Package 'stars'

April 23, 2019

Title Spatiotemporal Arrays, Raster and Vector Data Cubes

Version 0.3-1

Description Reading, manipulating, writing and plotting spatiotemporal arrays (raster and vector data cubes) in 'R', using 'GDAL' bindings provided by 'sf', and 'NetCDF' bindings by 'ncmeta' and 'RNetCDF'.

License Apache License

URL https://github.com/r-spatial/stars/

BugReports https://github.com/r-spatial/stars/issues/

Additional_repositories http://pebesma.staff.ifgi.de

Depends R (>= 3.3.0), abind, sf (>= 0.7-3)

Imports methods, parallel, classInt (>= 0.2-2), rlang, units

Suggests PCICt, RNetCDF (>= 1.8-2), covr, dplyr (>= 0.7-0), future.apply, ggforce, ggplot2, ggthemes, gstat, httr, jsonlite, knitr, lwgeom, maps, ncmeta (>= 0.0.3), pbapply, plm, raster, rmarkdown, sp, spacetime, testthat, viridis, xts, zoo, starsdata

VignetteBuilder knitr

Encoding UTF-8

RoxygenNote 6.1.1

Collate 'init.R' 'stars.R' 'read.R' 'sf.R' 'dimensions.R' 'values.R' 'plot.R' 'tidyverse.R' 'transform.R' 'ops.R' 'write.R' 'raster.R' 'sp.R' 'spacetime.R' 'ncdf.R' 'proxy.R' 'factors.R' 'rasterize.R' 'subset.R' 'warp.R' 'aggregate.R' 'xts.R' 'intervals.R' 'geom.R'

NeedsCompilation no

Author Edzer Pebesma [aut, cre] (<https://orcid.org/0000-0001-8049-7069>), Michael Sumner [ctb] (<https://orcid.org/0000-0002-2471-7511>), Etienne Racine [ctb], Adriano Fantini [ctb], David Blodgett [ctb]

Maintainer Edzer Pebesma <edzer.pebesma@uni-muenster.de>
Repository CRAN
Date/Publication 2019-04-23 12:30:03 UTC

R topics documented:

`aggregate.stars` *spatially or temporally aggregate stars object*

Description

spatially or temporally aggregate stars object, returning a data cube with lower spatial or temporal resolution

Usage

```
## S3 method for class 'stars'
aggregate(x, by, FUN, ..., drop = FALSE,
  join = st_intersects, as_points = any(st_dimension(by) == 2, na.rm =
  TRUE), rightmost.closed = FALSE)
```

Arguments

x	object of class stars with information to be aggregated
by	object of class sf, sfc, or a time class (Date, POSIXct, or PCICt) with aggregation geometry/time periods; if of class stars, it is converted to sfc by st_as_sfc(by, as_points = FALSE)
FUN	aggregation function, such as mean
...	arguments passed on to FUN, such as na.rm=TRUE
drop	logical; ignored
join	join function to find matches of x to by
as_points	see st_as_sf: shall raster pixels be taken as points, or small square polygons?
rightmost.closed	see findInterval

---

as *Coerce stars object into a Raster raster or brick*

Description

Coerce stars object into a Raster raster or brick

Arguments

from	object to coerce

---

c.stars *combine multiple stars objects, or combine multiple attributes in a single stars object into a single array*

Description

combine multiple stars objects, or combine multiple attributes in a single stars object into a single array

Usage

```
## S3 method for class 'stars'
c(..., along = NA_integer_)
```

Arguments

...	object(s) of class star: in case of multiple arguments, these are combined into a single stars object, in case of a single argument, its attributes are combined into a single attribute. In case of multiple objects, all objects should have the same dimensionality.
along	integer; see read_stars

Examples

```
tif = system.file("tif/L7_ETMs.tif", package = "stars")
x = read_stars(tif)
(new = c(x, x))
c(new) # collapses two arrays into one with an additional dimension
c(x, x, along = 3)
```

`cut_stars` *cut methods for stars objects*

Description

cut methods for stars objects

Usage

```
## S3 method for class 'array'
cut(x, breaks, ...)

## S3 method for class 'matrix'
cut(x, breaks, ...)

## S3 method for class 'stars'
cut(x, breaks, ...)
```

Arguments

`x`	see cut
`breaks`	see cut
`...`	see cut

Details

R's `factor` only works for vectors, not for arrays or matrices. This is a work-around (or hack?) to keep the factor levels generated by `cut` and use them in plots.

Value

an array or matrix with a `levels` attribute; see details

Examples

```
tif = system.file("tif/L7_ETMs.tif", package = "stars")
x = read_stars(tif)
cut(x, c(0, 50, 100, 255))
cut(x[,,,1], c(0, 50, 100, 255))
plot(cut(x[,,,1], c(0, 50, 100, 255)))
tif = system.file("tif/L7_ETMs.tif", package = "stars")
```

```
x1 = read_stars(tif)
(x1_cut = cut(x1, breaks = c(0, 50, 100, Inf)))  # shows factor in summary
plot(x1_cut[,,,c(3,6)]) # propagates through [ and plot
```

---

dplyr *dplyr verbs for stars objects*

Description

dplyr verbs for stars objects

Usage

```
filter.stars(.data, ...)

mutate.stars(.data, ...)

select.stars(.data, ...)

pull.stars(.data, var = -1)

as.tbl_cube.stars(x, ...)

slice.stars(.data, along, index, ..., drop = length(index) == 1)
```

Arguments

.data	object of class stars
...	see filter
var	see pull
x	object of class stars
along	name or index of dimension to which the slice should be applied
index	integer value(s) for this index
drop	logical; drop dimensions that only have a single index?

