# Package 'BayesSPsurv'

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**Type** Package

**Title** Bayesian Spatial Split Population Survival Model

**Version** 0.1.8

**Author** Brandon L. Bolte [aut], Nicolas Schmidt [aut, cre], Sergio Bejar [aut], Bumba Mukherjee [aut], Minnie M. Joo [ctb], Nguyen K. Huynh [ctb]

**Description** Bayesian parametric spatial split-population survival models for clustered event processes. The models account for both structural and spatial heterogeneity among "at risk" and "immune" populations, and incorporates time-varying covariates. This package currently implements Weibull, Exponential and Log-logistic forms for the duration component, and includes functions for a series of diagnostic tests and plots to easily visualize convergence and spatial effects. The user can also create their own spatial weights matrix based on their units and adjacencies of interest, making the use of these models flexible and broadly applicable to a variety of research areas.

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**Encoding** UTF-8

**LazyData** true

**Depends** R (>= 3.6.0)

**RoxygenNote** 7.1.0

**LinkingTo** Rcpp,
RcppArmadillo

**Imports** MCMCpack,
FastGP,
stats,
Rcpp,
RcppArmadillo,
coda,
dplyr,
reshape2

**Suggests** spduration

## R topics documented:

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`capdist` *Gleditsch and Ward Distance data*

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## Description

Dyadic dataset extracted from Gleditsch and Ward (2001). The dataset contains information on the distace between capital cities among independent nation-states.

## Usage

```
data(capdist)
```

## Format

A data frame with 41006 rows and 6 variables

## Details

**numa** COW code – country A.

**ida** Three letter ISO code – country A.

**numb** COW code – country B.

**idb** Three letter ISO code – country B.

**kmdist** Distance between capital cities in the kilometers.

**midist** Minimal distance between capital cities in the kilometers.

## Source

Gleditsch, Kristian S., and Michael D. Ward. (2001). "Measuring Space: A Minimum-Distance Database and Applications to International Studies." Journal of Conflict Resolution 38(6): 739-758.

exchangeSPsurv *exchangeSPsurv*

## Description

Markov Chain Monte Carlo (MCMC) to run Bayesian split population survival model with exchangeable frailties.

Returns a summary of a exchangeSPsurv object via summary.mcmc.

Print method for a exchangeSPsurv x.

Returns a plot of a exchangeSPsurv object via plot.mcmc.

## Usage

```
exchangeSPsurv(
  duration,
  immune,
  Y0,
  LY,
  S,
  data,
  N,
  burn,
  thin,
  w = c(1, 1, 1),
  m = 10,
  form = c("Weibull", "exponential", "loglog"),
  prop.var
)

## S3 method for class 'frailtySPsurv'
summary(object, parameter = c("betas", "gammas", "lambda"), ...)

## S3 method for class 'frailtySPsurv'
print(x, ...)

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

## Arguments

| | |
|---|---|
| duration | survival stage equation written in a formula of the form Y ~ X1 + X2 + ... where Y is duration until failure or censoring. |
| immune | split stage equation written in a formula of the form C ~ Z1 + Z2 + ... where C is a binary indicator of immunity. |
| Y0 | the elapsed time since inception until the beginning of time period (t-1). |
| LY | last observation year (coded as 1; 0 otherwise) due to censoring or failure. |
| S | spatial information (e.g. district ID) for each observation that matches the spatial matrix row/column information. |

| | |
|---|---|
| data | data.frame. |
| N | number of MCMC iterations. |
| burn | burn-in to be discarded. |
| thin | thinning to prevent from autocorrelation. |
| w | size of the slice in the slice sampling for (betas, gammas, rho). Write it as a vector. E.g. c(1,1,1). |
| m | limit on steps in the slice sampling. A vector of values for beta, gamma, rho. |
| form | type of parametric model (Weibull, Exponential, or Log-Logistic). |
| prop.var | proposed variance for Metropolis-Hastings. |
| object | an object of class frailtySPsurv, the output of exchangeSPsurv. |
| parameter | one of three parameters of the pooledSPsurv output. Indicate either "betas," "gammas," or "lambda." |
| ... | additional parameter. |
| x | an object of class frailtySPsurv, the output of exchangeSPsurv. |

## Value

exchangeSPsurv returns an object of class "exchangeSPsurv".

A "exchangeSPsurv" object has the following elements:

| | |
|---|---|
| betas | matrix, numeric values of the posterior for each variable in the duration equation . |
| gammas | matrix, numeric values of the posterior for each variable in the immune equation. |
| rho | numeric vector of values for rho. |
| lambda | numeric, vector of values for lambda. |
| delta | numeric, vector of values for delta. |
| W | matrix, numeric values of the posterior for Ws |
| V | matrix, numeric values of the posterior for Vs |
| X | matrix X's variables. |
| Z | matrix of Z's variables. |
| Y | the vector of 'Y'. |
| Y0 | the vector of 'Y0'. |
| C | the vector of 'C'. |
| S | the vector of 'S'. |
| form | character, type of distribution. |
| call | description for the model to be estimated. |

list. Empirical mean, standard deviation and quantiles for each variable.

list. Empirical mean, standard deviation and quantiles for each variable.

## Examples

