

Package ‘OBASpatial’

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Title Objective Bayesian Analysis for Spatial Regression Models

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Imports stats,modeest,cubature,truncdist,invgamma,LaplacesDemon,HDInterval,mvtnorm

Description

It makes an objective Bayesian analysis of the spatial regression model using both the normal (NSR) and student-T (TSR) distributions. The functions provided give prior and posterior objective densities and allow default Bayesian estimation of the model regression parameters. Details can be found in Ordonez et al. (2020) <arXiv:2004.04341>.

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R topics documented:

dataca20	2
dataelev	2
dnsrposoba	3
dnsrprioroba	5
dtsrposoba	6
dtsrprioroba	8
intmnorm	10
intmT	12
nsroba	14
nsrobapred1	16
summary.nsroba	17
summary.tsroba	19

tsroba	20
tsrobapred	23

Index	26
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dataca20	<i>Calcium Content In Soil Samples.</i>
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Description

This data set contains the calcium content measured in soil samples taken from the 0-20cm layer at 178 locations within a certain study area divided in three sub-areas. The elevation at each location was also recorded. See geoR package for details.

Usage

```
data("dataca20")
```

Format

A data frame with 178 observations on the following 3 variables.

east X Coordinate.

north Y coordinate.

calcont Calcium content measured in $mmol_c/dm^3$.

altitude A vector with the elevation of each sampling location, in meters.

area A factor indicating the sub area to which the locations belongs.

References

Oliveira, M. C. N. (2003). Métodos de estimação de parâmetros em modelos geoestatísticos com diferentes estruturas de covariâncias: uma aplicação ao teor de cálcio no solo. Ph.D. thesis, ESALQ/USP/Brasil.

dataelev	<i>Surface elevations</i>
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Description

Surface elevation data taken from Davis (1972). An object of the class geodata with elevation values at 52 locations.

Usage

```
data("dataelev")
```

Format

A data frame with 52 observations on the following 3 variables.

x X coordinate (multiple of 50 feet).

y Y coordinate (multiple of 50 feet).

elevation elevations (multiples of 10 feet).

References

Davis, J.C. (1973) *Statistics and Data Analysis in Geology*. Wiley.

dnsrposoba

Objective posterior density for the NSR model

Description

It calculates the density function $\pi(\phi)$ (up to a proportionality constant) for the TSR model using the based reference, Jeffreys' rule, Jeffreys' independent and vague priors. In this context ϕ corresponds to the range parameter.

Usage

```
dnsrposoba(x, formula, prior="reference", coords.col=1:2,
kappa=0.5, cov.model="exponential", data, asigma=2.1, intphi)
```

Arguments

x	The ϕ quantil value.
formula	A valid formula for a linear regression model.
prior	Objective prior densities available for the TSR model: (reference: Reference based, jef.rul: Jeffreys' rule, jef.ind: Jeffreys' independent).
coords.col	A vector with the column numbers corresponding to the spatial coordinates.
kappa	Shape parameter of the covariance function (fixed).
cov.model	Covariance functions available for the TSR model. matern: Matern, pow.exp: power exponential, exponential:exponential, cauchy: Cauchy, spherical: Spherical.
data	Data set with 2D spatial coordinates, the response and optional covariates.
asigma	Value of a for vague prior.
intphi	An interval for ϕ used for vague prior.

Details

The posterior distribution is computed for this priors under the improper family $\frac{\pi(\phi)}{(\sigma^2)^a}$. For the vague prior, it was considered the structure where a priori, ϕ follows an uniform distribution on the interval `intphi`.

For the Jeffreys independent prior, this family of priors generates improper posterior distribution when intercept is considered for the mean function.

Value

Posterior density of $x=\phi$.

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Berger, J.O, De Oliveira, V. and Sans'õ, B. (2001). Objective Bayesian Analysis of Spatially Correlated Data. *Journal of the American Statistical Association.*, 96, 1361 – 1374.

See Also

[dtsrposoba](#), [dtsrprioroba](#), [dnsrprioroba](#)

Examples

```
data(dataelev)

##### Using reference prior #####
dnsrposoba(x=5,prior="reference",formula=elevation~1,
kappa=1,cov.model="matern",data=dataelev)

##### Using Jeffreys' rule prior #####
dnsrposoba(x=5,prior="jef.rul",formula=elevation~1,
kappa=1,cov.model="matern",data=dataelev)

##### Using vague independent prior #####
dnsrposoba(x=5,prior="vague",formula=elevation~1,
kappa=0.3,cov.model="matern",data=dataelev,intphi=c(0.1,10))
```

dnsprioroba *Objective prior density for the NSR model*

Description

It calculates the density function $\pi(\phi)$ (up to a proportionality constant) for the NSR model using the based reference, Jeffreys' rule and Jeffreys' independent priors. In this context ϕ corresponds to the range parameter.

