Package ‘spatial’

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R topics documented:

`anova.trls` *Anova tables for fitted trend surface objects*

Description

Compute analysis of variance tables for one or more fitted trend surface model objects; where `anova.trls` is called with multiple objects, it passes on the arguments to `anovalist.trls`.

Usage

```
## S3 method for class 'trls'
anova(object, ...)
anovalist.trls(object, ...)
```

Arguments

`object`	A fitted trend surface model object from `surf.ls`
`...`	Further objects of the same kind

Value

`anova.trls` and `anovalist.trls` return objects corresponding to their printed tabular output.

References

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`surf.ls`

Examples

```
library(stats)
data(topo, package="MASS")
topo0 <- surf.ls(0, topo)
topo1 <- surf.ls(1, topo)
topo2 <- surf.ls(2, topo)
topo3 <- surf.ls(3, topo)
topo4 <- surf.ls(4, topo)
anova(topo0, topo1, topo2, topo3, topo4)
summary(topo4)
```

`correlogram` *Compute Spatial Correlograms*

Description

Compute spatial correlograms of spatial data or residuals.

Usage

```
correlogram(krig, nint, plotit = TRUE,  ...)
```

Arguments

`krig`	trend-surface or kriging object with columns `x`, `y`, and `z`
`nint`	number of bins used
`plotit`	logical for plotting
`...`	parameters for the plot

Details

Divides range of data into `nint` bins, and computes the covariance for pairs with separation in each bin, then divides by the variance. Returns results for bins with 6 or more pairs.

Value

`x` and `y` coordinates of the correlogram, and `cnt`, the number of pairs averaged per bin.

Side Effects

Plots the correlogram if `plotit` = `TRUE`.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

variogram

Examples

```
data(topo, package="MASS")
topo.kr <- surf.ls(2, topo)
correlogram(topo.kr, 25)
d <- seq(0, 7, 0.1)
lines(d, expcov(d, 0.7))
```

---

expcov *Spatial Covariance Functions*

Description

Spatial covariance functions for use with `surf.gls`.

Usage

```
expcov(r, d, alpha = 0, se = 1)
gaucov(r, d, alpha = 0, se = 1)
sphercov(r, d, alpha = 0, se = 1, D = 2)
```

Arguments

`r`	vector of distances at which to evaluate the covariance
`d`	range parameter
`alpha`	proportion of nugget effect
`se`	standard deviation at distance zero
`D`	dimension of spheres.

Value

vector of covariance values.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

surf.gls

Examples

```
data(topo, package="MASS")
topo.kr <- surf.ls(2, topo)
correlogram(topo.kr, 25)
d <- seq(0, 7, 0.1)
lines(d, expcov(d, 0.7))
```

Kaver — *Average K-functions from Simulations*

Description

Forms the average of a series of (usually simulated) K-functions.

Usage

```
Kaver(fs, nsim, ...)
```

Arguments

fs	full scale for K-fn
nsim	number of simulations
...	arguments to simulate one point process object

Value

list with components x and y of the average K-fn on L-scale.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

Kfn, Kenvl

Examples

```
towns <- ppinit("towns.dat")
par(pty="s")
plot(Kfn(towns, 40), type="b")
plot(Kfn(towns, 10), type="b", xlab="distance", ylab="L(t)")
for(i in 1:10) lines(Kfn(Psim(69), 10))
lims <- Kenvl(10,100,Psim(69))
lines(lims$x,lims$lower, lty=2, col="green")
lines(lims$x,lims$upper, lty=2, col="green")
lines(Kaver(10,25,Strauss(69,0.5,3.5)),  col="red")
```

Kenvl — *Compute Envelope and Average of Simulations of K-fns*

Description

Computes envelope (upper and lower limits) and average of simulations of K-fns

Usage

```
Kenvl(fs, nsim, ...)
```

Arguments

fs	full scale for K-fn
nsim	number of simulations
...	arguments to produce one simulation

Value

list with components

x	distances
lower	min of K-fns
upper	max of K-fns
aver	average of K-fns

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

Kfn, Kaver

Examples

```
towns <- ppinit("towns.dat")
par(pty="s")
plot(Kfn(towns, 40), type="b")
plot(Kfn(towns, 10), type="b", xlab="distance", ylab="L(t)")
for(i in 1:10) lines(Kfn(Psim(69), 10))
lims <- Kenvl(10,100,Psim(69))
lines(lims$x,lims$lower, lty=2, col="green")
lines(lims$x,lims$upper, lty=2, col="green")
lines(Kaver(10,25,Strauss(69,0.5,3.5)), col="red")
```

Kfn — *Compute K-fn of a Point Pattern*

Description

Actually computes $L = \sqrt{K/\pi}$.

