

# Package ‘mapsRinteractive’

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**Type** Package

**Title** Local Adaptation and Evaluation of Digital Soil Maps

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**Description** Local adaptation and evaluation of digital soil maps in raster format by use of point location soil property data.

**License** MIT + file LICENSE

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**BugReports** <https://github.com/soilmapper/mapsRinteractive/issues/>

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## R topics documented:

check	2
CLAYr	3
CLAYs	4
e	4
evaluate	5
even	6
kth	6
mae	7
me	8

mri . . . . .	9
odd . . . . .	12
ordkrige . . . . .	12
r2 . . . . .	14
regkrige . . . . .	15
reskrige . . . . .	16
rmse . . . . .	18
spdf_from_extent . . . . .	19

<b>Index</b>	<b>20</b>
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check	<i>check</i>
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---

## Description

Checks attributes, geometries and projections of spatial datasets.

## Usage

```
check(
  x = NULL,
  y = NULL,
  z = NULL,
  field = NULL,
  edge = 0,
  filter = 1,
  resolution = NULL
)
```

## Arguments

x	Raster dataset. Required. Must be have a defined coordinate system. If the coordinate system is not cartesian, the data will be projected onto the Web Mercator (epsg: 3857) coordinate system before any analyses/tests.
y	SpatialPolygonsDataFrame. Optional. Delineates the area within which the raster layer shall be locally adapted and evaluted. Must be projected. If not projected onto the same coordinate system as x, it will be reprojected to the coordinate system of x. If not provided, the analyses willbe performed within the intersect of the raster and the sampled area."
z	SpatialPointsDataFrame. Required. Must have at least one column with numerical data and these data must be of the same entity unit as the raster (specify this column by argument: field). Must be projected. If not projected to the same coordinate system as x, it will be reprojected to the coordinate system of x.
field	Character value. Required. Name of the column in y with the data that shall be used to locally adapt and evaluate the raster

edge	Numeric value. Optional. Specifies the width (m) of a buffer zone inside the edge of the polygon that is excluded from the analyses. Allowed values are within the closed range of 0-10000.
filter	Positive integer. Optional. No of cells in the side of a square window for mean filtering of x. Filtering is done before any resampling (see argument: resolution). Allowed values are within the closed range of 1-20.
resolution	Positive numeric value. Optional. The resolution (m) to which the imported raster shall be resampled before the adaptation. Allowed values are within the closed range of 0.1-10000. In addition, a resolution that means more than 1E+8 raster cells is not allowed.

### Details

Intended for checking data in functions of mapsRinteractive.

### Value

A list with checked and corrected datasets together with a vector of logged feedback.

---

CLAYr

*The Digital Soil Map of Sweden -topsoil clay content*

---

### Description

Excerpt from the Digital Soil Map of Sweden. Projected coordinate system: Sweref99TM (epsg: 3006). Attribute: predicted topsoil (0-20 cm depth) clay content (

### Usage

data(CLAYr)

### Format

Raster layer

### References

Available online: <https://www.sgu.se/samhallsplanering/planering-och-markanvandning/markanvandning/jordbruk-skog-och-fiske/lerhaltskartan-digital-akermarkskarta/>.

---

 CLAYS

*SLU farm (Brogarden) soil sample data -topsoil clay content*


---

**Description**

Projected coordinate system: Sweref99TM (epsg: 3006). Attribute: Lab analyzed topsoil (0-20 cm depth) clay content (

**Usage**

data(CLAYS)

**Format**

SpatialPointsDataFrame

**References**

Piikki, K., Wetterlind, J., Söderström, M., & Stenberg, B. (2015). Three-dimensional digital soil mapping of agricultural fields by integration of multiple proximal sensor data obtained from different sensing methods. *Precision agriculture*, 16(1), 29-45. <https://doi.org/10.1007/s11119-014-9381-6>

---

 e

*e*


---

**Description**

Calculates the Nash-Sutcliffe modelling efficiency (E) from observed and predicted values.

**Usage**

e(observed, predicted)

**Arguments**

observed	Numeric vector of observed values
predicted	Numeric vector of predicted values. The length shall be the same as for observed.

**Details**

$E = 1 - \frac{\sum(\text{observed} - \text{predicted})}{\sum(\text{observed} - \text{mean}(\text{observed}))}$

**Value**

The Nash-Sutcliffe modelling efficiency (E) calculated from observed and predicted values.