Examples

```
tif = system.file("tif/L7_ETMs.tif", package = "stars")
x1 = read_stars(tif)
library(dplyr)
x1 %>% slice("band", 2:3)
x1 %>% slice("x", 50:100)
```

geom_stars *ggplot geom for stars objects*

Description

ggplot geom for stars objects

Usage

```
geom_stars(mapping = NULL, data = NULL, ..., downsample = 1,
  sf = FALSE)
```

Arguments

mapping	see geom_raster
data	see geom_raster
...	see geom_raster
downsample	downsampling rate: e.g. 3 keeps rows and cols 1, 4, 7, 10 etc.; a value of 1 does not downsample
sf	logical; if TRUE rasters will be converted to polygons and plotted using geom_sf.

Details

geom_stars returns (a call to) either geom_raster, geom_tile, or geom_sf, depending on the raster or vector geometry; for the first to, an aes call is constructed with the raster dimension names and the first array as fill variable. Further calls to coord_equal and facet_wrap are needed to control aspect ratio and the layers to be plotted; see examples.

Examples

```
system.file("tif/L7_ETMs.tif", package = "stars") %>% read_stars() -> x
library(ggplot2)
ggplot() + geom_stars(data = x) +
    coord_equal() +
    facet_wrap(~band) +
    theme_void() +
    scale_x_discrete(expand=c(0,0))+
    scale_y_discrete(expand=c(0,0))
```

make_intervals *create an intervals object*

Description

create an intervals object, assuming left-closed and right-open intervals

Usage

```
make_intervals(start, end)
```

Arguments

start	vector with start values, or 2-column matrix with start and end values in column 1 and 2, respectively
end	vector with end values

ops_stars *S3 Ops Group Generic Functions for stars objects*

Description

Ops functions for stars objects, including comparison, product and divide, add, subtract

Usage

```
## S3 method for class 'stars'
Ops(e1, e2)

## S3 method for class 'stars'
Math(x, ...)

## S3 method for class 'stars_proxy'
Ops(e1, e2)

## S3 method for class 'stars_proxy'
Math(x, ...)
```

Arguments

e1	object of class stars
e2	object of class stars
x	object of class stars
...	parameters passed on to the Math functions

Value

object of class stars

Examples

```
tif = system.file("tif/L7_ETMs.tif", package = "stars")
x = read_stars(tif)
x * x
x / x
x + x
x + 10
all.equal(x * 10, 10 * x)
tif = system.file("tif/L7_ETMs.tif", package = "stars")
x = read_stars(tif)
a = sqrt(x)
b = log(x, base = 10)
```

---

plot.stars *plot stars object, with subplots for each level of first non-spatial dimension*

Description

plot stars object, with subplots for each level of first non-spatial dimension

Usage

```
## S3 method for class 'stars'
plot(x, y, ..., join_zlim = TRUE, main = names(x)[1],
  axes = FALSE, downsample = TRUE, nbreaks = 11,
  breaks = "quantile", col = grey(1:(nbreaks - 1)/nbreaks),
  key.pos = get_key_pos(x, ...), key.width = lcm(1.8),
  key.length = 0.618, reset = TRUE, box_col = grey(0.8),
  center_time = FALSE)

## S3 method for class 'stars'
image(x, ..., band = 1, attr = 1, asp = NULL,
  rgb = NULL, maxColorValue = ifelse(inherits(rgb, "data.frame"), 255,
  max(x[[attr]], na.rm = TRUE)), xlab = if (!axes) "" else names(d)[1],
  ylab = if (!axes) "" else names(d)[2], xlim = st_bbox(x)$xlim,
  ylim = st_bbox(x)$ylim, text_values = FALSE, axes = FALSE,
  interpolate = FALSE, as_points = FALSE, key.pos = NULL,
  logz = FALSE, key.width = lcm(1.8), key.length = 0.618)

## S3 method for class 'stars_proxy'
plot(x, y, ...,
  downsample = get_downsample(dim(x)))
```

Arguments

x	object of class stars
y	ignored
...	further arguments: for plot, passed on to image.stars; for image, passed on to image.default or rasterImage.
join_zlim	logical; if TRUE, compute a single, joint zlim (color scale) for all subplots from x
main	character; subplot title prefix; use "" to get only time, use NULL to suppress subplot titles
axes	logical; should axes and box be added to the plot?
downsample	logical; if TRUE will try to plot not many more pixels than actually are visibule.
nbreaks	number of color breaks; should be one more than number of colors. If missing and col is specified, it is derived from that.
breaks	actual color breaks, or a method name used for classIntervals.
col	colors to use for grid cells
key.pos	integer; side to plot a color key: 1 bottom, 2 left, 3 top, 4 right; set to NULL to omit key. Ignored if multiple columns are plotted in a single function call. Default depends on plot size, map aspect, and, if set, parameter asp.
key.width	amount of space reserved for width of the key (labels); relative or absolute (using lcm)
key.length	amount of space reserved for length of the key (labels); relative or absolute (using lcm)
reset	logical; if FALSE, keep the plot in a mode that allows adding further map elements; if TRUE restore original mode after plotting; see details.
box_col	color for box around sub-plots; use 0 to suppress plotting of boxes around sub-plots.
center_time	logical; if TRUE, sub-plot titles will show the center of time intervals, otherwise their start
band	integer; which band (dimension) to plot
attr	integer; which attribute to plot
asp	numeric; aspect ratio of image
rgb	integer; specify three bands to form an rgb composite. Experimental: rgb color table; see Details.
maxColorValue	numeric; passed on to rgb
xlab	character; x axis label
ylab	character; y axis label
xlim	x axis limits
ylim	y axis limits
text_values	logical; print values as text on image?
interpolate	logical; when using rasterImage (rgb), should pixels be interpolated?

as_points	logical; for curvilinear or sheared grids: parameter passed on to st_as_sf, determining whether raster cells will be plotted as symbols (fast, approximate) or small polygons (slow, exact)
logz	logical; if TRUE, use log10-scale for the attribute variable. In that case, breaks and at need to be given as log10-values; see examples.