Usage

```
dnsprioroba(x, trend="cte", prior="reference", coords.col=1:2,
kappa=0.5, cov.model="exponential", data)
```

Arguments

x	The ϕ quantil value.
trend	Builds the trend matrix in accordance to a specification of the mean provided by the user. See DETAILS below.
prior	Objective prior densities available for the TSR model: (reference: Reference based, jef.rul: Jeffreys' rule, jef.ind: Jeffreys' independent).
coords.col	A vector with the column numbers corresponding to the spatial coordinates.
kappa	Shape parameter of the covariance function (fixed).
cov.model	Covariance functions available for the TSR model. matern: Matern, pow.exp: power exponential, exponential:exponential, cauchy: Cauchy, spherical: Spherical.
data	Data set with 2D spatial coordinates, the response and optional covariates.

Details

Denote as $c = (c_1, c_2)$ the coordinates of a spatial location. trend defines the design matrix as:

- \emptyset (zero, without design matrix) Only valid for the Independent Jeffreys' prior
- "cte", the design matrix is such that mean function $\mu(c) = \mu$ is constant over the region.
- "1st", the design matrix is such that mean function becomes a first order polynomial on the coordinates:

$$\mu((c)) = \beta_0 + \beta_1 c_1 + \beta_2 c_2$$

- "2nd", the design matrix is such that mean function $\mu(c) = \mu$ becomes a second order polynomial on the coordinates:

$$\mu((c)) = \beta_0 + \beta_1 c_1 + \beta_2 c_2 + \beta_3 c_1^2 + \beta_4 c_2^2 + \beta_5 c_1 c_2$$

- ~model a model specification to include covariates (external trend) in the model.

Value

Prior density of $x=\phi$

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Berger, J.O, De Oliveira, V. and Sans'õ, B. (2001). Objective Bayesian Analysis of Spatially Correlated Data. Journal of the American Statistical Association., 96, 1361 – 1374.

See Also

[dtsrposoba](#), [dtsrprioroba](#), [dnsrposoba](#)

Examples

```
data(dataelev)## data using by Berger et. al (2001)

##### Using reference prior #####
dnsrprioroba(x=20,kappa=0.3,cov.model="matern",data=dataelev)

##### Using jef.rule prior#####
dnsrprioroba(x=20,prior="jef.rul",kappa=0.3,cov.model="matern",
data=dataelev)

##### Using jef.ind prior #####
dnsrprioroba(x=20,prior="jef.ind",trend=0,
kappa=0.3,cov.model="matern",data=dataelev)
```

dtsrposoba

Objective posterior density for the TSR model

Description

It calculates the density function $\pi(\phi, \nu)$ (up to a proportionality constant) for the TSR model using the based reference, Jeffreys' rule, Jeffreys' independent and vague priors. In this context ϕ corresponds to the range parameter and ν to the degrees of freedom.

Usage

```
dtsrposoba(x,formula,prior="reference",coords.col=1:2,
kappa=0.5,cov.model="exponential",data,asigma=2.1,intphi,intnu)
```

Arguments

x	A vector with the quantities (ϕ, ν) . For the vague prior x must be a three dimension vector (ϕ, ν, λ) with λ a number in the interval $(0.02, 0.5)$. See DETAILS below.
formula	A valid formula for a linear regression model.
prior	Objective prior densities available for the TSR model: (reference: Reference based, jef.rul: Jeffreys' rule, jef.ind: Jeffreys' independent).
coords.col	A vector with the column numbers corresponding to the spatial coordinates.
kappa	Shape parameter of the covariance function (fixed).
cov.model	Covariance functions available for the TSR model. matern: Matern, pow.exp: power exponential, exponential:exponential, cauchy: Cauchy, spherical: Spherical.
data	Data set with 2D spatial coordinates, the response and optional covariates.
asigma	Value of a for vague prior.
intphi	An interval for ϕ used for vague prior.
intnu	An interval for ν used for vague prior.