Usage

```
Kfn(pp, fs, k=100)
```

Arguments

pp	a list such as a pp object, including components x and y
fs	full scale of the plot
k	number of regularly spaced distances in (0, fs)

Details

relies on the domain D having been set by `ppinit` or `ppregion`.

Value

A list with components

x	vector of distances
y	vector of L-fn values
k	number of distances returned – may be less than k if fs is too large
dmin	minimum distance between pair of points
lm	maximum deviation from L(t) = t

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`ppinit`, `ppregion`, `Kaver`, `Kenvl`

Examples

```
towns <- ppinit("towns.dat")
par(pty="s")
plot(Kfn(towns, 10), type="s", xlab="distance", ylab="L(t)")
```

ppgetregion — *Get Domain for Spatial Point Pattern Analyses*

Description

Retrieves the rectangular domain `(xl, xu)` $\times$ `(yl, yu)` from the underlying `C` code.

Usage

```
ppgetregion()
```

Value

A vector of length four with names `c("xl", "xu", "yl", "yu")`.

References

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`ppregion`

ppinit — *Read a Point Process Object from a File*

Description

Read a file in standard format and create a point process object.

Usage

```
ppinit(file)
```

Arguments

`file`	string giving file name

Details

The file should contain

the number of points
a header (ignored)
xl xu yl yu scale
x y (repeated n times)

Value

class "pp" object with components x, y, xl, xu, yl, yu

Side Effects

Calls ppregion to set the domain.

References

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

ppregion

Examples

```
towns <- ppinit("towns.dat")
par(pty="s")
plot(Kfn(towns, 10), type="b", xlab="distance", ylab="L(t)")
```

---

pplik — *Pseudo-likelihood Estimation of a Strauss Spatial Point Process*

Description

Pseudo-likelihood estimation of a Strauss spatial point process.

Usage

```
pplik(pp, R, ng=50, trace=FALSE)
```

Arguments

pp	a pp object
R	the fixed parameter R
ng	use a ng x ng grid with border R in the domain for numerical integration.
trace	logical? Should function evaluations be printed?

Value

estimate for c in the interval $[0, 1]$.

References

Ripley, B. D. (1988) *Statistical Inference for Spatial Processes.* Cambridge.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

Strauss

Examples

```
pines <- ppinit("pines.dat")
pplik(pines, 0.7)
```

---

ppregion *Set Domain for Spatial Point Pattern Analyses*

Description

Sets the rectangular domain (xl, xu) × (yl, yu).

Usage

```
ppregion(xl = 0, xu = 1, yl = 0, yu = 1)
```

Arguments

xl	Either xl or a list containing components xl, xu, yl, yu (such as a point-process object)
xu	
yl	
yu	

Value

none

Side Effects

initializes variables in the C subroutines.

References

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

ppinit, ppgetregion

predict.trls *Predict method for trend surface fits*

Description

Predicted values based on trend surface model object

Usage

```
## S3 method for class 'trls'
predict(object, x, y, ...)
```

Arguments

object	Fitted trend surface model object returned by `surf.ls`
x	Vector of prediction location eastings (x coordinates)
y	Vector of prediction location northings (y coordinates)
...	further arguments passed to or from other methods.

Value

`predict.trls` produces a vector of predictions corresponding to the prediction locations. To display the output with `image` or `contour`, use `trmat` or convert the returned vector to matrix form.

References

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`surf.ls`, `trmat`

Examples

```
data(topo, package="MASS")
topo2 <- surf.ls(2, topo)
topo4 <- surf.ls(4, topo)
x <- c(1.78, 2.21)
y <- c(6.15, 6.15)
z2 <- predict(topo2, x, y)
z4 <- predict(topo4, x, y)
cat("2nd order predictions:", z2, "\n4th order predictions:", z4, "\n")
```

prmat *Evaluate Kriging Surface over a Grid*

Description

Evaluate Kriging surface over a grid.

Usage

```
prmat(obj, xl, xu, yl, yu, n)
```

Arguments

obj	object returned by `surf.gls`
xl	limits of the rectangle for grid
xu	
yl	
yu	
n	use `n` x `n` grid within the rectangle

Value

list with components `x`, `y` and `z` suitable for `contour` and `image`.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`surf.gls`, `trmat`, `semat`

Examples

```
data(topo, package="MASS")
topo.kr <- surf.gls(2, expcov, topo, d=0.7)
prsurf <- prmat(topo.kr, 0, 6.5, 0, 6.5, 50)
contour(prsurf, levels=seq(700, 925, 25))
```

Psim *Simulate Binomial Spatial Point Process*

Description

Simulate Binomial spatial point process.