Details

use of an rgb color table is experimental; see https://github.com/r-spatial/mapview/issues/208

when plotting a subsetted stars_proxy object, the default value for argument downsample will not be computed correctly, and it and has to be set manually.

Examples

```
tif = system.file("tif/L7_ETMs.tif", package = "stars")
x = read_stars(tif)
image(x, col = grey((3:9)/10))
image(x, rgb = c(1,3,5)) # rgb composite
```

---

read_ncdf *Read NetCDF into stars object*

Description

Read data from a file (or source) using the NetCDF library directly.

Usage

```
read_ncdf(.x, ..., var = NULL, ncsub = NULL,
  curvilinear = character(0), eps = 1e-12)
```

Arguments

.x	NetCDF file or source
...	ignored
var	variable name or names (they must be on matching grids)
ncsub	matrix of start, count columns (see Details)
curvilinear	length two character vector with names of subdatasets holding longitude and latitude values for all raster cells.
eps	numeric; dimension value increases are considered identical when they differ less than eps

Details

The following logic is applied to coordinates. If any coordinate axes have regularly spaced coordinate variables they are reduced to the offset/delta form with 'affine = c(0, 0)', otherwise the values of the coordinates are stored and used to define a rectilinear grid.

If the data has two or more dimensions and the first two are regular they are nominated as the 'raster' for plotting.

If the `curvilinear` argument is used it specifies the 2D arrays containing coordinate values for the first two dimensions of the data read. It is currently assumed that the coordinates are 2D and that they relate to the first two dimensions in that order.

If `var` is not set the first set of variables on a shared grid is used.

`start` and `count` columns of ncsub must correspond to the variable dimemsion (nrows) and be valid index using `var.get.nc` convention (start is 1-based). If the count value is `NA` then all steps are included. Axis order must match that of the variable/s being read.

Examples

```
f <- system.file("nc/reduced.nc", package = "stars")
read_ncdf(f)
read_ncdf(f, var = c("anom"))
read_ncdf(f, ncsub = cbind(start = c(1, 1, 1, 1), count = c(10, 12, 1, 1)))


#' precipitation data in a curvilinear NetCDF
prec_file = system.file("nc/test_stageiv_xyt.nc", package = "stars")
prec = read_ncdf(prec_file, curvilinear = c("lon", "lat"))

##plot(prec) ## gives error about unique breaks
## remove NAs, zeros, and give a large number
## of breaks (used for validating in detail)
qu_0_omit = function(x, ..., n = 22) {
  x = na.omit(x)
  c(0, quantile(x[x > 0], seq(0, 1, length.out = n)))
}
library(dplyr)
prec_slice = slice(prec, index = 17, along = "time")
plot(prec_slice, border = NA, breaks = qu_0_omit(prec_slice[[1]]), reset = FALSE)
nc = sf::read_sf(system.file("gpkg/nc.gpkg", package = "sf"), "nc.gpkg")
plot(st_geometry(nc), add = TRUE, reset = FALSE, col = NA)
```

`read_stars` *read raster/array dataset from file or connection*

Description

read raster/array dataset from file or connection

Usage

```
read_stars(.x, ..., options = character(0), driver = character(0),
  sub = TRUE, quiet = FALSE, NA_value = NA_real_,
  along = NA_integer_, RasterIO = list(), proxy = FALSE,
  curvilinear = character(0), normalize_path = TRUE)
```

Arguments

.x	character vector with name(s) of file(s) or data source(s) to be read
...	passed on to st_as_stars if curvilinear was set
options	character; opening options
driver	character; driver to use for opening file. To override fixing for subdatasets and autodetect them as well, use NULL.
sub	integer or logical; sub-datasets to be read
quiet	logical; print progress output?
NA_value	numeric value to be used for conversion into NA values; by default this is read from the input file
along	length-one character or integer, or list; determines how several arrays are combined, see Details.
RasterIO	list with named parameters for GDAL's RasterIO, to further control the extent, resolution and bands to be read from the data source; see details.
proxy	logical; if TRUE, an object of class stars_proxy is read which contains array metadata only; if FALSE the full array data is read in memory.
curvilinear	length two character vector with names of subdatasets holding longitude and latitude values for all raster cells.
normalize_path	logical; if FALSE, suppress a call to normalizePath on .x

Details

In case .x contains multiple files, they will all be read and combined with c.stars. Along which dimension, or how should objects be merged? If along is set to NA it will merge arrays as new attributes if all objects have identical dimensions, or else try to merge along time if a dimension called time indicates different time stamps. A single name (or positive value) for along will merge along that dimension, or create a new one if it does not already exist. If the arrays should be arranged along one of more dimensions with values (e.g. time stamps), a named list can passed to along to specify them; see example.

