Package 'fergm'

October 13, 2022

Date 2018-10-17

Type Package

Title Estimation and Fit Assessment of Frailty Exponential Random
Graph Models

Version 1.1.4

Author Jason W. Morgan [aut],
Benjamin W. Campbell [aut, cre],
Dino P. Christenson [aut],
Janet M. Box-Steffensmeier [aut]

Maintainer Benjamin W. Campbell <campbell.1721@osu.edu>

Description Frailty Exponential Random Graph Models estimated through pseudo likeli-
hood with frailty terms estimated using 'Stan' as per Box-
Steffensmeier et. al (2017) <doi:10.7910/DVN/K3D1M2>.
Goodness of fit for Frailty Exponential Random Graph Models is also available, with easy visu-
alizations for comparison to fit Exponential Random Graph Models.

URL http://github.com/benjamin-w-campbell/fergm

Depends R (>= 3.3), rstan (>= 2.16.2),

Imports ggplot2 (>= 2.2.1), parallel (>= 3.3.3), ergm (>= 3.9),
network (>= 1.13.0), extrafont (>= 0.17), matrixStats (>=
0.52.2), reshape2 (>= 1.4.2), stats (>= 3.4.4),

License GPL-3

Encoding UTF-8

LazyData false

RoxygenNote 6.0.1.9000

Suggests knitr, rmarkdown, testthat

VignetteBuilder knitr

NeedsCompilation no

Repository CRAN

Date/Publication 2018-10-17 22:20:11 UTC

R topics documented:

---

clean_summary *Clean posterior description of FERGM.*

Description

This function takes a stan object and return a clean summary of the posterior distribution.

Usage

```
clean_summary(fergm.fit = NULL, custom_var_names = NULL)
```

Arguments

fergm.fit   A model object returned by the fergm function. Must be specified.

custom_var_names

A vector of custom variable names used in presentation that match the order of the form object passed to fergm. If not provided, defaults to names inherited by fergm.fit.

Value

This function returns a matrix summarizing the posterior distribution, including variable names, posterior means, and 95

References

Box-Steffensmeier, Janet M., Dino P. Christenson, and Jason W. Morgan. 2018. "Modeling Unobserved Heterogeneity in Social Networks with the Frailty Exponential Random Graph Model." *Political Analysis*. (26)1:3-19.

Stan Development Team (2016). RStan: the R interface to Stan. R package version 2.14.1. http://mc-stan.org/.

Examples

```
## Not run:
# The fergm.fit$stan.fit object is of class stanfit.
   # We keep it this way such that users can rely upon
   # conventional stan functions for interpretation
   # getting posterior distributions from the fergm

   # Conventional rstan summary call

 # load example data
data("ergm.fit")
data("fergm.fit")
data("mesa")
stan.smry <- summary(fergm.fit$stan.fit)$summary
beta_df <- stan.smry[grep("beta", rownames(stan.smry)),]
est <- round(beta_df[,c(1,4,8)], 3)

  # We have a built in function to do this simply
est <- clean_summary(fergm.fit)
est <- clean_summary(fergm.fit,
custom_var_names = c("Edges", "Sex Homophily", "Grade Homophily",
"Race Homophily", "GWESP", "Alternating K-Stars"))

## End(Not run)
```

---

coef_plot	*Plots the coefficients of FERGM and ERGM objects.*

Description

This function allows the users to visualize FERGM estimates or to compare the coefficients of
ERGMs and FERGMs.

Usage

```
coef_plot(fergm.fit = NULL, ergm.fit = NULL, custom_var_names = NULL)
```

Arguments

fergm.fit   A model object returned by the fergm function. Must be specified.

ergm.fit   A model object returned by the ergm function. May be specified when compar-
ing ERGM and FERGM coefficients.

custom_var_names

A vector of custom variable names used in presentation that match the order of
the form object passed to fergm. If not provided, defaults to names inherited by
fergm.fit.

Value

This function produces a coefficient rope-ladder plot containing 95% confidence intervals using ggplot2. The function either takes `fergm` model output or `fergm` and `ergm` model output. The former is effective in summarizing `fergm` model output while the latter is effective in comparing FERGM and ERGM estimates.