Usage

```
Psim(n)
```

Arguments

n	number of points

Details

relies on the region being set by `ppinit` or `ppregion`.

Value

list of vectors of `x` and `y` coordinates.

Side Effects

uses the random number generator.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`SSI`, `Strauss`

Examples

```
towns <- ppinit("towns.dat")
par(pty="s")
plot(Kfn(towns, 10), type="s", xlab="distance", ylab="L(t)")
for(i in 1:10) lines(Kfn(Psim(69), 10))
```

semat — *Evaluate Kriging Standard Error of Prediction over a Grid*

Description

Evaluate Kriging standard error of prediction over a grid.

Usage

```
semat(obj, xl, xu, yl, yu, n, se)
```

Arguments

`obj`	object returned by `surf.gls`
`xl`	limits of the rectangle for grid
`xu`	
`yl`	
`yu`	
`n`	use `n` x `n` grid within the rectangle
`se`	standard error at distance zero as a multiple of the supplied covariance. Otherwise estimated, and it assumed that a correlation function was supplied.

Value

list with components x, y and z suitable for `contour` and `image`.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`surf.gls`, `trmat`, `prmat`

Examples

```
data(topo, package="MASS")
topo.kr <- surf.gls(2, expcov, topo, d=0.7)
prsurf <- prmat(topo.kr, 0, 6.5, 0, 6.5, 50)
contour(prsurf, levels=seq(700, 925, 25))
sesurf <- semat(topo.kr, 0, 6.5, 0, 6.5, 30)
contour(sesurf, levels=c(22,25))
```

SSI *Simulates Sequential Spatial Inhibition Point Process*

Description

Simulates SSI (sequential spatial inhibition) point process.

Usage

```
SSI(n, r)
```

Arguments

n	number of points
r	inhibition distance

Details

uses the region set by `ppinit` or `ppregion`.

Value

list of vectors of `x` and `y` coordinates

Side Effects

uses the random number generator.

Warnings

will never return if `r` is too large and it cannot place `n` points.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`Psim`, `Strauss`

Examples

```
towns <- ppinit("towns.dat")
par(pty = "s")
plot(Kfn(towns, 10), type = "b", xlab = "distance", ylab = "L(t)")
lines(Kaver(10, 25, SSI(69, 1.2)))
```

`Strauss` *Simulates Strauss Spatial Point Process*

Description

Simulates Strauss spatial point process.

Usage

```
Strauss(n, c=0, r)
```

Arguments

`n`	number of points
`c`	parameter `c` in $[0, 1]$. `c = 0` corresponds to complete inhibition at distances up to `r`.
`r`	inhibition distance

Details

Uses spatial birth-and-death process for 4`n` steps, or for 40`n` steps starting from a binomial pattern on the first call from an other function. Uses the region set by `ppinit` or `ppregion`.

Value

list of vectors of x and y coordinates

Side Effects

uses the random number generator

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`Psim`, `SSI`

Examples

```
towns <- ppinit("towns.dat")
par(pty="s")
plot(Kfn(towns, 10), type="b", xlab="distance", ylab="L(t)")
lines(Kaver(10, 25, Strauss(69,0.5,3.5)))
```

surf.gls *Fits a Trend Surface by Generalized Least-squares*

Description

Fits a trend surface by generalized least-squares.

Usage

```
surf.gls(np, covmod, x, y, z, nx = 1000, ...)
```

Arguments

`np`	degree of polynomial surface
`covmod`	function to evaluate covariance or correlation function
`x`	x coordinates or a data frame with columns `x`, `y`, `z`
`y`	y coordinates
`z`	z coordinates. Will supersede `x$z`
`nx`	Number of bins for table of the covariance. Increasing adds accuracy, and increases size of the object.
`...`	parameters for `covmod`

Value

list with components

`beta`	the coefficients
`x`	
`y`	
`z`	and others for internal use only.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`trmat`, `surf.ls`, `prmat`, `semat`, `expcov`, `gaucov`, `sphercov`

Examples

```
library(MASS)  # for eqscplot
data(topo, package="MASS")
topo.kr <- surf.gls(2, expcov, topo, d=0.7)
trsurf <- trmat(topo.kr, 0, 6.5, 0, 6.5, 50)
eqscplot(trsurf, type = "n")
contour(trsurf, add = TRUE)

prsurf <- prmat(topo.kr, 0, 6.5, 0, 6.5, 50)
contour(prsurf, levels=seq(700, 925, 25))
sesurf <- semat(topo.kr, 0, 6.5, 0, 6.5, 30)
eqscplot(sesurf, type = "n")
contour(sesurf, levels = c(22, 25), add = TRUE)
```

---

surf.ls *Fits a Trend Surface by Least-squares*

Description

Fits a trend surface by least-squares.