## References

Nash, J. E., & Sutcliffe, J. V. (1970). River flow forecasting through conceptual models part I—A discussion of principles. *Journal of hydrology*, 10(3), 282-290.

## Examples

```
o<-1:5
p<-c(2,2,4,3,5)
e(observed=o, predicted=p)
```

---

evaluate

*evaluate*

---

## Description

Computes evaluation measures from observed and predicted data.

## Usage

```
evaluate(df, observed, predicted)
```

## Arguments

df	Data.frame. Required. A data.frame with observed and predicted data.
observed	Character value. Required. The name of the column in df with predicted data. The data must be of class numeric.
predicted	Character value or vector. Required. The names of the column(s) in df with predicted data. The data must be of class numeric.

## Value

A data.frame with evaluation statistics. For details, see `mri` function.

## Examples

```
df<-data.frame(obs=1:9, pred=c(2, 9, 10, 8, 3, 4, 6, 12, 1))
e<-evaluate(df, 'obs', 'pred')
print(e)
```

even

*even*

---

**Description**

Checks if an integer is even.

**Usage**

```
even(x)
```

**Arguments**

x                    Integer.

**Value**

Logical value (TRUE or FALSE). TRUE means that the value is even.

**Examples**

```
even(3)
```

---

kth

*kth*

---

**Description**

Identification of the kth highest/lowest value(s).

**Usage**

```
kth(  
  x = NULL,  
  k = 2,  
  highest = TRUE,  
  index = FALSE,  
  unique = FALSE,  
  multiple = FALSE  
)
```

**Arguments**

x	Numeric vector.
k	Positive integer. The order of the value to find. Default = 2, which means that the next highest/lowest values is identified.
highest	Logical. TRUE means that the kth highest value(s) is/are identified. FALSE means that the kth lowest value(s) is/are identified. Default = TRUE.
index	Logical. TRUE means that the index/indices of the kth highest/lowest value(s) is/are returned. FALSE means that the kth highest/lowest value itself is returned. If ties exist and argument multiple = TRUE, the returned value is a vector, else it is a value. Default=FALSE.
unique	Logical. TRUE means that duplicates are removed before the identification of the kth highest/lowest value(s). Default=FALSE
multiple	Logical. TRUE means that, If ties exist a vector of all values in x that are equal to the kth highest/lowest values is returned. FALSE means that one random value from the vector of index values is returned. Default=FALSE

**Details**

NA values are removed.

**Value**

If index = FALSE: the kth highest/lowest value is returned.

If index = TRUE: the index of the kth highest/lowest value (s) is/are returned.

**Examples**

```
kth(x=1:20, k=3, highest=FALSE)
```

---

mae

*mae*


---

**Description**

Calculates the mean absolute error (MAE) from observed and predicted values.

**Usage**

```
mae(observed, predicted)
```

**Arguments**

observed	Numeric vector of observed values
predicted	Numeric vector of predicted values. The length shall be the same as for observed.

**Details**

```
mae = mean(abs(observed - predicted))
```

**Value**

The mean absolute error (MAE) calculated from the observed and the predicted values.

**Examples**

```
o<-1:5
p<-c(2,2,4,3,5)
mae(observed=o, predicted=p)
```

---

me

*me*

---

**Description**

Calculates the mean error (ME) from observed and predicted values.

**Usage**

```
me(observed, predicted)
```

**Arguments**

observed	Numeric vector of observed values
predicted	Numeric vector of predicted values. The length shall be the same as for observed.

**Details**

```
ME = bias = mean(observed - predicted)
```

**Value**

The mean error (ME) calculated from the observed and the predicted values.

**Examples**

```
o<-1:5
p<-c(2,2,4,3,5)
me(observed=o, predicted=p)
```



---

 mri

 mri
 

---

### Description

Local adaptation and evaluation of digital soil maps in raster format by use of point location soil property data.

### Usage

```
mri(
  x = NULL,
  y = NULL,
  z = NULL,
  field = NULL,
  edge = 0,
  filter = 1,
  resolution = NULL,
  md = "Sph",
  rg = NULL,
  ng = 0.1
)
```