References

Box-Steffensmeier, Janet M., Dino P. Christenson, and Jason W. Morgan. 2018. "Modeling Unobserved Heterogeneity in Social Networks with the Frailty Exponential Random Graph Model." *Political Analysis*. (26)1:3-19.references Box-Steffensmeier, Janet M., Dino P. Christenson, and Jason W. Morgan. 2017. "Modeling Unobserved Heterogeneity in Social Networks with the Frailty Exponential Random Graph Model." *Political Analysis*.

Stan Development Team (2016). RStan: the R interface to Stan. R package version 2.14.1. http://mc-stan.org/.

Examples

```
# load example data
data("ergm.fit")
data("fergm.fit")
data("mesa")
# Compare substantive implications via coef plot, these are with 95% credible intervals
coef_plot(fergm.fit = fergm.fit, ergm.fit = ergm.fit,
custom_var_names =  c("Edges", "Sex Homophily", "Grade Homophily",
"Race Homophily", "GWESP", "Alternating K-Stars"))
coef_plot(fergm.fit = fergm.fit,
custom_var_names =  c("Edges", "Sex Homophily", "Grade Homophily",
"Race Homophily", "GWESP", "Alternating K-Stars"))
```

---

coef_posterior_density

Plots the posterior density for FERGM model terms.

Description

This function allows the users to examine the posterior density of FERGM model terms.

Usage

```
coef_posterior_density(fergm.fit = NULL, custom_var_names = NULL)
```

Arguments

fergm.fit   A model object returned by the `fergm` function. Must be specified.

custom_var_names

A vector of custom variable names used in presentation that match the order of the `form` object passed to `fergm`. If not provided, defaults to names inherited by `fergm.fit`.

Value

This prints a list of posterior density plots produced using ggplot2.

References

Box-Steffensmeier, Janet M., Dino P. Christenson, and Jason W. Morgan. 2018. "Modeling Unobserved Heterogeneity in Social Networks with the Frailty Exponential Random Graph Model." *Political Analysis*. (26)1:3-19.

Stan Development Team (2016). RStan: the R interface to Stan. R package version 2.14.1. http://mc-stan.org/.

Examples

```
# load example data
data("ergm.fit")
data("fergm.fit")
data("mesa")

# rstan functions
# Histogram of the posterior
rstan::stan_hist(fergm.fit$stan.fit, par = "beta")
# Density of the posteriors
rstan::stan_dens(fergm.fit$stan.fit, par = "beta")

# We have a cleaner function to look at the posterior densities
densities <- coef_posterior_density(fergm.fit = fergm.fit,
custom_var_names = c("Edges", "Sex Homophily", "Grade Homophily", "Race Homophily",
"GWESP", "Alternating K-Stars"))
densities[[1]]
densities[[2]]
```

---

compare_predictions   *Compare predictions of ERGM to FERGM.*

Description

This function allows you to assess the importance of the frailty term in prediction by comparing the predictive accuracy of an ERGM to an FERGM. Note: Prior to estimating this function, ensure the network object of interest is saved to the global environment and named "net."

Usage

```
compare_predictions(ergm.fit = NULL, fergm.fit = NULL, seed = NULL,
  replications = 500)
```

Arguments

`ergm.fit`	A model object returned by the `ergm` function. Must be specified.
`fergm.fit`	A model object returned by the `fergm` function. Must be specified.
`seed`	An integer that sets the seed for the random number generator to assist in replication. Defaults to a null value for no seed setting.
`replications`	The number of networks to be simulated to assess predictions. Defaults to 500.

Value

The compare_predictions function returns a matrix reflecting the number of correctly predicted ties for the ERGM and FERGM for each network simulated.

References

Box-Steffensmeier, Janet M., Dino P. Christenson, and Jason W. Morgan. 2018. "Modeling Unobserved Heterogeneity in Social Networks with the Frailty Exponential Random Graph Model." *Political Analysis*. (26)1:3-19.