RasterIO is a list with zero or more of the following named arguments: nXOff, nYOff (both 1-based: the first row/col has offset value 1), nXSize, nYSize, nBufXSize, nBufYSize, bands, coderesample. see https://www.gdal.org/classGDALDataset.html#a80d005ed10aefafa8a55dc539c2f69da for their meaning; bands is an integer vector containing the band numbers to be read (1-based: first band is 1) Note that if nBufXSize or nBufYSize are specified for downsampling an image, resulting in an adjusted geotransform. resample reflects the resampling method and has to be one of: "nearest_neighbour" (the default), "bilinear", "cubic", "cubic_spline", "lanczos", "average", "mode", or "Gauss".

Value

object of class `stars`

Examples

```
tif = system.file("tif/L7_ETMs.tif", package = "stars")
(x1 = read_stars(tif))
(x2 = read_stars(c(tif, tif)))
(x3 = read_stars(c(tif, tif), along = "band"))
(x4 = read_stars(c(tif, tif), along = "new_dimensions")) # create 4-dimensional array
x1o = read_stars(tif, options = "OVERVIEW_LEVEL=1")
t1 = as.Date("2018-07-31")
# along is a named list indicating two dimensions:
read_stars(c(tif, tif, tif, tif), along = list(foo = c("bar1", "bar2"), time = c(t1, t1+2)))

m = matrix(1:120, nrow = 12, ncol = 10)
dim(m) = c(x = 10, y = 12) # named dim
st = st_as_stars(m)
attr(st, "dimensions")$y$delta = -1
attr(st, "dimensions")$y$offset = 12
st
tmp = tempfile(fileext = ".tif")
write_stars(st, tmp)
(red <- read_stars(tmp))
read_stars(tmp, RasterIO = list(nXOff = 1, nYOff = 1, nXsize = 10, nYSize = 12,
   nBufXSize = 2, nBufYSize = 2))[[1]]
(red <- read_stars(tmp, RasterIO = list(nXOff = 1, nYOff = 1, nXsize = 10, nYSize = 12,
   nBufXSize = 2, nBufYSize = 2)))
red[[1]] # cell values of subsample grid:
plot(st, reset = FALSE, axes = TRUE, ylim = c(-.1,12.1), xlim = c(-.1,10.1),
  main = "nBufXSize & nBufYSize demo", text_values = TRUE)
plot(st_as_sfc(red, as_points = TRUE), add = TRUE, col = 'red', pch = 16)
plot(st_as_sfc(st_as_stars(st), as_points = FALSE), add = TRUE, border = 'grey')
plot(st_as_sfc(red, as_points = FALSE), add = TRUE, border = 'green', lwd = 2)
file.remove(tmp)
```

---

redimension *redimension array, or collapse attributes into a new dimension*

Description

redimension array, or collapse attributes into a new dimension

Usage

```
st_redimension(x, new_dims, along, ...)

## S3 method for class 'stars'
st_redimension(x, new_dims = st_dimensions(x),
```

```
  along = list(new_dim = names(x)), ...)

## S3 method for class 'stars_proxy'
st_redimension(x, new_dims = st_dimensions(x),
  along = list(new_dim = names(x)), ...)
```

Arguments

x	object of class stars
new_dims	target dimensions
along	named list with new dimension name and values
...	ignored

---

stars_subset *subset stars objects*

Description

subset stars objects

Usage

```
## S3 method for class 'stars'
x[i = TRUE, ..., drop = FALSE,
  crop = !is_curvilinear(x)]

## S3 replacement method for class 'stars'
x[i] <- value
```

Arguments

x	object of class stars
i	first selector: integer, logical or character vector indicating attributes to select, or object of class sf or sfc used as spatial selector; see details
...	further (logical or integer vector) selectors, matched by order, to select on individual dimensions
drop	logical; if TRUE, degenerate dimensions (with only one value) are dropped
crop	logical; if TRUE and parameter i is a spatial geometry (sf or sfc) object, the extent (bounding box) of the result is cropped to match the extent of i using st_crop. Cropping curvilinear grids is not supported.
value	array of dimensions equal to those in x, or a vector or value that will be recycled to such an array

Details

if i is an object of class sf, sfc or bbox, the spatial subset covering this geometry is selected, possibly followed by cropping the extent. Array values for which the cell centre is not inside the geometry are assigned NA.

in an assignment (or replacement form, [<-), argument i needs to be a stars object with dimensions identical to x, and value will be recycled to the dimensions of the arrays in x.

Examples

```
tif = system.file("tif/L7_ETMs.tif", package = "stars")
x = read_stars(tif)
x[,,,1:3] # select bands
x[,1:100,100:200,] # select x and y by range
x["L7_ETMs.tif"] # select attribute
xy = structure(list(x = c(293253.999046018, 296400.196497684), y = c(9113801.64775462,
9111328.49619133)), .Names = c("x", "y"))
pts = st_as_sf(data.frame(do.call(cbind, xy)), coords = c("x", "y"), crs = st_crs(x))
image(x, axes = TRUE)
plot(st_as_sfc(st_bbox(pts)), col = NA, add = TRUE)
bb = st_bbox(pts)
(xx = x[bb])
image(xx)
plot(st_as_sfc(bb), add = TRUE, col = NA)
image(x)
pt = st_point(c(x = 290462.103109179, y = 9114202.32594085))
buf = st_buffer(st_sfc(pt, crs = st_crs(x)), 1500)
plot(buf, add = TRUE)

buf = st_sfc(st_polygon(list(st_buffer(pt, 1500)[[1]], st_buffer(pt, 1000)[[1]])),
   crs = st_crs(x))
image(x[buf])
plot(buf, add = TRUE, col = NA)
image(x[buf, crop=FALSE])
plot(buf, add = TRUE, col = NA)
```

