# Package ‘LatentSNA’

June 17, 2024

**Type** Package

**Title** Implement Network Science in a Generative Statistical Process for Brain-Behavior Linking

**Version** 0.1.0

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**Description** Neuroimaging connectivity analysis needs network science for brain-behavior linking (**<doi** 10.48550/arXiv.2309.11349 >).

**License** GPL (>= 2)

**Encoding** UTF-8

**LazyData** true

**Depends** R (>= 4.3.2),

**Imports** dplyr,
plyr,
coda,
stats,
MASS

**RoxygenNote** 7.3.1

**Suggests** knitr,
rmarkdown

**VignetteBuilder** knitr

# R topics documented:

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`latentSNA` *Attribute informed brain connectivity*

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## Description

An MCMC algorithm for fitting the latentSNA model

## Usage

```
latentSNA(X, Y, W, H, seed = 1, nscan =
10000, burn = 500, odens = 25,
prior=list())
```

## Arguments

| | |
|---|---|
| `X` | a list of V x V brain connectivity data. |
| `Y` | a matrix of N x P individual outcome data. |
| `W` | a matrix of N x Q covariates for the connectivity data. |
| `H` | a matrix of N x Q1 covariates for the attribute data. |
| `seed` | random seed |
| `nscan` | number of iterations of the Markov chain (beyond burn-in) |
| `burn` | burn in for the Markov chain |
| `odens` | output density for the Markov chain, chain thinning every odens iterations |
| `prior` | list: A list of hyperparameters for the prior distribution |

## Value

| | |
|---|---|
| `COV` | posterior mean of the covariance parameters between brain and behaviors |
| `BETAPM` | posterior mean of the regression coefficient parameters for the connectivity data |
| `GAMMAPM` | posterior mean of the regression coefficient parameters for the attribute data |
| `THETAPM` | posterior mean of the latent person variable |
| `APM` | posterior mean of connectivity intercepts |
| `BPM` | posterior mean of attribute intercepts |
| `U` | last iteration of latent connectivity for all regions |
| `UPM` | posterior mean of U |
| `UVPM.l` | list of posterior mean of connectivity |

| | |
|---|---|
| Theta | the last iteration of the Theta estimate |
| X | observed X |
| Y | observed Y |
| EFlPM | posterior mean estimates of X |
| ETPM | posterior mean estiamtes of Y |
| TMPM | posterior mean estimates of latent behavior component |
| FLPM | posterior mean estiamtes of latent connectivity component |
| input | input values |

## Author(s)

Selena Wang

## Examples

```
attach(X)
attach(Y)

## More MCMC burn-in iterations and iterations are needed than specified here.
model1=latentSNA(X, Y,W=NULL, H=NULL,
seed = 1, nscan = 1, burn = 1, odens = 1,
prior=list())
```

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latentSNA_PACKAGE *Create LatentSNA model for brain-behavior linking*

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## Description

latentSNA provides a latent model for jointly modeling brain connectivity with individual outcomes. The latent space models are implemented using the MCMC inference approach.

## Details

LatentSNA: the function latentSNA implements LatentSNA introduced by Wang et.al (2023).

## References

arXiv preprint arXiv:2309.11349, 2023.

## rbeta_a — *Conditional simulation of intercept and regression coefficients*

### Description

Simulates from the joint full conditional distribution of (beta) in a brain connectivity model

### Usage

```
rbeta_a(Fl, W = NULL, s2 = 1, U = U, ivA = NULL, beta0 = NULL, S0 = NULL)
```

### Arguments

| | |
|---|---|
| `Fl` | a list of V X V normal connectivity matrix |
| `W` | N x Q covariate matrix |
| `s2` | variance |
| `U` | a V by V by N array |
| `ivA` | prior inverse variance for the intercept parameters |
| `beta0` | prior mean vector for regression parameters |
| `S0` | prior precision matrix for regression parameters |

