

Package ‘rasterList’

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Title A Raster Where Cells are Generic Objects

Type Package

Description A S4 class has been created such that complex operations can be executed on each cell of a raster map. The raster of objects contains a raster map with the addition of a list of generic objects: one object for each raster cells. It allows to write few lines of R code for complex map algebra. Two environmental applications about frequency analysis of raster map of precipitation and creation of a raster map of soil water retention curves have been presented.

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Depends R(>= 3.0.1),raster,methods

Suggests

lmom,testthat,sp,sf,soilwater,lubridate,ggplot2,gridExtra,knitcitations,leaflet,lmomPi,stringr,trend,knitr

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Author Emanuele Cordano [aut, cre]

Maintainer Emanuele Cordano <emanuele.cordano@gmail.com>

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crop,RasterList-method

Crop methods for a [RasterList-class](#) object.

Description

Crop methods for a [RasterList-class](#) object.

Usage

```
## S4 method for signature 'RasterList'
crop(x, y, check.RasterList = TRUE, ...)
```

Arguments

x	a valid object
y	a Spatial Object or an Extent
check.RasterList	logical value. If it is TRUE, it checks the x RasterList-class object. Default is FALSE.
...	further arguments

Value

a "cropped" [RasterList-class](#) object

Examples

```
precf <- system.file("map/Mekrou_precipitation.grd", package="rasterList")
prec <- stack(precf)

## Sample L-moments
if (requireNamespace("lmom",quietly = TRUE)) {
  library(lmom)

  samlmom <- stack(rasterList(prec,FUN=samlmu))
  ## Fitting a Random Probability Distribution: it is a 'rasterList' Object
  fitdist <- rasterList(samlmom,FUN=pe1gam)
```

```
##### ZOOM IN
## set a mask
mask <-raster( extent(fitdist)/4 )

fitdist_masked <- crop ( x = fitdist,y=mask)
}
```

is.RasterList *Is a RasterList-class object ?*

Description

Is a [RasterList-class](#) object ?

Usage

```
is.RasterList(x)
```

Arguments

x a valid object

Value

a logical variable

Examples

```
r <- rasterList()
is.RasterList(r)
rr <- raster()
is.RasterList(rr)

f <- system.file("external/test.grd", package="raster")
ra <- rasterList(f)
is.RasterList(rr)
```

raster,RasterList-method

Raster *methods for a RasterList-class object.*

Description

Raster methods for a [RasterList-class](#) object.

Usage

```
## S4 method for signature 'RasterList'  
raster(x, FUN = NULL, ...)
```

Arguments

x	a valid RasterList-class object
FUN	if it not NULL a function is applied to all elements of the list slot in x.
...	further arguments

Value

a [RasterLayer-class](#) object

See Also

[stack,RasterListApply](#)

Examples

```
f <- system.file("external/test.grd", package="raster")  
ur <- rasterList(raster(f),FUN=function(x,d){x+0:d},d=10)  
  
r1 <- raster(ur)  
r2 <- raster(ur,FUN=function(x){x[2]})
```

rasterList	Creates a RasterList-class object
------------	---

Description

The method `rasterList` is the constructor of a [RasterList-class](#) from a generic object.

Usage

```
rasterList(object = NULL, list = NULL, object.name = NA, ...)  
as.RasterList(object, ...)  
  
rasterList(object = NULL, list = NULL, object.name = NA, ...)  
  
## S4 method for signature 'RasterLayer'  
rasterList(object = NULL, list = NULL, object.name = NA, ...)  
  
## S4 method for signature 'RasterStack'  
rasterList(object = NULL, list = NULL, object.name = NA, ...)  
  
## S4 method for signature 'RasterBrick'  
rasterList(object = NULL, list = NULL, object.name = NA, ...)  
  
## S4 method for signature 'RasterList'  
rasterList(object, list = NULL, object.name = NA, FUN = NULL, ...)
```

Arguments

<code>object</code>	the object to coerce
<code>list</code>	a list object to assign to the raster map.
<code>object.name</code>	character string containing the name to assign to object.
<code>...</code>	further arguments for raster (generic) or FUN (RasterList-class)
<code>FUN</code>	function that can be used to apply to each element of the list in a RasterList-class

Details

The argument `FUN` is useful to create or transform [RasterList-class](#) from other `Raster*` classes.

