

# Package ‘sf’

July 11, 2023

**Version** 1.0-14

**Title** Simple Features for R

**Description** Support for simple features, a standardized way to encode spatial vector data. Binds to 'GDAL' for reading and writing data, to 'GEOS' for geometrical operations, and to 'PROJ' for projection conversions and datum transformations. Uses by default the 's2' package for spherical geometry operations on ellipsoidal (long/lat) coordinates.

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**URL** <https://r-spatial.github.io/sf/>, <https://github.com/r-spatial/sf/>

**BugReports** <https://github.com/r-spatial/sf/issues/>

**Depends** methods, R (>= 3.3.0)

**Imports** classInt (>= 0.4-1), DBI (>= 0.8), graphics, grDevices, grid, magrittr, Rcpp (>= 0.12.18), s2 (>= 1.1.0), stats, tools, units (>= 0.7-0), utils

**Suggests** blob, covr, dplyr (>= 0.8-3), ggplot2, knitr, lwgeom (>= 0.2-1), maps, mapview, Matrix, microbenchmark, odbc, pbapply, pillar, pool, raster, rlang, rmarkdown, RPostgres (>= 1.1.0), RPostgreSQL, RSQLite, sp (>= 1.2-4), spatstat (>= 2.0-1), spatstat.geom, spatstat.random, spatstat.linnet, spatstat.utils, stars (>= 0.2-0), terra, testthat (>= 3.0.0), tibble (>= 1.4.1), tidyr (>= 1.2.0), tidyselect (>= 1.0.0), tmap (>= 2.0), vctrs, wk

**LinkingTo** Rcpp

**VignetteBuilder** knitr

**Encoding** UTF-8

**RoxygenNote** 7.2.3

**Config/testthat/edition** 3

**SystemRequirements** GDAL (>= 2.0.1), GEOS (>= 3.4.0), PROJ (>= 4.8.0), sqlite3

**Collate** 'RcppExports.R' 'init.R' 'crs.R' 'bbox.R' 'read.R' 'db.R' 'sfc.R' 'sfg.R' 'sf.R' 'bind.R' 'wkb.R' 'wkt.R' 'plot.R' 'geom-measures.R' 'geom-predicates.R' 'geom-transformers.R' 'transform.R' 'proj.R' 'sp.R' 'grid.R' 'arith.R' 'tidyverse.R' 'tidyverse-vctrs.R' 'cast\_sfg.R' 'cast\_sfc.R' 'graticule.R' 'datasets.R' 'aggregate.R' 'agr.R' 'maps.R' 'join.R' 'sample.R' 'valid.R' 'collection\_extract.R' 'jitter.R' 'sgbp.R' 'spatstat.R' 'stars.R' 'crop.R' 'gdal\_utils.R' 'nearest.R' 'normalize.R' 'defunct.R' 'z\_range.R' 'm\_range.R' 'shift\_longitude.R' 'make\_grid.R' 's2.R' 'terra.R' 'geos-overlayng.R' 'break\_antimeridian.R'

**NeedsCompilation** yes

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**Date/Publication** 2023-07-11 08:40:02 UTC

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---

aggregate.sf	<i>aggregate an sf object</i>
--------------	-------------------------------

---

## Description

aggregate an sf object, possibly union-ing geometries

## Usage

```
## S3 method for class 'sf'
aggregate(
  x,
  by,
  FUN,
  ...,
  do_union = TRUE,
  simplify = TRUE,
  join = st_intersects
)
```

## Arguments

x	object of class <code>sf</code>
by	either a list of grouping vectors with length equal to <code>nrow(x)</code> (see <a href="#">aggregate</a> ), or an object of class <code>sf</code> or <code>sfc</code> with geometries that are used to generate groupings, using the binary predicate specified by the argument <code>join</code>

FUN	function passed on to <a href="#">aggregate</a> , in case ids was specified and attributes need to be grouped
...	arguments passed on to FUN
do_union	logical; should grouped geometries be unioned using <a href="#">st_union</a> ? See details.
simplify	logical; see <a href="#">aggregate</a>
join	logical spatial predicate function to use if by is a simple features object or geometry; see <a href="#">st_join</a>

### Details

In case do\_union is FALSE, aggregate will simply combine geometries using [c.sfg](#). When polygons sharing a boundary are combined, this leads to geometries that are invalid; see <https://github.com/r-spatial/sf/issues/681>.

### Value

an sf object with aggregated attributes and geometries; additional grouping variables having the names of names(ids) or are named Group.i for ids[[i]]; see [aggregate](#).

### Note

Does not work using the formula notation involving ~ defined in [aggregate](#).

### Examples

```
m1 = cbind(c(0, 0, 1, 0), c(0, 1, 1, 0))
m2 = cbind(c(0, 1, 1, 0), c(0, 0, 1, 0))
pol = st_sfc(st_polygon(list(m1)), st_polygon(list(m2)))
set.seed(1985)
d = data.frame(matrix(runif(15), ncol = 3))
p = st_as_sf(x = d, coords = 1:2)
plot(pol)
plot(p, add = TRUE)
(p_ag1 = aggregate(p, pol, mean))
plot(p_ag1) # geometry same as pol
# works when x overlaps multiple objects in 'by':
p_buff = st_buffer(p, 0.2)
plot(p_buff, add = TRUE)
(p_ag2 = aggregate(p_buff, pol, mean)) # increased mean of second
# with non-matching features
m3 = cbind(c(0, 0, -0.1, 0), c(0, 0.1, 0.1, 0))
pol = st_sfc(st_polygon(list(m3)), st_polygon(list(m1)), st_polygon(list(m2)))
(p_ag3 = aggregate(p, pol, mean))
plot(p_ag3)
# In case we need to pass an argument to the join function:
(p_ag4 = aggregate(p, pol, mean,
  join = function(x, y) st_is_within_distance(x, y, dist = 0.3)))
```

---

as *Methods to coerce simple features to Spatial\* and Spatial\*DataFrame objects*

---

## Description

`as_Spatial()` allows to convert `sf` and `sfc` to `Spatial*DataFrame` and `Spatial*` for `sp` compatibility. You can also use `as(x, "Spatial")` To transform `sp` objects to `sf` and `sfc` with `as(x, "sf")`.

## Usage

```
as_Spatial(from, cast = TRUE, IDs = paste0("ID", seq_along(from)))
```

## Arguments

from	object of class <code>sf</code> , <code>sfc_POINT</code> , <code>sfc_MULTIPPOINT</code> , <code>sfc_LINSTRING</code> , <code>sfc_MULTILINSTRING</code> , <code>sfc_POLYGON</code> , or <code>sfc_MULTIPOLYGON</code> .
cast	logical; if TRUE, <code>st_cast()</code> from before converting, so that e.g. <code>GEOMETRY</code> objects with a mix of <code>POLYGON</code> and <code>MULTIPOLYGON</code> are cast to <code>MULTIPOLYGON</code> .
IDs	character vector with IDs for the <code>Spatial*</code> geometries

## Details

Package `sp` supports three dimensions for `POINT` and `MULTIPPOINT` (`SpatialPoint*`). Other geometries must be two-dimensional (`XY`). Dimensions can be dropped using `st_zm()` with `what = "M"` or `what = "ZM"`.

For converting simple features (i.e., `sf` objects) to their `Spatial` counterpart, use `as(obj, "Spatial")`

## Value

geometry-only object deriving from `Spatial`, of the appropriate class

## Examples

```
nc <- st_read(system.file("shape/nc.shp", package="sf"))
if (require(sp, quietly = TRUE)) {
  # convert to SpatialPolygonsDataFrame
  spdf <- as_Spatial(nc)
  # identical to
  spdf <- as(nc, "Spatial")
  # convert to SpatialPolygons
  as(st_geometry(nc), "Spatial")
  # back to sf
  as(spdf, "sf")
}
```

---

bind	<i>Bind rows (features) of sf objects</i>
------	---

---

## Description

Bind rows (features) of sf objects

Bind columns (variables) of sf objects

## Usage

```
## S3 method for class 'sf'  
rbind(..., deparse.level = 1)  
  
## S3 method for class 'sf'  
cbind(..., deparse.level = 1, sf_column_name = NULL)  
  
st_bind_cols(...)
```

## Arguments

... objects to bind; note that for the rbind and cbind methods, all objects have to be of class sf; see [dotsMethods](#)

deparse.level integer; see [rbind](#)

sf\_column\_name character; specifies active geometry; passed on to [st\\_sf](#)

## Details

both rbind and cbind have non-standard method dispatch (see [cbind](#)): the rbind or cbind method for sf objects is only called when all arguments to be binded are of class sf.

If you need to cbind e.g. a data.frame to an sf, use [data.frame](#) directly and use [st\\_sf](#) on its result, or use [bind\\_cols](#); see examples.

st\_bind\_cols is deprecated; use cbind instead.

## Value

cbind called with multiple sf objects warns about multiple geometry columns present when the geometry column to use is not specified by using argument sf\_column\_name; see also [st\\_sf](#).

## Examples

```
crs = st_crs(3857)  
a = st_sf(a=1, geom = st_sfc(st_point(0:1)), crs = crs)  
b = st_sf(a=1, geom = st_sfc(st_linestring(matrix(1:4,2))), crs = crs)  
c = st_sf(a=4, geom = st_sfc(st_multilinestring(list(matrix(1:4,2)))), crs = crs)  
rbind(a,b,c)  
rbind(a,b)
```

```

rbind(a,b)
rbind(b,c)
cbind(a,b,c) # warns
if (require(dplyr, quietly = TRUE))
  dplyr::bind_cols(a,b)
c = st_sf(a=4, geomc = st_sfc(st_multilinestring(list(matrix(1:4,2))))), crs = crs)
cbind(a,b,c, sf_column_name = "geomc")
df = data.frame(x=3)
st_sf(data.frame(c, df))
if (require(dplyr, quietly = TRUE))
  dplyr::bind_cols(c, df)

```

---

dbDataType,PostgreSQLConnection,sf-method

*Determine database type for R vector*

---

### Description

Determine database type for R vector

Determine database type for R vector

### Usage

```
## S4 method for signature 'PostgreSQLConnection,sf'
dbDataType(dbObj, obj)
```

```
## S4 method for signature 'DBIObject,sf'
dbDataType(dbObj, obj)
```

### Arguments

dbObj            DBIObject driver or connection.

obj              Object to convert

---

dbWriteTable,PostgreSQLConnection,character,sf-method

*Write sf object to Database*

---

### Description

Write sf object to Database

Write sf object to Database



**Usage**

```
## S4 method for signature 'PostgreSQLConnection,character,sf'
dbWriteTable(
  conn,
  name,
  value,
  ...,
  row.names = FALSE,
  overwrite = FALSE,
  append = FALSE,
  field.types = NULL,
  binary = TRUE
)

## S4 method for signature 'DBIObject,character,sf'
dbWriteTable(
  conn,
  name,
  value,
  ...,
  row.names = FALSE,
  overwrite = FALSE,
  append = FALSE,
  field.types = NULL,
  binary = TRUE
)
```

**Arguments**

conn	DBIObject
name	character vector of names (table names, fields, keywords).
value	a data.frame.
...	placeholder for future use.
row.names	Add a row.name column, or a vector of length nrow(obj) containing row.names; default FALSE.
overwrite	Will try to drop table before writing; default FALSE.
append	Append rows to existing table; default FALSE.
field.types	default NULL. Allows to override type conversion from R to PostgreSQL. See dbDataType() for details.
binary	Send geometries serialized as Well-Known Binary (WKB); if FALSE, uses Well-Known Text (WKT). Defaults to TRUE (WKB).

---

db_drivers	<i>Drivers for which update should be TRUE by default</i>
------------	---

---

**Description**

Drivers for which update should be TRUE by default

**Usage**

db\_drivers

**Format**

An object of class character of length 12.

---

extension_map	<i>Map extension to driver</i>
---------------	--------------------------------

---

**Description**

Map extension to driver

**Usage**

extension\_map

**Format**

An object of class list of length 26.

---

gdal	<i>functions to interact with gdal not meant to be called directly by users (but e.g. by stars::read_stars)</i>
------	---

---

**Description**

functions to interact with gdal not meant to be called directly by users (but e.g. by stars::read\_stars)

**Usage**

```
gdal_read(  
  x,  
  ...,  
  options = character(0),  
  driver = character(0),  
  read_data = TRUE,  
  NA_value = NA_real_,  
  RasterIO_parameters = list()  
)  
  
gdal_write(  
  x,  
  ...,  
  file,  
  driver = "GTiff",  
  options = character(0),  
  type = "Float32",  
  NA_value = NA_real_,  
  geotransform,  
  update = FALSE,  
  scale_offset = c(1, 0)  
)  
  
gdal_inv_geotransform(gt)  
  
gdal_crs(file, options = character(0))  
  
gdal_metadata(  
  file,  
  domain_item = character(0),  
  options = character(0),  
  parse = TRUE  
)  
  
gdal_subdatasets(file, options = character(0), name = TRUE)  
  
gdal_polygonize(  
  x,  
  mask = NULL,  
  file = tempfile(),  
  driver = "GTiff",  
  use_integer = TRUE,  
  geotransform,  
  breaks = classInt::classIntervals(na.omit(as.vector(x[[1]])))$brks,  
  use_contours = FALSE,  
  contour_lines = FALSE,  
  connect8 = FALSE,
```

```

    ...
)

gdal_rasterize(sf, x, gt, file, driver = "GTiff", options = character())

gdal_extract(f, pts, bilinear = FALSE)

gdal_read_mdin(
  file,
  array_name = character(0),
  options = character(0),
  offset = integer(0),
  count = integer(0),
  step = integer(0),
  proxy = FALSE,
  debug = FALSE
)

gdal_write_mdin(
  file,
  driver,
  dimx,
  cdl,
  wkt,
  xy,
  ...,
  root_group_options = character(0),
  options = character(0),
  as_float = TRUE
)

gdal_create(f, nxy, values, crs, xlim, ylim)

```

### Arguments

x	character vector, possibly of length larger than 1 when more than one raster is read
...	ignored
options	character; driver specific options regarding reading or creating the dataset
driver	character; driver short name; when empty vector, driver is auto-detected.
read_data	logical; if FALSE, only the imagery metadata is returned
NA_value	(double) non-NA value to use for missing values; if NA, when writing missing values are not specially flagged in output dataset, when reading the default (dataset) missing values are used (if present / set).
RasterIO_parameters	list with named parameters to GDAL's RasterIO; see the stars::read_stars documentation.

file	file name
type	gdal write type
geotransform	length 6 numeric vector with GDAL geotransform parameters.
update	logical; TRUE if in an existing raster file pixel values shall be updated.
scale_offset	length 2 numeric; contains scale and offset values
gt	double vector of length 6
domain_item	character vector of length 0, 1 (with domain), or 2 (with domain and item); use "" for the default domain, use NA_character_ to query the domain names.
parse	logical; should metadata be parsed into a named list (TRUE) or returned as character data?
name	logical; retrieve name of subdataset? If FALSE, retrieve description
mask	stars object with NA mask (0 where NA), or NULL
use_integer	boolean; if TRUE, raster values are read as (and rounded to) unsigned 32-bit integers values; if FALSE they are read as 32-bit floating points numbers. The former is supposedly faster.
breaks	numeric vector with break values for contour polygons (or lines)
use_contours	logical;
contour_lines	logical;
connect8	logical; if TRUE use 8 connection algorithm, rather than 4
sf	object of class sf
f	character; file name
pts	points matrix
bilinear	logical; use bilinear interpolation, rather than nearest neighbor?
array_name	array name
offset	offset (pixels)
count	number of pixels to read
step	step size (pixels)
proxy	logical; return proxy object?
debug	logical; print debug messages?
dimx	integer named vector with dimensions of object
cdl	list with variables, each having a named dim attribute
wkt	character; WKT of crs
xy	character; names of the spatial x and y dimension
root_group_options	character; driver specific options regarding the creation of the root group
as_float	logical; when TRUE write 4-byte floating point numbers, when FALSE write 8-byte doubles.
nxy	integer vector of length 2
values	fill value
crs	object of class crs
xlim	numeric
ylim	numeric

**Details**

These functions are exported for the single purpose of being used by package stars, they are not meant to be used directly and may change or disappear without prior notice or deprecation warnings.

gdal\_inv\_geotransform returns the inverse geotransform

gdal\_crs reads coordinate reference system from GDAL data set

get\_metadata gets metadata of a raster layer

gdal\_subdatasets returns the subdatasets of a gdal dataset

**Value**

object of class crs, see [st\\_crs](#).

named list with metadata items

gdal\_subdatasets returns a zero-length list if file does not have subdatasets, and else a named list with subdatasets.

**Examples**

```
## Not run:
f = system.file("tif/L7_ETMs.tif", package="stars")
f = system.file("nc/avhrr-only-v2.19810901.nc", package = "stars")
gdal_metadata(f)
gdal_metadata(f, NA_character_)
try(gdal_metadata(f, "wrongDomain"))
gdal_metadata(f, c("", "AREA_OR_POINT"))

## End(Not run)
```

---

gdal_addo	<i>add or remove overviews to/from a raster image</i>
-----------	---

---

**Description**

add or remove overviews to/from a raster image

**Usage**

```
gdal_addo(
  file,
  overviews = c(2, 4, 8, 16),
  method = "NEAREST",
  layers = integer(0),
  options = character(0),
  config_options = character(0),
  clean = FALSE,
  read_only = FALSE
)
```

**Arguments**

file	character; file name
overviews	integer; overview levels
method	character; method to create overview; one of: nearest, average, rms, gauss, cubic, cubicspline, lanczos, average_mp, average_magphase, mode
layers	integer; layers to create overviews for (default: all)
options	character; dataset opening options
config_options	named character vector with GDAL config options, like c(option1=value1, option2=value2)
clean	logical; if TRUE only remove overviews, do not add
read_only	logical; if TRUE, add overviews to another file with extension .ovr added to file

**Value**

TRUE, invisibly, on success

**See Also**

[gdal\\_utils](#) for access to other gdal utilities that have a C API

---

gdal\_utils

*Native interface to gdal utils*

---

**Description**

Native interface to gdal utils

**Usage**

```
gdal_utils(
  util = "info",
  source,
  destination,
  options = character(),
  quiet = !(util %in% c("info", "gdalinfo", "ogrinfo", "vectorinfo", "mdiminfo")) ||
    ("multi" %in% options),
  processing = character(),
  colorfilename = character(),
  config_options = character()
)
```

**Arguments**

util	character; one of info, warp, rasterize, translate, vectortranslate (for ogr2ogr), buildvrt, demprocessing, nearblack, grid, mdiminfo and mdimtranslate (the last two requiring GDAL 3.1), ogrinfo (requiring GDAL 3.7)
source	character; name of input layer(s); for warp, buildvrt or mdimtranslate this can be more than one
destination	character; name of output layer
options	character; options for the utility
quiet	logical; if TRUE, suppress printing the output for info and mdiminfo, and suppress printing progress
processing	character; processing options for demprocessing
colorfilename	character; name of color file for demprocessing (mandatory if processing="color-relief")
config_options	named character vector with GDAL config options, like c(option1=value1, option2=value2)

**Value**

info returns a character vector with the raster metadata; all other utils return (invisibly) a logical indicating success (i.e., TRUE); in case of failure, an error is raised.

**See Also**

[gdal\\_addo](#) for adding overlays to a raster file; [st\\_layers](#) to query geometry type(s) and crs from layers in a (vector) data source

**Examples**

```
if (sf_extSoftVersion()["GDAL"] > "2.1.0") {
# info utils can be used to list information about a raster
# dataset. More info: https://gdal.org/programs/ngdalinfo.html
in_file <- system.file("tif/geomatrix.tif", package = "sf")
gdal_utils("info", in_file, options = c("-mm", "-proj4"))

# vectortranslate utils can be used to convert simple features data between
# file formats. More info: https://gdal.org/programs/ogr2ogr.html
in_file <- system.file("shape/storms_xyz.shp", package="sf")
out_file <- paste0(tempfile(), ".gpkg")
gdal_utils(
  util = "vectortranslate",
  source = in_file,
  destination = out_file, # output format must be specified for GDAL < 2.3
  options = c("-f", "GPKG")
)
# The parameters can be specified as c("name") or c("name", "value"). The
# vectortranslate utils can perform also various operations during the
# conversion process. For example we can reproject the features during the
# translation.
```



```

gdal_utils(
  util = "vectortranslate",
  source = in_file,
  destination = out_file,
  options = c(
    "-f", "GPKG", # output file format for GDAL < 2.3
    "-s_srs", "EPSG:4326", # input file SRS
    "-t_srs", "EPSG:2264", # output file SRS
    "-overwrite"
  )
)
st_read(out_file)
# The parameter s_srs had to be specified because, in this case, the in_file
# has no associated SRS.
st_read(in_file)
}

```

---

geos\_binary\_ops

*Geometric operations on pairs of simple feature geometry sets*


---

## Description

Perform geometric set operations with simple feature geometry collections

## Usage

```

st_intersection(x, y, ...)

## S3 method for class 'sfc'
st_intersection(x, y, ...)

## S3 method for class 'sf'
st_intersection(x, y, ...)

st_difference(x, y, ...)

## S3 method for class 'sfc'
st_difference(x, y, ...)

st_sym_difference(x, y, ...)

st_snap(x, y, tolerance)

```

## Arguments

x	object of class sf, sfc or sfg
y	object of class sf, sfc or sfg
...	arguments passed on to <a href="#">s2_options</a>

tolerance            tolerance values used for `st_snap`; numeric value or object of class units; may have tolerance values for each feature in `x`

### Details

When using GEOS and not using `s2`, a spatial index is built on argument `x`; see <https://r-spatial.org/r/2017/06/22/spatial-index.html>. The reference for the STR tree algorithm is: Leutenegger, Scott T., Mario A. Lopez, and Jeffrey Edgington. "STR: A simple and efficient algorithm for R-tree packing." Data Engineering, 1997. Proceedings. 13th international conference on. IEEE, 1997. For the pdf, search Google Scholar.

When called with missing `y`, the `sfc` method for `st_intersection` returns all non-empty intersections of the geometries of `x`; an attribute `idx` contains a list-column with the indexes of contributing geometries.

when called with a missing `y`, the `sf` method for `st_intersection` returns an `sf` object with attributes taken from the contributing feature with lowest index; two fields are added: `n.overlaps` with the number of overlapping features in `x`, and a list-column `origins` with indexes of all overlapping features.

When `st_difference` is called with a single argument, overlapping areas are erased from geometries that are indexed at greater numbers in the argument to `x`; geometries that are empty or contained fully inside geometries with higher priority are removed entirely. The `st_difference.sfc` method with a single argument returns an object with an "idx" attribute with the original index for returned geometries.

`st_snap` snaps the vertices and segments of a geometry to another geometry's vertices. If `y` contains more than one geometry, its geometries are merged into a collection before snapping to that collection.

(from the GEOS docs:) "A snap distance tolerance is used to control where snapping is performed. Snapping one geometry to another can improve robustness for overlay operations by eliminating nearly-coincident edges (which cause problems during nodding and intersection calculation). Too much snapping can result in invalid topology being created, so the number and location of snapped vertices is decided using heuristics to determine when it is safe to snap. This can result in some potential snaps being omitted, however."

### Value

The intersection, difference or symmetric difference between two sets of geometries. The returned object has the same class as that of the first argument (`x`) with the non-empty geometries resulting from applying the operation to all geometry pairs in `x` and `y`. In case `x` is of class `sf`, the matching attributes of the original object(s) are added. The `sfc` geometry list-column returned carries an attribute `idx`, which is an `n-by-2` matrix with every row the index of the corresponding entries of `x` and `y`, respectively.

### Note

To find whether pairs of simple feature geometries intersect, use the function `st_intersects` instead of `st_intersection`.

When using GEOS and not using `s2` polygons contain their boundary. When using `s2` this is determined by the model defaults of `s2_options`, which can be overridden via the `...` argument, e.g. `model = "closed"` to force DE-9IM compliant behaviour of polygons (and reproduce GEOS results).

**See Also**

[st\\_union](#) for the union of simple features collections; [intersect](#) and [setdiff](#) for the base R set operations.