---

st_apply *st_apply apply a function to one or more array dimensions*

Description

st_apply apply a function to array dimensions: aggregate over space, time, or something else

Usage

```
## S3 method for class 'stars'
st_apply(X, MARGIN, FUN, ..., CLUSTER = NULL,
  PROGRESS = FALSE, FUTURE = FALSE, rename = TRUE)
```

Arguments

X	object of class stars
MARGIN	see apply; index number(s) or name(s) of the dimensions over which FUN will be applied
FUN	see apply
...	arguments passed on to FUN
CLUSTER	cluster to use for parallel apply; see makeCluster
PROGRESS	logical; if TRUE, use pbapply::pbapply to show progress bar
FUTURE	logical;if TRUE, use future.apply::future_apply
rename	logical; if TRUE and X has only one attribute and FUN is a simple function name, rename the attribute of the returned object to the function name

Value

object of class stars with accordingly reduced number of dimensions; in case FUN returns more than one value, a new dimension is created carrying the name of the function used; see the examples.

Examples

```
tif = system.file("tif/L7_ETMs.tif", package = "stars")
x = read_stars(tif)
st_apply(x, 1:2, mean) # mean band value for each pixel
st_apply(x, c("x", "y"), mean) # equivalent to the above
st_apply(x, 3, mean)   # mean of all pixels for each band
st_apply(x, "band", mean) # equivalent to the above
st_apply(x, 1:2, range) # min and max band value for each pixel
# to get a progress bar also in non-interactive mode, specify:
if (require(pbapply)) { # install it, if FALSE
  pboptions(type = "timer")
}
```

---

st_as_sf *Convert stars object into an sf object*

Description

Convert stars object into an sf object

Usage

```
## S3 method for class 'stars'
st_as_sfc(x, ..., as_points,
  which = seq_len(prod(dim(x)[1:2])))

## S3 method for class 'stars'
st_as_sf(x, ..., as_points = FALSE, merge = FALSE,
  na.rm = TRUE, use_integer = is.logical(x[[1]]) || is.integer(x[[1]]),
  long = FALSE, connect8 = FALSE)
```

Arguments

x	object of class stars
...	ignored
as_points	logical; should cells be converted to points or to polygons? See details.
which	linear index of cells to keep (this argument is not recommended to be used)
merge	logical; if TRUE, cells with identical values are merged (using GDAL_Polygonize or GDAL_FPolygonize); if FALSE, a polygon for each raster cell is returned; see details
na.rm	logical; should missing valued cells be removed, or also be converted to features?
use_integer	(relevant only if merge is TRUE): if TRUE, before polygonizing values are rounded to 32-bits signed integer values (GDALPolygonize), otherwise they are converted to 32-bit floating point values (GDALFPolygonize).
long	logical; if TRUE, return a long table form sf, with geometries and other dimensinos recycled
connect8	logical; if TRUE, use 8 connectedness. Otherwise the 4 connectedness algorithm will be applied.

Details

If merge is TRUE, only the first attribute is converted into an sf object. If na.rm is FALSE, areas with NA values are also written out as polygons. Note that the resulting polygons are typically invalid, and use st_make_valid to create valid polygons out of them.

Examples

```
tif = system.file("tif/L7_ETMs.tif", package = "stars")
x = read_stars(tif)
x = x[,,,6] # a band with lower values in it
x[[1]][x[[1]] < 30] = NA # set lower values to NA
x[[1]] = x[[1]] < 100 # make the rest binary
x
(p = st_as_sf(x)) # removes NA areas
(p = st_as_sf(x[,,,1], merge = TRUE)) # glues polygons together
all(st_is_valid(p)) # not all valid, see details
# plot(p, axes = TRUE)
(p = st_as_sf(x, na.rm = FALSE, merge = TRUE)) # includes polygons with NA values
# plot(p, axes = TRUE)
```

---

st_as_stars *convert objects into a stars object*

Description

convert objects into a stars object

Usage

```
st_as_stars(.x, ...)

## S3 method for class 'list'
st_as_stars(.x, ..., dimensions = NULL)

## Default S3 method:
st_as_stars(.x = NULL, ..., raster = NULL)

## S3 method for class 'stars'
st_as_stars(.x, ..., curvilinear = NULL,
  crs = st_crs(4326))

## S3 method for class 'bbox'
st_as_stars(.x, ..., nx = 360, ny = 180,
  deltax = diff(xlim)/nx, deltay = -diff(ylim)/ny,
  xlim = .x[c("xmin", "xmax")], ylim = .x[c("ymin", "ymax")],
  values = 0)

## S3 method for class 'sf'
st_as_stars(.x, ..., name = attr(.x, "sf_column"))

## S3 method for class 'Raster'
st_as_stars(.x, ...)

## S3 method for class 'stars_proxy'
st_as_stars(.x, ..., downsample = 0,
  url = attr(.x, "url"), env = parent.frame())
```

Arguments

.x	object to convert
...	ignored
dimensions	object of class dimensions
raster	character; the names of the dimensions that denote raster dimensions
curvilinear	only for creating curvilinear grids: named length 2 list holding longitude and latitude matrices; the names of this list should correspond to raster dimensions to be replaced
crs	object of class crs with the coordinate reference system of the values in curvilinear; see details
nx	integer; number of cells in x direction
ny	integer; number of cells in y direction
deltax	numeric; cell size in x direction
deltay	numeric; cell size in y direction (negative)
xlim	length 2 numeric vector with extent (min, max) in x direction

ylim	length 2 numeric vector with extent (min, max) in y direction
values	value(s) to populate the raster values with
name	character; name for the geometry dimensions
downsample	integer: if larger than 0, downsample with this rate (number of pixels to skip in every row/column); if length 2, specifies downsampling rate in x and y.
url	character; URL of the stars endpoint where the data reside
env	environment at the data endpoint to resolve objects in

Details

if curvilinear is a stars object with longitude and latitude values, its coordinate reference system is typically not that of the latitude and longitude values.