Details

The posterior distribution is computed for this priors under the improper family $\frac{\pi(\phi, \nu)}{(\sigma^2)^a}$. For the vague prior, it was considered the structure $\pi(\phi, \nu, \lambda) = \phi(\phi)\pi(\nu|\lambda)\pi(\lambda)$ where a priori, ϕ follows an uniform distribution on the interval `intphi`, $\nu|\lambda \text{Exp}(\lambda, A)$ with A the interval given by the argument `intnu` and $\lambda \text{unif}(0.02, 0.5)$.

For the Jeffreys independent prior, this family of priors generates improper posterior distribution when intercept is considered for the mean function.

Value

Posterior density of $x=(\phi, \nu)$ for the reference based, Jeffreys' rule and Jeffreys' independent priors. For the vague the result is the posterior density of $x=(\phi, \nu, \lambda)$

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Ordonez, J.A, M.O. Prates, L.A. Matos, and V.H. Lachos (2020+). Objective Bayesian analysis for spatial Student-t regression models (Submitted).

See Also

[dtsrposoba](#), [dtsrprioroba](#), [dtsrprioroba](#)

Examples

```

data(dataca20)

##### Using reference prior #####
dtsrposoba(x=c(5,11),prior="reference",formula=calcont~altitude+area,
kappa=0.3,cov.model="matern",data=dataca20)

##### Using Jeffreys' rule prior #####
dtsrposoba(x=c(5,11),prior="jef.rul",formula=calcont~altitude+area,
kappa=0.3,cov.model="matern",data=dataca20)

##### Using Jeffreys' independent prior #####
dtsrposoba(x=c(5,11),prior="jef.ind",formula=calcont~altitude+area
,kappa=0.3,cov.model="matern",data=dataca20)

##### Using vague independent prior #####
dtsrposoba(x=c(5,11,.3),prior="vague",formula=calcont~altitude+area,
kappa=0.3,cov.model="matern",data=dataca20,intphi=c(0.1,10),
intnu=c(4.1,30))

```

dtsrprioroba

Objective prior density for the TSR model

Description

It calculates the density function $\pi(\phi, \nu)$ (up to a proportionality constant) for the TSR model using the based reference, Jeffreys' rule and Jeffreys' independent priors. In this context ϕ corresponds to the range parameter and ν to the degrees of freedom.

Usage

```

dtsrprioroba(x,trend="cte",prior="reference",coords.col=1:2,
kappa=0.5,cov.model="exponential",data)

```

Arguments

x	A vector with the quantities (ϕ, ν)
trend	Builds the trend matrix in accordance to a specification of the mean provided by the user. See DETAILS below.
prior	Objective prior densities available for the TSR model: (reference: Reference based, jef.rul: Jeffreys' rule, jef.ind: Jeffreys' independent)
coords.col	A vector with the column numbers corresponding to the spatial coordinates.
kappa	Shape parameter of the covariance function (fixed)
cov.model	Covariance functions available for the TSR model. matern: Matern, pow.exp: power exponential, exponential:exponential, cauchy: Cauchy, spherical: Spherical
data	Data set with 2D spatial coordinates, the response and optional covariates

Details

Denote as $c = (c_1, c_2)$ the coordinates of a spatial location. `trend` defines the design matrix as:

- `0` (zero, without design matrix) Only valid for the Independent Jeffreys' prior
- `"cte"`, the design matrix is such that mean function $\mu(c) = \mu$ is constant over the region.
- `"1st"`, the design matrix is such that mean function becomes a first order polynomial on the coordinates:

$$\mu((c)) = \beta_0 + \beta_1 c_1 + \beta_2 c_2$$

- `"2nd"`, the design matrix is such that mean function $\mu(c) = \mu$ becomes a second order polynomial on the coordinates:

$$\mu((c)) = \beta_0 + \beta_1 c_1 + \beta_2 c_2 + \beta_3 c_1^2 + \beta_4 c_2^2 + \beta_5 c_1 c_2$$

- `~model` a model specification to include covariates (external trend) in the model.

Value

Density of $x=(\phi, \nu)$

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Ordonez, J.A, M.O. Prates, L.A. Matos, and V.H. Lachos (2020+). Objective Bayesian analysis for spatial Student-t regression models (Submitted).