**Examples**

```
set.seed(131)
library(sf)
m = rbind(c(0,0), c(1,0), c(1,1), c(0,1), c(0,0))
p = st_polygon(list(m))
n = 100
l = vector("list", n)
for (i in 1:n)
  l[[i]] = p + 10 * runif(2)
s = st_sfc(l)
plot(s, col = sf.colors(categorical = TRUE, alpha = .5))
title("overlapping squares")
d = st_difference(s) # sequential differences: s1, s2-s1, s3-s2-s1, ...
plot(d, col = sf.colors(categorical = TRUE, alpha = .5))
title("non-overlapping differences")
i = st_intersection(s) # all intersections
plot(i, col = sf.colors(categorical = TRUE, alpha = .5))
title("non-overlapping intersections")
summary(lengths(st_overlaps(s, s))) # includes self-counts!
summary(lengths(st_overlaps(d, d)))
summary(lengths(st_overlaps(i, i)))
sf = st_sf(s)
i = st_intersection(sf) # all intersections
plot(i["n.overlaps"])
summary(i$n.overlaps - lengths(i$origins))
# A helper function that erases all of y from x:
st_erase = function(x, y) st_difference(x, st_union(st_combine(y)))
poly = st_polygon(list(cbind(c(0, 0, 1, 1, 0), c(0, 1, 1, 0, 0))))
lines = st_multilinestring(list(
  cbind(c(0, 1), c(1, 1.05)),
  cbind(c(0, 1), c(0, -.05)),
  cbind(c(1, .95, 1), c(1.05, .5, -.05))
))
snapped = st_snap(poly, lines, tolerance=.1)
plot(snapped, col='red')
plot(poly, border='green', add=TRUE)
plot(lines, lwd=2, col='blue', add=TRUE)
```

---

geos\_binary\_pred

*Geometric binary predicates on pairs of simple feature geometry sets*


---

**Description**

Geometric binary predicates on pairs of simple feature geometry sets

**Usage**

```

st_intersects(x, y, sparse = TRUE, ...)

st_disjoint(x, y = x, sparse = TRUE, prepared = TRUE)

st_touches(x, y, sparse = TRUE, prepared = TRUE, ...)

st_crosses(x, y, sparse = TRUE, prepared = TRUE, ...)

st_within(x, y, sparse = TRUE, prepared = TRUE, ...)

st_contains(x, y, sparse = TRUE, prepared = TRUE, ..., model = "open")

st_contains_properly(x, y, sparse = TRUE, prepared = TRUE, ...)

st_overlaps(x, y, sparse = TRUE, prepared = TRUE, ...)

st_equals(
  x,
  y,
  sparse = TRUE,
  prepared = FALSE,
  ...,
  retain_unique = FALSE,
  remove_self = FALSE
)

st_covers(x, y, sparse = TRUE, prepared = TRUE, ..., model = "closed")

st_covered_by(x, y = x, sparse = TRUE, prepared = TRUE, ..., model = "closed")

st_equals_exact(x, y, par, sparse = TRUE, prepared = FALSE, ...)

st_is_within_distance(x, y = x, dist, sparse = TRUE, ...)

```

**Arguments**

x	object of class sf, sfc or sfg
y	object of class sf, sfc or sfg; if missing, x is used
sparse	logical; should a sparse index list be returned (TRUE) or a dense logical matrix? See below.
...	passed on to <a href="#">s2_options</a>
prepared	logical; prepare geometry for x, before looping over y? See Details.
model	character; polygon/polyline model; one of "open", "semi-open" or "closed"; see Details.
retain_unique	logical; if TRUE (and y is missing) return only indexes of points larger than the current index; this can be used to select unique geometries, see examples.

	This argument can be used for all geometry predicates; see als <a href="#">distinct.sf</a> to find records where geometries AND attributes are distinct.
remove_self	logical; if TRUE (and y is missing) return only indexes of geometries different from the current index; this can be used to omit self-intersections; see examples. This argument can be used for all geometry predicates
par	numeric; parameter used for "equals_exact" (margin);
dist	distance threshold; geometry indexes with distances smaller or equal to this value are returned; numeric value or units value having distance units.

## Details

If prepared is TRUE, and x contains POINT geometries and y contains polygons, then the polygon geometries are prepared, rather than the points.

For most predicates, a spatial index is built on argument x; see <https://r-spatial.org/r/2017/06/22/spatial-index.html>. Specifically, `st_intersects`, `st_disjoint`, `st_touches`, `st_crosses`, `st_within`, `st_contains`, `st_contains_properly`, `st_overlaps`, `st_equals`, `st_covers` and `st_covered_by` all build spatial indexes for more efficient geometry calculations. `st_relate`, `st_equals_exact`, and `do not`; `st_is_within_distance` uses a spatial index for geographic coordinates when `sf_use_s2()` is true.

If y is missing, `'st_predicate(x, x)'` is effectively called, and a square matrix is returned with diagonal elements `'st_predicate(x[i], x[i])'`.

Sparse geometry binary predicate ([sgbp](#)) lists have the following attributes: `region.id` with the `row.names` of x (if any, else 1:n), `ncol` with the number of features in y, and `predicate` with the name of the predicate used.

for model, see <https://github.com/r-spatial/s2/issues/32>

`'st_contains_properly(A,B)'` is true if A intersects B's interior, but not its edges or exterior; A contains A, but A does not properly contain A.

See also [st\\_relate](#) and <https://en.wikipedia.org/wiki/DE-9IM> for a more detailed description of the underlying algorithms.

`st_equals_exact` returns true for two geometries of the same type and their vertices corresponding by index are equal up to a specified tolerance.

## Value

If `sparse=FALSE`, `st_predicate` (with predicate e.g. "intersects") returns a dense logical matrix with element `i, j` TRUE when `predicate(x[i], y[j])` (e.g., when geometry of feature `i` and `j` intersect); if `sparse=TRUE`, an object of class [sgbp](#) with a sparse list representation of the same matrix, with list element `i` an integer vector with all indices `j` for which `predicate(x[i], y[j])` is TRUE (and hence a zero-length integer vector if none of them is TRUE). From the dense matrix, one can find out if one or more elements intersect by `apply(mat, 1, any)`, and from the sparse list by `lengths(lst) > 0`, see examples below.

## Note

For intersection on pairs of simple feature geometries, use the function [st\\_intersection](#) instead of `st_intersects`.

**Examples**

```

pts = st_sfc(st_point(c(.5,.5)), st_point(c(1.5, 1.5)), st_point(c(2.5, 2.5)))
pol = st_polygon(list(rbind(c(0,0), c(2,0), c(2,2), c(0,2), c(0,0))))
(lst = st_intersects(pts, pol))
(mat = st_intersects(pts, pol, sparse = FALSE))
# which points fall inside a polygon?
apply(mat, 1, any)
lengths(lst) > 0
# which points fall inside the first polygon?
st_intersects(pol, pts)[[1]]
# remove duplicate geometries:
p1 = st_point(0:1)
p2 = st_point(2:1)
p = st_sf(a = letters[1:8], geom = st_sfc(p1, p1, p2, p1, p1, p2, p2, p1))
st_equals(p)
st_equals(p, remove_self = TRUE)
(u = st_equals(p, retain_unique = TRUE))
# retain the records with unique geometries:
p[-unlist(u),]

```

---

geos\_combine

*Combine or union feature geometries*


---

**Description**

Combine several feature geometries into one, without unioning or resolving internal boundaries

**Usage**

```
st_combine(x)
```

```
st_union(x, y, ..., by_feature = FALSE, is_coverage = FALSE)
```

**Arguments**

x	object of class sf, sfc or sfg
y	object of class sf, sfc or sfg (optional)
...	ignored
by_feature	logical; if TRUE, union each feature, if FALSE return a single feature that is the geometric union of the set of features
is_coverage	logical; if TRUE, use an optimized algorithm for features that form a polygonal coverage (have no overlaps)

## Details

`st_combine` combines geometries without resolving borders, using `c.sfg` (analogous to `c` for ordinary vectors).

If `st_union` is called with a single argument, `x`, (with `y` missing) and `by_feature` is `FALSE` all geometries are unioned together and an `sfg` or single-geometry `sfc` object is returned. If `by_feature` is `TRUE` each feature geometry is unioned. This can for instance be used to resolve internal boundaries after polygons were combined using `st_combine`. If `y` is provided, all elements of `x` and `y` are unioned, pairwise (and `by_feature` is ignored). The former corresponds to `rgeos::gUnaryUnion`, the latter to `rgeos::gUnion`.

Unioning a set of overlapping polygons has the effect of merging the areas (i.e. the same effect as iteratively unioning all individual polygons together). Unioning a set of `LineStrings` has the effect of fully noding and dissolving the input linework. In this context "fully noded" means that there will be a node or endpoint in the output for every endpoint or line segment crossing in the input. "Dissolved" means that any duplicate (e.g. coincident) line segments or portions of line segments will be reduced to a single line segment in the output. Unioning a set of `Points` has the effect of merging all identical points (producing a set with no duplicates).

## Value

`st_combine` returns a single, combined geometry, with no resolved boundaries; returned geometries may well be invalid.

If `y` is missing, `st_union(x)` returns a single geometry with resolved boundaries, else the geometries for all unioned pairs of `x[i]` and `y[j]`.

## See Also

[st\\_intersection](#), [st\\_difference](#), [st\\_sym\\_difference](#)

## Examples

```
nc = st_read(system.file("shape/nc.shp", package="sf"))
st_combine(nc)
plot(st_union(nc))
```

## Description

Compute Euclidian or great circle distance between pairs of geometries; compute, the area or the length of a set of geometries.

**Usage**

```

st_area(x, ...)

## S3 method for class 'sfc'
st_area(x, ...)

st_length(x, ...)

st_distance(
  x,
  y,
  ...,
  dist_fun,
  by_element = FALSE,
  which = ifelse(isTRUE(st_is_longlat(x)), "Great Circle", "Euclidean"),
  par = 0,
  tolerance = 0
)

```

**Arguments**

x	object of class sf, sfc or sfg
...	passed on to <a href="#">s2_distance</a> or <a href="#">s2_distance_matrix</a>
y	object of class sf, sfc or sfg, defaults to x
dist_fun	deprecated
by_element	logical; if TRUE, return a vector with distance between the first elements of x and y, the second, etc; an error is raised if x and y are not the same length. If FALSE, return the dense matrix with all pairwise distances.
which	character; for Cartesian coordinates only: one of Euclidean, Hausdorff or Frechet; for geodetic coordinates, great circle distances are computed; see details
par	for which equal to Hausdorff or Frechet, optionally use a value between 0 and 1 to densify the geometry
tolerance	ignored if <code>st_is_longlat(x)</code> is FALSE; otherwise, if set to a positive value, the first distance smaller than tolerance will be returned, and true distance may be smaller; this may speed up computation. In meters, or a units object convertible to meters.

**Details**

great circle distance calculations use by default spherical distances ([s2\\_distance](#) or [s2\\_distance\\_matrix](#)); if `sf_use_s2()` is FALSE, ellipsoidal distances are computed using [st\\_geod\\_distance](#) which uses function `geod_inverse` from GeographicLib (part of PROJ); see Karney, Charles FF, 2013, Algorithms for geodesics, Journal of Geodesy 87(1), 43–55



**Value**

If the coordinate reference system of `x` was set, these functions return values with unit of measurement; see [set\\_units](#).

`st_area` returns the area of a geometry, in the coordinate reference system used; in case `x` is in degrees longitude/latitude, `st_geod_area` is used for area calculation.

`st_length` returns the length of a LINESTRING or MULTILINESTRING geometry, using the coordinate reference system. POINT, MULTIPOINT, POLYGON or MULTIPOLYGON geometries return zero.

If `by_element` is FALSE `st_distance` returns a dense numeric matrix of dimension `length(x)` by `length(y)`; otherwise it returns a numeric vector the same length as `x` and `y` with an error raised if the lengths of `x` and `y` are unequal. Distances involving empty geometries are NA.

**See Also**

[st\\_dimension](#), [st\\_cast](#) to convert geometry types

**Examples**

```
b0 = st_polygon(list(rbind(c(-1,-1), c(1,-1), c(1,1), c(-1,1), c(-1,-1))))
b1 = b0 + 2
b2 = b0 + c(-0.2, 2)
x = st_sfc(b0, b1, b2)
st_area(x)
line = st_sfc(st_linestring(rbind(c(30,30), c(40,40))), crs = 4326)
st_length(line)

outer = matrix(c(0,0,10,0,10,10,0,10,0,0),ncol=2, byrow=TRUE)
hole1 = matrix(c(1,1,1,2,2,2,2,1,1,1),ncol=2, byrow=TRUE)
hole2 = matrix(c(5,5,5,6,6,6,6,5,5,5),ncol=2, byrow=TRUE)

poly = st_polygon(list(outer, hole1, hole2))
mpoly = st_multipolygon(list(
  list(outer, hole1, hole2),
  list(outer + 12, hole1 + 12)
))

st_length(st_sfc(poly, mpoly))
p = st_sfc(st_point(c(0,0)), st_point(c(0,1)), st_point(c(0,2)))
st_distance(p, p)
st_distance(p, p, by_element = TRUE)
```

---

geos\_query

*Dimension, simplicity, validity or is\_empty queries on simple feature geometries*

---

**Description**

Dimension, simplicity, validity or `is_empty` queries on simple feature geometries

**Usage**

```
st_dimension(x, NA_if_empty = TRUE)

st_is_simple(x)

st_is_empty(x)
```

**Arguments**

x	object of class sf, sfc or sfg
NA_if_empty	logical; if TRUE, return NA for empty geometries

**Value**

`st_dimension` returns a numeric vector with 0 for points, 1 for lines, 2 for surfaces, and, if `NA_if_empty` is TRUE, NA for empty geometries.

`st_is_simple` returns a logical vector, indicating for each geometry whether it is simple (e.g., not self-intersecting)

`st_is_empty` returns for each geometry whether it is empty

**Examples**

```
x = st_sfc(
  st_point(0:1),
  st_linestring(rbind(c(0,0),c(1,1))),
  st_polygon(list(rbind(c(0,0),c(1,0),c(0,1),c(0,0)))),
  st_multipoint(),
  st_linestring(),
  st_geometrycollection())
st_dimension(x)
st_dimension(x, FALSE)
ls = st_linestring(rbind(c(0,0), c(1,1), c(1,0), c(0,1)))
st_is_simple(st_sfc(ls, st_point(c(0,0))))
ls = st_linestring(rbind(c(0,0), c(1,1), c(1,0), c(0,1)))
st_is_empty(st_sfc(ls, st_point(), st_linestring()))
```

**Description**

Geometric unary operations on simple feature geometries. These are all generics, with methods for `sfg`, `sfc` and `sf` objects, returning an object of the same class. All operations work on a per-feature basis, ignoring all other features.

**Usage**

```
st_buffer(  
  x,  
  dist,  
  nQuadSegs = 30,  
  endCapStyle = "ROUND",  
  joinStyle = "ROUND",  
  mitreLimit = 1,  
  singleSide = FALSE,  
  ...  
)  
  
st_boundary(x)  
  
st_convex_hull(x)  
  
st_concave_hull(x, ratio, ..., allow_holes)  
  
st_simplify(x, preserveTopology, dTolerance = 0)  
  
st_triangulate(x, dTolerance = 0, bOnlyEdges = FALSE)  
  
st_triangulate_constrained(x)  
  
st_inscribed_circle(x, dTolerance, ...)  
  
st_minimum_rotated_rectangle(x, ...)  
  
st_voronoi(x, envelope, dTolerance = 0, bOnlyEdges = FALSE)  
  
st_polygonize(x)  
  
st_line_merge(x)  
  
st_centroid(x, ..., of_largest_polygon = FALSE)  
  
st_point_on_surface(x)  
  
st_reverse(x)  
  
st_node(x)  
  
st_segmentize(x, dfMaxLength, ...)
```

**Arguments**

x	object of class sfg, sfc or sf
dist	numeric; buffer distance for all, or for each of the elements in x; in case dist

	is a units object, it should be convertible to <code>arc_degree</code> if <code>x</code> has geographic coordinates, and to <code>st_crs(x)\$units</code> otherwise
<code>nQuadSegs</code>	integer; number of segments per quadrant (fourth of a circle), for all or per feature; see details
<code>endCapStyle</code>	character; style of line ends, one of 'ROUND', 'FLAT', 'SQUARE'; see details
<code>joinStyle</code>	character; style of line joins, one of 'ROUND', 'MITRE', 'BEVEL'; see details
<code>mitreLimit</code>	numeric; limit of extension for a join if <code>joinStyle</code> 'MITRE' is used (default 1.0, minimum 0.0); see details
<code>singleSide</code>	logical; if TRUE, single-sided buffers are returned for linear geometries, in which case negative <code>dist</code> values give buffers on the right-hand side, positive on the left; see details
<code>...</code>	ignored
<code>ratio</code>	numeric; fraction convex: 1 returns the convex hulls, 0 maximally concave hulls
<code>allow_holes</code>	logical; if TRUE, the resulting concave hull may have holes
<code>preserveTopology</code>	logical; carry out topology preserving simplification? May be specified for each, or for all feature geometries. Note that topology is preserved only for single feature geometries, not for sets of them. If not specified (i.e. the default), then it is internally set equal to FALSE when the input data is specified with projected coordinates or <code>sf_use_s2()</code> returns FALSE. Ignored in all the other cases (with a warning when set equal to FALSE) since the function implicitly calls <code>s2::s2_simplify</code> which always preserve topological relationships (per single feature).
<code>dTolerance</code>	numeric; tolerance parameter, specified for all or for each feature geometry. If you run <code>st_simplify</code> , the input data is specified with long-lat coordinates and <code>sf_use_s2()</code> returns TRUE, then the value of <code>dTolerance</code> must be specified in meters.
<code>bOnlyEdges</code>	logical; if TRUE, return lines, else return polygons
<code>envelope</code>	object of class <code>sfc</code> or <code>sfg</code> containing a POLYGON with the envelope for a voronoi diagram; this only takes effect when it is larger than the default envelope, chosen when <code>envelope</code> is an empty polygon
<code>of_largest_polygon</code>	logical; for <code>st_centroid</code> : if TRUE, return centroid of the largest (sub)polygon of a MULTIPOLYGON rather than of the whole MULTIPOLYGON
<code>dfMaxLength</code>	maximum length of a line segment. If <code>x</code> has geographical coordinates (long/lat), <code>dfMaxLength</code> is either a numeric expressed in meter, or an object of class <code>units</code> with length units <code>rad</code> or <code>degree</code> ; segmentation in the long/lat case takes place along the great circle, using <code>st_geod_segmentize</code> .

## Details

`st_buffer` computes a buffer around this geometry/each geometry. If any of `endCapStyle`, `joinStyle`, or `mitreLimit` are set to non-default values ('ROUND', 'ROUND', 1.0 respectively) then the underlying 'buffer with style' GEOS function is used. If a negative buffer returns empty polygons instead of shrinking, set `st_use_s2()` to FALSE See [postgis.net/docs/ST\\_Buffer.html](https://postgis.net/docs/ST_Buffer.html) for details.

nQuadSegs, endCapsStyle, joinStyle, mitreLimit and singleSide only work when the GEOS back-end is used: for projected coordinates or when sf\_use\_s2() is set to FALSE.

st\_boundary returns the boundary of a geometry

st\_convex\_hull creates the convex hull of a set of points

st\_concave\_hull creates the concave hull of a geometry

st\_simplify simplifies lines by removing vertices.

st\_triangulate triangulates set of points (not constrained). st\_triangulate requires GEOS version 3.4 or above

st\_triangulate\_constrained returns the constrained delaunay triangulation of polygons; requires GEOS version 3.10 or above

st\_inscribed\_circle returns the maximum inscribed circle for polygon geometries. For st\_inscribed\_circle, if nQuadSegs is 0 a 2-point LINESTRING is returned with the center point and a boundary point of every circle, otherwise a circle (buffer) is returned where nQuadSegs controls the number of points per quadrant to approximate the circle. st\_inscribed\_circle requires GEOS version 3.9 or above

st\_minimum\_rotated\_rectangle returns the minimum rotated rectangular POLYGON which encloses the input geometry. The rectangle has width equal to the minimum diameter, and a longer length. If the convex hull of the input is degenerate (a line or point) a linestring or point is returned.

st\_voronoi creates voronoi tessellation. st\_voronoi requires GEOS version 3.5 or above

st\_polygonize creates polygon from lines that form a closed ring. In case of st\_polygonize, x must be an object of class LINESTRING or MULTILINESTRING, or an sfc geometry list-column object containing these

st\_line\_merge merges lines. In case of st\_line\_merge, x must be an object of class MULTILINESTRING, or an sfc geometry list-column object containing these

st\_centroid gives the centroid of a geometry

st\_point\_on\_surface returns a point guaranteed to be on the (multi)surface.

st\_reverse reverses the nodes in a line

st\_node adds nodes to linear geometries at intersections without a node, and only works on individual linear geometries

st\_segmentize adds points to straight lines

### Value

an object of the same class of x, with manipulated geometry.

### See Also

[chull](#) for a more efficient algorithm for calculating the convex hull

### Examples

```
## st_buffer, style options (taken from rgeos gBuffer)
l1 = st_as_sfc("LINESTRING(0 0,1 5,4 5,5 2,8 2,9 4,4 6.5)")
op = par(mfrow=c(2,3))
```

```

plot(st_buffer(l1, dist = 1, endCapStyle="ROUND"), reset = FALSE, main = "endCapStyle: ROUND")
plot(l1,col='blue',add=TRUE)
plot(st_buffer(l1, dist = 1, endCapStyle="FLAT"), reset = FALSE, main = "endCapStyle: FLAT")
plot(l1,col='blue',add=TRUE)
plot(st_buffer(l1, dist = 1, endCapStyle="SQUARE"), reset = FALSE, main = "endCapStyle: SQUARE")
plot(l1,col='blue',add=TRUE)
plot(st_buffer(l1, dist = 1, nQuadSegs=1), reset = FALSE, main = "nQuadSegs: 1")
plot(l1,col='blue',add=TRUE)
plot(st_buffer(l1, dist = 1, nQuadSegs=2), reset = FALSE, main = "nQuadSegs: 2")
plot(l1,col='blue',add=TRUE)
plot(st_buffer(l1, dist = 1, nQuadSegs= 5), reset = FALSE, main = "nQuadSegs: 5")
plot(l1,col='blue',add=TRUE)
par(op)

l2 = st_as_sfc("LINESTRING(0 0,1 5,3 2)")
op = par(mfrow = c(2, 3))
plot(st_buffer(l2, dist = 1, joinStyle="ROUND"), reset = FALSE, main = "joinStyle: ROUND")
plot(l2, col = 'blue', add = TRUE)
plot(st_buffer(l2, dist = 1, joinStyle="MITRE"), reset = FALSE, main = "joinStyle: MITRE")
plot(l2, col= 'blue', add = TRUE)
plot(st_buffer(l2, dist = 1, joinStyle="BEVEL"), reset = FALSE, main = "joinStyle: BEVEL")
plot(l2, col= 'blue', add=TRUE)
plot(st_buffer(l2, dist = 1, joinStyle="MITRE" , mitreLimit=0.5), reset = FALSE,
      main = "mitreLimit: 0.5")
plot(l2, col = 'blue', add = TRUE)
plot(st_buffer(l2, dist = 1, joinStyle="MITRE",mitreLimit=1), reset = FALSE,
      main = "mitreLimit: 1")
plot(l2, col = 'blue', add = TRUE)
plot(st_buffer(l2, dist = 1, joinStyle="MITRE",mitreLimit=3), reset = FALSE,
      main = "mitreLimit: 3")
plot(l2, col = 'blue', add = TRUE)
par(op)
nc = st_read(system.file("shape/nc.shp", package="sf"))
nc_g = st_geometry(nc)
plot(st_convex_hull(nc_g))
plot(nc_g, border = grey(.5), add = TRUE)
set.seed(131)
if (compareVersion(sf_extSoftVersion()[["GEOS"]], "3.11.0") > -1) {
  pts = cbind(runif(100), runif(100))
  m = st_multipoint(pts)
  co = sf:::st_concave_hull(m, 0.3)
  coh = sf:::st_concave_hull(m, 0.3, allow_holes = TRUE)
  plot(co, col = 'grey')
  plot(coh, add = TRUE, border = 'red')
  plot(m, add = TRUE)
}

# st_simplify examples:
op = par(mfrow = c(2, 3), mar = rep(0, 4))
plot(nc_g[1])
plot(st_simplify(nc_g[1], dTolerance = 1e3)) # 1000m
plot(st_simplify(nc_g[1], dTolerance = 5e3)) # 5000m

```

```

nc_g_planar = st_transform(nc_g, 2264) # planar coordinates, US foot
plot(nc_g_planar[1])
plot(st_simplify(nc_g_planar[1], dTolerance = 1e3)) # 1000 foot
plot(st_simplify(nc_g_planar[1], dTolerance = 5e3)) # 5000 foot
par(op)

if (compareVersion(sf_extSoftVersion()[["GEOS"]], "3.10.0") > -1) {
  pts = rbind(c(0,0), c(1,0), c(1,1), c(.5,.5), c(0,1), c(0,0))
  po = st_polygon(list(pts))
  co = st_triangulate_constrained(po)
  tr = st_triangulate(po)
  plot(po, col = NA, border = 'grey', lwd = 15)
  plot(tr, border = 'green', col = NA, lwd = 5, add = TRUE)
  plot(co, border = 'red', col = 'NA', add = TRUE)
}
if (compareVersion(sf_extSoftVersion()[["GEOS"]], "3.9.0") > -1) {
  nc_t = st_transform(nc, 'EPSG:2264')
  x = st_inscribed_circle(st_geometry(nc_t))
  plot(st_geometry(nc_t), asp = 1, col = grey(.9))
  plot(x, add = TRUE, col = '#ff9999')
}
set.seed(1)
x = st_multipoint(matrix(runif(10),,2))
box = st_polygon(list(rbind(c(0,0),c(1,0),c(1,1),c(0,1),c(0,0))))
if (compareVersion(sf_extSoftVersion()[["GEOS"]], "3.5.0") > -1) {
  v = st_sfc(st_voronoi(x, st_sfc(box)))
  plot(v, col = 0, border = 1, axes = TRUE)
  plot(box, add = TRUE, col = 0, border = 1) # a larger box is returned, as documented
  plot(x, add = TRUE, col = 'red', cex=2, pch=16)
  plot(st_intersection(st_cast(v), box)) # clip to smaller box
  plot(x, add = TRUE, col = 'red', cex=2, pch=16)
  # matching Voronoi polygons to data points:
  # https://github.com/r-spatial/sf/issues/1030
  # generate 50 random unif points:
  n = 100
  pts = st_as_sf(data.frame(matrix(runif(n), , 2), id = 1:(n/2)), coords = c("X1", "X2"))
  # compute Voronoi polygons:
  polys = st_collection_extract(st_voronoi(do.call(c, st_geometry(pts))))
  # match them to points:
  pts$polys = polys[unlist(st_intersects(pts, polys))]
  plot(pts["id"], pch = 16) # ID is color
  plot(st_set_geometry(pts, "polys")["id"], xlim = c(0,1), ylim = c(0,1), reset = FALSE)
  plot(st_geometry(pts), add = TRUE)
  layout(matrix(1)) # reset plot layout
}
mls = st_multilinestring(list(matrix(c(0,0,0,1,1,0,0),,2,byrow=TRUE)))
st_polygonize(st_sfc(mls))
mls = st_multilinestring(list(rbind(c(0,0), c(1,1)), rbind(c(2,0), c(1,1))))
st_line_merge(st_sfc(mls))
plot(nc_g, axes = TRUE)
plot(st_centroid(nc_g), add = TRUE, pch = 3, col = 'red')
mp = st_combine(st_buffer(st_sfc(lapply(1:3, function(x) st_point(c(x,x))), 0.2 * 1:3))
plot(mp)