```
walter <- spduration::add_duration(Walter_2015_JCR,"renewed_war",
                                   unitID = "id", tID = "year",
                                   freq = "year", ongoing = FALSE)

# add S
walter <- spatial_SA(data = walter, var_ccode = "ccode", threshold = 800L)

set.seed(123456)

model <-
    exchangeSPsurv(
           duration = duration ~ fhcompor1 + lgdpl + comprehensive + victory +
           instabl + intensityln + ethfrac + unpko,
           immune   = cured ~ fhcompor1 + lgdpl + victory,
           Y0       = 't.0',
           LY       = 'lastyear',
           S        = 'sp_id' ,
           data     = walter[[1]],
           N        = 100,
           burn     = 10,
           thin     = 10,
           w        = c(1,1,1),
           m        = 10,
           form     = "loglog",
           prop.var = 1e-05
)

print(model)

summary(model, parameter = "betas")

plot(model)
```

---

`pooledSPsurv` *pooledSPsurv*

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## Description

Markov Chain Monte Carlo (MCMC) to run Bayesian split population survival model with no frailties.

Returns a summary of a SPsurv object via `summary.mcmc`.

Print method for a `pooledSPsurv` x.

Returns a plot of a pooledSPsurv object via `plot.mcmc`.

## Usage

```
pooledSPsurv(
  duration,
  immune,
  Y0,
  LY,
  data,
  N,
  burn,
  thin,
  w = c(1, 1, 1),
  m = 10,
  form = c("Weibull", "exponential", "loglog")
)

## S3 method for class 'SPsurv'
summary(object, parameter = c("betas", "gammas", "lambda"), ...)

## S3 method for class 'SPsurv'
print(x, ...)

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

## Arguments

| | |
|---|---|
| duration | survival stage equation written in a formula of the form Y ~ X1 + X2 + ... where Y is duration until failure or censoring. |
| immune | split stage equation written in a formula of the form C ~ Z1 + Z2 + ... where C is a binary indicator of immunity. |
| Y0 | the elapsed time since inception until the beginning of time period (t-1). |
| LY | last observation year (coded as 1; 0 otherwise) due to censoring or failure. |
| data | data.frame. |
| N | number of MCMC iterations. |
| burn | burn-in to be discarded. |
| thin | thinning to prevent from autocorrelation. |
| w | size of the slice in the slice sampling for (betas, gammas, rho). Write it as a vector. E.g. c(1,1,1). |
| m | limit on steps in the slice sampling. A vector of values for beta, gamma, rho. |
| form | type of parametric model (Weibull, Exponential, or Log-Logistic). |
| object | an object of class SPsurv, the output of pooledSPsurv. |
| parameter | one of three parameters of the pooledSPsurv output. Indicate either "betas," "gammas," or "lambda." |
| ... | additional parameter. |
| x | an object of class SPsurv, the output of pooledSPsurv. |

## Value

pooledSPsurv returns an object of class "pooledSPsurv".