---

st_contour *Compute contour lines or sets*

Description

Compute contour lines or sets

Usage

```
st_contour(x, na.rm = TRUE, contour_lines = FALSE,
  breaks = classInt::classIntervals(na.omit(as.vector(x[[1]])))$brks)
```

Arguments

x	object of class stars
na.rm	logical; should missing valued cells be removed, or also be converted to features?
contour_lines	logical; if FALSE, polygons are returned (contour sets), otherwise contour lines
breaks	numerical; values at which to "draw" contour levels

Details

this function requires GDAL >= 2.4.0

See Also

for polygonizing rasters following grid boundaries, see st_as_sf with arguments as_points=FALSE and merge=TRUE

st_coordinates *retrieve coordinates for raster or vector cube cells*

Description

retrieve coordinates for raster or vector cube cells

Usage

```
## S3 method for class 'stars'
st_coordinates(x, ..., add_max = FALSE, center = TRUE)

## S3 method for class 'stars'
as.data.frame(x, ..., add_max = FALSE, center = NA)

as_tibble.stars(.x, ..., add_max = FALSE, center = NA)
```

Arguments

x	object of class stars
...	ignored
add_max	logical; if TRUE, dimensions are given with a min (x) and max (x_max) value
center	logical; (only if add_max is FALSE): should grid cell center coordinates be returned (TRUE) or offset values (FALSE)? center can be a named logical vector or list to specify values for each dimension.
.x	object to be converted to a tibble

st_crop *crop a stars object*

Description

crop a stars object

Usage

```
## S3 method for class 'stars_proxy'
st_crop(x, y, ..., crop = TRUE, epsilon = 0)

## S3 method for class 'stars'
st_crop(x, y, ..., crop = TRUE, epsilon = 0,
  as_points = all(st_dimension(y) == 2, na.rm = TRUE))
```

Arguments

x	object of class stars
y	object of class sf, sfc or bbox; see Details below.
...	ignored
crop	logical; if TRUE, the spatial extent of the returned object is cropped to still cover obj, if FALSE, the extent remains the same but cells outside y are given NA values.
epsilon	numeric; shrink the bounding box of y to its center with this factor.
as_points	logical; if FALSE, treat x as a set of points, else as a set of small polygons. Default: TRUE if y is two-dimensional, else FALSE

Details

for raster x, st_crop selects cells for which the cell centre is inside the bounding box; see the examples below.

Examples

```
l7 = read_stars(system.file("tif/L7_ETMs.tif", package = "stars"))
d = st_dimensions(l7)

# area around cells 3:10 (x) and 4:11 (y):
offset = c(d["x"]]$offset, d["y"]]$offset)
res = c(d["x"]]$delta, d["y"]]$delta)
bb = st_bbox(c(xmin = offset[1] + 2 * res[1],
ymin = offset[2] + 11 * res[2],
xmax = offset[1] + 10 * res[1],
ymax = offset[2] +  3 * res[2]), crs = st_crs(l7))
l7[bb]

plot(l7[,1:13,1:13,1], reset = FALSE)
image(l7[bb,,,1], add = TRUE, col = sf.colors())
plot(st_as_sfc(bb), add = TRUE, border = 'green', lwd = 2)

# slightly smaller bbox:
bb = st_bbox(c(xmin = offset[1] + 2.1 * res[1],
ymin = offset[2] + 10.9 * res[2],
xmax = offset[1] +  9.9 * res[1],
ymax = offset[2] +  3.1 * res[2]), crs = st_crs(l7))
l7[bb]

plot(l7[,1:13,1:13,1], reset = FALSE)
image(l7[bb,,,1], add = TRUE, col = sf.colors())
plot(st_as_sfc(bb), add = TRUE, border = 'green', lwd = 2)

# slightly larger bbox:
bb = st_bbox(c(xmin = offset[1] + 1.9 * res[1],
ymin = offset[2] + 11.1 * res[2],
xmax = offset[1] + 10.1 * res[1],
ymax = offset[2] +  2.9 * res[2]), crs = st_crs(l7))
l7[bb]
```

```
plot(l7[,1:13,1:13,1], reset = FALSE)
image(l7[bb,,,1], add = TRUE, col = sf.colors())
plot(st_as_sfc(bb), add = TRUE, border = 'green', lwd = 2)

# half a cell size larger bbox:
bb = st_bbox(c(xmin = offset[1] + 1.49 * res[1],
ymin = offset[2] + 11.51 * res[2],
xmax = offset[1] + 10.51 * res[1],
ymax = offset[2] +  2.49 * res[2]), crs = st_crs(l7))
l7[bb]

plot(l7[,1:13,1:13,1], reset = FALSE)
image(l7[bb,,,1], add = TRUE, col = sf.colors())
plot(st_as_sfc(bb), add = TRUE, border = 'green', lwd = 2)
```