### Arguments

x	Raster dataset. Required. Must have a defined coordinate system. If the coordinate system is not cartesian, the data will be projected onto the Web Mercator (epsg: 3857) coordinate system before any analyses/tests.
y	SpatialPolygonsDataFrame. Optional. Delineates the area within which the raster layer shall be locally adapted and evaluated. Must be projected. If not projected onto the same coordinate system as x, it will be reprojected to the coordinate system of x. If not provided, the analyses will be performed within the intersect of the raster and the sampled area."
z	SpatialPointsDataFrame. Required. Must have at least one column with numerical data and these data must be of the same entity unit as the raster (specify this column by argument: field). Must be projected. If not projected to the same coordinate system as x, it will be reprojected to the coordinate system of x.
field	Character value. Required. Name of the column in y with the data that shall be used to locally adapt and evaluate the raster
edge	Numeric value. Optional. Specifies the width (m) of a buffer zone inside the edge of the polygon that is excluded from the analyses. Allowed values are within the closed range of 0-10000.
filter	Positive integer. Optional. No of cells in the side of a square window for mean filtering of x. Filtering is done before any resampling (see argument: resolution). Allowed values are within the closed range of 1-20.

resolution	Positive numeric value. Optional. The resolution (m) to which the imported raster shall be resampled before the adaptation. Allowed values are within the closed range of 0.1-10000. In addition, a resolution that means more than 1E+8 raster cells is not allowed.
md	Character value. Optional. Variogram model type for the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by <code>gstat::vgm</code> . Default is "Sph" (spherical model).
rg	Numeric value. Optional. Range of the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by <code>gstat::vgm</code> . If no <code>rg</code> is specified it will be set to half of the square root of the mapping area: <code>y</code> (possibly shrunk by edge).
ng	Numeric value. Optional. Nugget of the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by <code>gstat::vgm</code> . The nugget is expressed as a fraction of the sill. A <code>ng = 0.1</code> means that the nugget is 10% by default equal to the variance of the data to be kriged (i.e the point observations or the residuals). Allowed values of <code>ng</code> are within the closed range of 0-1.

## Details

The `mri` function is intended for local adaptation and evaluation of large extent digital soil maps. A raster map and point location soil property are required. A `SpatialPolygonsDataFrame` can optionally be used to delineate the area for local adaptation and evaluation.

All spatial objects must have defined coordinate systems. If the defined coordinate systems are not the same, the point location data and the polygon data will be transformed to the coordinate system of the raster. If the defined coordinate system of the raster is not a cartesian coordinate system, all spatial datasets will be projected onto the Web Mercator coordinate system (epsg: 3857).

The four maps are (created and) evaluated are: the original raster map, a map created solely based on the soil samples data (ordinary kriging using a standardized variogram), two maps based on a combination of the raster data and the point observations (regression kriging and residual kriging, both using standardized variograms).

The maps are evaluated by leave-one-out cross validation and a number of evaluation measures are computed: the Nash-Sutcliffe modelling efficiency (E), the mean absolute error (MAE; Janssen & Heuberger, 1995), the coefficient of determination of a linear regression between predicted and measured values ( $r^2$ ).

The mapped area is the intersection between the original raster map (argument: `x`), any provided `SpatialPolygonsDataFrame` (argument: `y`) and the buffered point locations. The buffer width is  $1.5 \times (\text{next largest distance})$  between one point and its nearest neighbour.

The `mapsRInteractive` algorithms have been described and by Piikki et al.(2017) and Nijbroek et al. (2018) (before it was made available as an R package). More details can be found in these publications. It is also implemented in the open Swedish web application for precision agriculture `markdata.se` and the Sub-Saharan Africa Soil Data Manager.

On error: check that required data are provided (arguments `x`, `y`, `z` and `field`), check that all spatial datasets (arguments `x`, `y`, `z`) are projected, check that they do overlap and check that the arguments `edge`, `filter` and `resolution` have appropriate values.

**Value**

A list with:

- 1) 'maps'. A raster stack with the original raster map ('map'), the map, created by ordinary kriging of observed data ('ordkrig'), by residual kriging ('reskrig') and by regression kriging ('regkrig').
- 2) 'area'. SpatialPolygonsDataFrame with the polygon delineating the mapped area.
- 3) 'pts'. SpatialPointsDataFrame with the point locations used for mapping, i.e points falling within the mapped area, excluding points with NA values in the observed values or the values extracted from the original map. The column names mean: obs = observed values. map = original map values. ordkrig\_cv = values from the leave-one-out cross validation of the ordinary kriging. res = residuals (map - obs) reskrig\_cv = values from the leave-one-out cross validation of the residual kriging. regpred = predicted values from the linear regression (obs = a\*map + b) regres = residuals (regpred - obs) regkrig\_cv = values from the leave-one-out cross validation of the regression kriging.
- 4) 'evaluation'. a data.frame with evaluation statistics for the original map and the leave-one-out cross-validation of the other mapping methods.
- 5) 'feedback' a character vector with logged feedback on inputted and used data.