A "pooledSPsurv" object has the following elements:

| | |
|---|---|
| betas | matrix, numeric values of the posterior for each variable in the duration equation . |
| gammas | matrix, numeric values of the posterior for each variable in the immune equation. |
| rho | numeric vector of values for rho. |
| delta | numeric, vector of values for delta. |
| W | matrix, numeric values of the posterior for Ws |
| V | matrix, numeric values of the posterior for Vs |
| X | matrix X's variables. |
| Z | matrix of Z's variables. |
| Y | the vector of 'Y'. |
| Y0 | the vector of 'Y0'. |
| C | the vector of 'C'. |
| form | character, type of distribution. |
| call | description for the model to be estimated. |

list. Empirical mean, standard deviation and quantiles for each variable.

list. Empirical mean, standard deviation and quantiles for each variable.

## Examples

```
walter <- spduration::add_duration(Walter_2015_JCR,"renewed_war",
                                   unitID = "id", tID = "year",
                                   freq = "year", ongoing = FALSE)

set.seed(123456)

model <-
    pooledSPsurv(
        duration = duration ~ fhcompor1 + lgdpl + comprehensive + victory +
            instabl + intensityln + ethfrac + unpko,
        immune   = cured ~ fhcompor1 + lgdpl + victory,
        Y0       = 't.0',
        LY       = 'lastyear',
        data     = walter,
        N        = 100,
        burn     = 10,
        thin     = 10,
        w        = c(1,1,1),
        m        = 10,
        form     = "Weibull"
    )


print(model)
```

```
summary(model, parameter = "betas")

plot(model)
```

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spatialSPsurv *spatialSPsurv*

---

## Description

Markov Chain Monte Carlo (MCMC) to run time-varying Bayesian split population survival model with spatial frailties.

Returns a summary of a exchangeSPsurv object via summary.mcmc.

Print method for a spatialSPsurv x.

Returns a plot of a spatialSPsurv object via plot.mcmc.

## Usage

```
spatialSPsurv(
  duration,
  immune,
  Y0,
  LY,
  S,
  A,
  data,
  N,
  burn,
  thin,
  w = c(1, 1, 1),
  m = 10,
  form = c("Weibull", "exponential", "loglog"),
  prop.var
)

## S3 method for class 'spatialSPsurv'
summary(object, parameter = c("betas", "gammas", "lambda"), ...)

## S3 method for class 'spatialSPsurv'
print(x, ...)

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

## Arguments

| | |
|---|---|
| duration | survival stage equation written in a formula of the form Y ~ X1 + X2 + ... where Y is duration until failure or censoring. |

| | |
|---|---|
| immune | split stage equation written in a formula of the form C ~ Z1 + Z2 + ... where C is a binary indicator of immunity. |
| Y0 | the elapsed time since inception until the beginning of time period (t-1). |
| LY | last observation year (coded as 1; 0 otherwise) due to censoring or failure. |
| S | spatial information (e.g. district ID) for each observation that matches the spatial matrix row/column information. |
| A | an a times a spatial weights matrix where a is the number of unique spatial units (S) load as a separate file. |
| data | data.frame. |
| N | number of MCMC iterations. |
| burn | burn-in to be discarded. |
| thin | thinning to prevent from autocorrelation. |
| w | size of the slice in the slice sampling for (betas, gammas, rho). Write it as a vector. E.g. c(1,1,1). |
| m | limit on steps in the slice sampling. A vector of values for beta, gamma, rho. |
| form | type of parametric model (Weibull, Exponential, or Log-Logistic). |
| prop.var | proposal variance for Metropolis-Hastings. |
| object | an object of class spatialSPsurv, the output of spatialSPsurv. |
| parameter | one of three parameters of the pooledSPsurv output. Indicate either "betas," "gammas," or "lambda." |
| ... | additional parameter. |
| x | an object of class spatialSPsurv, the output of spatialSPsurv. |

## Value

spatialSPsurv returns an object of class "spatialSPsurv".

A "spatialSPsurv" object has the following elements:

| | |
|---|---|
| betas | matrix, numeric values of the posterior for each variable in the duration equation . |
| gammas | matrix, numeric values of the posterior for each variable in the immune equation. |
| rho | numeric vector of values for rho. |
| lambda | numeric, vector of values for lambda. |
| delta | numeric, vector of values for delta. |
| W | matrix, numeric values of the posterior for Ws |
| V | matrix, numeric values of the posterior for Vs |
| X | matrix X's variables. |
| Z | matrix of Z's variables. |
| Y | the vector of 'Y'. |
| Y0 | the vector of 'Y0'. |
| C | the vector of 'C'. |
| S | the vector of 'S'. |
| form | character, type of distribution. |
| call | description for the model to be estimated. |

list. Empirical mean, standard deviation and quantiles for each variable.

list. Empirical mean, standard deviation and quantiles for each variable.

## Examples

