Package: vectra (via r-universe)

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Title Columnar Query Engine for Larger-than-RAM Data

Version 0.14.1

Description A minimal columnar query engine with lazy execution on datasets larger than RAM. Provides 'dplyr'-like verbs (filter(), select(), mutate(), group_by(), summarise(), joins, window functions) and common aggregations (n(), sum(), mean(), min(), max(), sd(), first(), last()) backed by a pure C11 pull-based execution engine and a custom on-disk format ('.vtr'). Reads and writes 'GeoTIFF' (including tiled and 'BigTIFF' layouts) and a tiled raster format ('.vec') with overview pyramids and time cubes for larger-than-RAM raster data. Streams vector operations (spatial transforms, point-in-polygon and nearest-feature joins including a two-sided grid-partitioned join, select-by-location, clip, erase, dissolve, 'rasterization', 'polygonization', and contouring) through 'sf', and runs raster operations (zonal statistics, focal windows, terrain derivatives, resample or 'reproject' warp, polygon masking, map algebra, and 'mosaicking') in native C or over the tiled '.vec' format, one batch or tile at a time for data larger than RAM.

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`across` *Apply a function across multiple columns*

Description

Used inside `mutate()` or `summarise()` to apply a function to multiple columns selected with tidyselect. Returns a named list of expressions.

Usage

```
across(.cols, .fns, ..., .names = NULL)
```

Arguments

`.cols`	Column selection (tidyselect).
`.fns`	A function, formula, or named list of functions.
`...`	Additional arguments passed to `.fns`.
`.names`	A glue-style naming pattern. Uses `{.col}` and `{.fn}`. Default: `"{.col}"` if `.fns` is a single function, `"{.col}_{.fn}"` if `.fns` is a named list.

Value

A named list used internally by mutate/summarise.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
# In summarise (conceptual; across is expanded to individual expressions)
unlink(f)
```

append_vtr *Append rows or columns to an existing .vtr file*

Description

Grows an existing `.vtr` store in place. `along = "rows"` (the default) adds row groups to the end; `along = "cols"` attaches new columns to the rows already there.

Usage

```
append_vtr(
  x,
  path,
  along = c("rows", "cols"),
  compress = c("fast", "small", "none"),
  ...
)
```

Arguments

`x`	A `vectra_node` (lazy query) or a `data.frame`.
`path`	File path of an existing `.vtr` file to append to.
`along`	`"rows"` to add rows (default), `"cols"` to add columns.
`compress`	Compression for the appended rows or columns: `"fast"`, `"small"`, or `"none"`.
`...`	Additional arguments passed to methods.

Value

Invisible `NULL`.

Appending rows

The schema of `x` must exactly match the schema of the target file (same column names and types, in the same order). The row groups already in the store are neither read nor rewritten – the new ones are encoded and attached on their own – so the cost tracks the rows being appended rather than the size of the store.

That is what lets a table too long to hold in memory be built a batch at a time: write the first batch with `write_vtr()`, then append each later one as it is produced, with a peak of one batch rather than the whole table. Building a store this way costs one pass over the rows written, however many calls it takes.

Existing row groups keep their positions, so any `.vtri` index built with `create_index()` stays valid across a row append: each one takes in the appended row groups and keeps the rest, rather than being rebuilt from the whole store.

Appending columns

`x` supplies whole new columns for the rows already in the store: it must have exactly as many rows as the store holds, and column names that do not collide with the existing ones. The existing columns are never read or rewritten – the new columns are encoded and attached on their own – so the cost tracks what is being added rather than the size of the store.

That is what lets a table too wide to hold in memory be built a block of columns at a time: write the first block with `write_vtr()`, then append each later block as it is produced, with a peak of one block rather than the whole table. Row order is preserved, and the rows of `x` are matched to the store's rows by position.

Existing row-group boundaries and column data are untouched, so any `.vtri` index built with `create_index()` over the original columns stays valid across a column append: it is restamped for the grown store without being rebuilt.

File size

Either direction writes from the end of the store's data, where its row-group index starts, and writes a new index after the appended data, so the file holds one index however many appends built it. A store built by appending batch after batch is about as large as the same rows written by `write_vtr()` with the same row-group sizes. A store grown by appends in vectra 0.13.4 or earlier holds one superseded index per append; it reads and appends as usual, and writing it out with `write_vtr()` to a new file drops them.

Interruption

The index the file header points to is never overwritten while an append runs: before the appended data would reach it, a copy is written further along the file and the header is pointed at the copy, and the header is pointed at the new index only once that index is complete. So an interruption – a crash, a full disk, a killed process – at any point leaves the store readable either as it was before the call or as it is after it. The bytes an interrupted append wrote are referenced by nothing, and the next append writes over them.

A store grown in place is stamped so that readers predating this format refuse it rather than misread it, and is random-access only, which is how vectra reads a `.vtr` anyway.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars[1:10, ], f)
append_vtr(mtcars[11:20, ], f)
result <- tbl(f) |> collect()
stopifnot(nrow(result) == 20L)

# Attach two more columns to those same 20 rows
extra <- data.frame(kpl = result$mpg * 0.425,
                    heavy = result$wt > 3)
append_vtr(extra, f, along = "cols")
wide <- tbl(f) |> collect()
stopifnot(nrow(wide) == 20L, "kpl" %in% names(wide))
unlink(f)
```