**Author(s)**

Kristin Piikki Mats Söderström & John Mutua, <kristin.piikki@slu.se>

**References**

- Nijbroek, R., Piikki, K., Söderström, M., Kempen, B., Turner, K. G., Hengari, S., & Mutua, J. (2018). Soil Organic Carbon Baselines for Land Degradation Neutrality: Map Accuracy and Cost Tradeoffs with Respect to Complexity in Otjozondjupa, Namibia. *Sustainability*, 10(5), 1610. doi:10.3390/su10051610
- Piikki, K., Söderström, M., Stadig, H. 2017. Local adaptation of a national digital soil map for use in precision agriculture. *Adv. Anim. Biosci.* 8, 430–432.
- Janssen, P.H.M.; Heuberger, P.S.C. 1995. Calibration of process-oriented models. *Ecol. Model.*, 831, 55–66.
- Nash, J.E.; Sutcliffe, J.V. River flow forecasting through conceptual models part I—A discussion of principles. *J. Hydrol.* 1970, 103, 282–290.

**Examples**

```
##prepare raster dataset (the soil map to be adapted)
data('CLAYr')
CLAYr<-data.frame(CLAYr$POINT_X, CLAYr$POINT_Y, CLAYr$clay_percent) #rearrange columns
require(raster) #load required package
CLAYr<-rasterFromXYZ(CLAYr) #convert to raster
prj<-'+proj=utm +zone=33 +ellps=GRS80 +towgs84=0,0,0,0,0,0,0 +units=m +no_defs' #projection
crs(CLAYr)<-crs(prj) #define projection
names(CLAYr)<- 'clay_percent' #rename (not necessary)
##prepare example point location data
data('CLAYs')
CLAYs<-data.frame(CLAYs) #convert to data.frame
coordinates(CLAYs)<-~ POINT_X + POINT_Y #convert to SpatialPointsDataFrame
```

```
crs(CLAYs)<-crs(CLAYr) #define projection
##run local adaptation and evaluation
mri.out<-mri(x = CLAYr, z = CLAYs, field = 'clay_percent')
##check evaluation measures
print(mri.out$evaluation)
```

---

odd

*even*

---

### Description

Checks if an integer is odd.

### Usage

```
odd(x)
```

### Arguments

x                   Integer.

### Value

Logical value (TRUE or FALSE). TRUE means that the value is odd.

### Examples

```
odd(3)
```

---

ordkrige

*ordkrige*

---

### Description

Regression kriging using a standardized variogram.

### Usage

```
ordkrige(
  x = NULL,
  y = NULL,
  z = NULL,
  field = NULL,
  edge = 0,
  filter = 1,
  resolution = NULL,
```

```

md = "Sph",
rg = NULL,
ng = 0.1,
check_data = T
)

```

### Arguments

x	Raster dataset. Required. Must have a defined coordinate system. If the coordinate system is not cartesian, the data will be projected onto the Web Mercator (eps: 3857) coordinate system before any analyses/tests.
y	SpatialPolygonsDataFrame. Optional. Delineates the area within which the raster layer shall be locally adapted and evaluated. Must be projected. If not projected onto the same coordinate system as x, it will be reprojected to the coordinate system of x. If not provided, the analyses will be performed within the intersect of the raster and the sampled area."
z	SpatialPointsDataFrame. Required. Must have at least one column with numerical data and these data must be of the same entity unit as the raster (specify this column by argument: field). Must be projected. If not projected to the same coordinate system as x, it will be reprojected to the coordinate system of x.
field	Character value. Required. Name of the column in y with the data that shall be used to locally adapt and evaluate the raster
edge	Numeric value. Optional. Specifies the width (m) of a buffer zone inside the edge of the polygon that is excluded from the analyses. Allowed values are within the closed range of 0-10000.
filter	Positive integer. Optional. No of cells in the side of a square window for mean filtering of x. Filtering is done before any resampling (see argument: resolution). Allowed values are within the closed range of 1-20.
resolution	Positive numeric value. Optional. The resolution (m) to which the imported raster shall be resampled before the adaptation. Allowed values are within the closed range of 0.1-10000. In addition, a resolution that means more than 1E+8 raster cells is not allowed.
md	Character value. Optional. Variogram model type for the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by gstat::vgm. Default is "Sph" (spherical model).
rg	Numeric value. Optional. Range of the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by gstat::vgm. If no rg is specified it will be set to half of the square root of the mapping area: y (possibly shrunk by edge).
ng	Numeric value. Optional. Nugget of the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by gstat::vgm. The nugget is expressed as a fraction of the sill. A ng = 0.1 means that the nugget is 10% by default equal to the variance of the data to be kriged (i.e the point observations or the residuals). Allowed values of ng are within the closed range of 0-1.
check_data	Logical. Shall attributes, geometries and projections of the input data (arguments x, y and z) be checked. Default = TRUE.