Stan Development Team (2016). RStan: the R interface to Stan. R package version 2.14.1. `http://mc-stan.org/`.

Examples

```
# load example data
library(fergm)
data("ergm.fit")
data("fergm.fit")

# Use built in compare_predictions function to compare predictions of ERGM and FERGM,
# few replications due to example
# Make sure "net" is an object defined in the global environment.
net <- ergm.fit$network
predict_out <- compare_predictions(ergm.fit = ergm.fit, fergm.fit = fergm.fit,
                                   replications = 10, seed=12345)

# Use the built in compare_predictions_plot function to examine the densities of
#  correctly predicted ties from the compare_predictions simulations
compare_predictions_plot(predict_out)

# We can also conduct a KS test to determine if the FERGM fit
    # it statistically disginguishable from the ERGM fit
compare_predictions_test(predict_out)
```

compare_predictions_plot

> *Compare FERGM to ERGM predictions via plot. This is a plot function to compare the distributions of predictions from* ergm *and* fergm *objects.*

Description

Compare FERGM to ERGM predictions via plot. This is a plot function to compare the distributions of predictions from ergm and fergm objects.

Usage

```
compare_predictions_plot(compare_predictions_out = NULL)
```

Arguments

compare_predictions_out

> Matrix of correctly predicted ties produced by the compare_predictions function.

Value

The compare_predictions_plot function returns a ggplot2 plot of the density of the percent of correctly predicted ties simulated by the compare_predictions function.

References

Box-Steffensmeier, Janet M., Dino P. Christenson, and Jason W. Morgan. 2018. "Modeling Unobserved Heterogeneity in Social Networks with the Frailty Exponential Random Graph Model." *Political Analysis*. (26)1:3-19.

Stan Development Team (2016). RStan: the R interface to Stan. R package version 2.14.1. http://mc-stan.org/.

compare_predictions_test

> *KS Test for Difference in Predictive Performance*

Description

This is a plot function to determine whether the distributions of predictions from ERGM and FERGM objects differ. It does so by using a Kolmogorov-Smirnov Test.

Usage

```
compare_predictions_test(compare_predictions_out = NULL, alpha_level = 0.05)
```

Arguments

compare_predictions_out

        Matrix of correctly predicted ties produced by the `compare_predictions` function.

alpha_level   The significance level that should be used for the test.

Value

Returns `ks.test` output to determine if the percent of correctly predicted ERGM ties are less than those of the FERGM and prints a message to assist with interpretation

Examples

```
# load example data
data("ergm.fit")
data("fergm.fit")
data("mesa")
# Use built in compare_predictions function to compare predictions of ERGM and FERGM,
# few replications due to example
 net <- ergm.fit$network
predict_out <- compare_predictions(ergm.fit = ergm.fit, fergm.fit = fergm.fit,
                                   replications = 10, seed = 12345)

# We can also conduct a KS test to determine if the FERGM fit it statistically
 # distinguishable from the ERGM fit
compare_predictions_test(predict_out)
```

---

ergm.fit   *Output from an Exponential Random Graph Model fit on the Mesa High Network (Hunter et. al, 2008).*

Description

This is the output of a call to the ergm function fit with with an edge term, sex, grade, and race homophily, GWESP, and alternating k-stars. Fit according to the vignette "mesaHighVignette".

Usage

```
data(ergm.fit)
```

Format

An object of class `"ergm"`

References

Hunter et al. (2008) ergm: A package to fit, simulate and diagnose exponential-family models for networks. Journal of Statistical Software 24(3).

fergm	*Estimation of Frailty Exponential Random Graph Model (FERGM) via MPLE using Stan*

Description

This function estimates a FERGM

Usage

```
fergm(net = NULL, form = NULL, seed = 12345, chains = 4, warmup = 100,
  iter = 600, cores = 1)
```

Arguments

net	A network object that is to be explained using the right_hand_vars argument.
form	A character string specified as "ergm.term1 + ergm.term2", must be terms supported for ERGMs.
seed	An integer that sets the seed for the random number generator to assist in replication. Defaults to 12345. Set to null to prevent internal seed setting.
chains	An integer that sets the number of Markov chains that should be used by Stan.
warmup	The number of warm up or burn-in iterations that should be used before posterior draws are taken. Defaults to 100.
iter	The number of total number of samples that should be taken including warm ups Defaults to 600 total iterations, leading to a posterior sample size of 500.
cores	The number of cores to used should parallel processing be desired. Defaults to 1.