```
walter <- spduration::add_duration(Walter_2015_JCR,"renewed_war",
                                   unitID = "id", tID = "year",
                                   freq = "year", ongoing = FALSE)

walter <- spatial_SA(data = walter, var_ccode = "ccode", threshold = 800L)

set.seed(123456)

model <-
    spatialSPsurv(
        duration = duration ~ fhcompor1 + lgdpl + comprehensive + victory +
                   instabl + intensityln + ethfrac + unpko,
        immune   = cured ~ fhcompor1 + lgdpl + victory,
        Y0       = 't.0',
        LY       = 'lastyear',
        S        = 'sp_id' ,
        data     = walter[[1]],
        N        = 500,
        burn     = 10,
        thin     = 10,
        w        = c(1,1,1),
        m        = 10,
        form     = "Weibull",
        prop.var = 1e-05,
        A        = walter[[2]]
    )

print(model)

summary(model, parameter = "betas")

plot(model)
```

---

`spatial_SA` *spatial_SA*

---

## Description

matrix A and sp_id (S)

## Usage

```
spatial_SA(data, var_ccode, threshold = 800L)
```

## Arguments

| | |
|---|---|
| `data` | data.frame. |
| `var_ccode` | name of the variable that contains the country codes. |
| `threshold` | distance in kilometers. |

## Value

list. Contains database with variable sp_id (S) and matrix A.

## Examples

```
walter <- spduration::add_duration(Walter_2015_JCR,"renewed_war",
                                   unitID = "id",
                                   tID = "year",
                                   freq = "year",
                                   ongoing = FALSE)

walter <- spatial_SA(data = walter,
                     var_ccode = "ccode",
                     threshold = 800L)
```

---

SPstats *SPstats*

---

## Description

A function to calculate the deviance information criterion (DIC) and Log-likelihood for fitted model outputs of pooled, exchangeable, and spatial Split Population survival models for which a log-likelihood can be obtained, according to the formula *DIC = -2 * (L - P)*, where *L* is the log likelihood of the data given the posterior means of the parameter and *P* is the estimate of the effective number of parameters in the model.

## Usage

```
SPstats(object)
```

## Arguments

| | |
|---|---|
| `object` | An object of the output of pooled, exchangeable, or spatial Split Population survival model . |

## Value

List.

`Walter_2015_JCR` *Walter_2015_JCR*

## Description

Subsetted version of a time-series-cross-sectional (TSCS) dataset used in Walter (2015). It has data on duration of post-war peace as well as information on other relevant economic and political data. The variables duration, cured, t.0 and lastyear added by the authors of this package using the function add_duration.

## Usage

```
data(Walter_2015_JCR)
```

## Format

A data frame with 1237 rows and 8 variables

## Details

**fhcompor1** Freedom House civil liberties index.

**lgdpl** log of per capita GDP in 2005 dollars.

**comprehensive** combatants signed comprehensive peace agreement.

**victory** end of previous war with outright victory.

**instabl** dummy that indicates whether there was a positive or negative change in the Polity 2 score in the previous country-year.

**intensityln** deaths per year – logged.

**ethfrac** index of ethnic fractionalization.

**unpko** number of UN peacekeepers on the ground.

## Source

Walter, Barbara F. (2015), Why Bad Governance Leads to Repeat Civil War, Journal of Conflict Resolution 59(7), 1242 - 1272.

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