```

```

plot(st_centroid(mp), add = TRUE, col = 'red') # centroid of combined geometry
plot(st_centroid(mp, of_largest_polygon = TRUE), add = TRUE, col = 'blue', pch = 3)
plot(nc_g, axes = TRUE)
plot(st_point_on_surface(nc_g), add = TRUE, pch = 3, col = 'red')
if (compareVersion(sf_extSoftVersion()[["GEOS"]], "3.7.0") > -1) {
  st_reverse(st_linestring(rbind(c(1,1), c(2,2), c(3,3))))
}
(l = st_linestring(rbind(c(0,0), c(1,1), c(0,1), c(1,0), c(0,0))))
st_polygonize(st_node(l))
st_node(st_multilinestring(list(rbind(c(0,0), c(1,1), c(0,1), c(1,0), c(0,0)))))
sf = st_sf(a=1, geom=st_sfc(st_linestring(rbind(c(0,0),c(1,1))))) , crs = 4326)
if (require(lwgeom, quietly = TRUE)) {
  seg = st_segmentize(sf, units::set_units(100, km))
  seg = st_segmentize(sf, units::set_units(0.01, rad))
  nrow(seg$geom[[1]])
}

```

---

internal

*Internal functions*

---

### Description

Internal functions

### Usage

```
.stop_geos(msg)
```

### Arguments

msg                      error message

---

interpolate\_aw

*Areal-weighted interpolation of polygon data*

---

### Description

Areal-weighted interpolation of polygon data

### Usage

```
st_interpolate_aw(x, to, extensive, ...)
```

```
## S3 method for class 'sf'
```

```
st_interpolate_aw(x, to, extensive, ..., keep_NA = FALSE)
```



**Arguments**

x	object of class sf, for which we want to aggregate attributes
to	object of class sf or sfc, with the target geometries
extensive	logical; if TRUE, the attribute variables are assumed to be spatially extensive (like population) and the sum is preserved, otherwise, spatially intensive (like population density) and the mean is preserved.
...	ignored
keep_NA	logical; if TRUE, return all features in to, if FALSE return only those with non-NA values (but with row.names the index corresponding to the feature in to)

**Examples**

```
nc = st_read(system.file("shape/nc.shp", package="sf"))
g = st_make_grid(nc, n = c(10, 5))
a1 = st_interpolate_aw(nc["BIR74"], g, extensive = FALSE)
sum(a1$BIR74) / sum(nc$BIR74) # not close to one: property is assumed spatially intensive
a2 = st_interpolate_aw(nc["BIR74"], g, extensive = TRUE)
# verify mass preservation (pynophylactic) property:
sum(a2$BIR74) / sum(nc$BIR74)
a1$intensive = a1$BIR74
a1$extensive = a2$BIR74
plot(a1[c("intensive", "extensive")], key.pos = 4)
```

---

is\_driver\_available    *Check if driver is available*

---

**Description**

Search through the driver table if driver is listed

**Usage**

```
is_driver_available(drv, drivers = st_drivers())
```

**Arguments**

drv	character. Name of driver
drivers	data.frame. Table containing driver names and support. Default is from <a href="#">st_drivers</a>

---

is_driver_can	<i>Check if a driver can perform an action</i>
---------------	--

---

### Description

Search through the driver table to match a driver name with an action (e.g. "write") and check if the action is supported.

### Usage

```
is_driver_can(drv, drivers = st_drivers(), operation = "write")
```

### Arguments

drv	character. Name of driver
drivers	data.frame. Table containing driver names and support. Default is from <a href="#">st_drivers</a>
operation	character. What action to check

---

is_geometry_column	<i>Check if the columns could be of a coercable type for sf</i>
--------------------	---

---

### Description

Check if the columns could be of a coercable type for sf

### Usage

```
is_geometry_column(con, x, classes = "")
```

### Arguments

con	database connection
x	inherits data.frame
classes	classes inherited

---

merge.sf	<i>merge method for sf and data.frame object</i>
----------	--

---

## Description

merge method for sf and data.frame object

## Usage

```
## S3 method for class 'sf'  
merge(x, y, ...)
```

## Arguments

x	object of class sf
y	object of class data.frame
...	arguments passed on to merge.data.frame

## Examples

```
a = data.frame(a = 1:3, b = 5:7)  
st_geometry(a) = st_sfc(st_point(c(0,0)), st_point(c(1,1)), st_point(c(2,2)))  
b = data.frame(x = c("a", "b", "c"), b = c(2,5,6))  
merge(a, b)  
merge(a, b, all = TRUE)
```

---

nc	<i>North Carolina SIDS data</i>
----	---------------------------------

---

## Description

Sudden Infant Death Syndrome (SIDS) sample data for North Carolina counties, two time periods (1974-78 and 1979-84). The details of the columns can be found on the [seealso URL](#), spdep package's vignette. Please note that, though this is basically the same as nc.sids dataset in spData package, nc only contains a subset of variables. The differences are also discussed on the vignette.

## See Also

<https://r-spatial.github.io/spdep/articles/sids.html>

**Description**

S3 Ops Group Generic Functions for simple feature geometries

**Usage**

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

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

**Arguments**

e1	object of class sfg or sfc
e2	numeric, or object of class sfg; in case e1 is of class sfc also an object of class sfc is allowed

**Details**

in case e2 is numeric, +, -, \*, /,

If e1 is of class sfc, and e2 is a length 2 numeric, then it is considered a two-dimensional point (and if needed repeated as such) only for operations + and -, in other cases the individual numbers are repeated; see commented examples.

It has been reported (<https://github.com/r-spatial/sf/issues/2067>) that certain ATLAS versions result in invalid polygons, where the final point in a ring is no longer equal to the first point. In that case, setting the precisions with `st_set_precision` may help.

**Value**

object of class sfg

**Examples**

```
st_point(c(1,2,3)) + 4
st_point(c(1,2,3)) * 3 + 4
m = matrix(0, 2, 2)
diag(m) = c(1, 3)
# affine:
st_point(c(1,2)) * m + c(2,5)
# world in 0-360 range:
if (require(maps, quietly = TRUE)) {
  w = st_as_sf(map('world', plot = FALSE, fill = TRUE))
  w2 = (st_geometry(w) + c(360,90)) %% c(360) - c(0,90)
```

```

w3 = st_wrap_dateline(st_set_crs(w2 - c(180,0), 4326)) + c(180,0)
plot(st_set_crs(w3, 4326), axes = TRUE)
}
(mp <- st_point(c(1,2)) + st_point(c(3,4))) # MULTIPOINT (1 2, 3 4)
mp - st_point(c(3,4)) # POINT (1 2)
opar = par(mfrow = c(2,2), mar = c(0, 0, 1, 0))
a = st_buffer(st_point(c(0,0)), 2)
b = a + c(2, 0)
p = function(m) { plot(c(a,b)); plot(eval(parse(text=m)), col=grey(.9), add = TRUE); title(m) }
lapply(c('a | b', 'a / b', 'a & b', 'a %% b'), p)
par(opar)
sfc = st_sfc(st_point(0:1), st_point(2:3))
sfc + c(2,3) # added to EACH geometry
sfc * c(2,3) # first geometry multiplied by 2, second by 3
nc = st_transform(st_read(system.file("gpkg/nc.gpkg", package="sf")), 32119) # nc state plane, m
b = st_buffer(st_centroid(st_union(nc)), units::set_units(50, km)) # shoot a hole in nc:
plot(st_geometry(nc) / b, col = grey(.9))

```

---

plot

*plot sf object*


---

## Description

plot one or more attributes of an sf object on a map Plot sf object

## Usage

```

## S3 method for class 'sf'
plot(
  x,
  y,
  ...,
  main,
  pal = NULL,
  nbreaks = 10,
  breaks = "pretty",
  max.plot = if (is.null(n <- getOption("sf_max.plot"))) 9 else n,
  key.pos = get_key_pos(x, ...),
  key.length = 0.618,
  key.width = lcm(1.8),
  reset = TRUE,
  logz = FALSE,
  extent = x,
  xlim = st_bbox(extent)[c(1, 3)],
  ylim = st_bbox(extent)[c(2, 4)]
)

get_key_pos(x, ...)

```

```
## S3 method for class 'sfc_POINT'
plot(
  x,
  y,
  ...,
  pch = 1,
  cex = 1,
  col = 1,
  bg = 0,
  lwd = 1,
  lty = 1,
  type = "p",
  add = FALSE
)

## S3 method for class 'sfc_MULTIPPOINT'
plot(
  x,
  y,
  ...,
  pch = 1,
  cex = 1,
  col = 1,
  bg = 0,
  lwd = 1,
  lty = 1,
  type = "p",
  add = FALSE
)

## S3 method for class 'sfc_LINESTRING'
plot(x, y, ..., lty = 1, lwd = 1, col = 1, pch = 1, type = "l", add = FALSE)

## S3 method for class 'sfc_CIRCULARSTRING'
plot(x, y, ...)

## S3 method for class 'sfc_MULTILINESTRING'
plot(x, y, ..., lty = 1, lwd = 1, col = 1, pch = 1, type = "l", add = FALSE)

## S3 method for class 'sfc_POLYGON'
plot(
  x,
  y,
  ...,
  lty = 1,
  lwd = 1,
  col = NA,
```

```
    cex = 1,
    pch = NA,
    border = 1,
    add = FALSE,
    rule = "evenodd",
    xpd = par("xpd")
)

## S3 method for class 'sfc_MULTIPOLYGON'
plot(
  x,
  y,
  ...,
  lty = 1,
  lwd = 1,
  col = NA,
  border = 1,
  add = FALSE,
  rule = "evenodd",
  xpd = par("xpd")
)

## S3 method for class 'sfc_GEOMETRYCOLLECTION'
plot(
  x,
  y,
  ...,
  pch = 1,
  cex = 1,
  bg = 0,
  lty = 1,
  lwd = 1,
  col = 1,
  border = 1,
  add = FALSE
)

## S3 method for class 'sfc_GEOMETRY'
plot(
  x,
  y,
  ...,
  pch = 1,
  cex = 1,
  bg = 0,
  lty = 1,
  lwd = 1,
  col = ifelse(st_dimension(x) == 2, NA, 1),

```

```

    border = 1,
    add = FALSE
)

## S3 method for class 'sfg'
plot(x, ...)

plot_sf(
  x,
  xlim = NULL,
  ylim = NULL,
  asp = NA,
  axes = FALSE,
  bgc = par("bg"),
  ...,
  xaxs,
  yaxs,
  lab,
  setParUsrBB = FALSE,
  bgMap = NULL,
  expandBB = c(0, 0, 0, 0),
  graticule = NA_crs_,
  col_graticule = "grey",
  border,
  extent = x
)

sf.colors(n = 10, cutoff.tails = c(0.35, 0.2), alpha = 1, categorical = FALSE)

```

### Arguments

<code>x</code>	object of class <code>sf</code>
<code>y</code>	ignored
<code>...</code>	further specifications, see <a href="#">plot_sf</a> and <a href="#">plot</a> and details.
<code>main</code>	title for plot (NULL to remove)
<code>pal</code>	palette function, similar to <a href="#">rainbow</a> , or palette values; if omitted, <code>sf.colors</code> is used
<code>nbreaks</code>	number of colors breaks (ignored for factor or character variables)
<code>breaks</code>	either a numeric vector with the actual breaks, or a name of a method accepted by the <code>style</code> argument of <a href="#">classIntervals</a>
<code>max.plot</code>	integer; lower boundary to maximum number of attributes to plot; the default value (9) can be overridden by setting the global option <code>sf_max.plot</code> , e.g. <code>options(sf_max.plot=2)</code>
<code>key.pos</code>	integer; side to plot a color key: 1 bottom, 2 left, 3 top, 4 right; set to NULL to omit key completely, 0 to only not plot the key, or -1 to select automatically. If multiple columns are plotted in a single function call by default no key is plotted and every submap is stretched individually; if a key is requested (and <code>col</code> is



	missing) all maps are colored according to a single key. Auto select depends on plot size, map aspect, and, if set, parameter asp.
key.length	amount of space reserved for the key along its axis, length of the scale bar
key.width	amount of space reserved for the key (incl. labels), thickness/width of the scale bar
reset	logical; if FALSE, keep the plot in a mode that allows adding further map elements; if TRUE restore original mode after plotting sf objects with attributes; see details.
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.
extent	object with an st_bbox method to define plot extent; defaults to x
xlim	see <a href="#">plot.window</a>
ylim	see <a href="#">plot.window</a>
pch	plotting symbol
cex	symbol size
col	color for plotting features; if length(col) does not equal 1 or nrow(x), a warning is emitted that colors will be recycled. Specifying col suppresses plotting the legend key.
bg	symbol background color
lwd	line width
lty	line type
type	plot type: 'p' for points, 'l' for lines, 'b' for both
add	logical; add to current plot? Note that when using add=TRUE, you may have to set reset=FALSE in the first plot command.
border	color of polygon border(s); using NA hides them
rule	see <a href="#">polypath</a> ; for winding, exterior ring direction should be opposite that of the holes; with evenodd, plotting is robust against misspecified ring directions
xpd	see <a href="#">par</a> ; sets polygon clipping strategy; only implemented for POLYGON and MULTIPOLYGON
asp	see below, and see <a href="#">par</a>
axes	logical; should axes be plotted? (default FALSE)
bgc	background color
xaxs	see <a href="#">par</a>
yaxs	see <a href="#">par</a>
lab	see <a href="#">par</a>
setParUsrBB	default FALSE; set the par "usr" bounding box; see below
bgMap	object of class ggmap, or returned by function RgoogleMaps::GetMap
expandBB	numeric; fractional values to expand the bounding box with, in each direction (bottom, left, top, right)

graticule	logical, or object of class crs (e.g., <code>st_crs(4326)</code> for a WGS84 graticule), or object created by <code>st_graticule</code> ; TRUE will give the WGS84 graticule or object returned by <code>st_graticule</code>
col_graticule	color to used for the graticule (if present)
n	integer; number of colors
cutoff.tails	numeric, in [0,0.5] start and end values
alpha	numeric, in [0,1], transparency
categorical	logical; do we want colors for a categorical variable? (see details)

### Details

`plot.sf` maximally plots `max.plot` maps with colors following from attribute columns, one map per attribute. It uses `sf.colors` for default colors. For more control over placement of individual maps, set parameter `mfrow` with `par` prior to plotting, and plot single maps one by one; note that this only works in combination with setting parameters `key.pos=NULL` (no legend) and `reset=FALSE`.

`plot.sfc` plots the geometry, additional parameters can be passed on to control color, lines or symbols.

When setting `reset` to `FALSE`, the original device parameters are lost, and the device must be reset using `dev.off()` in order to reset it.

parameter `at` can be set to specify where labels are placed along the key; see examples.

The features are plotted in the order as they appear in the `sf` object. See examples for when a different plotting order is wanted.

`plot_sf` sets up the plotting area, axes, graticule, or webmap background; it is called by all `plot` methods before anything is drawn.

The argument `setParUsrBB` may be used to pass the logical value `TRUE` to functions within `plot.Spatial`. When set to `TRUE`, `par("usr")` will be overwritten with `c(xlim, ylim)`, which defaults to the bounding box of the spatial object. This is only needed in the particular context of graphic output to a specified device with given width and height, to be matched to the spatial object, when using `par("xaxs")` and `par("yaxs")` in addition to `par(mar=c(0, 0, 0, 0))`.

The default aspect for map plots is 1; if however data are not projected (coordinates are long/lat), the aspect is by default set to  $1/\cos(My * \pi/180)$  with `My` the y coordinate of the middle of the map (the mean of `ylim`, which defaults to the y range of bounding box). This implies an **Equirectangular projection**.

non-categorical colors from `sf.colors` were taken from `bpy.colors`, with modified `cutoff.tails` defaults. If `categorical` is `TRUE`, default colors are from <https://colorbrewer2.org/> (if `n < 9`, `Set2`, else `Set3`).

### Examples

```
nc = st_read(system.file("gpkg/nc.gpkg", package="sf"), quiet = TRUE)
# plot single attribute, auto-legend:
plot(nc["SID74"])
# plot multiple:
plot(nc[c("SID74", "SID79")]) # better use ggplot2::geom_sf to facet and get a single legend!
# adding to a plot of an sf object only works when using reset=FALSE in the first plot:
```

```

plot(nc["SID74"], reset = FALSE)
plot(st_centroid(st_geometry(nc)), add = TRUE)
# log10 z-scale:
plot(nc["SID74"], logz = TRUE, breaks = c(0,.5,1,1.5,2), at = c(0,.5,1,1.5,2))
# and we need to reset the plotting device after that, e.g. by
layout(1)
# when plotting only geometries, the reset=FALSE is not needed:
plot(st_geometry(nc))
plot(st_geometry(nc)[1], col = 'red', add = TRUE)
# add a custom legend to an arbitray plot:
layout(matrix(1:2, ncol = 2), widths = c(1, lcm(2)))
plot(1)
.image_scale(1:10, col = sf.colors(9), key.length = lcm(8), key.pos = 4, at = 1:10)
# manipulate plotting order, plot largest polygons first:
p = st_polygon(list(rbind(c(0,0), c(1,0), c(1,1), c(0,1), c(0,0))))
x = st_sf(a=1:4, st_sfc(p, p * 2, p * 3, p * 4)) # plot(x, col=2:5) only shows the largest polygon!
plot(x[order(st_area(x), decreasing = TRUE),], col = 2:5) # plot largest polygons first

sf.colors(10)

```

---

prefix\_map

*Map prefix to driver*


---

### Description

Map prefix to driver

### Usage

```
prefix_map
```

### Format

An object of class `list` of length 10.

---

proj\_tools

*Manage PROJ settings*


---

### Description

Manage PROJ search path and network settings

**Usage**

```

sf_proj_search_paths(paths = character(0))

sf_proj_network(enable = FALSE, url = character(0))

sf_proj_pipelines(
  source_crs,
  target_crs,
  authority = character(0),
  AOI = numeric(0),
  Use = "NONE",
  grid_availability = "USED",
  desired_accuracy = -1,
  strict_containment = FALSE,
  axis_order_authority_compliant = st_axis_order()
)

```

**Arguments**

paths	the search path to be set; omit if no paths need to be set
enable	logical; set this to enable (TRUE) or disable (FALSE) the proj network search facility
url	character; use this to specify and override the default proj network CDN
source_crs	object of class 'crs' or character
target_crs	object of class 'crs' or character
authority	character; constrain output pipelines to those of authority
AOI	length four numeric; desired area of interest for the resulting coordinate transformations (west, south, east, north, in degrees). For an area of interest crossing the anti-meridian, west will be greater than east.
Use	one of "NONE", "BOTH", "INTERSECTION", "SMALLEST", indicating how AOI's of source_crs and target_crs are being used
grid_availability	character; one of "USED" (Grid availability is only used for sorting results. Operations where some grids are missing will be sorted last), "DISCARD" (Completely discard an operation if a required grid is missing), "IGNORED" (Ignore grid availability at all. Results will be presented as if all grids were available.), or "AVAILABLE" (Results will be presented as if grids known to PROJ (that is registered in the grid_alternatives table of its database) were available. Used typically when networking is enabled.)
desired_accuracy	numeric; only return pipelines with at least this accuracy
strict_containment	logical; default FALSE; permit partial matching of the area of interest; if TRUE strictly contain the area of interest. The area of interest is either as given in AOI, or as implied by the source/target coordinate reference systems

`axis_order_authority_compliant`

logical; if FALSE always choose 'x' or longitude for the first axis; if TRUE, follow the axis orders given by the coordinate reference systems when constructing the for the first axis; if FALSE, follow the axis orders given by

### Value

'sf\_proj\_search\_paths()' returns the search path (possibly after setting it)

'sf\_proj\_network' when called without arguments returns a logical indicating whether network search of datum grids is enabled, when called with arguments it returns a character vector with the URL of the CDN used (or specified with 'url').

'sf\_proj\_pipelines' returns a table with candidate coordinate transformation pipelines along with their accuracy; 'NA' accuracy indicates ballpark accuracy.

---

rawToHex	<i>Convert raw vector(s) into hexadecimal character string(s)</i>
----------	---

---

### Description

Convert raw vector(s) into hexadecimal character string(s)

### Usage

```
rawToHex(x)
```

### Arguments

x                      raw vector, or list with raw vectors

---

s2	<i>functions for spherical geometry, using s2 package</i>
----	---

---

### Description

functions for spherical geometry, using the s2 package based on the google s2geometry.io library

### Usage

```
sf_use_s2(use_s2)
```

```
st_as_s2(x, ...)
```

```
## S3 method for class 'sf'
```

```
st_as_s2(x, ...)
```

```
## S3 method for class 'sfc'
```

```
st_as_s2(x, ..., oriented = getOption("s2_oriented", FALSE), rebuild = FALSE)
```

**Arguments**

<code>use_s2</code>	logical; if TRUE, use the s2 spherical geometry package for geographical coordinate operations
<code>x</code>	object of class sf, sfc or sfg
<code>...</code>	passed on
<code>oriented</code>	logical; if FALSE, polygons that cover more than half of the globe are inverted; if TRUE, no reversal takes place and it is assumed that the inside of the polygon is to the left of the polygon's path.
<code>rebuild</code>	logical; call <code>s2_rebuild</code> on the geometry (think of this as a <code>st_make_valid</code> on the sphere)

**Details**

`st_as_s2` converts an sf POLYGON object into a form readable by s2.

**Value**

`sf_use_s2` returns the value of this variable before (re)setting it, invisibly if `use_s2` is not missing.

**Examples**

```
m = rbind(c(-1,-1), c(1,-1), c(1,1), c(-1,1), c(-1,-1))
m1 = rbind(c(-1,-1), c(1,-1), c(1,1), c(-1,1), c(-1,0), c(-1,-1))
m0 = m[5:1,]
mp = st_multipolygon(list(
  list(m, 0.8 * m0, 0.01 * m1 + 0.9),
  list(0.7 * m, 0.6 * m0),
  list(0.5 * m0),
  list(m+2),
  list(m+4, (.9 * m0) + 4)
))
sf = st_sfc(mp, mp, crs = 'EPSG:4326')
s2 = st_as_s2(sf)
```

---

sf

*Create sf object*


---

**Description**

Create sf, which extends data.frame-like objects with a simple feature list column

**Usage**

```

st_sf(
  ...,
  agr = NA_agr_,
  row.names,
  stringsAsFactors = sf_stringsAsFactors(),
  crs,
  precision,
  sf_column_name = NULL,
  check_ring_dir = FALSE,
  sfc_last = TRUE
)

## S3 method for class 'sf'
x[i, j, ..., drop = FALSE, op = st_intersects]

## S3 method for class 'sf'
print(x, ..., n = getOption("sf_max_print", default = 10))

```

**Arguments**

...	column elements to be binded into an <code>sf</code> object or a single <code>list</code> or <code>data.frame</code> with such columns; at least one of these columns shall be a geometry list-column of class <code>sfc</code> or be a list-column that can be converted into an <code>sfc</code> by <a href="#">st_as_sfc</a> .
<code>agr</code>	character vector; see details below.
<code>row.names</code>	row.names for the created <code>sf</code> object
<code>stringsAsFactors</code>	logical; see <a href="#">st_read</a>
<code>crs</code>	coordinate reference system, something suitable as input to <a href="#">st_crs</a>
<code>precision</code>	numeric; see <a href="#">st_as_binary</a>
<code>sf_column_name</code>	character; name of the active list-column with simple feature geometries; in case there is more than one and <code>sf_column_name</code> is <code>NULL</code> , the first one is taken.
<code>check_ring_dir</code>	see <a href="#">st_read</a>
<code>sfc_last</code>	logical; if <code>TRUE</code> , <code>sfc</code> columns are always put last, otherwise column order is left unmodified.
<code>x</code>	object of class <code>sf</code>
<code>i</code>	record selection, see <a href="#">[.data.frame]</a>
<code>j</code>	variable selection, see <a href="#">[.data.frame]</a>
<code>drop</code>	logical, default <code>FALSE</code> ; if <code>TRUE</code> drop the geometry column and return a <code>data.frame</code> , else make the geometry sticky and return a <code>sf</code> object.
<code>op</code>	function; geometrical binary predicate function to apply when <code>i</code> is a simple feature object
<code>n</code>	maximum number of features to print; can be set globally by <code>options(sf_max_print=...)</code>

## Details

`agr`, attribute-geometry-relationship, specifies for each non-geometry attribute column how it relates to the geometry, and can have one of following values: "constant", "aggregate", "identity". "constant" is used for attributes that are constant throughout the geometry (e.g. land use), "aggregate" where the attribute is an aggregate value over the geometry (e.g. population density or population count), "identity" when the attributes uniquely identifies the geometry of particular "thing", such as a building ID or a city name. The default value, `NA_agr_`, implies we don't know.