### Value

| | |
|---|---|
| `beta` | regression coefficients |
| `a` | subject-specific intercept |

### Author(s)

Selena Wang

## rFl_nrm — *Simulate missing values in a normal connectivity model*

### Description

Simulates missing values of a sociomatrix under a normal connectivity model

### Usage

```
rFl_nrm(Z, EZ, s2, X)
```

### Arguments

| | |
|---|---|
| `Z` | a square matrix, the current value of Z |
| `EZ` | expected value of Z |
| `s2` | dyadic variance |
| `X` | square relational matrix |

## Value

a square matrix, equal to at non-missing values

## Author(s)

Selena Wang

---

`rH_bin` *Simulate H*

---

## Description

Simulates a random latent matrix H given its expectation and a behavior matrix Y

## Usage

```
rH_bin(H,EH,Y,s1=1)
```

## Arguments

| | |
|---|---|
| H | a n X m matrix, the current value of H |
| EH | expected value of H |
| Y | n X m binary item response matrix |
| s1 | item response variance |

## Value

a n X m matrix, the new value of H

## Author(s)

Selena Wang

---

`rH_nrm` *Simulate missing values in a normal behavior model*

---

## Description

Simulates missing values under a behavior model

## Usage

```
rH_nrm(H, EH,s1, Y)
```

## Arguments

| | |
|---|---|
| H | a matrix, the current value of H |
| EH | expected value of H |
| s1 | behavior variance |
| Y | behavior matrix |

### Value

a behavior matrix, equal to at non-missing values

### Author(s)

Selena Wang

---

`rs1_b` *Gibbs update for behavior variance*

---

### Description

Gibbs update for behavior variance

### Usage

```
rs1_b(Tm, offset=0,nu1=NULL,s10=NULL)
```

### Arguments

| | |
|---|---|
| `Tm` | a list of V X P normal behavior matrix |
| `nu1` | prior degrees of freedom |
| `s10` | prior estimate of s1 |

### Value

a new value of s1

### Author(s)

Selena Wang

---

`rs2` *Gibbs update for connectivity variance*

---

### Description

Gibbs update for connectivity variance

### Usage

```
rs2(Fl,offset = offset, nu2=NULL,s20=NULL)
```

### Arguments

| | |
|---|---|
| `Fl` | a list of V X V normal connectivity matrix |
| `nu2` | prior degrees of freedom |
| `s20` | prior estimate of s2 |

### Value

a new value of s2

### Author(s)

Selena Wang

## rSu — *Gibbs update for latent effects covariance*

### Description

Gibbs update for latent effects covariance

### Usage

```
rSu(U,Su0=NULL,etau=NULL)
```

### Arguments

| | |
|---|---|
| U | latent connectivity and behavior |
| Su0 | prior (inverse) scale matrix for the prior distribution |
| etau | prior degrees of freedom for the prior distribution |

### Author(s)

Selena Wang

## rTheta_b — *Gibbs sampling of Theta*

### Description

A Gibbs sampler for updating the Person latent effect Theta.

### Usage

```
rTheta_b(H, beta, Alpha, Theta ,U, Stheta, Sutheta, Su, s1)
```

### Arguments

| | |
|---|---|
| H | N X P normal behavior matrix |
| beta | P X 1 behavior intercept vector |
| Alpha | 1 X 1 intercept vector |
| Theta | current value of Theta |
| U | matrix containing current value of U |
| Stheta | covariance of Theta |
| Sutheta | covariance between U and Theta |
| Su | matrix containing covariance of U |
| s1 | behavior variance |

### Value

| | |
|---|---|
| `Theta` | a new value of Theta |

### Author(s)

Selena Wang

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`rU` *Gibbs sampling of U*

---

### Description

A Gibbs sampler for updating U.