Usage

```
surf.ls(np, x, y, z)
```

Arguments

`np`	degree of polynomial surface
`x`	x coordinates or a data frame with columns `x`, `y`, `z`
`y`	y coordinates
`z`	z coordinates. Will supersede `x$z`

Value

list with components

`beta`	the coefficients
`x`	
`y`	
`z`	and others for internal use only.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

trmat, surf.gls

Examples

```
library(MASS)  # for eqscplot
data(topo, package="MASS")
topo.kr <- surf.ls(2, topo)
trsurf <- trmat(topo.kr, 0, 6.5, 0, 6.5, 50)
eqscplot(trsurf, type = "n")
contour(trsurf, add = TRUE)
points(topo)

eqscplot(trsurf, type = "n")
contour(trsurf, add = TRUE)
plot(topo.kr, add = TRUE)
title(xlab= "Circle radius proportional to Cook's influence statistic")
```

trls.influence — *Regression diagnostics for trend surfaces*

Description

This function provides the basic quantities which are used in forming a variety of diagnostics for checking the quality of regression fits for trend surfaces calculated by `surf.ls`.

Usage

```
trls.influence(object)
## S3 method for class 'trls'
plot(x, border = "red", col = NA, pch = 4, cex = 0.6,
     add = FALSE, div = 8, ...)
```

Arguments

`object, x`	Fitted trend surface model from `surf.ls`
`div`	scaling factor for influence circle radii in `plot.trls`
`add`	add influence plot to existing graphics if `TRUE`
`border, col, pch, cex, ...`	additional graphical parameters

Value

`trls.influence` returns a list with components:

`r`	raw residuals as given by `residuals.trls`
`hii`	diagonal elements of the Hat matrix
`stresid`	standardised residuals
`Di`	Cook's statistic

References

Unwin, D. J., Wrigley, N. (1987) Towards a general-theory of control point distribution effects in trend surface models. *Computers and Geosciences,* **13**, 351–355.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

`surf.ls`, `influence.measures`, `plot.lm`

Examples

```
library(MASS)  # for eqscplot
data(topo, package = "MASS")
topo2 <- surf.ls(2, topo)
infl.topo2 <- trls.influence(topo2)
(cand <- as.data.frame(infl.topo2)[abs(infl.topo2$stresid) > 1.5, ])
cand.xy <- topo[as.integer(rownames(cand)), c("x", "y")]
trsurf <- trmat(topo2, 0, 6.5, 0, 6.5, 50)
eqscplot(trsurf, type = "n")
contour(trsurf, add = TRUE, col = "grey")
plot(topo2, add = TRUE, div = 3)
points(cand.xy, pch = 16, col = "orange")
text(cand.xy, labels = rownames(cand.xy), pos = 4, offset = 0.5)
```

---

trmat *Evaluate Trend Surface over a Grid*

Description

Evaluate trend surface over a grid.

Usage

```
trmat(obj, xl, xu, yl, yu, n)
```

Arguments

`obj`	object returned by `surf.ls` or `surf.gls`
`xl`	limits of the rectangle for grid
`xu`	
`yl`	
`yu`	
`n`	use `n x n` grid within the rectangle

Value

list with components `x`, `y` and `z` suitable for `contour` and `image`.

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

surf.ls, surf.gls

Examples

```
data(topo, package="MASS")
topo.kr <- surf.ls(2, topo)
trsurf <- trmat(topo.kr, 0, 6.5, 0, 6.5, 50)
```

---

variogram *Compute Spatial Variogram*

Description

Compute spatial (semi-)variogram of spatial data or residuals.

Usage

```
variogram(krig, nint, plotit = TRUE, ...)
```

Arguments

krig	trend-surface or kriging object with columns x, y, and z
nint	number of bins used
plotit	logical for plotting
...	parameters for the plot

Details

Divides range of data into nint bins, and computes the average squared difference for pairs with separation in each bin. Returns results for bins with 6 or more pairs.

Value

x and y coordinates of the variogram and cnt, the number of pairs averaged per bin.

Side Effects

Plots the variogram if plotit = TRUE

References

Ripley, B. D. (1981) *Spatial Statistics.* Wiley.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S.* Fourth edition. Springer.

See Also

correlogram

Examples

```
data(topo, package="MASS")
topo.kr <- surf.ls(2, topo)
variogram(topo.kr, 25)
```

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