Value

a [RasterList-class](#) object.

Examples

```

f <- system.file("external/test.grd", package="raster")
rr <- rasterList(f)
rs <- as.RasterList(f)
# The package-provided datasets shall be only used as example datasets.
prefc <- system.file("map/precipitation.grd", package="rasterList")##
## A resampled precipitation raster map based on CHIRS dataset:
## Funk, Chris, Pete Peterson, Martin Landsfeld, Diego Pedreros, James Verdin,
## Shradhdhanand Shukla, Gregory Husak, James Rowland, Laura Harrison,
## Andrew Hoell and Joel Michaelson.
## "The climate hazards infrared precipitation with stations - a new environmental
## record for monitoring extremes". Scientific Data 2, 150066. doi:10.1038/sdata.2015.66 2015.
## http://chg.geog.ucsb.edu/data/chirps/
##
## Not run:
if (requireNamespace("lmom",quietly = TRUE) & requireNamespace("lubridate",quietly = TRUE)) {
## Sample L-moments
  library(lmom)
  library(lubridate)

prec <- stack(prefc)
samlmom <- stack(rasterList(prec,FUN=samlmu))
## Fitting a Random Probability Distribution: it is a 'rasterList' Object
fitdist <- rasterList(samlmom,FUN=pe1gam)
}

## End(Not run)

if (requireNamespace("lmom",quietly = TRUE) & requireNamespace("lubridate",quietly = TRUE)) {
  library(lmom)
  library(lubridate)
  precf <- system.file("map/Mekrou_precipitation.grd", package="rasterList")
  prec <- stack(prefc)
  # Set time
  time <- as.Date(names(prec),format="X%Y.%m.%d")
  year <- sprintf("X%04d",lubridate::year(time)) ##as.character(time,format="X%Y")

## Compute Annual Precipitation (sum aggregation)
yearlyprec <- stackApply(x=prec,fun=sum,indices=year)
## L-moments
samlmom <- stack(rasterList(yearlyprec,FUN=samlmu))
fitdist <- rasterList(samlmom,FUN=pe1gam)

}

```

Description

Class RasterList

Details

It contains [RasterLayer-class](#) with the following adjoint slots:

list: a list of generic object whose length corresponds to the number of cells. Each list element for each cell;

name: an identification name of the object. Default is NA.

This class inherits the [RasterLayer-class](#) class considering each pixel of the raster is a generic object.

Author(s)

Emanuele Cordano

See Also

[raster,Raster-class](#)

Examples

```
showClass("RasterList")
```

RasterList-Package

RasterList: A package for Rasters Where Cells are Generic Objects

Description

The aim of this package is to develop a way to make some complex operations on each cells of a Raster Maps. Generally raster contains numeric values in each cells and in each band. Sometimes complex operation required the definition of particular object, in case such operation should be executed for each cell of a raster map, it becomes challenging. Then RasterList-package makes these operations easy to be implented with few lines of codes.

Details

The [RasterList-class](#) is a S4 class that inherits the [RasterLayer-class](#) and it an added slot called list. The list slot is a **list** object of so many elements how many are the cells of the inherited [RasterLayer-class](#) class, so that there is bijective corrensponce between a raster cell and a list element. The RasterList package provides three categories of important functions:

rasterList: it is the constructor of a [RasterList-class](#) object from a generic object, it also transforms a [RasterList-class](#) into another one through a function argument.

rasterListFun: it is a function that constructs a particular **RasterList-class** object in which the objects are function-type.

RasterListApply: it is a function that allows to operate among two or more **RasterList-class** objects defined in the same spatial extent through a generic function `fun(x,y,...)` where `x` and `y` are each cell/element of two **RasterList-class** objects given as arguments `x` and `y` of **RasterListApply**.