Value

This function returns a list that includes the Stan output (stan.fit), the data object passed to Stan (stan.dta), and the original formula (form).

References

Box-Steffensmeier, Janet M., Dino P. Christenson, and Jason W. Morgan. 2018. "Modeling Unobserved Heterogeneity in Social Networks with the Frailty Exponential Random Graph Model." *Political Analysis*. (26)1:3-19.

Stan Development Team (2016). RStan: the R interface to Stan. R package version 2.14.1. http://mc-stan.org/.

Examples

```
## Not run:
set.seed(1)

data("faux.mesa.high")

mesa <- faux.mesa.high

mesa.fit <- ergm::ergm(mesa ~ edges +
                nodematch('Sex') +
                nodematch('Grade', diff = FALSE) +
                nodematch('Race', diff = FALSE) +
                gwesp(decay = 0.2, fixed = TRUE) +
                altkstar(lambda = 0.6, fixed = TRUE))

library(fergm)
form <- c("edges + nodematch('Sex') + nodematch('Grade', diff = FALSE) +
          nodematch('Race', diff = FALSE) +
          gwesp(decay = 0.2, fixed = TRUE) + altkstar(lambda = 0.6, fixed = TRUE)")

fergm.fit <- fergm(net = mesa, form = form, chains = 2)

## End(Not run)
```

---

fergm.fit   *Output from a Frailty Exponential Random Graph Model fit on the*
                           Mesa High Network (Hunter et. al, 2008)

Description

This is the output of a call to the ergm function fit with with an edge term, sex, grade, and race homophily, GWESP, and alternating k-stars. Fit according to "mesaHighVignette".

Usage

```
data(fergm.fit)
```

Format

A list containing an object of class "stan.fit"

References

Hunter et al. (2008) ergm: A package to fit, simulate and diagnose exponential-family models for networks. Journal of Statistical Software 24(3).

---

fergm_beta_traceplot *Plot traceplots for model terms.*

Description

This function takes a `fergm` object and plots the time series of each chain per model term using ggplot2.

Usage

```
fergm_beta_traceplot(fergm.fit = NULL, custom_var_names = NULL)
```

Arguments

fergm.fit   A model object returned by the `fergm` function. Must be specified.

custom_var_names

A vector of custom variable names used in presentation that match the order of the `form` object passed to `fergm`. If not provided, defaults to names inherited by `fergm.fit`.

Value

This prints a ggplot2 traceplot for the effects of interest.

References

Box-Steffensmeier, Janet M., Dino P. Christenson, and Jason W. Morgan. 2018. "Modeling Unobserved Heterogeneity in Social Networks with the Frailty Exponential Random Graph Model." *Political Analysis*. (26)1:3-19.

Stan Development Team (2016). RStan: the R interface to Stan. R package version 2.14.1. http://mc-stan.org/.

Examples

```
# load example data
data("ergm.fit")
data("fergm.fit")
data("mesa")
# Use rstan's built in traceplot function
trace <- rstan::traceplot(fergm.fit$stan.fit, pars = "beta")
trace

# We have our own version that includes variable names and tidies it up a bit
fergm_beta_traceplot(fergm.fit,
                     custom_var_names =  c("Edges", "Sex Homophily",
                   "Grade Homophily", "Race Homophily", "GWESP", "Alternating K-Stars"))
```

mesa	*Mesa High Network (Hunter et. al, 2008).*

Description

This is a network included in Hunter et al. (2008) that represents a simulated in-school friendship network.

Usage

```
data(mesa)
```

Format

An object of class `"network"`

References

Hunter et al. (2008) ergm: A package to fit, simulate and diagnose exponential-family models for networks. Journal of Statistical Software 24(3).

Index