

# Package ‘OBASpatial’

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**Type** Package

**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>.

**License** GPL (>= 2)

**NeedsCompilation** no

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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
nsrobapred . . . . .	16
summary.nsroba . . . . .	17
summary.tsroba . . . . .	19

tsroba . . . . .	20
tsrobapred . . . . .	23

<b>Index</b>	<b>26</b>
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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.

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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  $\phi$  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 $\phi$ 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 $\phi$ 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,  $\phi$  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'ò, 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  $\phi$  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 $\phi$ 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  $\phi$  corresponds to the range parameter and  $\nu$  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 $(\phi, \nu)$ . For the vague prior x must be a three dimension vector $(\phi, \nu, \lambda)$ with $\lambda$ 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 $\phi$ used for vague prior.
intnu	An interval for $\nu$ 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,  $\phi$  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  $\phi$  corresponds to the range parameter and  $\nu$  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 $(\phi, \nu)$
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  $\mathbf{c} = (c_1, c_2)$  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  $\mu(\mathbf{c}) = \mu$  is constant over the region.
- `"1st"`, the design matrix is such that mean function becomes a first order polynomial on the coordinates:

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

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

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

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

## Value

Density of  $\mathbf{x}=(\phi, \nu)$

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

## 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  $\phi$  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 $\phi$ used for vague prior.
maxEval	Maximum number of iterations for the integral computation.

**Details**

Let  $m_k$  a parametric model with parameter vector  $\theta_k$ . 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  $\phi$  corresponds to the range parameter and  $\nu$  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 $\phi$ used for vague prior.
intnu	An interval for $\nu$ used for vague prior.
maxEval	Maximum number of iterations for the integral computation.

### Details

Let  $m_k$  a parametric model with parameter vector  $\theta_k$ . 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 $(\beta, \sigma, \phi)$ . 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 $\phi$ used for the uniform proposal. See DETAILS below.
ini.pars	Initial values for $(\sigma^2, \phi)$ 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,  $\phi$  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 $\sigma^2$ .
<code>phiF</code>	Sample obtained for $\phi$ .
<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\`o, B. (2001). Objective Bayesian Analysis of Spatially Correlated Data. *Journal of the American Statistical Association.*, 96, 1361 – 1374.

**See Also**

[dnrsposoba](#), [dtsrprioroba](#), [dnsrprioroba](#), [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)
```

---

nsrobapred

*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

```
nsrobapred(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 <a href="#">nsroba</a> 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]
nsrobapred(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 $\sigma^2, \phi$ .
betaF	Sample obtained for <i>beta</i> .
sigmaF	Sample obtained for $\sigma^2$ .
phiF	Sample obtained for $\phi$ .

**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 <a href="#">tsroba</a> function).
...	Additional arguments.

**Value**

mean.str	Estimates for the mean structure parameters <i>beta</i> .
var.str	Estimates for the variance structure parameters $\sigma^2, \phi, \nu$ .
betaF	Sample obtained for <i>beta</i> .
sigmaF	Sample obtained for $\sigma^2$ .
phiF	Sample obtained for $\phi$ .
nuF	Sample obtained for $\nu$ .

**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**

[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 $\nu$
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 $\phi$ used for the uniform proposal. See DETAILS below.
intnu	An interval for $\nu$ used for the uniform proposal. See DETAILS below.
ini.pars	Initial values for $(\sigma^2, \phi, \nu)$ 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,  $\phi$  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 $\sigma^2$ .
phiF	Sample obtained for $\phi$ .
nuF	Sample obtained for $\nu$ .
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 <a href="#">tsroba</a> 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](#), [nsrobapred](#)

**Examples**

```
set.seed(25)
data(dataaca20)
d1=dataaca20[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=dataaca20[159:178,]
formula=calcont~altitude+area
xpred=model.matrix(formula, data=datapred)

tsrobapred(res, xpred=xpred, coordspred=dataaca20[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  
nsrobapred, 16, 24  
  
summary.nsroba, 17  
summary.tsroba, 19  
  
tsroba, 15, 18, 19, 20, 22, 24  
tsrobapred, 17, 23