Some examples, concerning the fitting of a probability function for each cell of a stack (**RasterStack-class** object) of precipitation time-series or the estimation of soil water retention curve for each cell of a raster map, are shown throughout the package manual. The precipitation example dataset in raster format were extracted by the CHIRPS database:

Funk, Chris, Pete Peterson, Martin Landsfeld, Diego Pedreros, James Verdin, Shraddhanand Shukla, Gregory Husak, James Rowland, Laura Harrison, Andrew Hoell and Joel Michaelsen. "The climate hazards infrared precipitation with stations - a new environmental record for monitoring extremes". Scientific Data 2, 150066. doi:10.1038/sdata.2015.66 2015 , <https://chc.ucsb.edu/data/chirps>.

The package-provided datasets shall be only used as example datasets.

The development of this package has been sponsored by ACEWATER2 and "Water for Growth and Poverty Reduction in the Mekrou" projects of the Joint Research Centre of the European Commission (<http://aquaknow.jrc.ec.europa.eu>).

RasterListApply *A function for operations among RasterList-class objects.*

Description

A function for operations among **RasterList-class** objects.

Usage

```
RasterListApply(..., FUN = NULL)
```

Arguments

...	a set of arguments containing the RasterList-class objects whose lists are operated by FUN.
FUN	a function

Value

a **RasterList-class** object

See Also

[mapply](#), [rasterList](#)

Examples

```
f <- system.file("external/test.grd", package="raster")

ra <- rasterList(f)
rb <- rasterList(f)

rm <- RasterListApply(x=ra,y=rb,z=10,FUN=function(x,y,z){x+y+z})

### Fitting a probability distribution for precipitation
### in each cell with "lmom" package (L Moments)

if (requireNamespace("lmom",quietly = TRUE)) {
  library(lmom)

  # The package-provided datasets shall be only used as example datasets.
  precf <- system.file("map/Mekrou_precipitation.grd", package="rasterList") ##
  ## A resampled precipitation raster map based on CHIRS dataset:
  ## Funk, Chris, Pete Peterson, Martin Landsfeld, Diego Pedreros, James Verdin,
  ## Shradhanand Shukla, Gregory Husak, James Rowland, Laura Harrison,
  ## Andrew Hoell and Joel Michaelson.
  ## "The climate hazards infrared precipitation with stations -a new environmental
  ## record for monitoring extremes". Scientific Data 2, 150066. doi:10.1038/sdata.2015.66 2015.
  ## http://chg.geog.ucsb.edu/data/chirps/
  ##
  prec <- stack(precf)
  ## Sample L-moments
  samlmom <- stack(rasterList(prec,FUN=samlmu))
  ## Fitting a Random Probability Distribution: it is a 'rasterList' Object
  fitdist <- rasterList(samlmom,FUN=pelgam)

  ## KS TESTING

  kstesting <- RasterListApply(x=rasterList(prec),y="cdfgam",para=fitdist,FUN=ks.test)

  ## Mapping of p-value
  pval_ks <- raster(kstesting,FUN=function(x){x$p.value})

}
```

rasterListFun

Execution of the elements of a RasterList

Description

This function transmors a generic [RasterList-class](#) object into another [RasterList-class](#) object where elements are all function-type.

Usage

```
rasterListFun(object)
```

Arguments

object an object to be coerced to [RasterList-class](#)

Value

This function works with `RasterList-class` objects in which all elements of `object@list` slot are functions. It returns a "global" function that works at "raster" scale. The returned function will have the following usage signature: `fun(xval, ...)` where one `xval` (if its lengths is different from 1) element is the applied to each element and ... are further common arguments.