When a single value is provided to `agr`, it is cascaded across all input columns; otherwise, a named vector like `c(feature1='constant', ...)` will set `agr` value to 'constant' for the input column named `feature1`. See `demo(nc)` for a worked example of this.

When confronted with a `data.frame`-like object, `st_sf` will try to find a geometry column of class `sfc`, and otherwise try to convert list-columns when available into a geometry column, using [st\\_as\\_sfc](#).

`[.sf]` will return a `data.frame` or vector if the geometry column (of class `sfc`) is dropped (`drop=TRUE`), an `sfc` object if only the geometry column is selected, and otherwise return an `sf` object; see also [\[.data.frame\]](#); for `[.sf ...]` arguments are passed to `op`.

## Examples

```
g = st_sfc(st_point(1:2))
st_sf(a=3,g)
st_sf(g, a=3)
st_sf(a=3, st_sfc(st_point(1:2))) # better to name it!
# create empty structure with preallocated empty geometries:
nrows <- 10
geometry = st_sfc(lapply(1:nrows, function(x) st_geometrycollection()))
df <- st_sf(id = 1:nrows, geometry = geometry)
g = st_sfc(st_point(1:2), st_point(3:4))
s = st_sf(a=3:4, g)
s[1,]
class(s[1,])
s[,1]
class(s[,1])
s[,2]
class(s[,2])
g = st_sf(a=2:3, g)
pol = st_sfc(st_polygon(list(cbind(c(0,3,3,0,0),c(0,0,3,3,0))))))
h = st_sf(r = 5, pol)
g[h,]
h[g,]
```

---

sf-defunct

*Deprecated functions in sf*

---

## Description

These functions are provided for compatibility with older version of `sf`. They may eventually be completely removed.



**Usage**

```

st_read_db(
  conn = NULL,
  table = NULL,
  query = NULL,
  geom_column = NULL,
  EWKB = TRUE,
  ...
)

```

**Arguments**

conn	open database connection
table	table name
query	SQL query to select records; see details
geom_column	deprecated. Geometry column name
EWKB	logical; is the WKB of type EWKB? if missing, defaults to TRUE
...	parameter(s) passed on to <a href="#">st_as_sf</a>

**Details**

The `geom_column` argument is deprecated. The function will automatically find the geometry type columns. For the RPostgreSQL drivers it will try to cast all the character columns, which can be long for very wide tables.

**Details**

<code>st_read_db</code>	now a synonym for <a href="#">st_read</a>
<code>st_write_db</code>	now a synonym for <a href="#">st_write</a>

---

sfc

---

*Create simple feature geometry list column*


---

**Description**

Create simple feature geometry list column, set class, and add coordinate reference system and precision

**Usage**

```

st_sfc(

```

```

...,
crs = NA_crs_,
precision = 0,
check_ring_dir = FALSE,
dim,
recompute_bbox = FALSE
)

```

### Arguments

...	zero or more simple feature geometries (objects of class <code>sfg</code> ), or a single list of such objects; NULL values will get replaced by empty geometries.
<code>crs</code>	coordinate reference system: integer with the EPSG code, or character with proj4string
<code>precision</code>	numeric; see <a href="#">st_as_binary</a>
<code>check_ring_dir</code>	see <a href="#">st_read</a>
<code>dim</code>	character; if this function is called without valid geometries, this argument may carry the right dimension to set empty geometries
<code>recompute_bbox</code>	logical; use TRUE to force recomputation of the bounding box

### Details

A simple feature geometry list-column is a list of class `c("stc_TYPE", "sfc")` which most often contains objects of identical type; in case of a mix of types or an empty set, TYPE is set to the superclass GEOMETRY.

### Value

an object of class `sfc`, which is a classed list-column with simple feature geometries.

### Examples

```

pt1 = st_point(c(0,1))
pt2 = st_point(c(1,1))
(sfc = st_sfc(pt1, pt2))
d = st_sf(data.frame(a=1:2, geom=sfc))

```

---

<code>sf_extSoftVersion</code>	<i>Provide the external dependencies versions of the libraries linked to sf</i>
--------------------------------	---

---

### Description

Provide the external dependencies versions of the libraries linked to sf

### Usage

```
sf_extSoftVersion()
```

---

sf_project	<i>directly transform a set of coordinates</i>
------------	--

---

**Description**

directly transform a set of coordinates

**Usage**

```
sf_add_proj_units()

sf_project(
  from = character(),
  to = character(),
  pts,
  keep = FALSE,
  warn = TRUE,
  authority_compliant = st_axis_order()
)
```

**Arguments**

from	character description of source CRS, or object of class <code>crs</code> , or pipeline describing a transformation
to	character description of target CRS, or object of class <code>crs</code>
pts	two-, three- or four-column numeric matrix, or object that can be coerced into a matrix; columns 3 and 4 contain z and t values.
keep	logical value controlling the handling of unprojectable points. If 'keep' is 'TRUE', then such points will yield 'Inf' or '-Inf' in the return value; otherwise an error is reported and nothing is returned.
warn	logical; if TRUE, warn when non-finite values are generated
authority_compliant	logical; TRUE means handle axis order authority compliant (e.g. EPSG:4326 implying x=lat, y=lon), FALSE means use visualisation order (i.e. always x=lon, y=lat)

**Details**

`sf_add_proj_units` loads the PROJ units 'link', 'us\_in', 'ind\_yd', 'ind\_ft', and 'ind\_ch' into the `udunits` database, and returns TRUE invisibly on success.

**Value**

two-column numeric matrix with transformed/converted coordinates, returning invalid values as `Inf`

**Examples**

```
sf_add_proj_units()
```

---

sgbp

---

*Methods for dealing with sparse geometry binary predicate lists*


---

**Description**

Methods for dealing with sparse geometry binary predicate lists

**Usage**

```
## S3 method for class 'sgbp'
print(x, ..., n = 10, max_nb = 10)
```

```
## S3 method for class 'sgbp'
t(x)
```

```
## S3 method for class 'sgbp'
as.matrix(x, ...)
```

```
## S3 method for class 'sgbp'
dim(x)
```

**Arguments**

x	object of class sgbp
...	ignored
n	integer; maximum number of items to print
max_nb	integer; maximum number of neighbours to print for each item

**Details**

sgbp are sparse matrices, stored as a list with integer vectors holding the ordered TRUE indices of each row. This means that for a dense,  $m \times n$  matrix  $Q$  and a list  $L$ , if  $Q[i, j]$  is TRUE then  $j$  is an element of  $L[[i]]$ . Reversed: when  $k$  is the value of  $L[[i]][j]$ , then  $Q[i, k]$  is TRUE.

---

st	<i>Create simple feature from a numeric vector, matrix or list</i>
----	--

---

### Description

Create simple feature from a numeric vector, matrix or list

### Usage

```

st_point(x = c(NA_real_, NA_real_), dim = "XYZ")

st_multipoint(x = matrix(numeric(0), 0, 2), dim = "XYZ")

st_linestring(x = matrix(numeric(0), 0, 2), dim = "XYZ")

st_polygon(x = list(), dim = if (length(x)) "XYZ" else "XY")

st_multilinestring(x = list(), dim = if (length(x)) "XYZ" else "XY")

st_multipolygon(x = list(), dim = if (length(x)) "XYZ" else "XY")

st_geometrycollection(x = list(), dims = "XY")

## S3 method for class 'sfg'
print(x, ..., width = 0)

## S3 method for class 'sfg'
head(x, n = 10L, ...)

## S3 method for class 'sfg'
format(x, ..., width = 30)

## S3 method for class 'sfg'
c(..., recursive = FALSE, flatten = TRUE)

## S3 method for class 'sfg'
as.matrix(x, ...)

```

### Arguments

x	for <code>st_point</code> , numeric vector (or one-row-matrix) of length 2, 3 or 4; for <code>st_linestring</code> and <code>st_multipoint</code> , numeric matrix with points in rows; for <code>st_polygon</code> and <code>st_multilinestring</code> , list with numeric matrices with points in rows; for <code>st_multipolygon</code> , list of lists with numeric matrices; for <code>st_geometrycollection</code> list with (non-geometrycollection) simple feature objects
---	--

dim	character, indicating dimensions: "XY", "XYZ", "XYM", or "XYZM"; only really needed for three-dimensional points (which can be either XYZ or XYM) or empty geometries; see details
dims	character; specify dimensionality in case of an empty (NULL) geometrycollection, in which case x is the empty list().
...	objects to be pasted together into a single simple feature
width	integer; number of characters to be printed (max 30; 0 means print everything)
n	integer; number of elements to be selected
recursive	logical; ignored
flatten	logical; if TRUE, try to simplify results; if FALSE, return geometrycollection containing all objects

### Details

"XYZ" refers to coordinates where the third dimension represents altitude, "XYM" refers to three-dimensional coordinates where the third dimension refers to something else ("M" for measure); checking of the sanity of x may be only partial.

When `flatten=TRUE`, this method may merge points into a multipoint structure, and may not preserve order, and hence cannot be reverted. When given fish, it returns fish soup.

### Value

object of the same nature as x, but with appropriate class attribute set

`as.matrix` returns the set of points that form a geometry as a single matrix, where each point is a row; use `unlist(x, recursive = FALSE)` to get sets of matrices.

### Examples

```
(p1 = st_point(c(1,2)))
class(p1)
st_bbox(p1)
(p2 = st_point(c(1,2,3)))
class(p2)
(p3 = st_point(c(1,2,3), "XYM"))
pts = matrix(1:10, , 2)
(mp1 = st_multipoint(pts))
pts = matrix(1:15, , 3)
(mp2 = st_multipoint(pts))
(mp3 = st_multipoint(pts, "XYM"))
pts = matrix(1:20, , 4)
(mp4 = st_multipoint(pts))
pts = matrix(1:10, , 2)
(ls1 = st_linestring(pts))
pts = matrix(1:15, , 3)
(ls2 = st_linestring(pts))
(ls3 = st_linestring(pts, "XYM"))
pts = matrix(1:20, , 4)
(ls4 = st_linestring(pts))
```

```

outer = matrix(c(0,0,10,0,10,10,0,10,0,0),ncol=2, byrow=TRUE)
hole1 = matrix(c(1,1,1,2,2,2,2,1,1,1),ncol=2, byrow=TRUE)
hole2 = matrix(c(5,5,5,6,6,6,6,5,5,5),ncol=2, byrow=TRUE)
pts = list(outer, hole1, hole2)
(ml1 = st_multilinestring(pts))
pts3 = lapply(pts, function(x) cbind(x, 0))
(ml2 = st_multilinestring(pts3))
(ml3 = st_multilinestring(pts3, "XYM"))
pts4 = lapply(pts3, function(x) cbind(x, 0))
(ml4 = st_multilinestring(pts4))
outer = matrix(c(0,0,10,0,10,10,0,10,0,0),ncol=2, byrow=TRUE)
hole1 = matrix(c(1,1,1,2,2,2,2,1,1,1),ncol=2, byrow=TRUE)
hole2 = matrix(c(5,5,5,6,6,6,6,5,5,5),ncol=2, byrow=TRUE)
pts = list(outer, hole1, hole2)
(pl1 = st_polygon(pts))
pts3 = lapply(pts, function(x) cbind(x, 0))
(pl2 = st_polygon(pts3))
(pl3 = st_polygon(pts3, "XYM"))
pts4 = lapply(pts3, function(x) cbind(x, 0))
(pl4 = st_polygon(pts4))
pol1 = list(outer, hole1, hole2)
pol2 = list(outer + 12, hole1 + 12)
pol3 = list(outer + 24)
mp = list(pol1,pol2,pol3)
(mp1 = st_multipolygon(mp))
pts3 = lapply(mp, function(x) lapply(x, function(y) cbind(y, 0)))
(mp2 = st_multipolygon(pts3))
(mp3 = st_multipolygon(pts3, "XYM"))
pts4 = lapply(mp2, function(x) lapply(x, function(y) cbind(y, 0)))
(mp4 = st_multipolygon(pts4))
(gc = st_geometrycollection(list(p1, ls1, pl1, mp1)))
st_geometrycollection() # empty geometry
c(st_point(1:2), st_point(5:6))
c(st_point(1:2), st_multipoint(matrix(5:8,2)))
c(st_multipoint(matrix(1:4,2)), st_multipoint(matrix(5:8,2)))
c(st_linestring(matrix(1:6,3)), st_linestring(matrix(11:16,3)))
c(st_multilinestring(list(matrix(1:6,3))), st_multilinestring(list(matrix(11:16,3))))
pl = list(rbind(c(0,0), c(1,0), c(1,1), c(0,1), c(0,0)))
c(st_polygon(pl), st_polygon(pl))
c(st_polygon(pl), st_multipolygon(list(pl)))
c(st_linestring(matrix(1:6,3)), st_point(1:2))
c(st_geometrycollection(list(st_point(1:2), st_linestring(matrix(1:6,3))),
  st_geometrycollection(list(st_multilinestring(list(matrix(11:16,3))))))
c(st_geometrycollection(list(st_point(1:2), st_linestring(matrix(1:6,3))),
  st_multilinestring(list(matrix(11:16,3))), st_point(5:6),
  st_geometrycollection(list(st_point(10:11))))

```

**Description**

functions only exported to be used internally by stars

**Usage**

```
.get_layout(bb, n, total_size, key.pos, key.length, mfrow = NULL)

.degAxis(side, at, labels, ..., lon, lat, ndiscr, reset)

.image_scale(
  z,
  col,
  breaks = NULL,
  key.pos,
  add.axis = TRUE,
  at = NULL,
  ...,
  axes = FALSE,
  key.length,
  logz = FALSE,
  lab = ""
)

.image_scale_factor(
  z,
  col,
  key.pos,
  add.axis = TRUE,
  ...,
  axes = FALSE,
  key.width,
  key.length
)
```

**Arguments**

bb	ignore
n	ignore
total_size	ignore
key.pos	ignore
key.length	ignore
mfrow	length-2 integer vector with number of rows, columns
side	ignore
at	ignore
labels	ignore
...	ignore



lon	ignore
lat	ignore
ndiscr	ignore
reset	ignore
z	ignore
col	ignore
breaks	ignore
add.axis	ignore
axes	ignore
logz	ignore
lab	ignore
key.width	ignore

---

st_agr	<i>get or set relation_to_geometry attribute of an sf object</i>
--------	--

---

### Description

get or set relation\_to\_geometry attribute of an sf object

### Usage

NA\_agr\_

st\_agr(x, ...)

st\_agr(x) <- value

st\_set\_agr(x, value)

### Arguments

x	object of class sf
...	ignored
value	character, or factor with appropriate levels; if named, names should correspond to the non-geometry list-column columns of x

### Format

An object of class factor of length 1.

### Details

NA\_agr\_ is the agr object with a missing value.

---

st\_as\_binary                      *Convert sfc object to an WKB object*

---

### Description

Convert sfc object to an WKB object

### Usage

```
st_as_binary(x, ...)

## S3 method for class 'sfc'
st_as_binary(
  x,
  ...,
  EWKB = FALSE,
  endian = .Platform$endian,
  pureR = FALSE,
  precision = attr(x, "precision"),
  hex = FALSE
)

## S3 method for class 'sfg'
st_as_binary(
  x,
  ...,
  endian = .Platform$endian,
  EWKB = FALSE,
  pureR = FALSE,
  hex = FALSE,
  srid = 0
)
```

### Arguments

x	object to convert
...	ignored
EWKB	logical; use EWKB (PostGIS), or (default) ISO-WKB?
endian	character; either "big" or "little"; default: use that of platform
pureR	logical; use pure R solution, or C++?
precision	numeric; if zero, do not modify; to reduce precision: negative values convert to float (4-byte real); positive values convert to round(x*precision)/precision. See details.
hex	logical; return as (unclassed) hexadecimal encoded character vector?
srid	integer; override srid (can be used when the srid is unavailable locally).

## Details

st\_as\_binary is called on sfc objects on their way to the GDAL or GEOS libraries, and hence does rounding (if requested) on the fly before e.g. computing spatial predicates like [st\\_intersects](#). The examples show a round-trip of an sfc to and from binary.

For the precision model used, see also <https://locationtech.github.io/jts/javadoc/org/locationtech/jts/geom/PrecisionModel.html>. There, it is written that: "... to specify 3 decimal places of precision, use a scale factor of 1000. To specify -3 decimal places of precision (i.e. rounding to the nearest 1000), use a scale factor of 0.001.". Note that ALL coordinates, so also Z or M values (if present) are affected.

## Examples

```
# examples of setting precision:
st_point(c(1/3, 1/6)) %>% st_sfc(precision = 1000) %>% st_as_binary %>% st_as_sfc
st_point(c(1/3, 1/6)) %>% st_sfc(precision = 100) %>% st_as_binary %>% st_as_sfc
st_point(1e6 * c(1/3, 1/6)) %>% st_sfc(precision = 0.01) %>% st_as_binary %>% st_as_sfc
st_point(1e6 * c(1/3, 1/6)) %>% st_sfc(precision = 0.001) %>% st_as_binary %>% st_as_sfc
```

---

st_as_grob	<i>Convert sf* object to a grob</i>
------------	-------------------------------------

---

## Description

Convert sf\* object to an grid graphics object (grob)

## Usage

```
st_as_grob(x, ...)
```

## Arguments

x	object to be converted into an object class grob
...	passed on to the xxxGrob function, e.g. gp = gpar(col = 'red')

---

st_as_sf	<i>Convert foreign object to an sf object</i>
----------	---

---

## Description

Convert foreign object to an sf object

**Usage**

```
st_as_sf(x, ...)

## S3 method for class 'data.frame'
st_as_sf(
  x,
  ...,
  agr = NA_agr_,
  coords,
  wkt,
  dim = "XYZ",
  remove = TRUE,
  na.fail = TRUE,
  sf_column_name = NULL
)

## S3 method for class 'sf'
st_as_sf(x, ...)

## S3 method for class 'sfc'
st_as_sf(x, ...)

## S3 method for class 'Spatial'
st_as_sf(x, ...)

## S3 method for class 'map'
st_as_sf(x, ..., fill = TRUE, group = TRUE)

## S3 method for class 'ppp'
st_as_sf(x, ...)

## S3 method for class 'psp'
st_as_sf(x, ...)

## S3 method for class 'lpp'
st_as_sf(x, ...)

## S3 method for class 's2_geography'
st_as_sf(x, ..., crs = st_crs(4326))
```

**Arguments**

x	object to be converted into an object class sf
...	passed on to <a href="#">st_sf</a> , might included named arguments crs or precision
agr	character vector; see details section of <a href="#">st_sf</a>
coords	in case of point data: names or numbers of the numeric columns holding coordinates

wkt	name or number of the character column that holds WKT encoded geometries
dim	passed on to <a href="#">st_point</a> (only when argument coords is given)
remove	logical; when coords or wkt is given, remove these columns from data.frame?
na.fail	logical; if TRUE, raise an error if coordinates contain missing values
sf_column_name	character; name of the active list-column with simple feature geometries; in case there is more than one and sf_column_name is NULL, the first one is taken.
fill	logical; the value for fill that was used in the call to <a href="#">map</a> .
group	logical; if TRUE, group id labels from <a href="#">map</a> by their prefix before :
crs	coordinate reference system to be assigned; object of class crs

### Details

setting argument wkt annihilates the use of argument coords. If x contains a column called "geometry", coords will result in overwriting of this column by the [sfc](#) geometry list-column. Setting wkt will replace this column with the geometry list-column, unless remove is FALSE.

### Examples

```
pt1 = st_point(c(0,1))
pt2 = st_point(c(1,1))
st_sfc(pt1, pt2)
d = data.frame(a = 1:2)
d$geom = st_sfc(pt1, pt2)
df = st_as_sf(d)
d$geom = c("POINT(0 0)", "POINT(0 1)")
df = st_as_sf(d, wkt = "geom")
d$geom2 = st_sfc(pt1, pt2)
st_as_sf(d) # should warn
if (require(sp, quietly = TRUE)) {
  data(meuse, package = "sp")
  meuse_sf = st_as_sf(meuse, coords = c("x", "y"), crs = 28992, agr = "constant")
  meuse_sf[1:3,]
  summary(meuse_sf)
}
if (require(sp, quietly = TRUE)) {
  x = rbind(c(-1,-1), c(1,-1), c(1,1), c(-1,1), c(-1,-1))
  x1 = 0.1 * x + 0.1
  x2 = 0.1 * x + 0.4
  x3 = 0.1 * x + 0.7
  y = x + 3
  y1 = x1 + 3
  y3 = x3 + 3
  m = matrix(c(3, 0), 5, 2, byrow = TRUE)
  z = x + m
  z1 = x1 + m
  z2 = x2 + m
  z3 = x3 + m
  p1 = Polygons(list( Polygon(x[5:1,]), Polygon(x2), Polygon(x3),
    Polygon(y[5:1,]), Polygon(y1), Polygon(x1), Polygon(y3)), "ID1")
```

```

p2 = Polygons(list( Polygon(z[5:1,]), Polygon(z2), Polygon(z3), Polygon(z1)),
  "ID2")
r = SpatialPolygons(list(p1,p2))
a = suppressWarnings(st_as_sf(r))
summary(a)
demo(meuse, ask = FALSE, echo = FALSE)
summary(st_as_sf(meuse))
summary(st_as_sf(meuse.grid))
summary(st_as_sf(meuse.area))
summary(st_as_sf(meuse.riv))
summary(st_as_sf(as(meuse.riv, "SpatialLines")))
pol.grd = as(meuse.grid, "SpatialPolygonsDataFrame")
# summary(st_as_sf(pol.grd))
# summary(st_as_sf(as(pol.grd, "SpatialLinesDataFrame")))
}
if (require(spatstat.geom)) {
  g = st_as_sf(gorillas)
  # select only the points:
  g[st_is(g, "POINT"),]
}
if (require(spatstat.linnet)) {
  data(chicago)
  plot(st_as_sf(chicago)["label"])
  plot(st_as_sf(chicago)[-1,"label"])
}

```

---

st\_as\_sfc

*Convert foreign geometry object to an sfc object*


---

## Description

Convert foreign geometry object to an sfc object

## Usage

```

## S3 method for class 'pq_geometry'
st_as_sfc(
  x,
  ...,
  EWKB = TRUE,
  spatialite = FALSE,
  pureR = FALSE,
  crs = NA_crs_
)

## S3 method for class 'list'
st_as_sfc(x, ..., crs = NA_crs_)

## S3 method for class 'blob'

```

```
st_as_sfc(x, ...)

## S3 method for class 'bbox'
st_as_sfc(x, ...)

## S3 method for class 'WKB'
st_as_sfc(
  x,
  ...,
  EWKB = FALSE,
  spatialite = FALSE,
  pureR = FALSE,
  crs = NA_crs_
)

## S3 method for class 'raw'
st_as_sfc(x, ...)

## S3 method for class 'character'
st_as_sfc(x, crs = NA_integer_, ..., GeoJSON = FALSE)

## S3 method for class 'factor'
st_as_sfc(x, ...)

st_as_sfc(x, ...)

## S3 method for class 'SpatialPoints'
st_as_sfc(x, ..., precision = 0)

## S3 method for class 'SpatialPixels'
st_as_sfc(x, ..., precision = 0)

## S3 method for class 'SpatialMultiPoints'
st_as_sfc(x, ..., precision = 0)

## S3 method for class 'SpatialLines'
st_as_sfc(x, ..., precision = 0, forceMulti = FALSE)

## S3 method for class 'SpatialPolygons'
st_as_sfc(x, ..., precision = 0, forceMulti = FALSE)

## S3 method for class 'map'
st_as_sfc(x, ...)

## S3 method for class 's2_geography'
st_as_sfc(
  x,
  ...,
```

```

    crs = st_crs(4326),
    endian = match(.Platform$endian, c("big", "little")) - 1L
  )

```

### Arguments

x	object to convert
...	further arguments
EWKB	logical; if TRUE, parse as EWKB (extended WKB; PostGIS: ST_AsEWKB), otherwise as ISO WKB (PostGIS: ST_AsBinary)
spatialite	logical; if TRUE, WKB is assumed to be in the spatialite dialect, see <a href="https://www.gaia-gis.it/gaia-sins/BLOB-Geometry.html">https://www.gaia-gis.it/gaia-sins/BLOB-Geometry.html</a> ; this is only supported in native endian-ness (i.e., files written on system with the same endian-ness as that on which it is being read).
pureR	logical; if TRUE, use only R code, if FALSE, use compiled (C++) code; use TRUE when the endian-ness of the binary differs from the host machine (.Platform\$endian).
crs	coordinate reference system to be assigned; object of class crs
GeoJSON	logical; if TRUE, try to read geometries from GeoJSON text strings geometry, see <a href="#">st_crs()</a>
precision	precision value; see <a href="#">st_as_binary</a>
forceMulti	logical; if TRUE, force coercion into MULTIPOLYGON or MULTILINE objects, else autodetect
endian	integer; 0 or 1: defaults to the endian of the native machine

### Details

When converting from WKB, the object x is either a character vector such as typically obtained from PostGIS (either with leading "0x" or without), or a list with raw vectors representing the features in binary (raw) form.