See Also

[dtsrposoba](#), [dnsrprioroba](#), [dnsrposoba](#)

Examples

```
data(dataca20)

##### Using reference prior and a constant trend#####
dtsrprioroba(x=c(6,100),kappa=0.3,cov.model="matern",data=dataca20)

##### Using jef.rule prior and 1st trend#####
dtsrprioroba(x=c(6,100),prior="jef.rul",trend=~altitude+area,
kappa=0.3,cov.model="matern",data=dataca20)

##### Using jef.ind prior #####
dtsrprioroba(x=c(6,100),prior="jef.ind",trend=0,
kappa=0.3,cov.model="matern",data=dataca20)
```

intmnorm

*Marginal posterior density for a model.***Description**

It calculates the marginal density density for a model M (up to a proportionality constant) for the NSR model using the based reference, Jeffreys' rule, Jeffreys' independent and vague priors. In this context ϕ corresponds to the range parameter.

Usage

```
intmnorm(formula,prior="reference",coords.col=1:2,kappa=0.5,
cov.model="exponential",data,asigma=2.1,intphi,maxEval)
```

Arguments

formula	A valid formula for a linear regression model.
prior	Objective prior densities available for the TSR model: (reference: Reference based, jef.rul: Jeffreys' rule, jef.ind: Jeffreys' independent).
coords.col	A vector with the column numbers corresponding to the spatial coordinates.
kappa	Shape parameter of the covariance function (fixed).
cov.model	Covariance functions available for the TSR model. matern: Matern, pow.exp: power exponential, exponential:exponential, cauchy: Cauchy, spherical: Spherical.
data	Data set with 2D spatial coordinates, the response and optional covariates.
asigma	Value of a for vague prior.
intphi	An interval for ϕ used for vague prior.
maxEval	Maximum number of iterations for the integral computation.

Details

Let m_k a parametric model with parameter vector θ_k . Under the TSR model and the prior density proposal:

$$\frac{\pi(\phi)}{(\sigma^2)^a}$$

we have that the marginal density is given by:

$$\int L(\theta_{m_k})\pi(m_k)dm_k$$

This quantity can be useful as a criteria for model selection. The computation of m_k could be compute demanding depending on the number of iterations in maxEval.

Value

Marginal density of the model m_k for the reference based, Jeffreys' rule, Jeffreys' independent and vague priors.

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Berger, J.O, De Oliveira, V. and Sans'õ, B. (2001). Objective Bayesian Analysis of Spatially Correlated Data. Journal of the American Statistical Association., 96, 1361 – 1374.

See Also

[dnrposoba](#), [dtsrprioroba](#), [dnrrioroba](#)

Examples

```
data(dataca20)

set.seed(25)
data(dataelev)## data using by Berger et. al (2001)

##### Using reference prior #####
m1=intmnorm(prior="reference",formula=elevation~1,
kappa=0.5,cov.model="matern",data=dataelev,maxEval=1000)

log(m1)

##### Using reference prior kappa=1 #####
m2=intmnorm(prior="reference",formula=elevation~1,
kappa=1,cov.model="matern",data=dataelev,maxEval=1000)
log(m2)

##### Using reference prior kappa=1.5 #####
m3=intmnorm(prior="reference",formula=elevation~1
,kappa=1.5,cov.model="matern",data=dataelev,maxEval=1000)
log(m3)

tot=m1+m2+m3

#####posterior probabilities: higher probability:
#####prior="reference", kappa=1
p1=m1/tot
```

p2=m2/tot
p3=m3/tot

intmT

Marginal posterior density for a model.

Description

It calculates the marginal density density for a model M (up to a proportionality constant) for the TSR model using the based reference, Jeffreys' rule, Jeffreys' independent and vague priors. In this context ϕ corresponds to the range parameter and ν to the degrees of freedom.

Usage

```
intmT(formula,prior="reference",coords.col=1:2,kappa=0.5,
cov.model="exponential",data,asigma,intphi="default",intnu=c(4.1,Inf),maxEval)
```

Arguments

formula	A valid formula for a linear regression model.
prior	Objective prior densities available for the TSR model: (reference: Reference based, jef.rul: Jeffreys' rule, jef.ind: Jeffreys' independent).
coords.col	A vector with the column numbers corresponding to the spatial coordinates.
kappa	Shape parameter of the covariance function (fixed).
cov.model	Covariance functions available for the TSR model. matern: Matern, pow.exp: power exponential, exponential:exponential, cauchy: Cauchy, spherical: Spherical.
data	Data set with 2D spatial coordinates, the response and optional covariates.
asigma	Value of a for vague prior.
intphi	An interval for ϕ used for vague prior.
intnu	An interval for ν used for vague prior.
maxEval	Maximum number of iterations for the integral computation.