`st_dimensions` *get dimensions from stars object*

Description

get dimensions from stars object

Usage

```
st_dimensions(.x, ...)

## S3 method for class 'stars'
st_dimensions(.x, ...)

## S3 method for class 'array'
st_dimensions(.x, ...)

## Default S3 method:
st_dimensions(.x, ..., .raster, affine = c(0, 0),
  cell_midpoints = FALSE, point = FALSE)

st_set_dimensions(.x, which, values = NULL, point = NULL,
  names = NULL, ...)

st_get_dimension_values(.x, which, ..., max = FALSE, center = NA)
```

Arguments

`.x`	object to retrieve dimensions information from
`...`	further arguments
`.raster`	length 2 character array with names (if any) of the raster dimensions
`affine`	numeric; specify parameters of the affine transformation

cell_midpoints	logical; if TRUE AND the dimension values are strictly regular, the values are interpreted as the cell midpoint values rather than the cell offset values when calculating offset (i.e., the half-cell-size correction is applied); can have a value for each dimension, or else is recycled
point	logical; does the pixel value (measure) refer to a point (location) value or to an pixel (area) summary value?
which	integer or character; index or name of the dimension to be changed
values	values for this dimension (e.g. sfc list-column)
names	character; new names vector for (all) dimensions, ignoring which
max	logical; if TRUE return the end, rather than the beginning of an interval
center	logical; if TRUE return the center of an interval; if NA return the center for raster dimensions, and the start of intervals in other cases

Details

dimensions can be specified in two ways. The simplest is to pass a vector with numeric values for a numeric dimension, or character values for a categorical dimension. Parameter cell_midpoints is used to specify whether numeric values refer to the offset (start) of a dimension interval (default), or to the center; the center case is only available for regular dimensions. For rectilinear numeric dimensions, one can specify either a vector with cell borders (start values), or a data.frame with two columns named "start" and "end", with the respective interval start and end values. In the first case, the end values are computed from the start values by assuming the last two intervals have equal width.

Value

the dimensions attribute of x, of class dimensions

Examples

```
x = read_stars(system.file("tif/L7_ETMs.tif", package = "stars"))
# Landsat 7 ETM+ band semantics: https://landsat.gsfc.nasa.gov/the-enhanced-thematic-mapper-plus/
# set bands to values 1,2,3,4,5,7:
(x1 = st_set_dimensions(x, "band", values = c(1,2,3,4,5,7), names = "band_number", point = TRUE))
# set band values as bandwidth
rbind(c(0.45,0.515), c(0.525,0.605), c(0.63,0.69), c(0.775,0.90), c(1.55,1.75), c(2.08,2.35)) %>%
  units::set_units("um") -> bw # or: units::set_units(µm) -> bw
# set bandwidth midpoint:
(x2 = st_set_dimensions(x, "band", values = 0.5 * (bw[,1]+bw[,2]),
   names = "bandwidth_midpoint", point = TRUE))
# set bandwidth intervals:
(x3 = st_set_dimensions(x, "band", values = make_intervals(bw), names = "bandwidth"))
```

st_rasterize *rasterize simple feature geometries*

Description

rasterize simple feature geometries

Usage

```
st_rasterize(sf, template = st_as_stars(st_bbox(sf), values = NA_real_,
  ...), file = tempfile(), driver = "GTiff", options = character(0),
  ...)
```

Arguments

sf	object of class sf
template	stars object with desired target geometry
file	temporary file name
driver	driver for temporary file
options	character; options vector for GDALRasterize
...	arguments passed on to st_as_stars

Examples

```
demo(nc, echo = FALSE, ask = FALSE)
(x = st_rasterize(nc)) # default grid:
plot(x, axes = TRUE)
# a bit more customized grid:
(x = st_rasterize(nc, st_as_stars(st_bbox(nc), nx = 100, ny = 50, values = NA_real_)))
plot(x, axes = TRUE)
(ls = st_sf(a = 1:2, st_sfc(st_linestring(rbind(c(0.1, 0), c(1.1, 1))),
   st_linestring(rbind(c(0, 0.05), c(1, 0.05))))))
(grd = st_as_stars(st_bbox(ls), nx = 10, ny = 10, xlim = c(0, 1.0), ylim = c(0, 1),
   values = NA_real_))
# the following two plots suggests a half-gridcell-shift problem:
sf_extSoftVersion()["GDAL"]
plot(st_rasterize(ls, grd), axes = TRUE, reset = FALSE) # ALL_TOUCHED=FALSE;
plot(ls, add = TRUE, col = "red")
plot(st_rasterize(ls, grd, options = "ALL_TOUCHED=TRUE"), axes = TRUE, reset = FALSE)
plot(ls, add = TRUE, col = "red")
# add lines to existing 0 values, summing values in case of multiple lines:
(grd = st_as_stars(st_bbox(ls), nx = 10, ny = 10, xlim = c(0, 1.0), ylim = c(0, 1), values = 0))
r = st_rasterize(ls, grd, options = c("MERGE_ALG=ADD", "ALL_TOUCHED=TRUE"))
plot(r, axes = TRUE, reset = FALSE)
plot(ls, add = TRUE, col = "red")
```

st_transform *transform features, or warp/resample grids in stars objects to a new coordinate reference system*

Description

transform features, or warp/resample grids in stars objects to a new coordinate reference system

Usage

```
## S3 method for class 'stars'
st_transform(x, crs, ...)

st_transform_proj.stars(x, crs, ...)
```

Arguments

x	object of class stars, with either raster or simple feature geometries
crs	object of class crs with target crs
...	ignored

Details

For simple feature dimensions, st_transform is called, leading to lossless transformation. For gridded spatial data, a curvilinear grid with transformed grid cell (centers) is returned. To convert this to a regular grid in the new CRS, use st_warp.