If x is a character vector, it should be a vector containing [well-known-text](#), or Postgis EWKT or GeoJSON representations of a single geometry for each vector element.

If x is a factor, it is converted to character.

### Examples

```

wkb = structure(list("01010000204071000000000000801A064100000000AC5C1441"), class = "WKB")
st_as_sfc(wkb, EWKB = TRUE)
wkb = structure(list("0x01010000204071000000000000801A064100000000AC5C1441"), class = "WKB")
st_as_sfc(wkb, EWKB = TRUE)
st_as_sfc(st_as_binary(st_sfc(st_point(0:1)))[[1]], crs = 4326)
st_as_sfc("SRID=3978;LINESTRING(1663106 -105415,1664320 -104617)")

```



---

st_as_text	<i>Return Well-known Text representation of simple feature geometry or coordinate reference system</i>
------------	--

---

### Description

Return Well-known Text representation of simple feature geometry or coordinate reference system

### Usage

```
## S3 method for class 'crs'
st_as_text(x, ..., projjson = FALSE, pretty = FALSE)

st_as_text(x, ...)

## S3 method for class 'sfg'
st_as_text(x, ...)

## S3 method for class 'sfc'
st_as_text(x, ..., EWKT = FALSE)
```

### Arguments

x	object of class sfg, sfc or crs
...	modifiers; in particular digits can be passed to control the number of digits used
projjson	logical; if TRUE, return projjson form (requires GDAL 3.1 and PROJ 6.2), else return well-known-text form
pretty	logical; if TRUE, print human-readable well-known-text representation of a coordinate reference system
EWKT	logical; if TRUE, print SRID=xxx; before the WKT string if epsg is available

### Details

The returned WKT representation of simple feature geometry conforms to the [simple features access](#) specification and extensions (known as EWKT, supported by PostGIS and other simple features implementations for addition of a SRID to a WKT string).

### Examples

```
st_as_text(st_point(1:2))
st_as_text(st_sfc(st_point(c(-90,40))), crs = 4326), EWKT = TRUE)
```

---

st_bbox	<i>Return bounding of a simple feature or simple feature set</i>
---------	--

---

**Description**

Return bounding of a simple feature or simple feature set

**Usage**

```
## S3 method for class 'bbox'  
is.na(x)  
  
st_bbox(obj, ...)  
  
## S3 method for class 'POINT'  
st_bbox(obj, ...)  
  
## S3 method for class 'MULTIPOINT'  
st_bbox(obj, ...)  
  
## S3 method for class 'LINESTRING'  
st_bbox(obj, ...)  
  
## S3 method for class 'POLYGON'  
st_bbox(obj, ...)  
  
## S3 method for class 'MULTILINESTRING'  
st_bbox(obj, ...)  
  
## S3 method for class 'MULTIPOLYGON'  
st_bbox(obj, ...)  
  
## S3 method for class 'GEOMETRYCOLLECTION'  
st_bbox(obj, ...)  
  
## S3 method for class 'MULTISURFACE'  
st_bbox(obj, ...)  
  
## S3 method for class 'MULTICURVE'  
st_bbox(obj, ...)  
  
## S3 method for class 'CURVEPOLYGON'  
st_bbox(obj, ...)  
  
## S3 method for class 'COMPOUNDCURVE'  
st_bbox(obj, ...)
```

```
## S3 method for class 'POLYHEDRALSURFACE'
st_bbox(obj, ...)

## S3 method for class 'TIN'
st_bbox(obj, ...)

## S3 method for class 'TRIANGLE'
st_bbox(obj, ...)

## S3 method for class 'CIRCULARSTRING'
st_bbox(obj, ...)

## S3 method for class 'sfc'
st_bbox(obj, ...)

## S3 method for class 'sf'
st_bbox(obj, ...)

## S3 method for class 'Spatial'
st_bbox(obj, ...)

## S3 method for class 'Raster'
st_bbox(obj, ...)

## S3 method for class 'Extent'
st_bbox(obj, ..., crs = NA_crs_)

## S3 method for class 'numeric'
st_bbox(obj, ..., crs = NA_crs_)

NA_bbox_

## S3 method for class 'bbox'
format(x, ...)
```

## Arguments

x	object of class bbox
obj	object to compute the bounding box from
...	for format.bbox, passed on to <a href="#">format</a> to format individual numbers
crs	object of class crs, or argument to <a href="#">st_crs</a> , specifying the CRS of this bounding box.

## Format

An object of class bbox of length 4.

**Details**

NA\_bbox\_ represents the missing value for a bbox object

**Value**

a numeric vector of length four, with xmin, ymin, xmax and ymax values; if obj is of class sf, sfc, Spatial or Raster, the object returned has a class bbox, an attribute crs and a method to print the bbox and an st\_crs method to retrieve the coordinate reference system corresponding to obj (and hence the bounding box). st\_as\_sfc has a methods for bbox objects to generate a polygon around the four bounding box points.

**Examples**

```
a = st_sf(a = 1:2, geom = st_sfc(st_point(0:1), st_point(1:2)), crs = 4326)
st_bbox(a)
st_as_sfc(st_bbox(a))
st_bbox(c(xmin = 16.1, xmax = 16.6, ymax = 48.6, ymin = 47.9), crs = st_crs(4326))
```

---

st\_break\_antimeridian *Break antimeridian for plotting not centred on Greenwich*

---

**Description**

Longitudes can be broken at the antimeridian of a target central longitude to permit plotting of (usually world) line or polygon objects centred on the chosen central longitude. The method may only be used with non-projected, geographical coordinates and linestring or polygon objects. s2 is turned off internally to permit the use of a rectangular bounding box. If the input geometries go outside [-180, 180] degrees longitude, the protruding geometries will also be split using the same tol= values; in this case empty geometries will be dropped first.

**Usage**

```
st_break_antimeridian(x, lon_0 = 0, tol = 1e-04, ...)

## S3 method for class 'sf'
st_break_antimeridian(x, lon_0 = 0, tol = 1e-04, ...)

## S3 method for class 'sfc'
st_break_antimeridian(x, lon_0 = 0, tol = 1e-04, ...)
```

**Arguments**

x	object of class sf or sfc
lon_0	target central longitude (degrees)
tol	half of break width (degrees, default 0.0001)
...	ingnored here

**Examples**

```

if (require("maps", quietly=TRUE)) {
  opar = par(mfrow=c(3, 2))
  wld = st_as_sf(map(fill=FALSE, interior=FALSE, plot=FALSE), fill=FALSE)
  for (lon_0 in c(-170, -90, -10, 10, 90, 170)) {
    wld |> st_break_antimeridian(lon_0=lon_0) |>
      st_transform(paste0("+proj=natearth +lon_0=", lon_0)) |>
      st_geometry() |> plot(main=lon_0)
  }
  par(opar)
}

```

---

st\_cast

*Cast geometry to another type: either simplify, or cast explicitly*


---

**Description**

Cast geometry to another type: either simplify, or cast explicitly

**Usage**

```

## S3 method for class 'MULTIPOLYGON'
st_cast(x, to, ...)

## S3 method for class 'MULTILINESTRING'
st_cast(x, to, ...)

## S3 method for class 'MULTIPOINT'
st_cast(x, to, ...)

## S3 method for class 'POLYGON'
st_cast(x, to, ...)

## S3 method for class 'LINESTRING'
st_cast(x, to, ...)

## S3 method for class 'POINT'
st_cast(x, to, ...)

## S3 method for class 'GEOMETRYCOLLECTION'
st_cast(x, to, ...)

## S3 method for class 'CIRCULARSTRING'
st_cast(x, to, ...)

```

```

## S3 method for class 'MULTISURFACE'
st_cast(x, to, ...)

## S3 method for class 'COMPOUNDCURVE'
st_cast(x, to, ...)

## S3 method for class 'MULTICURVE'
st_cast(x, to, ...)

## S3 method for class 'CURVE'
st_cast(x, to, ...)

st_cast(x, to, ...)

## S3 method for class 'sfc'
st_cast(x, to, ..., ids = seq_along(x), group_or_split = TRUE)

## S3 method for class 'sf'
st_cast(x, to, ..., warn = TRUE, do_split = TRUE)

## S3 method for class 'sfc_CIRCULARSTRING'
st_cast(x, to, ...)

```

### Arguments

x	object of class sfg, sfc or sf
to	character; target type, if missing, simplification is tried; when x is of type sfg (i.e., a single geometry) then to needs to be specified.
...	ignored
ids	integer vector, denoting how geometries should be grouped (default: no grouping)
group_or_split	logical; if TRUE, group or split geometries; if FALSE, carry out a 1-1 per-geometry conversion.
warn	logical; if TRUE, warn if attributes are assigned to sub-geometries
do_split	logical; if TRUE, allow splitting of geometries in sub-geometries

### Details

When converting a GEOMETRYCOLLECTION to COMPOUNDCURVE, MULTISURFACE or CURVEPOLYGON, the user is responsible for the validity of the resulting object: no checks are being carried out by the software.

When converting mixed, GEOMETRY sets, it may help to first convert to the MULTI-type, see examples

the st\_cast method for sf objects can only split geometries, e.g. cast MULTIPOINT into multiple POINT features. In case of splitting, attributes are repeated and a warning is issued when non-constant attributes are assigned to sub-geometries. To merge feature geometries and attribute values, use [aggregate](#) or [summarise](#).

**Value**

object of class `to` if successful, or unmodified object if unsuccessful. If information gets lost while type casting, a warning is raised.

In case `to` is missing, `st_cast.sfc` will coerce combinations of "POINT" and "MULTIPOINT", "LINESTRING" and "MULTILINESTRING", "POLYGON" and "MULTIPOLYGON" into their "MULTI..." form, or in case all geometries are "GEOMETRYCOLLECTION" will return a list of all the contents of the "GEOMETRYCOLLECTION" objects, or else do nothing. In case `to` is specified, if `to` is "GEOMETRY", geometries are not converted, else, `st_cast` will try to coerce all elements into `to`; `ids` may be specified to group e.g. "POINT" objects into a "MULTIPOINT", if not specified no grouping takes place. If e.g. a "sfc\_MULTIPOINT" is cast to a "sfc\_POINT", the objects are split, so no information gets lost, unless `group_or_split` is FALSE.

**Examples**

```
# example(st_read)
nc = st_read(system.file("shape/nc.shp", package="sf"))
mpl <- nc$geometry[[4]]
#st_cast(x) ## error 'argument "to" is missing, with no default'
cast_all <- function(xg) {
  lapply(c("MULTIPOLYGON", "MULTILINESTRING", "MULTIPOINT", "POLYGON", "LINESTRING", "POINT"),
         function(x) st_cast(xg, x))
}
st_sfc(cast_all(mpl))
## no closing coordinates should remain for multipoint
any(duplicated(unclass(st_cast(mpl, "MULTIPOINT")))) ## should be FALSE
## number of duplicated coordinates in the linestrings should equal the number of polygon rings
## (... in this case, won't always be true)
sum(duplicated(do.call(rbind, unclass(st_cast(mpl, "MULTILINESTRING"))))
    ) == sum(unlist(lapply(mpl, length))) ## should be TRUE

p1 <- structure(c(0, 1, 3, 2, 1, 0, 0, 0, 2, 4, 4, 0), .Dim = c(6L, 2L))
p2 <- structure(c(1, 1, 2, 1, 1, 2, 2, 1), .Dim = c(4L, 2L))
st_polygon(list(p1, p2))
m1s <- st_cast(nc$geometry[[4]], "MULTILINESTRING")
st_sfc(cast_all(m1s))
mpt <- st_cast(nc$geometry[[4]], "MULTIPOINT")
st_sfc(cast_all(mpt))
p1 <- st_cast(nc$geometry[[4]], "POLYGON")
st_sfc(cast_all(p1))
ls <- st_cast(nc$geometry[[4]], "LINESTRING")
st_sfc(cast_all(ls))
pt <- st_cast(nc$geometry[[4]], "POINT")
## st_sfc(cast_all(pt)) ## Error: cannot create MULTIPOLYGON from POINT
st_sfc(lapply(c("POINT", "MULTIPOINT"), function(x) st_cast(pt, x)))
s = st_multipoint(rbind(c(1,0)))
st_cast(s, "POINT")
# https://github.com/r-spatial/sf/issues/1930:
pt1 <- st_point(c(0,1))
pt23 <- st_multipoint(matrix(c(1,2,3,4), ncol = 2, byrow = TRUE))
d <- st_sf(geom = st_sfc(pt1, pt23))
st_cast(d, "POINT") # will not convert the entire MULTIPOINT, and warns
```

```
st_cast(d, "MULTIPOINT") %>% st_cast("POINT")
```

---

```
st_cast_sfc_default    Coerce geometry to MULTI* geometry
```

---

### Description

Mixes of POINTS and MULTIPOINTS, LINESTRING and MULTILINESTRING, POLYGON and MULTIPOLYGON are returned as MULTIPOINTS, MULTILINESTRING and MULTIPOLYGONS respectively

### Usage

```
st_cast_sfc_default(x)
```

### Arguments

x                    list of geometries or simple features

### Details

Geometries that are already MULTI\* are left unchanged. Features that can't be cast to a single MULTI\* geometry are return as a GEOMETRYCOLLECTION

---

```
st_collection_extract Given an object with geometries of type GEOMETRY or  
GEOMETRYCOLLECTION, return an object consisting only of ele-  
ments of the specified type.
```

---

### Description

Similar to ST\_CollectionExtract in PostGIS. If there are no sub-geometries of the specified type, an empty geometry is returned.

### Usage

```
st_collection_extract(  
  x,  
  type = c("POLYGON", "POINT", "LINESTRING"),  
  warn = FALSE  
)  
  
## S3 method for class 'sfg'  
st_collection_extract(  
  x,  
  type = c("POLYGON", "POINT", "LINESTRING"),
```



```

    warn = FALSE
  )

## S3 method for class 'sfc'
st_collection_extract(
  x,
  type = c("POLYGON", "POINT", "LINESTRING"),
  warn = FALSE
)

## S3 method for class 'sf'
st_collection_extract(
  x,
  type = c("POLYGON", "POINT", "LINESTRING"),
  warn = FALSE
)

```

### Arguments

x	an object of class sf, sfc or sfg that has mixed geometry (GEOMETRY or GEOMETRYCOLLECTION).
type	character; one of "POLYGON", "POINT", "LINESTRING"
warn	logical; if TRUE, warn if attributes are assigned to sub-geometries when casting (see <a href="#">st_cast</a> )

### Value

An object having the same class as x, with geometries consisting only of elements of the specified type. For sfg objects, an sfg object is returned if there is only one geometry of the specified type, otherwise the geometries are combined into an sfc object of the relevant type. If any subgeometries in the input are MULTI, then all of the subgeometries in the output will be MULTI.

### Examples

```

pt <- st_point(c(1, 0))
ls <- st_linestring(matrix(c(4, 3, 0, 0), ncol = 2))
poly1 <- st_polygon(list(matrix(c(5.5, 7, 7, 6, 5.5, 0, 0, -0.5, -0.5, 0), ncol = 2)))
poly2 <- st_polygon(list(matrix(c(6.6, 8, 8, 7, 6.6, 1, 1, 1.5, 1.5, 1), ncol = 2)))
multipoly <- st_multipolygon(list(poly1, poly2))

i <- st_geometrycollection(list(pt, ls, poly1, poly2))
j <- st_geometrycollection(list(pt, ls, poly1, poly2, multipoly))

st_collection_extract(i, "POLYGON")
st_collection_extract(i, "POINT")
st_collection_extract(i, "LINESTRING")

## A GEOMETRYCOLLECTION
aa <- rbind(st_sf(a=1, geom = st_sfc(i)),
st_sf(a=2, geom = st_sfc(j)))

```

```

## With sf objects
st_collection_extract(aa, "POLYGON")
st_collection_extract(aa, "LINESTRING")
st_collection_extract(aa, "POINT")

## With sfc objects
st_collection_extract(st_geometry(aa), "POLYGON")
st_collection_extract(st_geometry(aa), "LINESTRING")
st_collection_extract(st_geometry(aa), "POINT")

## A GEOMETRY of single types
bb <- rbind(
  st_sf(a = 1, geom = st_sfc(pt)),
  st_sf(a = 2, geom = st_sfc(ls)),
  st_sf(a = 3, geom = st_sfc(poly1)),
  st_sf(a = 4, geom = st_sfc(multipoly))
)

st_collection_extract(bb, "POLYGON")

## A GEOMETRY of mixed single types and GEOMETRYCOLLECTIONS
cc <- rbind(aa, bb)

st_collection_extract(cc, "POLYGON")

```

---

st_coordinates	<i>retrieve coordinates in matrix form</i>
----------------	--

---

## Description

retrieve coordinates in matrix form

## Usage

```
st_coordinates(x, ...)
```

## Arguments

x	object of class sf, sfc or sfg
...	ignored

## Value

matrix with coordinates (X, Y, possibly Z and/or M) in rows, possibly followed by integer indicators L1,...,L3 that point out to which structure the coordinate belongs; for POINT this is absent (each coordinate is a feature), for LINESTRING L1 refers to the feature, for MULTILINESTRING L1 refers to the part and L2 to the simple feature, for POLYGON L1 refers to the main ring or holes and L2 to

the simple feature, for MULTIPOLYGON L1 refers to the main ring or holes, L2 to the ring id in the MULTIPOLYGON, and L3 to the simple feature.

For POLYGONS, L1 can be used to identify exterior rings and inner holes. The exterior ring is when L1 is equal to 1. Interior rings are identified when L1 is greater than 1. L2 can be used to differentiate between the feature. Whereas for MULTIPOLYGON, L3 refers to the MULTIPOLYGON feature and L2 refers to the component POLYGON.

---

st_crop	<i>crop an sf object to a specific rectangle</i>
---------	--

---

### Description

crop an sf object to a specific rectangle

### Usage

```
st_crop(x, y, ...)

## S3 method for class 'sfc'
st_crop(x, y, ..., xmin, ymin, xmax, ymax)

## S3 method for class 'sf'
st_crop(x, y, ...)
```

### Arguments

x	object of class sf or sfc
y	numeric vector with named elements xmin, ymin, xmax and ymax, or object of class bbox, or object for which there is an <a href="#">st_bbox</a> method to convert it to a bbox object
...	ignored
xmin	minimum x extent of cropping area
ymin	minimum y extent of cropping area
xmax	maximum x extent of cropping area
ymax	maximum y extent of cropping area

### Details

setting arguments xmin, ymin, xmax and ymax implies that argument y gets ignored.

## Examples

```
box = c(xmin = 0, ymin = 0, xmax = 1, ymax = 1)
pol = st_sfc(st_buffer(st_point(c(.5, .5)), .6))
pol_sf = st_sf(a=1, geom=pol)
plot(st_crop(pol, box))
plot(st_crop(pol_sf, st_bbox(box)))
# alternative:
plot(st_crop(pol, xmin = 0, ymin = 0, xmax = 1, ymax = 1))
```

---

st\_crs

*Retrieve coordinate reference system from object*

---

## Description

Retrieve coordinate reference system from sf or sfc object

Set or replace retrieve coordinate reference system from object

## Usage

```
st_crs(x, ...)
```

## S3 method for class 'sf'

```
st_crs(x, ...)
```

## S3 method for class 'numeric'

```
st_crs(x, ...)
```

## S3 method for class 'character'

```
st_crs(x, ...)
```

## S3 method for class 'sfc'

```
st_crs(x, ..., parameters = FALSE)
```

## S3 method for class 'bbox'

```
st_crs(x, ...)
```

## S3 method for class 'CRS'

```
st_crs(x, ...)
```

## S3 method for class 'crs'

```
st_crs(x, ...)
```

```
st_crs(x) <- value
```

## S3 replacement method for class 'sf'

```
st_crs(x) <- value
```

```

## S3 replacement method for class 'sfc'
st_crs(x) <- value

st_set_crs(x, value)

NA_crs_

## S3 method for class 'crs'
is.na(x)

## S3 method for class 'crs'
x$name

## S3 method for class 'crs'
format(x, ...)

st_axis_order(authority_compliant = logical(0))

```

### Arguments

x	numeric, character, or object of class <code>sf</code> or <code>sfc</code>
...	ignored
parameters	logical; FALSE by default; if TRUE return a list of coordinate reference system parameters, with named elements <code>SemiMajor</code> , <code>InvFlattening</code> , <code>units_gdal</code> , <code>IsVertical</code> , <code>WktPretty</code> , and <code>Wkt</code>
value	one of (i) character: a string accepted by GDAL, (ii) integer, a valid EPSG value (numeric), or (iii) an object of class <code>crs</code> .
name	element name
authority_compliant	logical; specify whether axis order should be handled compliant to the authority; if omitted, the current value is printed.

### Format

An object of class `crs` of length 2.

### Details

The `*crs` functions create, get, set or replace the `crs` attribute of a simple feature geometry list-column. This attribute is of class `crs`, and is a list consisting of `input` (user input, e.g. "EPSG:4326" or "WGS84" or a proj4string), and `wkt`, an automatically generated wkt2 representation of the `crs`. If `x` is identical to the `wkt2` representation, and the CRS has a name, this name is used for the `input` field.

Comparison of two objects of class `crs` uses the GDAL function `OGRSpatialReference::IsSame`.

In case a coordinate reference system is replaced, no transformation takes place and a warning is raised to stress this.

`NA_crs_` is the `crs` object with missing values for `input` and `wkt`.

the `$` method for `crs` objects retrieves named elements using the GDAL interface; named elements include "SemiMajor", "SemiMinor", "InvFlattening", "IsGeographic", "units\_gdal", "IsVertical", "WktPretty", "Wkt", "Name", "proj4string", "epsg", "yx", "ud\_unit", and axes (this may be subject to changes in future GDAL versions). "ud\_unit" returns a valid `units` object or NULL if units are missing.

`format.crs` returns NA if the `crs` is missing valued, or else the name of a `crs` if it is different from "unknown", or else the user input if it was set, or else its "proj4string" representation;

`st_axis_order` can be used to get and set the axis order: TRUE indicates axes order according to the authority (e.g. EPSG:4326 defining coordinates to be latitude,longitude pairs), FALSE indicates the usual GIS (display) order (longitude,latitude). This can be useful when data are read, or have to be written, with coordinates in authority compliant order. The return value is the current state of this (FALSE, by default).

## Value

If `x` is numeric, return `crs` object for EPSG:`x`; if `x` is character, return `crs` object for `x`; if `x` is of class `sf` or `sfc`, return its `crs` object.

Object of class `crs`, which is a list with elements `input` (length-1 character) and `wkt` (length-1 character). Elements may be NA valued; if all elements are NA the CRS is missing valued, and coordinates are assumed to relate to an arbitrary Cartesian coordinate system.

`st_axis_order` returns the (logical) current value if called without argument, or (invisibly) the previous value if it is being set.

## Examples

```
sfc = st_sfc(st_point(c(0,0)), st_point(c(1,1)))
sf = st_sf(a = 1:2, geom = sfc)
st_crs(sf) = 4326
st_geometry(sf)
sfc = st_sfc(st_point(c(0,0)), st_point(c(1,1)))
st_crs(sfc) = 4326
sfc
sfc = st_sfc(st_point(c(0,0)), st_point(c(1,1)))
sfc %>% st_set_crs(4326) %>% st_transform(3857)
st_crs("EPSG:3857")$input
st_crs(3857)$proj4string
st_crs(3857)$b      # numeric
st_crs(3857)$units # character
pt = st_sfc(st_point(c(0, 60)), crs = 4326)
# st_axis_order() only has effect in GDAL >= 2.5.0:
st_axis_order() # query default: FALSE means interpret pt as (longitude latitude)
st_transform(pt, 3857)[[1]]
old_value = FALSE
if (sf_extSoftVersion()["GDAL"] >= "2.5.0")
  (old_value = st_axis_order(TRUE))
# now interpret pt as (latitude longitude), as EPSG:4326 prescribes:
st_axis_order() # query current value
st_transform(pt, 3857)[[1]]
st_axis_order(old_value) # set back to old value
```

---

st_drivers	<i>Get GDAL drivers</i>
------------	-------------------------

---

**Description**

Get a list of the available GDAL drivers

**Usage**

```
st_drivers(what = "vector", regex)
```

**Arguments**

what	character: "vector" or "raster", anything else will return all drivers.
regex	character; regular expression to filter the name and long_name fields on

**Details**

The drivers available will depend on the installation of GDAL/OGR, and can vary; the `st_drivers()` function shows all the drivers that are readable, and which may be written. The field `vsi` refers to the driver's capability to read/create datasets through the VSI\*L API. [See GDAL website for additional details on driver support.](#)

**Value**

A `data.frame` with driver metadata.