Details

Let m_k a parametric model with parameter vector θ_k . Under the TSR model and the prior density proposal:

$$\frac{\pi(\phi, \nu)}{(\sigma^2)^a}$$

we have that the marginal density is given by:

$$\int L(\theta_{m_k})\pi(m_k)dm_k$$

This quantity can be useful as a criteria for model selection. The computation of m_k could be compute demanding depending on the number of iterations in maxEval.

Value

Marginal density of the model m_k for the reference based, Jeffreys' rule, Jeffreys' independent and vague priors.

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Ordonez, J.A, M.O. Prates, L.A. Matos, and V.H. Lachos (2020+). Objective Bayesian analysis for spatial Student-t regression models (Submitted).

See Also

[dnrposoba](#), [dtsrprioroba](#), [dnrrioroba](#)

Examples

```
set.seed(25)
data(dataca20)

##### Using reference prior #####
m1=intmT(prior="reference", formula=calcont~altitude+area,
kappa=0.3, cov.model="matern", data=dataca20, maxEval=1000)

##### Using Jeffreys' rule prior #####
m1j=intmT(prior="jef.rul", formula=calcont~altitude+area,
kappa=0.3, cov.model="matern", data=dataca20, maxEval=1000)

##### Using Jeffreys' independent prior #####
m1ji=intmT(prior="jef.ind", formula=calcont~altitude+area
, kappa=0.3, cov.model="matern", data=dataca20, maxEval=1000)

m1v=intmT(prior="vague", formula=calcont~altitude+area
, kappa=0.3, cov.model="matern", data=dataca20, maxEval=1000, intphi="default")

tot=m1+m1j+m1ji+m1v

#####posterior probabilities: higher probability:
#####prior="reference", kappa=0.3
```

```

p1=m1/tot
pj=m1j/tot
pji=m1ji/tot
pv=m1v/tot

```

nsroba

Bayesian estimation for the NSR model.

Description

This function performs Bayesian estimation of $\theta = (\beta, \sigma^2, \phi)$ for the NSR model using the based reference, Jeffreys' rule, Jeffreys' independent and vague priors.

Usage

```

nsroba(formula, method="median",
prior = "reference", coords.col = 1:2, kappa = 0.5,
cov.model = "matern", data, asigma=2.1, intphi = "default",
ini.pars, burn=500, iter=5000, thin=10)

```

Arguments

formula	A valid formula for a linear regression model.
method	Method to estimate (β, σ, ϕ) . The methods available are "mean", "median" and "mode".
prior	Objective prior densities available for the TSR model: (reference: Reference based, jef.rul: Jeffreys' rule, jef.ind: Jeffreys' independent, vague, Vague).
coords.col	A vector with the column numbers corresponding to the spatial coordinates.
kappa	Shape parameter of the covariance function (fixed).
cov.model	Covariance functions available for the TSR model. matern: Matern, pow.exp: power exponential, exponential:exponential, cauchy: Cauchy, spherical: Spherical.
data	Data set with 2D spatial coordinates, the response and optional covariates.
asigma	Value of a for vague prior.
intphi	An interval for ϕ used for the uniform proposal. See DETAILS below.
ini.pars	Initial values for (σ^2, ϕ) in that order.
burn	Number of observations considered in burning process.
iter	Number of iterations for the sampling procedure.
thin	Number of observations considered in thin process.

Details

For the "unif" proposal, it was considered the structure where a priori, ϕ follows an uniform distribution on the interval `intphi`. By default, this interval is computed using the empirical range of data.

For the Jeffreys independent prior, the sampling procedure generates improper posterior distribution when `intercept` is considered for the mean function.

Value

<code>dist</code>	Joint sample (matrix object) obtaining for $(\mathbf{beta}, \sigma^2, \phi)$.
<code>betaF</code>	Sample obtained for \mathbf{beta} .
<code>sigmaF</code>	Sample obtained for σ^2 .
<code>phiF</code>	Sample obtained for ϕ .
<code>coords</code>	Spatial data coordinates.
<code>kappa</code>	Shape parameter of the covariance function.
<code>X</code>	Design matrix of the model.
<code>type</code>	Covariance function of the model.
<code>theta</code>	Bayesian estimator of $(\mathbf{beta}, \sigma, \phi)$.
<code>y</code>	Response variable.
<code>prior</code>	Prior density considered.

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Berger, J.O, De Oliveira, V. and Sans'õ, B. (2001). Objective Bayesian Analysis of Spatially Correlated Data. *Journal of the American Statistical Association.*, 96, 1361 – 1374.