**Details**

This is the ordinary kriging function called by the `mri` function. It uses a standardized variogram and requires a raster template for which predictions are made. For details, see documentation of the `mri` function.

**Value**

A list with 1) a raster layer with predicted values and 2) a `SpatialPolygonsDataFrame` with cross-validation data. For details, see `mri` function.

---

r2	<i>r2</i>
----	-----------

---

**Description**

Calculates the coefficient of determination ( $r^2$ ) for a linear regression model between predicted values and observed values.

**Usage**

```
r2(observed, predicted)
```

**Arguments**

observed	Numeric vector of observed values
predicted	Numeric vector of predicted values. The length shall be the same as for observed.

**Value**

Coefficient of determination ( $r^2$ ) for a linear regression model between predicted values and observed values.

**Examples**

```
o<-1:5
p<-c(2,2,4,3,5)
r2(observed=o, predicted=p)
```

---

regkrige	<i>regkrige</i>
----------	-----------------

---

### Description

Regression kriging using a standardized variogram.

### Usage

```
regkrige(
  x = NULL,
  y = NULL,
  z = NULL,
  field = NULL,
  edge = 0,
  filter = 1,
  resolution = NULL,
  md = "Sph",
  rg = NULL,
  ng = 0.1,
  check_data = T
)
```

### Arguments

x	Raster dataset. Required. Must have a defined coordinate system. If the coordinate system is not cartesian, the data will be projected onto the Web Mercator (epsg: 3857) coordinate system before any analyses/tests.
y	SpatialPolygonsDataFrame. Optional. Delineates the area within which the raster layer shall be locally adapted and evaluated. Must be projected. If not projected onto the same coordinate system as x, it will be reprojected to the coordinate system of x. If not provided, the analyses will be performed within the intersect of the raster and the sampled area."
z	SpatialPointsDataFrame. Required. Must have at least one column with numerical data and these data must be of the same entity unit as the raster (specify this column by argument: field). Must be projected. If not projected to the same coordinate system as x, it will be reprojected to the coordinate system of x.
field	Character value. Required. Name of the column in y with the data that shall be used to locally adapt and evaluate the raster
edge	Numeric value. Optional. Specifies the width (m) of a buffer zone inside the edge of the polygon that is excluded from the analyses. Allowed values are within the closed range of 0-10000.
filter	Positive integer. Optional. No. of cells in the side of a square window for mean filtering of x. Filtering is done before any resampling (see argument: resolution). Allowed values are within the closed range of 1-20.

resolution	Positive numeric value. Optional. The resolution (m) to which the imported raster shall be resampled before the adaptation. Allowed values are within the closed range of 0.1-10000. In addition, a resolution that means more than 1E+8 raster cells is not allowed.
md	Character value. Optional. Variogram model type for the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by <code>gstat::vgm</code> . Default is "Sph" (spherical model).
rg	Numeric value. Optional. Range of the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by <code>gstat::vgm</code> . If no <code>rg</code> is specified it will be set to half of the square root of the mapping area: <code>y</code> (possibly shrunked by edge).
ng	Numeric value. Optional. Nugget of the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by <code>gstat::vgm</code> . The nugget is expressed as a fraction of the sill. A <code>ng = 0.1</code> means that the nugget is 10% by default equal to the variance of the data to be kriged (i.e the point observations or the residuals). Allowed values of <code>ng</code> are within the closed range of 0-1.
check_data	Logical. Shall attributes, geometries and projections of the input data (arguments <code>x</code> , <code>y</code> and <code>z</code> ) be checked. Default = TRUE.

### Details

This is the regression kriging function called by the `mri` function. For details, see documentation of the `mri` function.

### Value

A list with 1) a raster layer with predicted values and 2) a `SpatialPolygonsDataFrame` with cross-validation data. For details, see `mri` function.

---

reskrige

*reskrige*

---

### Description

Regression kriging using a standardized variogram.

