

Description

Summarise a babebi fit object

Usage

```
## S3 method for class 'babebi_fit'
summary(object, digits = 3, ...)
```

Arguments

object	An object of class babebi_fit.
digits	Number of digits to print.
...	Further arguments passed to or from other methods.

Value

An object of class summary.babebi_fit.

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