arrange *Sort rows by column values*

Description

Sort rows by column values

Usage

```
arrange(.data, ...)
```

Arguments

.data	A vectra_node object.
...	Column names (unquoted). Wrap in desc() for descending order.

Details

Uses an external merge sort bounded by the memory budget (vectra_mem()). When data exceeds it, sorted runs are spilled to temporary .vtr files and merged via a k-way min-heap. NAs sort last, in ascending and descending order alike.

This is a materializing operation.

Value

A new vectra_node with sorted rows.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> arrange(desc(mpg)) |> collect() |> head()
unlink(f)
```

as_embedding *Encode vectors as an embedding column*

Description

Packs numeric vectors into the hex float32 blobs vectra stores embedding columns as. Write the result as an ordinary character column; the distance functions cosine(), l2(), and dot() decode it inside the engine.

Usage

```
as_embedding(x)
```

Arguments

x	A numeric matrix (one embedding per row), a list of equal-length numeric vectors, or a single numeric vector (one embedding).

Value

A character vector with one hex-encoded blob per embedding.

See Also

cosine(), l2(), dot()

Examples

```
m <- matrix(rnorm(12), nrow = 3)        # 3 embeddings of length 4
emb <- as_embedding(m)
df <- data.frame(id = 1:3, emb = emb)
```

---

bind_rows *Bind rows or columns from multiple vectra tables*

Description

Bind rows or columns from multiple vectra tables

Usage

```
bind_rows(..., .id = NULL)

bind_cols(...)
```

Arguments

...	vectra_node objects or data.frames to combine.
.id	Optional column name for a source identifier.

Details

When all inputs are vectra_node objects with identical column names and types and no .id is requested, bind_rows creates a streaming ConcatNode that iterates children sequentially without materializing.

Otherwise, inputs are collected and combined in R. Missing columns are filled with NA.

bind_cols requires the same number of rows in each input.

Value

A vectra_node (streaming) when all inputs are vectra_node with identical schemas and .id is NULL. Otherwise a data.frame.

Examples

```
f1 <- tempfile(fileext = ".vtr")
f2 <- tempfile(fileext = ".vtr")
write_vtr(data.frame(x = 1:3, y = 4:6), f1)
write_vtr(data.frame(x = 7:9, y = 10:12), f2)
bind_rows(tbl(f1), tbl(f2)) |> collect()
bind_cols(tbl(f1), tbl(f2))
unlink(c(f1, f2))
```

---

block_fuzzy_lookup *Fuzzy-match query keys against a materialized block*

Description

Computes string distances between query keys and a string column in a materialized block. Optionally uses exact-match blocking on a second column (e.g., genus) to reduce the search space.

Usage