### Usage

```
reskrige(
  x = NULL,
  y = NULL,
  z = NULL,
  field = NULL,
  edge = 0,
  filter = 1,
```



```

    resolution = NULL,
    md = "Sph",
    rg = NULL,
    ng = 0.1,
    check_data = T
)

```

## Arguments

x	Raster dataset. Required. Must have a defined coordinate system. If the coordinate system is not cartesian, the data will be projected onto the Web Mercator (epsg: 3857) coordinate system before any analyses/tests.
y	SpatialPolygonsDataFrame. Optional. Delineates the area within which the raster layer shall be locally adapted and evaluated. Must be projected. If not projected onto the same coordinate system as x, it will be reprojected to the coordinate system of x. If not provided, the analyses will be performed within the intersect of the raster and the sampled area."
z	SpatialPointsDataFrame. Required. Must have at least one column with numerical data and these data must be of the same entity unit as the raster (specify this column by argument: field). Must be projected. If not projected to the same coordinate system as x, it will be reprojected to the coordinate system of x.
field	Character value. Required. Name of the column in y with the data that shall be used to locally adapt and evaluate the raster
edge	Numeric value. Optional. Specifies the width (m) of a buffer zone inside the edge of the polygon that is excluded from the analyses. Allowed values are within the closed range of 0-10000.
filter	Positive integer. Optional. No of cells in the side of a square window for mean filtering of x. Filtering is done before any resampling (see argument: resolution). Allowed values are within the closed range of 1-20.
resolution	Positive numeric value. Optional. The resolution (m) to which the imported raster shall be resampled before the adaptation. Allowed values are within the closed range of 0.1-10000. In addition, a resolution that means more than 1E+8 raster cells is not allowed.
md	Character value. Optional. Variogram model type for the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by gstat::vgm. Default is "Sph" (spherical model).
rg	Numeric value. Optional. Range of the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by gstat::vgm. If no rg is specified it will be set to half of the square root of the mapping area: y (possibly shrunk by edge).
ng	Numeric value. Optional. Nugget of the standardized variograms used for ordinary kriging interpolation of observed data or residuals. Variograms are generated by gstat::vgm. The nugget is expressed as a fraction of the sill. A ng = 0.1 means that the nugget is 10% by default equal to the variance of the data to be kriged (i.e the point observations or the residuals). Allowed values of ng are within the closed range of 0-1.

check\_data      Logical. Shall attributes, geometries and projections of the input data (arguments x, y and z) be checked. Default = TRUE.

### Details

This is the residual kriging function called by the mri function. For details, see documentation of the mri function.

### Value

A list with 1) a raster layer with predicted values and 2) a SpatialPolygonsDataFrame with cross-validation data. For details, see mri function.

---

rmse

*rmse*

---

### Description

Calculates the root mean square error (RMSE) from observed and predicted values.

### Usage

```
rmse(observed, predicted)
```

### Arguments

observed      Numeric vector of observed values

predicted      Numeric vector of predicted values. The length shall be the same as for observed.

### Details

$$\text{rmse} = \sqrt{\text{mean}((\text{observed} - \text{predicted})^2)}$$

### Value

The root mean square error (RMSE) calculated from the observed and the predicted values.

### Examples

```
o<-1:5
p<-c(2,2,4,3,5)
rmse(observed=o, predicted=p)
```

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spdf_from_extent	<i>spdf_from_extent</i>
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**Description**

Create a spatialPolygonsDataFrame from extent of a spatial object.

**Usage**

```
spdf_from_extent(x)
```

**Arguments**

x                    A spatial object.

**Details**

If x is projected, the spatialpolygonsdataframe will also be projected

**Value**

SpatialPolygonsDataFrame.

**Examples**

```
require(raster) #load required package.  
r1<-raster::raster(ext=extent(c(0,10,0,10)), res=1, vals=1:100) #create example raster.  
spdf<-spdf_from_extent(r1) #convert the raster extent to SpatialPolygonsdataFrame.  
plot(spdf) #Plot results.
```

# Index

## \* **Internal**

check, [2](#)

## \* **datasets**

CLAYr, [3](#)

CLAYs, [4](#)

check, [2](#)

CLAYr, [3](#)

CLAYs, [4](#)

e, [4](#)

evaluate, [5](#)

even, [6](#)

kth, [6](#)

mae, [7](#)

me, [8](#)

mri, [9](#)

odd, [12](#)

ordkrige, [12](#)

r2, [14](#)

regkrige, [15](#)

reskrige, [16](#)

rmse, [18](#)

spdf\_from\_extent, [19](#)