See Also

[dnrsposoba](#), [dtsrprioroba](#), [dnrprprioroba](#), [tsroba](#)

Examples

```
set.seed(25)
data(dataelev)
```

```
#####covariance matern: kappa=0.5
res=nsroba(elevation~1, kappa = 0.5, cov.model = "matern", data=dataelev,
ini.pars=c(10,3))

summary(res)

#####covariance matern: kappa=1
res1=nsroba(elevation~1, kappa = 1, cov.model = "matern", data=dataelev,
ini.pars=c(10,3))

summary(res1)

#####covariance matern: kappa=1.5
res2=nsroba(elevation~1, kappa = 1.5, cov.model = "matern", data=dataelev,
ini.pars=c(10,3))

summary(res2)
```

nsrobapred1

Prediction under Normal Objective Bayesian Analysis (OBA).

Description

This function uses the sampling distribution of parameters obtained from the function `tsroba` to predict values at unknown locations.

Usage

```
nsrobapred1(xpred, coordspred, obj)
```

Arguments

<code>xpred</code>	Values of the X design matrix for prediction coordinates.
<code>coordspred</code>	Points coordinates to be predicted.
<code>obj</code>	object of the class "nsroba" (see nsroba function).

Details

This function predicts using the sampling distribution of parameters obtained from the function `nsroba` and the conditional normal distribution of the predicted values given the data.

Value

This function returns a vector with the predicted values at the specified locations.

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Berger, J.O, De Oliveira, V. and Sans'ò, B. (2001). Objective Bayesian Analysis of Spatially Correlated Data. *Journal of the American Statistical Association.*, 96, 1361 – 1374.

Diggle, P. and P. Ribeiro (2007). *Model-Based Geostatistics*. Springer Series in Statistics.

See Also

[nsroba](#), [tsrobapred](#)

Examples

```
set.seed(25)
data(dataelev)
d1=dataelev[1:42,]

reselev=nsroba(elevation~1, kappa = 0.5, cov.model = "matern", data=d1,
ini.pars=c(10,3),intphi=c(0.8,10))

datapred1=dataelev[43:52,]
coordspred1=datapred1[,1:2]
nsrobapred1(obj=reselev,coordspred=coordspred1,xpred=rep(1,10))
```

summary.nsroba

Summary of a nsroba object

Description

summary method for class "nsroba".

Usage

```
## S3 method for class 'nsroba'
summary(object,...)
```

Arguments

object object of the class "nsroba" (see [nsroba](#) function).
... Additional arguments.

Value

mean.str	Estimates for the mean structure parameters <i>beta</i> .
var.str	Estimates for the variance structure parameters σ^2, ϕ .
betaF	Sample obtained for <i>beta</i> .
sigmaF	Sample obtained for σ^2 .
phiF	Sample obtained for ϕ .

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Berger, J.O, De Oliveira, V. and Sansl'o, B. (2001). Objective Bayesian Analysis of Spatially Correlated Data. Journal of the American Statistical Association., 96, 1361 – 1374.

See Also

[dnrposoba](#), [dtsrprioroba](#), [dnrprioroba](#), [tsroba](#)

Examples

```
set.seed(25)
data(dataelev)

#####covariance matern: kappa=0.5
res=nsroba(elevation~1, kappa = 0.5, cov.model = "matern", data=dataelev,
ini.pars=c(10,3))

summary(res)
```

summary.tsroba	<i>Summary of a nsroba object</i>
----------------	-----------------------------------

Description

summary method for class "tsroba".

Usage

```
## S3 method for class 'tsroba'  
summary(object, ...)
```

Arguments

object	object of the class "tsroba" (see tsroba function).
...	Additional arguments.

Value

mean.str	Estimates for the mean structure parameters <i>beta</i> .
var.str	Estimates for the variance structure parameters σ^2, ϕ, ν .
betaF	Sample obtained for <i>beta</i> .
sigmaF	Sample obtained for σ^2 .
phiF	Sample obtained for ϕ .
nuF	Sample obtained for ν .

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Ordonez, J.A, M.O. Prates, L.A. Matos, and V.H. Lachos (2020+). Objective Bayesian analysis for spatial Student-t regression models. (Submitted)

See Also

[dnrsposoba](#), [dtsrprioroba](#), [dnrsrprioroba](#), [tsroba](#)

Examples

```

set.seed(25)
data(dataca20)
d1=dataca20[1:158,]

xpred=model.matrix(calcont~altitude+area,data=dataca20[159:178,])
xobs=model.matrix(calcont~altitude+area,data=dataca20[1:158,])
coordspred=dataca20[159:178,1:2]

#####covariance matern: kappa=0.3 prior:reference
res=tsroba(calcont~altitude+area, kappa = 0.3, data=d1,
           ini.pars=c(10,3,10))

summary(res)

```

 tsroba

Bayesian estimation for the TSR model.