```
block_fuzzy_lookup(
  block,
  column,
  keys,
  method = "dl",
  max_dist = 0.2,
  block_col = NULL,
  block_keys = NULL,
  n_threads = 4L
)
```

Arguments

block	A vectra_block from materialize().
column	Character scalar. Name of the string column to fuzzy-match against.
keys	Character vector. Query strings to match.
method	Character. Distance method: "dl" (Damerau-Levenshtein, default), "levenshtein", or "jw" (Jaro-Winkler).
max_dist	Numeric. Maximum normalized distance (default 0.2).
block_col	Optional character scalar. Column name for exact-match blocking (e.g., genus). When provided, only rows where block_col matches the corresponding block_keys value are compared.

block_keys	Optional character vector (same length as keys). Exact-match values for blocking. Required when block_col is provided.
n_threads	Integer. Number of OpenMP threads (default 4L).

Value

A data.frame with columns query_idx (1-based position in keys), fuzzy_dist (normalized distance), plus all columns from the block.

---

block_lookup *Probe a materialized block by column value*

Description

Performs a hash lookup on a string column of a materialized block. Returns all rows where the column value matches one of the query keys. Hash indices are built lazily on first use and cached for subsequent calls.

Usage

```
block_lookup(block, column, keys, ci = FALSE)
```

Arguments

block	A vectra_block from materialize().
column	Character scalar. Name of the string column to match against.
keys	Character vector. Query values to look up.
ci	Logical. Case-insensitive matching (default FALSE).

Value

A data.frame with column query_idx (1-based position in keys) plus all columns from the block, for each (query, block_row) match pair.

Examples

```
f <- tempfile(fileext = ".vtr")
df <- data.frame(taxonID = 1:2,
                 canonicalName = c("Quercus robur", "Pinus sylvestris"))
write_vtr(df, f)
blk <- materialize(tbl(f))
hits <- block_lookup(blk, "canonicalName", c("Quercus robur"))
ci_hits <- block_lookup(blk, "canonicalName", c("quercus robur"), ci = TRUE)
unlink(f)
```

chunk_feeder *Turn a query into a resettable chunk generator*

Description

Wraps a query so a pull-based consumer can read it one chunk at a time and re-read it from the start as many times as needed. The returned closure follows the `data(reset)` protocol that `biglm::bigglm()` expects: called with `reset = TRUE` it rewinds to the beginning of the data, and called with `reset = FALSE` it returns the next chunk as a data.frame, or `NULL` once the data is exhausted. This lets `bigglm()` fit a generalized linear model on a dataset larger than RAM, streaming each iteratively reweighted pass through the engine without ever holding the full design matrix.

Usage

```
chunk_feeder(.source)
```

Arguments

`.source`	Either a function of no arguments returning a fresh `vectra_node` each time it is called (e.g. `function() tbl_csv("occ.csv") |> select(presence, bio1, bio12)`), or an offloaded node from `offload()`. Every chunk must contain all variables the consumer's formula references.

Details

Because a vectra node is consumed as it streams, re-reading requires a fresh node on each pass. `chunk_feeder()` accepts either form: a *factory*, a function of no arguments that returns a new node each time it is called; or an offloaded node from `offload()`, which is backed by a file and replays from disk directly. On every `reset = TRUE` a fresh stream is started, so the same query is replayed on each pass.

Prefer feeding an `offload()` of the prepared query: the pipeline (scan, joins, mutate) runs once into the spill, and every reweighted pass is then a disk scan of the prepared columns rather than a re-run of the pipeline.

Value

A function `function(reset = FALSE)`. With `reset = TRUE` it rewinds and returns `invisible(NULL)`; with `reset = FALSE` it returns the next chunk as a data.frame, or `NULL` at end of stream.

See Also

`offload()` for the replay cache, and `collect_chunked()` for single-pass reductions that vectra drives.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)

feed <- chunk_feeder(function() tbl(f) |> select(mpg, wt, hp))
feed(reset = TRUE)       # rewind to the start of the stream
first <- feed()          # first chunk as a data.frame
head(first)


# Out-of-core GLM: prepare once with offload(), then bigglm() replays it.
if (requireNamespace("biglm", quietly = TRUE)) {
  s <- offload(tbl(f) |> select(mpg, wt, hp))
  fit <- biglm::bigglm(mpg ~ wt + hp, data = chunk_feeder(s),
                       family = gaussian())
  coef(fit)
}

unlink(f)
```

`collect` *Execute a lazy query and return the result*

Description

Pulls all batches from the execution plan and materializes the result in memory. A plain query returns a data.frame. A query whose output still carries a geometry column, which the spatial verbs (`spatial_map()`, `spatial_join()`, `spatial_clip()`, `spatial_overlay()` and the rest) mark on the node, returns an `sf` object, with the hex-WKB column decoded and the node's coordinate reference system set. A string column whose values are hex-encoded WKB is recognised from its content, so a stored geometry column comes back as `sf` without any spatial verb. The geometry marker follows the column through `filter()`, `select()`, `rename()`, `mutate()` and joins, and is dropped once the column is.