Examples

```
library(sp)
library(rasterList)
library(soilwater)
set.seed(1234)
data(meuse.grid)
data(meuse)
coordinates(meuse.grid) <- ~x+y
coordinates(meuse) <- ~x+y
gridded(meuse.grid) <- TRUE

soilmap <- stack(meuse.grid)[['soil']]
elevmap <- rasterize(x=meuse,y=soilmap,field="elev",fun=mean)
soilparcsv <- system.file("external/soil_data.csv",package="soilwater")
soilpar <- read.table(soilparcsv,stringsAsFactors=FALSE,header=TRUE,sep=",")
## From help(meuse,help_type="html")
##soil type according to the 1:50 000 soil map of the Netherlands.
## 1 = Rd10A (Calcareous weakly-developed meadow soils, light sandy clay);
## 2 = Rd90C/VII (Non-calcareous weakly-developed meadow soils, heavy sandy clay to light clay);
## 3 = Bkd26/VII (Red Brick soil, fine-sandy, silty light clay)
soiltype_id <- c(1,2,3)
soiltype_name <- c("sandy clay","sandy clay","silty clay loam")

meuse.soilrasterlist <- rasterList(soilmap,FUN=function(i,soiltype_name,soilpar){

o <- NULL
if (!is.na(i)) {
ii <- which(soilpar$type==soiltype_name[i])
o <- soilpar[ii,]
type <- o[["type"]]
o <- o[names(o)!="type"]
o <- o[names(o)!="Ks_m_per_hour"]
names(o)[names(o)=="Ks_m_per_sec"] <- "ks"
names(o)[names(o)=="swc"] <- "theta_sat"
names(o)[names(o)=="rwc"] <- "theta_res"
```

```

attr(o,"type") <- type
## add noise
noise <- rnorm(length(o))
o <- o*(1+0.005*noise)

o["m"] <- 1-1/o["n"]

} else {

o <- soilpar[which(soilpar$type==soiltype_name[1]),]
type <- o[["type"]]
o <- o[names(o)!="type"]
o <- o[names(o)!="Ks_m_per_hour"]
names(o)[names(o)=="Ks_m_per_sec"] <- "ks"
names(o)[names(o)=="swc"] <- "theta_sat"
names(o)[names(o)=="rwc"] <- "theta_res"
o[] <- NA
}

return(o)
},soiltype_name=soiltype_name,soilpar=soilpar)

meuse.swclist <- rasterList(meuse.soilrasterlist,FUN=function(x) {

o <- NA
## swc      rwc  alpha      n      m      ks
## 9 0.4295507 0.1093227 3.39387 1.39617 0.2837546 2.018317e-07

o <- function(psi,...,func="swc"){

args <- c(list(psi=psi,...),as.list(x))
oo <- do.call(args=args,what=get(func))
return(oo)

}

return(o)

})

### RasterList with soil water retention curves (One for each cell!)

swcfunr <- rasterListFun(meuse.swclist)

```

```
## RasterLayer of soil water content assuming a uniformly distributed pressure head
psi <- -0.9
soil_water_content <- raster(swcfunr(psi))
plot(soil_water_content)

## RasterLayer of soil water content from a generic map of soil water pressure head
psi <- 0.2-(elevmap-5)
psi[] <- -0.9+0.1*rnorm(ncell(psi[])) ## Alternatively to the values of the previous line!
soil_water_content <- raster(swcfunr(psi))
plot(soil_water_content)

## END
```

stack,RasterList-method

Creates a [RasterStack-class](#) object from a [RasterList-class](#)

Description

The method transforms a [RasterList-class](#) into a [RasterStack-class](#) in case of the list elements are numeric vectors.

Usage

```
## S4 method for signature 'RasterList'
stack(x, ...)
```

Arguments

x	a rasterList-class object
...	further arguments for rasterList

Value

a [RasterStack-class](#) object

See Also

[rasterList](#)

Examples

```
f <- system.file("external/test.grd", package="raster")

## Creates a simple generic RasterList

r1 <- rasterList(f)

list <- as.list(as.vector(r1))
list <- lapply(X=list, FUN=function (x) {c(x,x+10,x+15)})

r1 <- rasterList(r1,list=list,object.name="test")

ss <- stack(r1)

il <- 8331
list[[il]] <- numeric(0)
r1a <- rasterList(r1,list=list,object.name="test2")
sa <- stack(r1a)
```

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