See Also

st_warp

Examples

```
geomatrix = system.file("tif/geomatrix.tif", package = "stars")
(x = read_stars(geomatrix))
new = st_crs(4326)
y = st_transform(x, new)
plot(st_transform(st_as_sfc(st_bbox(x)), new), col = NA, border = 'red')
plot(st_as_sfc(y, as_points=FALSE), col = NA, border = 'green', axes = TRUE, add = TRUE)
image(y, col = heat.colors(12), add = TRUE)
plot(st_as_sfc(y, as_points=TRUE), pch=3, cex=.5, col = 'blue', add = TRUE)
plot(st_transform(st_as_sfc(x, as_points=FALSE), new), add = TRUE)
```

st_warp *Warp (resample) grids in stars objects to a new grid, possibly in an new coordinate reference system*

Description

Warp (resample) grids in stars objects to a new grid, possibly in an new coordinate reference system

Usage

```
st_warp(src, dest, ..., crs = NA_crs_, cellsize = NA_real_,
  segments = 100, use_gdal = FALSE, options = character(0),
  no_data_value = NA_real_, debug = FALSE, method = "near")
```

Arguments

src	object of class stars with source raster
dest	object of class stars with target raster geometry
...	ignored
crs	coordinate reference system for destination grid, only used when dest is missing
cellsize	cellsize in target coordinate reference system
segments	(total) number of segments for segmentizing the bounding box before transforming to the new crs
use_gdal	logical; if TRUE, use gdalwarp, through gdal_utils
options	character vector with options, passed on to gdalwarp
no_data_value	value used by gdalwarp for no_data (NA) when writing to temporaray file
debug	logical; if TRUE, do not remove the temporary gdalwarp destination file, and print its name
method	character; see details for options; methods other than near only work when use_gdal=TRUE

Details

method should be one of near, bilinear, cubic, cubicspline, lanczos, average, mode, max, min, med, q1 or q3; see https://github.com/r-spatial/stars/issues/109

For gridded spatial data (dimensions x and y), see figure; the existing grid is transformed into a regular grid defined by dest, possibly in a new coordinate reference system. If dest is not specified, but crs is, the procedure used to choose a target grid is similar to that of projectRaster (currently only with method='ngb'). This entails: (i) the envelope (bounding box polygon) is transformed into the new crs, possibly after segmentation (red box); (ii) a grid is formed in this new crs, touching the transformed envelope on its East and North side, with (if cellsize is not given) a cellsize similar to the cell size of src, with an extent that at least covers x; (iii) for each cell center of this new grid, the matching grid cell of x is used; if there is no match, an NA value is used.

Examples

```
geomatrix = system.file("tif/geomatrix.tif", package = "stars")
(x = read_stars(geomatrix))
new_crs = st_crs(4326)
y = st_warp(x, crs = new_crs)
plot(st_transform(st_as_sfc(st_bbox(x)), new_crs), col = NA, border = 'red')
plot(st_as_sfc(y, as_points=FALSE), col = NA, border = 'green', axes = TRUE, add = TRUE)
image(y, add = TRUE, nbreaks = 6)
plot(st_as_sfc(y, as_points=TRUE), pch=3, cex=.5, col = 'blue', add = TRUE)
plot(st_transform(st_as_sfc(x, as_points=FALSE), new_crs), add = TRUE)
```

---

st_xy2sfc *replace x y raster dimensions with simple feature geometry list (points, or polygons = rasterize)*

Description

replace x y raster dimensions with simple feature geometry list (points, or polygons = rasterize)

Usage

```
st_xy2sfc(x, as_points, ..., na.rm = TRUE)
```

Arguments

x	object of class stars
as_points	logical; if TRUE, generate points at cell centers, else generate polygons
...	arguments passed on to st_as_sfc
na.rm	logical; remove cells with all missing values?

Value

object of class stars with x and y raster dimensions replaced by a single sfc geometry list column containing either points or square polygons

write_stars *write stars object to gdal dataset (typically: to file)*

Description

write stars object to gdal dataset (typically: to file)

Usage

```
write_stars(obj, dsn, layer, ...)

## S3 method for class 'stars'
write_stars(obj, dsn, layer = 1, ...,
  driver = detect.driver(dsn), options = character(0),
  type = "Float32", NA_value = NA_real_, update = FALSE)

## S3 method for class 'stars_proxy'
write_stars(obj, dsn, layer = 1, ...,
  driver = detect.driver(dsn), options = character(0),
  type = "Float32", NA_value = NA_real_, chunk_size = c(dim(obj)[1],
  floor(2.5e+07/dim(obj)[1])), progress = TRUE)
```

Arguments

obj	object of class stars
dsn	gdal dataset (file) name
layer	attribute name; if missing, the first attribute is written
...	passed on to gdal_write
driver	driver driver name; see st_drivers
options	character vector with options
type	character; output binary type, one of: Byte for eight bit unsigned integer, UInt16 for sixteen bit unsigned integer, Int16 for sixteen bit signed integer, UInt32 for thirty two bit unsigned integer, Int32 for thirty two bit signed integer, Float32 for thirty two bit floating point, Float64 for sixty four bit floating point.
NA_value	non-NA value that should represent R's NA value in the target raster file; if set to NA, it will be ignored.
update	logical; if TRUE, an existing file is being updated
chunk_size	length two integer vector with the number of pixels (x, y) used in the read/write loop; see details.
progress	logical; if TRUE, a progress bar is shown

Details

write_stars first creates the target file, then updates it sequentially by writing blocks of chunk_size.

Index