**Examples**

```
# The following driver lists depend on the GDAL setup and platform used:  
st_drivers()  
st_drivers("raster", "GeoT")
```

---

st_geometry	<i>Get, set, replace or rename geometry from an sf object</i>
-------------	---

---

**Description**

Get, set, replace or rename geometry from an sf object

**Usage**

```
## S3 method for class 'sfc'
st_geometry(obj, ...)

st_geometry(obj, ...)

## S3 method for class 'sf'
st_geometry(obj, ...)

## S3 method for class 'sfc'
st_geometry(obj, ...)

## S3 method for class 'sfg'
st_geometry(obj, ...)

st_geometry(x) <- value

st_set_geometry(x, value)

st_drop_geometry(x, ...)

## S3 method for class 'sf'
st_drop_geometry(x, ...)

## Default S3 method:
st_drop_geometry(x, ...)
```

**Arguments**

obj	object of class sf or sfc
...	ignored
x	object of class data.frame or sf
value	object of class sfc, or character to set, replace, or rename the geometry of x

**Details**

when applied to a data.frame and when value is an object of class sfc, st\_set\_geometry and st\_geometry<- will first check for the existence of an attribute sf\_column and overwrite that, or else look for list-columns of class sfc and overwrite the first of that, or else write the geometry list-column to a column named geometry. In case value is character and x is of class sf, the "active" geometry column is set to x[[value]].

the replacement function applied to sf objects will overwrite the geometry list-column, if value is NULL, it will remove it and coerce x to a data.frame.

if x is of class sf, st\_drop\_geometry drops the geometry of its argument, and reclasses it accordingly; otherwise it returns x unmodified.



**Value**

st\_geometry returns an object of class `sfc`, a list-column with geometries

st\_geometry returns an object of class `sf`. Assigning geometry to a `data.frame` creates an `sf` object, assigning it to an `sf` object replaces the geometry list-column.

**Examples**

```
df = data.frame(a = 1:2)
sfc = st_sfc(st_point(c(3,4)), st_point(c(10,11)))
st_geometry(sfc)
st_geometry(df) <- sfc
class(df)
st_geometry(df)
st_geometry(df) <- sfc # replaces
st_geometry(df) <- NULL # remove geometry, coerce to data.frame
sf <- st_set_geometry(df, sfc) # set geometry, return sf
st_set_geometry(sf, NULL) # remove geometry, coerce to data.frame
```

---

st_geometry_type	<i>Return geometry type of an object</i>
------------------	--

---

**Description**

Return geometry type of an object, as a factor

**Usage**

```
st_geometry_type(x, by_geometry = TRUE)
```

**Arguments**

x	object of class <code>sf</code> or <code>sfc</code>
by_geometry	logical; if TRUE, return geometry type of each geometry, else return geometry type of the set

**Value**

a factor with the geometry type of each simple feature geometry in x, or that of the whole set

---

st\_graticule

*Compute graticules and their parameters*


---

### Description

Compute graticules and their parameters

### Usage

```
st_graticule(
  x = c(-180, -90, 180, 90),
  crs = st_crs(x),
  datum = st_crs(4326),
  ...,
  lon = NULL,
  lat = NULL,
  ndiscr = 100,
  margin = 0.001
)
```

### Arguments

x	object of class <code>sf</code> , <code>sfc</code> or <code>sfg</code> or numeric vector with bounding box given as (minx, miny, maxx, maxy).
crs	object of class <code>crs</code> , with the display coordinate reference system
datum	either an object of class <code>crs</code> with the coordinate reference system for the graticules, or <code>NULL</code> in which case a grid in the coordinate system of <code>x</code> is drawn, or <code>NA</code> , in which case an empty <code>sf</code> object is returned.
...	ignored
lon	numeric; values in degrees East for the meridians, associated with <code>datum</code>
lat	numeric; values in degrees North for the parallels, associated with <code>datum</code>
ndiscr	integer; number of points to discretize a parallel or meridian
margin	numeric; small number to trim a longlat bounding box that touches or crosses +/-180 long or +/-90 latitude.

### Value

an object of class `sf` with additional attributes describing the type (E: meridian, N: parallel) degree value, label, start and end coordinates and angle; see example.

### Use of graticules

In cartographic visualization, the use of graticules is not advised, unless the graphical output will be used for measurement or navigation, or the direction of North is important for the interpretation of

the content, or the content is intended to display distortions and artifacts created by projection. Unnecessary use of graticules only adds visual clutter but little relevant information. Use of coastlines, administrative boundaries or place names permits most viewers of the output to orient themselves better than a graticule.

### Examples

```
library(sf)
if (require(maps, quietly = TRUE)) {

  usa = st_as_sf(map('usa', plot = FALSE, fill = TRUE))
  laea = st_crs("+proj=laea +lat_0=30 +lon_0=-95") # Lambert equal area
  usa <- st_transform(usa, laea)

  bb = st_bbox(usa)
  bbox = st_linestring(rbind(c( bb[1],bb[2]),c( bb[3],bb[2]),
    c( bb[3],bb[4]),c( bb[1],bb[4]),c( bb[1],bb[2])))

  g = st_graticule(usa)
  plot(usa, xlim = 1.2 * c(-2450853.4, 2186391.9))
  plot(g[1], add = TRUE, col = 'grey')
  plot(bbox, add = TRUE)
  points(g$x_start, g$y_start, col = 'red')
  points(g$x_end, g$y_end, col = 'blue')

  invisible(lapply(seq_len(nrow(g)), function(i) {
    if (g$type[i] == "N" && g$x_start[i] - min(g$x_start) < 1000)
      text(g[i,"x_start"], g[i,"y_start"], labels = parse(text = g[i,"degree_label"]),
        srt = g$angle_start[i], pos = 2, cex = .7)
    if (g$type[i] == "E" && g$y_start[i] - min(g$y_start) < 1000)
      text(g[i,"x_start"], g[i,"y_start"], labels = parse(text = g[i,"degree_label"]),
        srt = g$angle_start[i] - 90, pos = 1, cex = .7)
    if (g$type[i] == "N" && g$x_end[i] - max(g$x_end) > -1000)
      text(g[i,"x_end"], g[i,"y_end"], labels = parse(text = g[i,"degree_label"]),
        srt = g$angle_end[i], pos = 4, cex = .7)
    if (g$type[i] == "E" && g$y_end[i] - max(g$y_end) > -1000)
      text(g[i,"x_end"], g[i,"y_end"], labels = parse(text = g[i,"degree_label"]),
        srt = g$angle_end[i] - 90, pos = 3, cex = .7)
  })))
  plot(usa, graticule = st_crs(4326), axes = TRUE, lon = seq(-60,-130,by=-10))
}
```

---

st\_is

*test equality between the geometry type and a class or set of classes*


---

### Description

test equality between the geometry type and a class or set of classes

**Usage**

```
st_is(x, type)
```

**Arguments**

x	object of class sf, sfc or sfg
type	character; class, or set of classes, to test against

**Examples**

```
st_is(st_point(0:1), "POINT")
sfc = st_sfc(st_point(0:1), st_linestring(matrix(1:6,,2)))
st_is(sfc, "POINT")
st_is(sfc, "POLYGON")
st_is(sfc, "LINESTRING")
st_is(st_sf(a = 1:2, sfc), "LINESTRING")
st_is(sfc, c("POINT", "LINESTRING"))
```

---

st\_is\_longlat

---

*Assert whether simple feature coordinates are longlat degrees*


---

**Description**

Assert whether simple feature coordinates are longlat degrees

**Usage**

```
st_is_longlat(x)
```

**Arguments**

x	object of class sf or sfc, or otherwise an object of a class that has an <code>st_crs</code> method returning a crs object
---	--

**Value**

TRUE if x has geographic coordinates, FALSE if it has projected coordinates, or NA if `is.na(st_crs(x))`.

---

st_jitter	<i>jitter geometries</i>
-----------	--------------------------

---

### Description

jitter geometries

### Usage

```
st_jitter(x, amount, factor = 0.002)
```

### Arguments

x	object of class sf or sfc
amount	numeric; amount of jittering applied; if missing, the amount is set to factor * the bounding box diagonal; units of coordinates.
factor	numeric; fractional amount of jittering to be applied

### Details

jitters coordinates with an amount such that `runif(1, -amount, amount)` is added to the coordinates. x- and y-coordinates are jittered independently but all coordinates of a single geometry are jittered with the same amount, meaning that the geometry shape does not change. For longlat data, a latitude correction is made such that jittering in East and North directions are identical in distance in the center of the bounding box of x.

### Examples

```
nc = st_read(system.file("gpkg/nc.gpkg", package="sf"))
pts = st_centroid(st_geometry(nc))
plot(pts)
plot(st_jitter(pts, .05), add = TRUE, col = 'red')
plot(st_geometry(nc))
plot(st_jitter(st_geometry(nc), factor = .01), add = TRUE, col = '#ff8888')
```

---

st_join	<i>spatial join, spatial filter</i>
---------	-------------------------------------

---

### Description

spatial join, spatial filter

**Usage**

```

st_join(x, y, join, ...)

## S3 method for class 'sf'
st_join(
  x,
  y,
  join = st_intersects,
  ...,
  suffix = c(".x", ".y"),
  left = TRUE,
  largest = FALSE
)

st_filter(x, y, ...)

## S3 method for class 'sf'
st_filter(x, y, ..., .predicate = st_intersects)

```

**Arguments**

x	object of class sf
y	object of class sf
join	geometry predicate function with the same profile as <a href="#">st_intersects</a> ; see details
...	for st_join: arguments passed on to the join function or to st_intersection when largest is TRUE; for st_filter arguments passed on to the .predicate function, e.g. prepared, or a pattern for <a href="#">st_relate</a>
suffix	length 2 character vector; see <a href="#">merge</a>
left	logical; if TRUE return the left join, otherwise an inner join; see details. see also <a href="#">left_join</a>
largest	logical; if TRUE, return x features augmented with the fields of y that have the largest overlap with each of the features of x; see <a href="https://github.com/r-spatial/sf/issues/578">https://github.com/r-spatial/sf/issues/578</a>
.predicate	geometry predicate function with the same profile as <a href="#">st_intersects</a> ; see details

**Details**

alternative values for argument join are:

- [st\\_contains\\_properly](#)
- [st\\_contains](#)
- [st\\_covered\\_by](#)
- [st\\_covers](#)
- [st\\_crosses](#)
- [st\\_disjoint](#)
- [st\\_equals\\_exact](#)

- [st\\_equals](#)
- [st\\_is\\_within\\_distance](#)
- [st\\_nearest\\_feature](#)
- [st\\_overlaps](#)
- [st\\_touches](#)
- [st\\_within](#)
- any user-defined function of the same profile as the above

A left join returns all records of the x object with y fields for non-matched records filled with NA values; an inner join returns only records that spatially match.

To replicate the results of `st_within(x, y)` you will need to use `st_join(x, y, join = "st_within", left = FALSE)`.

### Value

an object of class `sf`, joined based on geometry

### Examples

```
a = st_sf(a = 1:3,
  geom = st_sfc(st_point(c(1,1)), st_point(c(2,2)), st_point(c(3,3))))
b = st_sf(a = 11:14,
  geom = st_sfc(st_point(c(10,10)), st_point(c(2,2)), st_point(c(2,2)), st_point(c(3,3))))
st_join(a, b)
st_join(a, b, left = FALSE)
# two ways to aggregate y's attribute values outcome over x's geometries:
st_join(a, b) %>% aggregate(list(.$a.x), mean)
if (require(dplyr, quietly = TRUE)) {
  st_join(a, b) %>% group_by(a.x) %>% summarise(mean(a.y))
}
# example of largest = TRUE:
nc <- st_transform(st_read(system.file("shape/nc.shp", package="sf")), 2264)
gr = st_sf(
  label = apply(expand.grid(1:10, LETTERS[10:1])[,2:1], 1, paste0, collapse = " "),
  geom = st_make_grid(st_as_sfc(st_bbox(nc))))
gr$col = sf.colors(10, categorical = TRUE, alpha = .3)
# cut, to check, NA's work out:
gr = gr[-(1:30),]
nc_j <- st_join(nc, gr, largest = TRUE)
# the two datasets:
opar = par(mfrow = c(2,1), mar = rep(0,4))
plot(st_geometry(nc_j))
plot(st_geometry(gr), add = TRUE, col = gr$col)
text(st_coordinates(st_centroid(gr)), labels = gr$label)
# the joined dataset:
plot(st_geometry(nc_j), border = 'black', col = nc_j$col)
text(st_coordinates(st_centroid(nc_j)), labels = nc_j$label, cex = .8)
plot(st_geometry(gr), border = 'green', add = TRUE)
par(opar)
# st_filter keeps the geometries in x where .predicate(x,y) returns any match in y for x
```

```
st_filter(a, b)
# for an anti-join, use the union of y
st_filter(a, st_union(b), .predicate = st_disjoint)
```

---

st_layers	<i>Return properties of layers in a datasource</i>
-----------	--

---

### Description

Return properties of layers in a datasource

### Usage

```
st_layers(dsn, options = character(0), do_count = FALSE)
```

### Arguments

dsn	data source name (interpretation varies by driver - for some drivers, dsn is a file name, but may also be a folder, or contain the name and access credentials of a database)
options	character; driver dependent dataset open options, multiple options supported.
do_count	logical; if TRUE, count the features by reading them, even if their count is not reported by the driver

### Value

list object of class sf\_layers with elements

**name** name of the layer

**geomtype** list with for each layer the geometry types

**features** number of features (if reported; see do\_count)

**fields** number of fields

**crs** list with for each layer the crs object



---

st_line_sample	<i>Sample points on a linear geometry</i>
----------------	---

---

## Description

Sample points on a linear geometry

## Usage

```
st_line_sample(x, n, density, type = "regular", sample = NULL)
```

## Arguments

x	object of class sf, sfc or sfg
n	integer; number of points to choose per geometry; if missing, n will be computed as <code>round(density * st_length(geom))</code> .
density	numeric; density (points per distance unit) of the sampling, possibly a vector of length equal to the number of features (otherwise recycled); density may be of class units.
type	character; indicate the sampling type, either "regular" or "random"
sample	numeric; a vector of numbers between 0 and 1 indicating the points to sample - if defined sample overrules n, density and type.

## Examples

```
ls = st_sfc(st_linestring(rbind(c(0,0),c(0,1))),
  st_linestring(rbind(c(0,0),c(10,0))))
st_line_sample(ls, density = 1)
ls = st_sfc(st_linestring(rbind(c(0,0),c(0,1))),
  st_linestring(rbind(c(0,0),c(.1,0))), crs = 4326)
try(st_line_sample(ls, density = 1/1000)) # error
st_line_sample(st_transform(ls, 3857), n = 5) # five points for each line
st_line_sample(st_transform(ls, 3857), n = c(1, 3)) # one and three points
st_line_sample(st_transform(ls, 3857), density = 1/1000) # one per km
st_line_sample(st_transform(ls, 3857), density = c(1/1000, 1/10000)) # one per km, one per 10 km
st_line_sample(st_transform(ls, 3857), density = units::set_units(1, 1/km)) # one per km
# five equidistant points including start and end:
st_line_sample(st_transform(ls, 3857), sample = c(0, 0.25, 0.5, 0.75, 1))
```

---

st_make_grid	<i>Create a regular tessellation over the bounding box of an sf or sfc object</i>
--------------	---

---

## Description

Create a square or hexagonal grid covering the bounding box of the geometry of an sf or sfc object

## Usage

```
st_make_grid(
  x,
  cellsize = c(diff(st_bbox(x)[c(1, 3)]), diff(st_bbox(x)[c(2, 4)]))/n,
  offset = st_bbox(x)[c("xmin", "ymin")],
  n = c(10, 10),
  crs = if (missing(x)) NA_crs_ else st_crs(x),
  what = "polygons",
  square = TRUE,
  flat_topped = FALSE
)
```

## Arguments

x	object of class <a href="#">sf</a> or <a href="#">sfc</a>
cellsize	numeric of length 1 or 2 with target cellsize: for square or rectangular cells the width and height, for hexagonal cells the distance between opposite edges (edge length is cellsize/sqrt(3)). A length units object can be passed, or an area unit object with area size of the square or hexagonal cell.
offset	numeric of length 2; lower left corner coordinates (x, y) of the grid
n	integer of length 1 or 2, number of grid cells in x and y direction (columns, rows)
crs	object of class <a href="#">crs</a> ; coordinate reference system of the target of the target grid in case argument x is missing, if x is not missing, its crs is inherited.
what	character; one of: "polygons", "corners", or "centers"
square	logical; if FALSE, create hexagonal grid
flat_topped	logical; if TRUE generate flat topped hexagons, else generate pointy topped

## Value

Object of class [sfc](#) (simple feature geometry list column) with, depending on what and square, square or hexagonal polygons, corner points of these polygons, or center points of these polygons.

**Examples**

```

plot(st_make_grid(what = "centers"), axes = TRUE)
plot(st_make_grid(what = "corners"), add = TRUE, col = 'green', pch=3)
sfc = st_sfc(st_polygon(list(rbind(c(0,0), c(1,0), c(1,1), c(0,0)))))
plot(st_make_grid(sfc, cellsize = .1, square = FALSE))
plot(sfc, add = TRUE)
# non-default offset:
plot(st_make_grid(sfc, cellsize = .1, square = FALSE, offset = c(0, .05 / (sqrt(3)/2))))
plot(sfc, add = TRUE)
nc = st_read(system.file("shape/nc.shp", package="sf"))
g = st_make_grid(nc)
plot(g)
plot(st_geometry(nc), add = TRUE)
# g[nc] selects cells that intersect with nc:
plot(g[nc], col = '#ff000088', add = TRUE)

```

---

st\_m\_range

*Return 'm' range of a simple feature or simple feature set*


---

**Description**

Return 'm' range of a simple feature or simple feature set

**Usage**

```

## S3 method for class 'm_range'
is.na(x)

st_m_range(obj, ...)

## S3 method for class 'POINT'
st_m_range(obj, ...)

## S3 method for class 'MULTIPOINT'
st_m_range(obj, ...)

## S3 method for class 'LINESTRING'
st_m_range(obj, ...)

## S3 method for class 'POLYGON'
st_m_range(obj, ...)

## S3 method for class 'MULTILINESTRING'
st_m_range(obj, ...)

## S3 method for class 'MULTIPOLYGON'
st_m_range(obj, ...)

```

```
## S3 method for class 'GEOMETRYCOLLECTION'  
st_m_range(obj, ...)  
  
## S3 method for class 'MULTISURFACE'  
st_m_range(obj, ...)  
  
## S3 method for class 'MULTICURVE'  
st_m_range(obj, ...)  
  
## S3 method for class 'CURVEPOLYGON'  
st_m_range(obj, ...)  
  
## S3 method for class 'COMPOUNDCURVE'  
st_m_range(obj, ...)  
  
## S3 method for class 'POLYHEDRALSURFACE'  
st_m_range(obj, ...)  
  
## S3 method for class 'TIN'  
st_m_range(obj, ...)  
  
## S3 method for class 'TRIANGLE'  
st_m_range(obj, ...)  
  
## S3 method for class 'CIRCULARSTRING'  
st_m_range(obj, ...)  
  
## S3 method for class 'sfc'  
st_m_range(obj, ...)  
  
## S3 method for class 'sf'  
st_m_range(obj, ...)  
  
## S3 method for class 'numeric'  
st_m_range(obj, ..., crs = NA_crs_)  
  
NA_m_range_
```

## Arguments

x	object of class <code>m_range</code>
obj	object to compute the m range from
...	ignored
crs	object of class <code>crs</code> , or argument to <code>st_crs</code> , specifying the CRS of this bounding box.

**Format**

An object of class `m_range` of length 2.

**Details**

`NA_m_range_` represents the missing value for a `m_range` object

**Value**

a numeric vector of length two, with `mmin` and `mmax` values; if `obj` is of class `sf` or `sfc` the object if `obj` is of class `sf` or `sfc` the object returned has a class `m_range`

**Examples**

```
a = st_sf(a = 1:2, geom = st_sfc(st_point(0:3), st_point(1:4)), crs = 4326)
st_m_range(a)
st_m_range(c(mmin = 16.1, mmax = 16.6), crs = st_crs(4326))
```

---

`st_nearest_feature`      *get index of nearest feature*

---

**Description**

get index of nearest feature

**Usage**

```
st_nearest_feature(
  x,
  y,
  ...,
  check_crs = TRUE,
  longlat = isTRUE(st_is_longlat(x))
)
```

**Arguments**

<code>x</code>	object of class <code>sfg</code> , <code>sfc</code> or <code>sf</code>
<code>y</code>	object of class <code>sfg</code> , <code>sfc</code> or <code>sf</code> ; if missing, features in <code>x</code> will be compared to all remaining features in <code>x</code> .
<code>...</code>	ignored
<code>check_crs</code>	logical; should <code>x</code> and <code>y</code> be checked for CRS equality?
<code>longlat</code>	logical; does <code>x</code> have ellipsoidal coordinates?

**Value**

for each feature (geometry) in *x* the index of the nearest feature (geometry) in set *y*, or in the remaining set of *x* if *y* is missing; empty geometries result in NA indexes

**See Also**

[st\\_nearest\\_points](#) for finding the nearest points for pairs of feature geometries

**Examples**

```
ls1 = st_linestring(rbind(c(0,0), c(1,0)))
ls2 = st_linestring(rbind(c(0,0.1), c(1,0.1)))
ls3 = st_linestring(rbind(c(0,1), c(1,1)))
(l = st_sfc(ls1, ls2, ls3))

p1 = st_point(c(0.1, -0.1))
p2 = st_point(c(0.1, 0.11))
p3 = st_point(c(0.1, 0.09))
p4 = st_point(c(0.1, 0.9))

(p = st_sfc(p1, p2, p3, p4))
try(st_nearest_feature(p, l))
try(st_nearest_points(p, l[st_nearest_feature(p,l)], pairwise = TRUE))

r = sqrt(2)/10
b1 = st_buffer(st_point(c(.1,.1)), r)
b2 = st_buffer(st_point(c(.9,.9)), r)
b3 = st_buffer(st_point(c(.9,.1)), r)
circles = st_sfc(b1, b2, b3)
plot(circles, col = NA, border = 2:4)
pts = st_sfc(st_point(c(.3,.1)), st_point(c(.6,.2)), st_point(c(.6,.6)), st_point(c(.4,.8)))
plot(pts, add = TRUE, col = 1)
# draw points to nearest circle:
nearest = try(st_nearest_feature(pts, circles))
if (inherits(nearest, "try-error")) # GEOS 3.6.1 not available
  nearest = c(1, 3, 2, 2)
ls = st_nearest_points(pts, circles[nearest], pairwise = TRUE)
plot(ls, col = 5:8, add = TRUE)
# compute distance between pairs of nearest features:
st_distance(pts, circles[nearest], by_element = TRUE)
```

---

st\_nearest\_points      *get nearest points between pairs of geometries*

---

**Description**

get nearest points between pairs of geometries

**Usage**

```

st_nearest_points(x, y, ...)

## S3 method for class 'sfc'
st_nearest_points(x, y, ..., pairwise = FALSE)

## S3 method for class 'sfg'
st_nearest_points(x, y, ...)

## S3 method for class 'sf'
st_nearest_points(x, y, ...)

```

**Arguments**

x	object of class sfg, sfc or sf
y	object of class sfg, sfc or sf
...	ignored
pairwise	logical; if FALSE (default) return nearest points between all pairs, if TRUE, return nearest points between subsequent pairs.

**Details**

in case x lies inside y, when using S2, the end points are on polygon boundaries, when using GEOS the end point are identical to x.

**Value**

an *sfc* object with all two-point LINESTRING geometries of point pairs from the first to the second geometry, of length  $x * y$ , with y cycling fastest. See examples for ideas how to convert these to POINT geometries.

**See Also**

[st\\_nearest\\_feature](#) for finding the nearest feature

**Examples**

```

r = sqrt(2)/10
pt1 = st_point(c(.1,.1))
pt2 = st_point(c(.9,.9))
pt3 = st_point(c(.9,.1))
b1 = st_buffer(pt1, r)
b2 = st_buffer(pt2, r)
b3 = st_buffer(pt3, r)
(ls0 = st_nearest_points(b1, b2)) # sfg
(ls = st_nearest_points(st_sfc(b1), st_sfc(b2, b3))) # sfc
plot(b1, xlim = c(-.2,1.2), ylim = c(-.2,1.2), col = NA, border = 'green')
plot(st_sfc(b2, b3), add = TRUE, col = NA, border = 'blue')
plot(ls, add = TRUE, col = 'red')

```

```
nc = st_read(system.file("gpkg/nc.gpkg", package="sf"))
plot(st_geometry(nc))
ls = st_nearest_points(nc[1,], nc)
plot(ls, col = 'red', add = TRUE)
pts = st_cast(ls, "POINT") # gives all start & end points
# starting, "from" points, corresponding to x:
plot(pts[seq(1, 200, 2)], add = TRUE, col = 'blue')
# ending, "to" points, corresponding to y:
plot(pts[seq(2, 200, 2)], add = TRUE, col = 'green')
```

---

st\_normalize

*Normalize simple features*


---

### Description

st\_normalize transforms the coordinates in the input feature to fall between 0 and 1. By default the current domain is set to the bounding box of the input, but other domains can be used as well

### Usage

```
st_normalize(x, domain = st_bbox(x), ...)
```

### Arguments

x	object of class sf, sfc or sfg
domain	The domain x should be normalized from as a length 4 vector of the form c(xmin, ymin, xmax, ymax). Defaults to the bounding box of x
...	ignored

### Examples

```
p1 = st_point(c(7,52))
st_normalize(p1, domain = c(0, 0, 10, 100))

p2 = st_point(c(-30,20))
sfc = st_sfc(p1, p2, crs = 4326)
sfc
sfc_norm <- st_normalize(sfc)
st_bbox(sfc_norm)
```



---

st_precision	<i>Get precision</i>
--------------	----------------------

---

### Description

Get precision

Set precision

### Usage

```
st_precision(x)
```

```
st_set_precision(x, precision)
```

```
st_precision(x) <- value
```

### Arguments

x	object of class <code>sfc</code> or <code>sf</code>
precision	numeric, or object of class <code>units</code> with distance units (but see details); see <a href="#">st_as_binary</a> for how to do this.
value	precision value

### Details

If precision is a `units` object, the object on which we set precision must have a coordinate reference system with compatible distance units.