Description

This function performs Bayesian estimation of $\theta = (\beta, \sigma^2, \phi)$ for the TSR model using the based reference, Jeffreys' rule, Jeffreys' independent and vague priors.

Usage

```

tsroba(formula, method="median",sdnu=1,
       prior = "reference",coords.col = 1:2,kappa = 0.5,
       cov.model = "matern", data,asigma=2.1, intphi = "default",
       intnu="default",ini.pars,burn=500, iter=5000,thin=10)

```

Arguments

formula	A valid formula for a linear regression model.
method	Method to estimate $(\beta, \sigma, \phi, \nu)$. The methods availables are "mean", "median" and "mode".
sdnu	Standard deviation logarithm for the lognormal proposal for ν
prior	Objective prior densities available for the TSR model: (reference: Reference based, jef.rul: Jeffreys' rule, jef.ind: Jeffreys' independent, vague: Vague).
coords.col	A vector with the column numbers corresponding to the spatial coordinates.
kappa	Shape parameter of the covariance function (fixed).

cov.model	Covariance functions available for the TSR model. matern: Matern, pow.exp: power exponential, exponential:exponential, cauchy: Cauchy, spherical: Spherical.
data	Data set with 2D spatial coordinates, the response and optional covariates.
asigma	Value of a for vague prior.
intphi	An interval for ϕ used for the uniform proposal. See DETAILS below.
intnu	An interval for ν used for the uniform proposal. See DETAILS below.
ini.pars	Initial values for (σ^2, ϕ, ν) in that order.
burn	Number of observations considered in burning process.
iter	Number of iterations for the sampling procedure.
thin	Number of observations considered in thin process.

Details

For the prior proposal, it was considered the structure $\pi(\phi, \nu, \lambda) = \phi(\phi)\pi(\nu|\lambda)\pi(\lambda)$. The "unif" denotes the proposal where a priori, ϕ follows an uniform distribution on the interval `intphi`, by default, this interval is computed using the empirical range of data. $\nu|\lambda \text{ } Texp(\lambda, A)$ with A the interval given by the argument `intnu` and $\lambda \text{ } unif(0.02, 0.5)$

For the Jeffreys independent prior, the sampling procedure generates improper posterior distribution when intercept is considered for the mean function.

Value

dist	Joint sample (matrix object) obtaining for $(\mathbf{beta}, \sigma^2, \phi)$.
betaF	Sample obtained for \mathbf{beta} .
sigmaF	Sample obtained for σ^2 .
phiF	Sample obtained for ϕ .
nuF	Sample obtained for ν .
coords	Spatial data coordinates.
kappa	Shape parameter of the covariance function.
\$X	Design matrix of the model.
\$type	Covariance function of the model.
\$theta	Bayesian estimator of $(\mathbf{beta}, \sigma, \phi)$.
\$y	Response variable.
\$prior	Prior density considered.
\$prob	Acceptance probability of the MCMC procedure.

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Ordóñez, J.A, M.O. Prattes, L.A. Matos, and V.H. Lachos (2020+). Objective Bayesian analysis for spatial Student-t regression models. (Submitted)

See Also

[dnrposoba](#), [dtsrprioroba](#), [dnrprioroba](#), [tsroba](#)

Examples

```

set.seed(25)
data(dataca20)
d1=dataca20[1:158,]

xpred=model.matrix(calcont~altitude+area,data=dataca20[159:178,])
xobs=model.matrix(calcont~altitude+area,data=dataca20[1:158,])
coordspred=dataca20[159:178,1:2]

#####covariance matern: kappa=0.3 prior:reference
res=tsroba(calcont~altitude+area, kappa = 0.3, data=d1,
           ini.pars=c(10,3,10),iter=10000,burn=500,thin=20)

summary(res)

#####covariance matern: kappa=0.3 prior:jef.rul
res1=tsroba(calcont~altitude+area, kappa = 0.3,
            data=d1,prior="jef.rul",ini.pars=c(10,3,10),
            iter=10000,burn=500,thin=20)

summary(res1)

#####covariance matern: kappa=0.3 prior:jef.ind
res2=tsroba(calcont~altitude+area, kappa = 0.3, data=d1,
            prior="jef.ind",ini.pars=c(10,3,10),iter=10000,
            burn=500,thin=20)

summary(res2)

#####covariance matern: kappa=0.3 prior:vague
res3=tsroba(calcont~altitude+area, kappa = 0.3,
            data=d1,prior="vague",ini.pars=c(10,3,10),,iter=10000,
            burn=500,thin=20)

summary(res3)

####obtaining posterior probabilities