### Usage

```
rU(Fl,EFl, U,Theta, Stheta, Sutheta, Su,  s2)
```

### Arguments

| | |
|---|---|
| `Fl` | a list of V X V normal relational matrix |
| `EFl` | a list of the same dimension as Fl. It is assumed that Fl-offset follows a SRRM, so the offset should contain any multiplicative effects (such as `U%*% t(U)` ) |
| `U` | V X K matrix containing current value of U |
| `Theta` | D X V current value of Theta |
| `Stheta` | D X D covariance of Theta |
| `Sutheta` | D X K covariance between U and Theta |
| `Su` | K X K matrix containing covariance of U |
| `s2` | dyadic variance |

### Value

| | |
|---|---|
| `U` | a new value of U |

### Author(s)

Selena Wang

rwish — *Simulation from a Wishart distribution*

## Description

Simulates a random Wishart-distributed matrix

## Usage

```
rwish(S0, nu = dim(S0)[1] + 2)
```

## Arguments

| | |
|---|---|
| `S0` | a positive definite matrix |
| `nu` | a positive integer |

## Value

a positive definite matrix

## Author(s)

Selena Wang

rXi — *Gibbs sampling of behaivor parameters Xi*

## Description

A Gibbs sampler for updating the behavior parameters.

## Usage

```
rXi(H, beta, Alpha, Theta, mxi, Sigmaxi, s1 = 1)
```

## Arguments

| | |
|---|---|
| `H` | normal behavior matrix |
| `beta` | behavior intercept vector |
| `Alpha` | behavior intercept vector |
| `Theta` | current value of Theta |
| `mxi` | vector of prior for the mean of Xi |
| `Sigmaxi` | matrix of prior for the variance of Xi |
| `s1` | behavior variance |

## Value

| | |
|---|---|
| `beta` | a new value of beta |
| `Alpha` | a new value of Alpha |

### Author(s)

Selena Wang

---

`simH` *Simulate H given its expectation and covariance*

---

### Description

Simulate H given its expectation and covariance

### Usage

```
simH(EH, s1 = 1)
```

### Arguments

| | |
|---|---|
| EH | expected value of H |
| s1 | attribute variance |

### Value

a simulated value of H

### Author(s)

Selena Wang

---

`simX_nrm` *Simulate a normal connectivity matrix*

---

### Description

Simulates a normal connectivity matrix

### Usage

```
simX_nrm(EX, s2)
```

### Arguments

| | |
|---|---|
| EX | square matrix giving the expected value of the connectivity matrix |
| s2 | dyadic variance |

### Value

a square matrix

### Author(s)

Selena Wang

## simY_nrm — *Simulate a normal behavior matrix*

### Description

Simulates a normal behavior matrix

### Usage

```
simY_nrm(EY, s1)
```

### Arguments

| | |
|---|---|
| EY | matrix giving the expected value of the behavior matrix |
| s1 | variance |

### Value

a N by P matrix

### Author(s)

Selena Wang

## simZ — *Simulate Z given its expectation and covariance*

### Description

Simulate Z given its expectation and covariance

### Usage

```
simZ(EZ,s2=1)
```

### Arguments

| | |
|---|---|
| EZ | expected value of Z |
| s2 | dyadic variance |

### Value

a simulated value of Z

### Author(s)

Selena Wang

X *Simulated a list of V by V connectivity data*

## Description

The dataset contains a list of V by V connectivity data

## Usage

```
X
```

## Format

List including a list of weighted adjacency matrices of length N.

## Details

a list of V by V connectivity data

Y *Simulated a matrix of N by P individual outcomes data*

## Description

The dataset contains a matrix of N by P individual outcomes data

## Usage

```
Y
```

## Format

List including a matrix of N by P individual outcomes data about N individuals and P variables measuring a latent construct

## Details

a matrix of N by P individual outcomes data `zscores` *z-scores*

## Description

Computes the normal scores

## Usage

```
zscores(y,ties.method="average")
```

## Arguments

| | |
|---|---|
| `y` | a numeric vector |
| `ties.method` | method for dealing with ties |

## Value

a numeric vector

## Author(s)

Selena Wang

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