Setting a precision has no direct effect on coordinates of geometries, but merely set an attribute tag to an `sfc` object. The effect takes place in [st\\_as\\_binary](#) or, more precise, in the C++ function `CPL_write_wkb`, where simple feature geometries are being serialized to well-known-binary (WKB). This happens always when routines are called in GEOS library (geometrical operations or predicates), for writing geometries using [st\\_write](#) or [write\\_sf](#), `st_make_valid` in package `lwgeom`; also [aggregate](#) and [summarise](#) by default union geometries, which calls a GEOS library function. Routines in these libraries receive rounded coordinates, and possibly return results based on them. [st\\_as\\_binary](#) contains an example of a roundtrip of `sfc` geometries through WKB, in order to see the rounding happening to R data.

The reason to support precision is that geometrical operations in GEOS or `liblwgeom` may work better at reduced precision. For writing data from R to external resources it is harder to think of a good reason to limiting precision.

### See Also

[st\\_as\\_binary](#) for an explanation of what setting precision does, and the examples therein.

**Examples**

```
x <- st_sfc(st_point(c(pi, pi)))
st_precision(x)
st_precision(x) <- 0.01
st_precision(x)
```

---

st\_read

*Read simple features or layers from file or database*


---

**Description**

Read simple features from file or database, or retrieve layer names and their geometry type(s)

Read PostGIS table directly through DBI and RPostgreSQL interface, converting Well-Know Binary geometries to sfc

**Usage**

```
st_read(dsn, layer, ...)
```

```
## S3 method for class 'character'
st_read(
  dsn,
  layer,
  ...,
  query = NA,
  options = NULL,
  quiet = FALSE,
  geometry_column = 1L,
  type = 0,
  promote_to_multi = TRUE,
  stringsAsFactors = sf_stringsAsFactors(),
  int64_as_string = FALSE,
  check_ring_dir = FALSE,
  fid_column_name = character(0),
  drivers = character(0),
  wkt_filter = character(0),
  optional = FALSE
)
```

```
read_sf(..., quiet = TRUE, stringsAsFactors = FALSE, as_tibble = TRUE)
```

```
## S3 method for class 'DBIObject'
st_read(
  dsn = NULL,
  layer = NULL,
  query = NULL,
```

```

    EWKB = TRUE,
    quiet = TRUE,
    as_tibble = FALSE,
    geometry_column = NULL,
    ...
)

```

## Arguments

dsn	data source name (interpretation varies by driver - for some drivers, dsn is a file name, but may also be a folder, or contain the name and access credentials of a database); in case of GeoJSON, dsn may be the character string holding the geojson data. It can also be an open database connection.
layer	layer name (varies by driver, may be a file name without extension); in case layer is missing, st_read will read the first layer of dsn, give a warning and (unless quiet = TRUE) print a message when there are multiple layers, or give an error if there are no layers in dsn. If dsn is a database connection, then layer can be a table name or a database identifier (see <a href="#">Id</a> ). It is also possible to omit layer and rather use the query argument.
...	parameter(s) passed on to <a href="#">st_as_sf</a>
query	SQL query to select records; see details
options	character; driver dependent dataset open options, multiple options supported. For possible values, see the "Open options" section of the GDAL documentation of the corresponding driver, and <a href="https://github.com/r-spatial/sf/issues/1157">https://github.com/r-spatial/sf/issues/1157</a> for an example.
quiet	logical; suppress info on name, driver, size and spatial reference, or signaling no or multiple layers
geometry_column	integer or character; in case of multiple geometry fields, which one to take?
type	integer; ISO number of desired simple feature type; see details. If left zero, and promote_to_multi is TRUE, in case of mixed feature geometry types, conversion to the highest numeric type value found will be attempted. A vector with different values for each geometry column can be given.
promote_to_multi	logical; in case of a mix of Point and MultiPoint, or of LineString and Multi-LineString, or of Polygon and MultiPolygon, convert all to the Multi variety; defaults to TRUE
stringsAsFactors	logical; logical: should character vectors be converted to factors? Default for read_sf or R version >= 4.1.0 is FALSE, for st_read and R version < 4.1.0 equal to default.stringsAsFactors()
int64_as_string	logical; if TRUE, Int64 attributes are returned as string; if FALSE, they are returned as double and a warning is given when precision is lost (i.e., values are larger than 2 <sup>53</sup> ).
check_ring_dir	logical; if TRUE, polygon ring directions are checked and if necessary corrected (when seen from above: exterior ring counter clockwise, holes clockwise)

fid_column_name	character; name of column to write feature IDs to; defaults to not doing this
drivers	character; limited set of driver short names to be tried (default: try all)
wkt_filter	character; WKT representation of a spatial filter (may be used as bounding box, selecting overlapping geometries); see examples
optional	logical; passed to <a href="#">as.data.frame</a> ; always TRUE when as_tibble is TRUE
as_tibble	logical; should the returned table be of class tibble or data.frame?
EWKB	logical; is the WKB of type EWKB? if missing, defaults to TRUE

## Details

for geometry\_column, see also [https://trac.osgeo.org/gdal/wiki/rfc41\\_multiple\\_geometry\\_fields](https://trac.osgeo.org/gdal/wiki/rfc41_multiple_geometry_fields)

for values for type see [https://en.wikipedia.org/wiki/Well-known\\_text#Well-known\\_binary](https://en.wikipedia.org/wiki/Well-known_text#Well-known_binary), but note that not every target value may lead to successful conversion. The typical conversion from POLYGON (3) to MULTIPOLYGON (6) should work; the other way around (type=3), secondary rings from MULTIPOLYGONS may be dropped without warnings. promote\_to\_multi is handled on a per-geometry column basis; type may be specified for each geometry column.

Note that stray files in data source directories (such as \*.dbf) may lead to spurious errors that accompanying \*.shp are missing.

In case of problems reading shapefiles from USB drives on OSX, please see <https://github.com/r-spatial/sf/issues/252>. Reading shapefiles (or other data sources) directly from zip files can be done by prepending the path with /vsizip/. This is part of the GDAL Virtual File Systems interface that also supports .gz, curl, and other operations, including chaining; see [https://gdal.org/user/virtual\\_file\\_systems.html](https://gdal.org/user/virtual_file_systems.html) for a complete description and examples.

For query with a character dsn the query text is handed to 'ExecuteSQL' on the GDAL/OGR data set and will result in the creation of a new layer (and layer is ignored). See 'OGRSQL' [https://gdal.org/user/ogr\\_sql\\_dialect.html](https://gdal.org/user/ogr_sql_dialect.html) for details. Please note that the 'FID' special field is driver-dependent, and may be either 0-based (e.g. ESRI Shapefile), 1-based (e.g. MapInfo) or arbitrary (e.g. OSM). Other features of OGRSQL are also likely to be driver dependent. The available layer names may be obtained with [st\\_layers](#). Care will be required to properly escape the use of some layer names.

read\_sf and write\_sf are aliases for st\_read and st\_write, respectively, with some modified default arguments. read\_sf and write\_sf are quiet by default: they do not print information about the data source. read\_sf returns an sf-tibble rather than an sf-data.frame. write\_sf delete layers by default: it overwrites existing files without asking or warning.

if table is not given but query is, the spatial reference system (crs) of the table queried is only available in case it has been stored into each geometry record (e.g., by PostGIS, when using EWKB)

The function will automatically find the 'geometry' type columns for drivers that support it. For the other drivers, it will try to cast all the character columns, which can be slow for very wide tables.

## Value

object of class [sf](#) when a layer was successfully read; in case argument layer is missing and data source dsn does not contain a single layer, an object of class [sf\\_layers](#) is returned with the layer names, each with their geometry type(s). Note that the number of layers may also be zero.

**Note**

The use of `system.file` in examples make sure that examples run regardless where R is installed: typical users will not use `system.file` but give the file name directly, either with full path or relative to the current working directory (see [getwd](#)). "Shapefiles" consist of several files with the same basename that reside in the same directory, only one of them having extension `.shp`.

**See Also**

[st\\_layers](#), [st\\_drivers](#)

**Examples**

```
nc = st_read(system.file("shape/nc.shp", package="sf"))
summary(nc) # note that AREA was computed using Euclidian area on lon/lat degrees

## only three fields by select clause
## only two features by where clause
nc_sql = st_read(system.file("shape/nc.shp", package="sf"),
                  query = "SELECT NAME, SID74, FIPS FROM \"nc\" WHERE BIR74 > 20000")
## Not run:
library(sp)
example(meuse, ask = FALSE, echo = FALSE)
try(st_write(st_as_sf(meuse), "PG:dbname=postgis", "meuse",
             layer_options = "OVERWRITE=true"))
try(st_meuse <- st_read("PG:dbname=postgis", "meuse"))
if (exists("st_meuse"))
  summary(st_meuse)

## End(Not run)

## Not run:
## note that we need special escaping of layer within single quotes (nc.gpkg)
## and that geom needs to be included in the select, otherwise we don't detect it
layer <- st_layers(system.file("gpkg/nc.gpkg", package = "sf"))$name[1]
nc_gpkg_sql = st_read(system.file("gpkg/nc.gpkg", package = "sf"),
                      query = sprintf("SELECT NAME, SID74, FIPS, geom FROM \"%s\" WHERE BIR74 > 20000", layer))

## End(Not run)
# spatial filter, as wkt:
wkt = st_as_text(st_geometry(nc[1,]))
# filter by (bbox overlaps of) first feature geometry:
st_read(system.file("gpkg/nc.gpkg", package="sf"), wkt_filter = wkt)
# read geojson from string:
geojson_txt <- paste("{\"type\":\"MultiPoint\",\"coordinates\":",
                    "[[[3.2,4],[3.4.6],[3.8,4.4],[3.5,3.8],[3.4,3.6],[3.9,4.5]]]}",
                    "\n")
x = st_read(geojson_txt)
x
## Not run:
library(RPostgreSQL)
try(conn <- dbConnect(PostgreSQL(), dbname = "postgis"))
if (exists("conn") && !inherits(conn, "try-error")) {
  x = st_read(conn, "meuse", query = "select * from meuse limit 3;")
}
```

```

x = st_read(conn, table = "public.meuse")
print(st_crs(x)) # SRID resolved by the database, not by GDAL!
dbDisconnect(conn)
}

## End(Not run)

```

---

st_relate	<i>Compute DE9-IM relation between pairs of geometries, or match it to a given pattern</i>
-----------	--

---

### Description

Compute DE9-IM relation between pairs of geometries, or match it to a given pattern

### Usage

```
st_relate(x, y, pattern = NA_character_, sparse = !is.na(pattern))
```

### Arguments

x	object of class sf, sfc or sfg
y	object of class sf, sfc or sfg
pattern	character; define the pattern to match to, see details.
sparse	logical; should a sparse matrix be returned (TRUE) or a dense matrix?

### Value

In case pattern is not given, st\_relate returns a dense character matrix; element [i,j] has nine characters, referring to the DE9-IM relationship between x[i] and y[j], encoded as IxIy,IxBBy,IxEy,BxIy,BxBBy,BxEy,ExIy,ExBBy where I refers to interior, B to boundary, and E to exterior, and e.g. BxIy the dimensionality of the intersection of the the boundary of x[i] and the interior of y[j], which is one of 0,1,2,F, digits denoting dimensionality, F denoting not intersecting. When pattern is given, a dense logical matrix or sparse index list returned with matches to the given pattern; see [st\\_intersection](#) for a description of the returned matrix or list. See also <https://en.wikipedia.org/wiki/DE-9IM> for further explanation.

### Examples

```

p1 = st_point(c(0,0))
p2 = st_point(c(2,2))
pol1 = st_polygon(list(rbind(c(0,0),c(1,0),c(1,1),c(0,1),c(0,0)))) - 0.5
pol2 = pol1 + 1
pol3 = pol1 + 2
st_relate(st_sfc(p1, p2), st_sfc(pol1, pol2, pol3))
sfc = st_sfc(st_point(c(0,0)), st_point(c(3,3)))
grd = st_make_grid(sfc, n = c(3,3))
st_intersects(grd)

```

```

st_relate(grd, pattern = "****1****") # sides, not corners, internals
st_relate(grd, pattern = "****0****") # only corners touch
st_rook = function(a, b = a) st_relate(a, b, pattern = "F***1****")
st_rook(grd)
# queen neighbours, see \url{https://github.com/r-spatial/sf/issues/234#issuecomment-300511129}
st_queen <- function(a, b = a) st_relate(a, b, pattern = "F***T****")

```

---

st\_sample                      *sample points on or in (sets of) spatial features*

---

### Description

Sample points on or in (sets of) spatial features. By default, returns a pre-specified number of points that is equal to size (if type = "random" and exact = TRUE) or an approximation of size otherwise. spatstat methods are interfaced and do not use the size argument, see examples.

### Usage

```

st_sample(x, size, ...)

## S3 method for class 'sf'
st_sample(x, size, ...)

## S3 method for class 'sfc'
st_sample(
  x,
  size,
  ...,
  type = "random",
  exact = TRUE,
  warn_if_not_integer = TRUE,
  by_polygon = FALSE,
  progress = FALSE
)

## S3 method for class 'sfg'
st_sample(x, size, ...)

```

### Arguments

x	object of class sf or sfc
size	sample size(s) requested; either total size, or a numeric vector with sample sizes for each feature geometry. When sampling polygons, the returned sampling size may differ from the requested size, as the bounding box is sampled, and sampled points intersecting the polygon are returned.
...	passed on to <a href="#">sample</a> for multipoint sampling, or to spatstat functions for spatstat sampling types (see details)

type	character; indicates the spatial sampling type; one of random, hexagonal (triangular really), regular, Fibonacci, or one of the spatstat methods such as Thomas for calling spatstat.random::rThomas (see Details).
exact	logical; should the length of output be exactly
warn_if_not_integer	logical; if FALSE then no warning is emitted if size is not an integer
by_polygon	logical; for MULTIPOLYGON geometries, should the effort be split by POLYGON? See <a href="https://github.com/r-spatial/sf/issues/1480">https://github.com/r-spatial/sf/issues/1480</a> the same as specified by size? TRUE by default. Only applies to polygons, and when type = "random".
progress	logical; if TRUE show progress bar (only if size is a vector).

### Details

The function is vectorised: it samples size points across all geometries in the object if size is a single number, or the specified number of points in each feature if size is a vector of integers equal in length to the geometry of x.

if x has dimension 2 (polygons) and geographical coordinates (long/lat), uniform random sampling on the sphere is applied, see e.g. <http://mathworld.wolfram.com/SpherePointPicking.html>.

For regular or hexagonal sampling of polygons, the resulting size is only an approximation.

As parameter called offset can be passed to control ("fix") regular or hexagonal sampling: for polygons a length 2 numeric vector (by default: a random point from st\_bbox(x)); for lines use a number like runif(1).

Fibonacci sampling see: Alvaro Gonzalez, 2010. Measurement of Areas on a Sphere Using Fibonacci and Latitude-Longitude Lattices. Mathematical Geosciences 42(1), p. 49-64

For regular sampling on the sphere, see also geosphere::regularCoordinates.

Sampling methods from package spatstat are interfaced (see examples), and need their own parameters to be set. For instance, to use spatstat.random::rThomas(), set type = "Thomas".

### Value

an sfc object containing the sampled POINT geometries

### Examples

```
nc = st_read(system.file("shape/nc.shp", package="sf"))
p1 = st_sample(nc[1:3, ], 6)
p2 = st_sample(nc[1:3, ], 1:3)
plot(st_geometry(nc)[1:3])
plot(p1, add = TRUE)
plot(p2, add = TRUE, pch = 2)
x = st_sfc(st_polygon(list(rbind(c(0,0),c(90,0),c(90,90),c(0,90),c(0,0))))), crs = st_crs(4326))
plot(x, axes = TRUE, graticule = TRUE)
if (sf_extSoftVersion()["proj.4"] >= "4.9.0")
  plot(p <- st_sample(x, 1000), add = TRUE)
if (require(lwgeom, quietly = TRUE)) { # for st_segmentize()
x2 = st_transform(st_segmentize(x, 1e4), st_crs("+proj=ortho +lat_0=30 +lon_0=45"))
g = st_transform(st_graticule(), st_crs("+proj=ortho +lat_0=30 +lon_0=45"))
```



```

plot(x2, graticule = g)
if (sf_extSoftVersion()["proj.4"] >= "4.9.0") {
  p2 = st_transform(p, st_crs("+proj=ortho +lat_0=30 +lon_0=45"))
  plot(p2, add = TRUE)
}
}
x = st_sfc(st_polygon(list(rbind(c(0,0),c(90,0),c(90,10),c(0,90),c(0,0))))) # NOT long/lat:
plot(x)
p_exact = st_sample(x, 1000, exact = TRUE)
p_not_exact = st_sample(x, 1000, exact = FALSE)
length(p_exact); length(p_not_exact)
plot(st_sample(x, 1000), add = TRUE)
x = st_sfc(st_polygon(list(rbind(c(-180,-90),c(180,-90),c(180,90),c(-180,90),c(-180,-90)))),
  crs=st_crs(4326))
# FIXME:
#if (sf_extSoftVersion()["proj.4"] >= "4.9.0") {
# p = st_sample(x, 1000)
# st_sample(p, 3)
#}
# hexagonal:
sfc = st_sfc(st_polygon(list(rbind(c(0,0), c(1,0), c(1,1), c(0,0)))))
plot(sfc)
h = st_sample(sfc, 100, type = "hexagonal")
h1 = st_sample(sfc, 100, type = "hexagonal")
plot(h, add = TRUE)
plot(h1, col = 'red', add = TRUE)
c(length(h), length(h1)) # approximate!
pt = st_multipoint(matrix(1:20,,2))
ls = st_sfc(st_linestring(rbind(c(0,0),c(0,1))),
  st_linestring(rbind(c(0,0),c(.1,0))),
  st_linestring(rbind(c(0,1),c(.1,1))),
  st_linestring(rbind(c(2,2),c(2,2.00001)))))
st_sample(ls, 80)
plot(st_sample(ls, 80))
# spatstat example:
if (require(spatstat.random)) {
  x <- sf::st_sfc(sf::st_polygon(list(rbind(c(0, 0), c(10, 0), c(10, 10), c(0, 0)))))
  # for spatstat.random::rThomas(), set type = "Thomas":
  pts <- st_sample(x, kappa = 1, mu = 10, scale = 0.1, type = "Thomas")
}

```

---

st\_shift\_longitude

*Shift or re-center geographical coordinates for a Pacific view*


---

## Description

All longitudes  $< 0$  are added to 360, to avoid for instance parts of Alaska being represented on the far left and right of a plot because they have values straddling 180 degrees. In general, using a projected coordinate reference system is to be preferred, but this method permits a geographical coordinate reference system to be used. This is the sf equivalent of [recenter](#) in the sp package and ST\_ShiftLongitude in PostGIS.

**Usage**

```

st_shift_longitude(x)

## S3 method for class 'sfc'
st_shift_longitude(x, ...)

## S3 method for class 'sf'
st_shift_longitude(x, ...)

```

**Arguments**

```

x                object of class sf or sfc
...              ignored

```

**Examples**

```

## sfc
pt1 = st_point(c(-170, 50))
pt2 = st_point(c(170, 50))
(sfc = st_sfc(pt1, pt2))
sfc = st_set_crs(sfc, 4326)
st_shift_longitude(sfc)

## sf
d = st_as_sf(data.frame(id = 1:2, geometry = sfc))
st_shift_longitude(d)

```

---

st\_transform

*Transform or convert coordinates of simple feature*


---

**Description**

Transform or convert coordinates of simple feature

**Usage**

```

st_can_transform(src, dst)

st_transform(x, crs, ...)

## S3 method for class 'sfc'
st_transform(
  x,
  crs = st_crs(x),
  ...,
  aoi = numeric(0),
  pipeline = character(0),

```

```

    reverse = FALSE,
    desired_accuracy = -1,
    allow_ballpark = TRUE,
    partial = TRUE,
    check = FALSE
)

## S3 method for class 'sf'
st_transform(x, crs = st_crs(x), ...)

## S3 method for class 'sfg'
st_transform(x, crs = st_crs(x), ...)

st_wrap_dateline(x, options, quiet)

## S3 method for class 'sfc'
st_wrap_dateline(x, options = "WRAPDATELINE=YES", quiet = TRUE)

## S3 method for class 'sf'
st_wrap_dateline(x, options = "WRAPDATELINE=YES", quiet = TRUE)

## S3 method for class 'sfg'
st_wrap_dateline(x, options = "WRAPDATELINE=YES", quiet = TRUE)

sf_proj_info(type = "proj", path)

```

## Arguments

src	source crs
dst	destination crs
x	object of class sf, sfc or sfg
crs	target coordinate reference system: object of class 'crs', or input string for <a href="#">st_crs</a>
...	ignored
aoi	area of interest, in degrees: WestLongitude, SouthLatitude, EastLongitude, North-Latitude
pipeline	character; coordinate operation pipeline, for overriding the default operation
reverse	boolean; has only an effect when pipeline is defined: if TRUE, the inverse operation of the pipeline is applied
desired_accuracy	numeric; Only coordinate operations that offer an accuracy of at least the one specified will be considered; a negative value disables this feature (requires GDAL >= 3.3)
allow_ballpark	logical; are ballpark (low accuracy) transformations allowed? (requires GDAL >= 3.3)
partial	logical; allow for partial projection, if not all points of a geometry can be projected (corresponds to setting environment variable OGR_ENABLE_PARTIAL_REPROJECTION to TRUE)

check	logical; if TRUE, perform a sanity check on resulting polygons
options	character; should have "WRAPDATELINE=YES" to function; another parameter that is used is "DATELINEOFFSET=10" (where 10 is the default value)
quiet	logical; print options after they have been parsed?
type	character; one of have_datum_files, proj, ellps, datum, units or prime_meridians; see Details.
path	character; PROJ search path to be set

## Details

st\_can\_transform returns a boolean indicating whether coordinates with CRS src can be transformed into CRS dst

Transforms coordinates of object to new projection. Features that cannot be transformed are returned as empty geometries. Transforms using the pipeline= argument may fail if there is ambiguity in the axis order of the specified coordinate reference system; if you need the traditional GIS order, use "OGC:CRS84", not "EPSG:4326". Extra care is needed with the ESRI Shapefile format, because WKT1 does not store axis order unambiguously.

The st\_transform method for sfg objects assumes that the CRS of the object is available as an attribute of that name.

For a discussion of using options, see <https://github.com/r-spatial/sf/issues/280> and <https://github.com/r-spatial/sf/issues/1983>

sf\_proj\_info lists the available projections, ellipses, datums, units, or data search path of the PROJ library when type is equal to proj, ellps, datum, units or path; when type equals have\_datum\_files a boolean is returned indicating whether datum files are installed and accessible (checking for conus).

for PROJ >= 6, sf\_proj\_info does not provide option type = "datums". PROJ < 6 does not provide the option type = "prime\_meridians".

for PROJ >= 7.1.0, the "units" query of sf\_proj\_info returns the to\_meter variable as numeric, previous versions return a character vector containing a numeric expression.

## See Also

[st\\_transform\\_proj](#), part of package lwgeom.

[sf\\_project](#) projects a matrix of coordinates, bypassing GDAL altogether

[st\\_break\\_antimeridian](#)

## Examples

```
p1 = st_point(c(7,52))
p2 = st_point(c(-30,20))
sfc = st_sfc(p1, p2, crs = 4326)
sfc
st_transform(sfc, 3857)
st_transform(st_sf(a=2:1, geom=sfc), "+init=epsg:3857")
try(st_transform(sfc, 3857, aoi = c(-280,-90,180,90)))
if (sf_extSoftVersion()["GDAL"] >= "3.0.0") {
```

```

    st_transform(sfc, pipeline =
      "+proj=pipeline +step +proj=axisswap +order=2,1") # reverse axes
    st_transform(sfc, pipeline =
      "+proj=pipeline +step +proj=axisswap +order=2,1", reverse = TRUE) # also reverse axes
  }
nc = st_read(system.file("shape/nc.shp", package="sf"))
st_area(nc[1,]) # area from long/lat
st_area(st_transform(nc[1,], 32119)) # NC state plane, m
st_area(st_transform(nc[1,], 2264)) # NC state plane, US foot
library(units)
set_units(st_area(st_transform(nc[1,], 2264)), m^2)
st_transform(structure(p1, proj4string = "+init=epsg:4326"), "+init=epsg:3857")
st_wrap_dateline(st_sfc(st_linestring(rbind(c(-179,0),c(179,0)))), crs = 4326))
sf_proj_info("datum")

```

---

st\_viewport

---

*Create viewport from sf, sfc or sfg object*


---

## Description

Create viewport from sf, sfc or sfg object

## Usage

```
st_viewport(x, ..., bbox = st_bbox(x), asp)
```

## Arguments

x	object of class sf, sfc or sfg object
...	parameters passed on to <a href="#">viewport</a>
bbox	the bounding box used for aspect ratio
asp	numeric; target aspect ratio (y/x), see <a href="#">Details</a>

## Details

parameters width, height, xscale and yscale are set such that aspect ratio is honoured and plot size is maximized in the current viewport; others can be passed as ...

If asp is missing, it is taken as 1, except when isTRUE(st\_is\_longlat(x)), in which case it is set to  $1.0 / \cos(y)$ , with y the middle of the latitude bounding box.