```

```

###(just comparing priors with kappa=0.3).
###the real application (see Ordonez et.al) consider kappa=0.3,0.5,0.7.

##### Using reference prior #####
m1=intmT(prior="reference",formula=calcont~altitude+area,
kappa=0.3,cov.model="matern",data=dataaca20,maxEval=1000)

##### Using Jeffreys' rule prior #####
m1j=intmT(prior="jef.rul",formula=calcont~altitude+area,
kappa=0.3,cov.model="matern",data=dataaca20,maxEval=1000)

##### Using Jeffreys' independent prior #####
m1ji=intmT(prior="jef.ind",formula=calcont~altitude+area
,kappa=0.3,cov.model="matern",data=dataaca20,maxEval=1000)

m1v=intmT(prior="vague",formula=calcont~altitude+area
,kappa=0.3,cov.model="matern",data=dataaca20,maxEval=1000,intphi="default")

tot=m1+m1j+m1ji+m1v

####posterior probabilities####
p1=m1/tot
pj=m1j/tot
pji=m1ji/tot
pv=m1v/tot

#####MSPE#####

pme=tsrobapred(res,xpred=xpred,coordspred=coordspred)
pme1=tsrobapred(res1,xpred=xpred,coordspred=coordspred)
pme2=tsrobapred(res2,xpred=xpred,coordspred=coordspred)
pme3=tsrobapred(res3,xpred=xpred,coordspred=coordspred)

mse=mean((pme-dataaca20$calcont[159:178])^2)
mse1=mean((pme1-dataaca20$calcont[159:178])^2)
mse2=mean((pme2-dataaca20$calcont[159:178])^2)
mse3=mean((pme3-dataaca20$calcont[159:178])^2)

```

tsrobapred

Prediction under Student-t Objective Bayesian Analysis (OBA).

Description

This function uses the sampling distribution of parameters obtained from the function tsroba to predict values at unknown locations.

Usage

```
tsrobapred(obj, xpred, coordspred)
```

Arguments

obj	object of the class "tsroba" (see tsroba function).
xpred	Values of the X design matrix for prediction coordinates.
coordspred	Points coordinates to be predicted.

Details

This function predicts using the sampling distribution of parameters obtained from the function `tsroba` and the conditional Student-t distribution of the predicted values given the data.

Value

This function returns a vector with the predicted values at the specified locations.

Author(s)

Jose A. Ordonez, Marcos O. Prates, Larissa A. Matos, Victor H. Lachos.

References

Diggle, P. and P. Ribeiro (2007). Model-Based Geostatistics. Springer Series in Statistics.
 Ordonez, J.A, M.O. Prates, L.A. Matos, and V.H. Lachos (2020+). Objective Bayesian analysis for spatial Student-t regression models. (Submitted)

See Also

[tsroba](#), [nsrobapred1](#)

Examples

```
set.seed(25)
data(dataca20)
d1=dataca20[1:158,]

#####covariance matern: kappa=0.3 prior:reference
res=tsroba(calcont~altitude+area, kappa = 0.3, data=d1,
ini.pars=c(10,3,10), iter=50, thin=1, burn=5)

datapred=dataca20[159:178,]
formula=calcont~altitude+area
xpred=model.matrix(formula, data=datapred)

tsrobapred(res, xpred=xpred, coordspred=dataca20[159:178, 1:2])
```


Index

dataca20, 2
dataelev, 2
dnrposoba, 3, 6, 7, 9, 11, 13, 15, 18, 19, 22
dnrprioroba, 4, 5, 7, 9, 11, 13, 15, 18, 19, 22
dtsrposoba, 4, 6, 6, 9
dtsrprioroba, 4, 6, 7, 8, 11, 13, 15, 18, 19, 22

intmnorm, 10
intmT, 12

nsroba, 14, 16, 17
nsrobapred1, 16, 24

summary.nsroba, 17
summary.tsroba, 19

tsroba, 15, 18, 19, 20, 22, 24
tsrobapred, 17, 23