## Value

The output of the call to [viewport](#)

**Examples**

```
library(grid)
nc = st_read(system.file("shape/nc.shp", package="sf"))
grid.newpage()
pushViewport(viewport(width = 0.8, height = 0.8))
pushViewport(st_viewport(nc))
invisible(lapply(st_geometry(nc), function(x) grid.draw(st_as_grob(x, gp = gpar(fill = 'red')))))
```

---

st\_write

---

*Write simple features object to file or database*


---

**Description**

Write simple features object to file or database

**Usage**

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

## S3 method for class 'sfc'
st_write(obj, dsn, layer, ...)

## S3 method for class 'sf'
st_write(
  obj,
  dsn,
  layer = NULL,
  ...,
  driver = guess_driver_can_write(dsn),
  dataset_options = NULL,
  layer_options = NULL,
  quiet = FALSE,
  factorsAsCharacter = TRUE,
  append = NA,
  delete_dsn = FALSE,
  delete_layer = !is.na(append) && !append,
  fid_column_name = NULL,
  config_options = character(0)
)

## S3 method for class 'data.frame'
st_write(obj, dsn, layer = NULL, ...)

write_sf(..., quiet = TRUE, append = FALSE, delete_layer = !append)

st_delete(
  dsn,
```

```

    layer = character(0),
    driver = guess_driver_can_write(dsn),
    quiet = FALSE
)

```

### Arguments

obj	object of class sf or sfc
dsn	data source name. Interpretation varies by driver: can be a filename, a folder, a database name, or a Database Connection (we officially test support for <code>RPostgres::Postgres()</code> connections).
layer	layer name. Varies by driver, may be a file name without extension; for database connection, it is the name of the table. If layer is missing, the basename of dsn is taken.
...	other arguments passed to <code>dbWriteTable</code> when dsn is a Database Connection
driver	character; name of driver to be used; if missing and dsn is not a Database Connection, a driver name is guessed from dsn; <code>st_drivers()</code> returns the drivers that are available with their properties; links to full driver documentation are found at <a href="https://gdal.org/drivers/vector/index.html">https://gdal.org/drivers/vector/index.html</a>
dataset_options	character; driver dependent dataset creation options; multiple options supported.
layer_options	character; driver dependent layer creation options; multiple options supported.
quiet	logical; suppress info on name, driver, size and spatial reference
factorsAsCharacter	logical; convert factor levels to character strings (TRUE, default), otherwise into numbers when factorsAsCharacter is FALSE. For database connections, factorsAsCharacter is always TRUE.
append	logical; should we append to an existing layer, or replace it? if TRUE append, if FALSE replace. The default for <code>st_write</code> is NA which raises an error if the layer exists. The default for <code>write_sf</code> is FALSE, which overwrites any existing data. See also next two arguments for more control on overwrite behavior.
delete_dsn	logical; delete data source dsn before attempting to write?
delete_layer	logical; delete layer layer before attempting to write? The default for <code>st_write</code> is FALSE which raises an error if the layer exists. The default for <code>write_sf</code> is TRUE.
fid_column_name	character, name of column with feature IDs; if specified, this column is no longer written as feature attribute.
config_options	character, named vector with GDAL config options

### Details

Columns (variables) of a class not supported are dropped with a warning.

When updating an existing layer, records are appended to it if the updating object has the right variable names and types. If names don't match an error is raised. If types don't match, behaviour is undefined: GDAL may raise warnings or errors or fail silently.

When deleting layers or data sources is not successful, no error is emitted. `delete_dsn` and `delete_layer` should be handled with care; the former may erase complete directories or databases.

`st_delete` deletes layer(s) in a data source, or a data source if layers are omitted; it returns TRUE on success, FALSE on failure, invisibly.

### Value

obj, invisibly

### See Also

[st\\_drivers](#), [dbWriteTable](#)

### Examples

```
nc = st_read(system.file("shape/nc.shp", package="sf"))
st_write(nc, paste0(tempdir(), "/", "nc.shp"))
st_write(nc, paste0(tempdir(), "/", "nc.shp"), delete_layer = TRUE) # overwrites
if (require(sp, quietly = TRUE)) {
  data(meuse, package = "sp") # loads data.frame from sp
  meuse_sf = st_as_sf(meuse, coords = c("x", "y"), crs = 28992)
  # writes X and Y as columns:
  st_write(meuse_sf, paste0(tempdir(), "/", "meuse.csv"), layer_options = "GEOMETRY=AS_XY")
  st_write(meuse_sf, paste0(tempdir(), "/", "meuse.csv"), layer_options = "GEOMETRY=AS_WKT",
    delete_dsn=TRUE) # overwrites
## Not run:
library(sp)
example(meuse, ask = FALSE, echo = FALSE)
try(st_write(st_as_sf(meuse), "PG:dbname=postgis", "meuse_sf",
  layer_options = c("OVERWRITE=yes", "LAUNDER=true")))
demo(nc, ask = FALSE)
try(st_write(nc, "PG:dbname=postgis", "sids", layer_options = "OVERWRITE=true"))

## End(Not run)
}
```

---

st\_zm

*Drop or add Z and/or M dimensions from feature geometries*

---

### Description

Drop Z and/or M dimensions from feature geometries, resetting classes appropriately

### Usage

```
st_zm(x, ..., drop = TRUE, what = "ZM")
```



**Arguments**

x	object of class sfg, sfc or sf
...	ignored
drop	logical; drop, or (FALSE) add?
what	character which dimensions to drop or add

**Details**

Only combinations drop=TRUE, what = "ZM", and drop=FALSE, what="Z" are supported so far. In case add=TRUE, x should have XY geometry, and zero values are added for Z.

**Examples**

```
st_zm(st_linestring(matrix(1:32,8)))
x = st_sfc(st_linestring(matrix(1:32,8)), st_linestring(matrix(1:8,2)))
st_zm(x)
a = st_sf(a = 1:2, geom=x)
st_zm(a)
```

---

st\_z\_range

*Return 'z' range of a simple feature or simple feature set*


---

**Description**

Return 'z' range of a simple feature or simple feature set

**Usage**

```
## S3 method for class 'z_range'
is.na(x)

st_z_range(obj, ...)

## S3 method for class 'POINT'
st_z_range(obj, ...)

## S3 method for class 'MULTIPOINT'
st_z_range(obj, ...)

## S3 method for class 'LINESTRING'
st_z_range(obj, ...)

## S3 method for class 'POLYGON'
st_z_range(obj, ...)

## S3 method for class 'MULTILINESTRING'
```

```
st_z_range(obj, ...)  
  
## S3 method for class 'MULTIPOLYGON'  
st_z_range(obj, ...)  
  
## S3 method for class 'GEOMETRYCOLLECTION'  
st_z_range(obj, ...)  
  
## S3 method for class 'MULTISURFACE'  
st_z_range(obj, ...)  
  
## S3 method for class 'MULTICURVE'  
st_z_range(obj, ...)  
  
## S3 method for class 'CURVEPOLYGON'  
st_z_range(obj, ...)  
  
## S3 method for class 'COMPOUNDCURVE'  
st_z_range(obj, ...)  
  
## S3 method for class 'POLYHEDRALSURFACE'  
st_z_range(obj, ...)  
  
## S3 method for class 'TIN'  
st_z_range(obj, ...)  
  
## S3 method for class 'TRIANGLE'  
st_z_range(obj, ...)  
  
## S3 method for class 'CIRCULARSTRING'  
st_z_range(obj, ...)  
  
## S3 method for class 'sfc'  
st_z_range(obj, ...)  
  
## S3 method for class 'sf'  
st_z_range(obj, ...)  
  
## S3 method for class 'numeric'  
st_z_range(obj, ..., crs = NA_crs_)  
  
NA_z_range_
```

### Arguments

x	object of class z_range
obj	object to compute the z range from
...	ignored

crs                    object of class crs, or argument to `st_crs`, specifying the CRS of this bounding box.

### Format

An object of class `z_range` of length 2.

### Details

`NA_z_range_` represents the missing value for a `z_range` object

### Value

a numeric vector of length two, with `zmin` and `zmax` values; if `obj` is of class `sf` or `sfc` the object returned has a class `z_range`

### Examples

```
a = st_sf(a = 1:2, geom = st_sfc(st_point(0:2), st_point(1:3)), crs = 4326)
st_z_range(a)
st_z_range(c(zmin = 16.1, zmax = 16.6), crs = st_crs(4326))
```

---

summary.sfc	<i>Summarize simple feature column</i>
-------------	--

---

### Description

Summarize simple feature column

### Usage

```
## S3 method for class 'sfc'
summary(object, ..., maxsum = 7L, maxp4s = 10L)
```

### Arguments

object	object of class <code>sfc</code>
...	ignored
maxsum	maximum number of classes to summarize the simple feature column to
maxp4s	maximum number of characters to print from the PROJ string

---

tibble	<i>Summarize simple feature type for tibble</i>
--------	---

---

**Description**

Summarize simple feature type for tibble

Summarize simple feature item for tibble

**Usage**

```
type_sum.sfc(x, ...)
```

```
obj_sum.sfc(x)
```

```
pillar_shaft.sfc(x, ...)
```

**Arguments**

x                    object of class sfc

...                  ignored

**Details**

see [type\\_sum](#)

---

tidyverse	<i>Tidyverse methods for sf objects (remove .sf suffix!)</i>
-----------	--

---

**Description**

Tidyverse methods for sf objects. Geometries are sticky, use [as.data.frame](#) to let dplyr's own methods drop them. Use these methods without the .sf suffix and after loading the tidyverse package with the generic (or after loading package tidyverse).

**Usage**

```
dplyr_reconstruct.sf(data, template)
```

```
filter.sf(.data, ..., .dots)
```

```
arrange.sf(.data, ..., .dots)
```

```
group_by.sf(.data, ..., add = FALSE)
```

```
ungroup.sf(x, ...)
```

```
rowwise.sf(x, ...)

mutate.sf(.data, ..., .dots)

transmute.sf(.data, ..., .dots)

select.sf(.data, ...)

rename.sf(.data, ...)

slice.sf(.data, ..., .dots)

summarise.sf(.data, ..., .dots, do_union = TRUE, is_coverage = FALSE)

distinct.sf(.data, ..., .keep_all = FALSE)

gather.sf(
  data,
  key,
  value,
  ...,
  na.rm = FALSE,
  convert = FALSE,
  factor_key = FALSE
)

pivot_longer.sf(
  data,
  cols,
  names_to = "name",
  names_prefix = NULL,
  names_sep = NULL,
  names_pattern = NULL,
  names_ptypes = NULL,
  names_transform = NULL,
  names_repair = "check_unique",
  values_to = "value",
  values_drop_na = FALSE,
  values_ptypes = NULL,
  values_transform = NULL,
  ...
)

pivot_wider.sf(
  data,
  id_cols = NULL,
  names_from,
```

```
names_prefix = "",
names_sep = "_",
names_glue = NULL,
names_sort = FALSE,
names_repair = "check_unique",
values_from,
values_fill = NULL,
values_fn = NULL,
...
)

spread.sf(
  data,
  key,
  value,
  fill = NA,
  convert = FALSE,
  drop = TRUE,
  sep = NULL
)

sample_n.sf(tbl, size, replace = FALSE, weight = NULL, .env = parent.frame())

sample_frac.sf(
  tbl,
  size = 1,
  replace = FALSE,
  weight = NULL,
  .env = parent.frame()
)

nest.sf(.data, ...)

separate.sf(
  data,
  col,
  into,
  sep = "[^[:alnum:]]+",
  remove = TRUE,
  convert = FALSE,
  extra = "warn",
  fill = "warn",
  ...
)

separate_rows.sf(data, ..., sep = "[^[:alnum:]]+", convert = FALSE)

unite.sf(data, col, ..., sep = "_", remove = TRUE)
```

```

unnest.sf(data, ..., .preserve = NULL)

drop_na.sf(x, ...)

inner_join.sf(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), ...)

left_join.sf(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), ...)

right_join.sf(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), ...)

full_join.sf(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), ...)

semi_join.sf(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), ...)

anti_join.sf(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), ...)

```

### Arguments

<code>data</code>	see original function docs
<code>template</code>	see original function docs
<code>.data</code>	data object of class <a href="#">sf</a>
<code>...</code>	other arguments
<code>.dots</code>	see corresponding function in package <code>dplyr</code>
<code>add</code>	see corresponding function in <code>dplyr</code>
<code>x, y</code>	A pair of data frames, data frame extensions (e.g. a tibble), or lazy data frames (e.g. from <code>dbplyr</code> or <code>dtplyr</code> ). See <i>Methods</i> , below, for more details.
<code>do_union</code>	logical; in case <code>summary</code> does not create a geometry column, should geometries be created by unioning using <a href="#">st_union</a> , or simply by combining using <a href="#">st_combine</a> ? Using <a href="#">st_union</a> resolves internal boundaries, but in case of unioning points, this will likely change the order of the points; see <i>Details</i> .
<code>is_coverage</code>	logical; if <code>do_union</code> is TRUE, use an optimized algorithm for features that form a polygonal coverage (have no overlaps)
<code>.keep_all</code>	see corresponding function in <code>dplyr</code>
<code>key</code>	see original function docs
<code>value</code>	see original function docs
<code>na.rm</code>	see original function docs
<code>convert</code>	see <a href="#">separate_rows</a>
<code>factor_key</code>	see original function docs
<code>cols</code>	see original function docs
<code>names_to</code>	see original function docs
<code>names_prefix</code>	see original function docs
<code>names_sep</code>	see original function docs

names_pattern	see original function docs
names_ptypes	see original function docs
names_transform	see original function docs
names_repair	see original function docs
values_to	see original function docs
values_drop_na	see original function docs
values_ptypes	see original function docs
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id_cols	see original function docs
names_from	see original function docs
names_glue	see original function docs
names_sort	see original function docs
values_from	see original function docs
values_fill	see original function docs
values_fn	see original function docs
fill	see original function docs
drop	see original function docs
sep	see <a href="#">separate_rows</a>
tbl	see original function docs
size	see original function docs
replace	see original function docs
weight	see original function docs
.env	see original function docs
col	see <a href="#">separate</a>
into	see <a href="#">separate</a>
remove	see <a href="#">separate</a>
extra	see <a href="#">separate</a>
.preserve	see <a href="#">unnest</a>
by	<p>A join specification created with <a href="#">join_by()</a>, or a character vector of variables to join by.</p> <p>If NULL, the default, <code>*_join()</code> will perform a natural join, using all variables in common across x and y. A message lists the variables so that you can check they're correct; suppress the message by supplying <code>by</code> explicitly.</p> <p>To join on different variables between x and y, use a <a href="#">join_by()</a> specification. For example, <code>join_by(a == b)</code> will match <code>x\$a</code> to <code>y\$b</code>.</p> <p>To join by multiple variables, use a <a href="#">join_by()</a> specification with multiple expressions. For example, <code>join_by(a == b, c == d)</code> will match <code>x\$a</code> to <code>y\$b</code> and</p>



`x$c` to `y$d`. If the column names are the same between `x` and `y`, you can shorten this by listing only the variable names, like `join_by(a, c)`.

`join_by()` can also be used to perform inequality, rolling, and overlap joins. See the documentation at [?join\\_by](#) for details on these types of joins.

For simple equality joins, you can alternatively specify a character vector of variable names to join by. For example, `by = c("a", "b")` joins `x$a` to `y$a` and `x$b` to `y$b`. If variable names differ between `x` and `y`, use a named character vector like `by = c("x_a" = "y_a", "x_b" = "y_b")`.

To perform a cross-join, generating all combinations of `x` and `y`, see `cross_join()`.

copy	If <code>x</code> and <code>y</code> are not from the same data source, and <code>copy</code> is <code>TRUE</code> , then <code>y</code> will be copied into the same <code>src</code> as <code>x</code> . This allows you to join tables across <code>srcs</code> , but it is a potentially expensive operation so you must opt into it.
suffix	If there are non-joined duplicate variables in <code>x</code> and <code>y</code> , these suffixes will be added to the output to disambiguate them. Should be a character vector of length 2.

## Details

`select` keeps the geometry regardless whether it is selected or not; to deselect it, first pipe through `as.data.frame` to let `dplyr`'s own `select` drop it.

In case one or more of the arguments (expressions) in the `summarise` call creates a geometry list-column, the first of these will be the (active) geometry of the returned object. If this is not the case, a geometry column is created, depending on the value of `do_union`.

In case `do_union` is `FALSE`, `summarise` will simply combine geometries using `c.sfg`. When polygons sharing a boundary are combined, this leads to geometries that are invalid; see for instance <https://github.com/r-spatial/sf/issues/681>.

`distinct` gives distinct records for which all attributes and geometries are distinct; `st_equals` is used to find out which geometries are distinct.

`nest` assumes that a simple feature geometry list-column was among the columns that were nested.

## Value

an object of class `sf`

## Examples

```
if (require(dplyr, quietly = TRUE)) {
  nc = read_sf(system.file("shape/nc.shp", package="sf"))
  nc %>% filter(AREA > .1) %>% plot()
  # plot 10 smallest counties in grey:
  st_geometry(nc) %>% plot()
  nc %>% select(AREA) %>% arrange(AREA) %>% slice(1:10) %>% plot(add = TRUE, col = 'grey')
  title("the ten counties with smallest area")
  nc2 <- nc %>% mutate(area10 = AREA/10)
  nc %>% slice(1:2)
}
# plot 10 smallest counties in grey:
if (require(dplyr, quietly = TRUE)) {
  st_geometry(nc) %>% plot()
```

```

nc %>% select(AREA) %>% arrange(AREA) %>% slice(1:10) %>% plot(add = TRUE, col = 'grey')
title("the ten counties with smallest area")
}
if (require(dplyr, quietly = TRUE)) {
  nc$area_cl = cut(nc$AREA, c(0, .1, .12, .15, .25))
  nc %>% group_by(area_cl) %>% class()
}
if (require(dplyr, quietly = TRUE)) {
  nc2 <- nc %>% mutate(area10 = AREA/10)
}
if (require(dplyr, quietly = TRUE)) {
  nc %>% transmute(AREA = AREA/10, geometry = geometry) %>% class()
  nc %>% transmute(AREA = AREA/10) %>% class()
}
if (require(dplyr, quietly = TRUE)) {
  nc %>% select(SID74, SID79) %>% names()
  nc %>% select(SID74, SID79, geometry) %>% names()
  nc %>% select(SID74, SID79) %>% class()
  nc %>% select(SID74, SID79, geometry) %>% class()
}
if (require(dplyr, quietly = TRUE)) {
  nc2 <- nc %>% rename(area = AREA)
}
if (require(dplyr, quietly = TRUE)) {
  nc %>% slice(1:2)
}
if (require(dplyr, quietly = TRUE)) {
  nc$area_cl = cut(nc$AREA, c(0, .1, .12, .15, .25))
  nc.g <- nc %>% group_by(area_cl)
  nc.g %>% summarise(mean(AREA))
  nc.g %>% summarise(mean(AREA)) %>% plot(col = grey(3:6 / 7))
  nc %>% as.data.frame %>% summarise(mean(AREA))
}
if (require(dplyr, quietly = TRUE)) {
  nc[c(1:100, 1:10), ] %>% distinct() %>% nrow()
}
if (require(tidyr, quietly = TRUE) && require(dplyr, quietly = TRUE)) {
  nc %>% select(SID74, SID79) %>% gather("VAR", "SID", -geometry) %>% summary()
}
if (require(tidyr, quietly = TRUE) && require(dplyr, quietly = TRUE)) {
  nc$row = 1:100 # needed for spread to work
  nc %>% select(SID74, SID79, geometry, row) %>%
  gather("VAR", "SID", -geometry, -row) %>%
  spread(VAR, SID) %>% head()
}
if (require(tidyr, quietly = TRUE) && require(dplyr, quietly = TRUE)) {
  storms.sf = st_as_sf(storms, coords = c("long", "lat"), crs = 4326)
  x <- storms.sf %>% group_by(name, year) %>% nest
  trs = lapply(x$data, function(tr) st_cast(st_combine(tr), "LINESTRING")[[1]]) %>%
  st_sfc(crs = 4326)
  trs.sf = st_sf(x[,1:2], trs)
  plot(trs.sf["year"], axes = TRUE)
}

```

---

transform.sf	<i>transform method for sf objects</i>
--------------	--

---

**Description**

Can be used to create or modify attribute variables; for transforming geometries see [st\\_transform](#), and all other functions starting with st\_.

**Usage**

```
## S3 method for class 'sf'
transform(`_data`, ...)
```

**Arguments**

<code>_data</code>	object of class sf
<code>...</code>	Further arguments of the form <code>new_variable=expression</code>

**Examples**

```
a = data.frame(x1 = 1:3, x2 = 5:7)
st_geometry(a) = st_sfc(st_point(c(0,0)), st_point(c(1,1)), st_point(c(2,2)))
transform(a, x1_sq = x1^2)
transform(a, x1_x2 = x1*x2)
```

---

valid	<i>Check validity or make an invalid geometry valid</i>
-------	---

---

**Description**

Checks whether a geometry is valid, or makes an invalid geometry valid

**Usage**

```
st_is_valid(x, ...)

## S3 method for class 'sfc'
st_is_valid(x, ..., NA_on_exception = TRUE, reason = FALSE)

## S3 method for class 'sf'
st_is_valid(x, ...)

## S3 method for class 'sfg'
st_is_valid(x, ...)

st_make_valid(x, ...)
```

```

## S3 method for class 'sfg'
st_make_valid(x, ...)

## S3 method for class 'sfc'
st_make_valid(
  x,
  ...,
  oriented = FALSE,
  s2_options = s2::s2_options(snap = s2::s2_snap_precision(1e+07), ...),
  geos_method = "valid_structure",
  geos_keep_collapsed = TRUE
)

```

### Arguments

<code>x</code>	object of class <code>sfg</code> , <code>sfg</code> or <code>sf</code>
<code>...</code>	passed on to <a href="#">s2_options</a>
<code>NA_on_exception</code>	logical; if TRUE, for polygons that would otherwise raise a GEOS error (exception, e.g. for a POLYGON having more than zero but less than 4 points, or a LINESTRING having one point) return an NA rather than raising an error, and suppress warning messages (e.g. about self-intersection); if FALSE, regular GEOS errors and warnings will be emitted.
<code>reason</code>	logical; if TRUE, return a character with, for each geometry, the reason for invalidity, NA on exception, or "Valid Geometry" otherwise.
<code>oriented</code>	logical; only relevant if <code>st_is_longlat(x)</code> is TRUE; see <a href="#">s2</a>
<code>s2_options</code>	only relevant if <code>st_is_longlat(x)</code> is TRUE; options for <a href="#">s2_rebuild</a> , see <a href="#">s2_options</a> and <a href="#">Details</a> .
<code>geos_method</code>	character; either "valid_linework" (Original method, combines all rings into a set of noded lines and then extracts valid polygons from that linework) or "valid_structure" (Structured method, first makes all rings valid then merges shells and subtracts holes from shells to generate valid result. Assumes that holes and shells are correctly categorized.) (requires GEOS >= 3.10.1)
<code>geos_keep_collapsed</code>	logical; When this parameter is not set to FALSE, the "valid_structure" method will keep any component that has collapsed into a lower dimensionality. For example, a ring collapsing to a line, or a line collapsing to a point (requires GEOS >= 3.10.1)

### Details

For projected geometries, `st_make_valid` uses the `lwgeom_makevalid` method also used by the PostGIS command `ST_makevalid` if the GEOS version linked to is smaller than 3.8.0, and otherwise the version shipped in GEOS; for geometries having ellipsoidal coordinates `s2::s2_rebuild` is being used.

if `s2_options` is not specified and `x` has a non-zero precision set, then this precision value will be used as the value in `s2_snap_precision`, passed on to `s2_options`, rather than the `1e7` default.

**Value**

`st_is_valid` returns a logical vector indicating for each geometries of `x` whether it is valid. `st_make_valid` returns an object with a topologically valid geometry.

Object of the same class as `x`

**Examples**

```
p1 = st_as_sfc("POLYGON((0 0, 0 10, 10 0, 10 10, 0 0))")
st_is_valid(p1)
st_is_valid(st_sfc(st_point(0:1), p1[[1]]), reason = TRUE)
library(sf)
x = st_sfc(st_polygon(list(rbind(c(0,0),c(0.5,0),c(0.5,0.5),c(0.5,0),c(1,0),c(1,1),c(0,1),c(0,0))))))
suppressWarnings(st_is_valid(x))
y = st_make_valid(x)
st_is_valid(y)
y %>% st_cast()
```

vctrs

*vctrs methods for sf objects***Description**

vctrs methods for sf objects

**Usage**

```
vec_ptype2.sfc(x, y, ...)
```

```
## Default S3 method:
```

```
vec_ptype2.sfc(x, y, ..., x_arg = "x", y_arg = "y")
```

```
## S3 method for class 'sfc'
```

```
vec_ptype2.sfc(x, y, ...)
```

```
vec_cast.sfc(x, to, ...)
```

```
## S3 method for class 'sfc'
```

```
vec_cast.sfc(x, to, ...)
```

```
## Default S3 method:
```

```
vec_cast.sfc(x, to, ...)
```

**Arguments**

<code>x, y</code>	Vector types.
<code>...</code>	These dots are for future extensions and must be empty.
<code>x_arg, y_arg</code>	Argument names for <code>x</code> and <code>y</code> .
<code>to</code>	Type to cast to. If <code>NULL</code> , <code>x</code> will be returned as is.

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