Usage

```
collect(x, ...)

## S3 method for class 'vectra_node'
collect(x, sf = TRUE, geom = NULL, crs = NULL, ...)
```

Arguments

`x`	A `vectra_node` object.
`...`	Ignored.

sf	If TRUE (default), a spatial result is returned as an sf object. FALSE returns the data.frame with the geometry as a hex-WKB string column. Ignored for a non-spatial query.
geom	Name of a hex-WKB geometry column to decode when the node does not already carry one, for instance a column read straight from a .vtr file. NULL (default) uses the geometry column the node carries.
crs	Coordinate reference system for the sf result. NULL (default) uses the one the node carries, or leaves it unknown.

Details

For a result still larger than RAM, keep it as a node and write it out with write_vtr(), stream it to a vector file with sf::st_write(), or reduce it with collect_chunked().

Value

A data.frame, or an sf object for a spatial query.

See Also

spatial_map(), collect_chunked()

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
result <- tbl(f) |> collect()
head(result)
unlink(f)
```

---

collect_chunked *Fold a function over a query, one batch at a time*

Description

Streams a lazy query through R in bounded pieces and reduces them with f, instead of materializing the whole result the way collect() does. The engine pulls one batch (a data.frame of up to a few hundred thousand rows) at a time; f is called as f(acc, chunk) and its return value becomes the accumulator for the next batch. Peak memory is one batch plus whatever the accumulator holds, so a result far larger than RAM can be reduced to a small summary in a single pass.

Usage

```
collect_chunked(x, f, .init = NULL, combine = NULL, commutative = FALSE)

## Default S3 method:
collect_chunked(x, f, .init = NULL, combine = NULL, commutative = FALSE)

## S3 method for class 'vectra_node'
collect_chunked(x, f, .init = NULL, combine = NULL, commutative = FALSE)

## S3 method for class 'vectra_offload'
collect_chunked(x, f, .init = NULL, combine = NULL, commutative = FALSE)

## S3 method for class 'vectra_shard'
collect_chunked(x, f, .init = NULL, combine = NULL, commutative = FALSE)

## S3 method for class 'vectra_partition'
collect_chunked(x, f, .init = NULL, combine = NULL, commutative = FALSE)
```

Arguments

x	A vectra_node (from tbl(), tbl_csv(), tbl_tiff(), ... and any chain of verbs). It is consumed: after collect_chunked() returns, the stream is drained and x cannot be collected again.
f	A function of two arguments function(acc, chunk) returning the updated accumulator. chunk is a data.frame holding the next batch of rows.
.init	Initial accumulator value. Passed to f with the first batch and returned unchanged if the query yields no rows. When combine is supplied this is also the monoid identity (the value combine leaves unchanged).
combine	Optional function function(acc, acc) that merges two accumulators. Supplying it declares the reduction a monoid with .init as identity, which is what lets the fold run over the independent shards of a partition (offload(x, by = ...)) and have the partial results merged correctly. For a plain node the stream is a single sequence, so combine is not needed and is ignored.
commutative	Logical; declare that combine does not depend on the order of its arguments. Lets a partitioned fold merge shards in any order (no stable sort required). Default FALSE.

Details

This is the streaming counterpart to a fold (Reduce()): use it when the query returns more rows than fit in memory but the *reduction* is small. A running count, per-group sufficient statistics, the cross-products X'X and X'y behind a linear fit, an online mean or histogram - all accumulate in bounded space across the stream. When you instead need the model-fitting consumer to drive the iteration (and to re-read the data on each pass, as an iteratively reweighted GLM does), use chunk_feeder().

Value

The final accumulator. For a node: `f` applied left-to-right across every batch, seeded with `.init`. For a partition: each shard folded with `f/.init`, then those per-shard accumulators merged with `combine`.

See Also

`chunk_feeder()` for pull-based consumers such as `biglm::bigglm()`, `offload()` for the replay cache and the partitioned monoidal reduce, `group_map()` and `group_modify()` for per-shard application, and `collect()` to materialize the full result.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)

# Row count without materializing the result.
collect_chunked(tbl(f), function(acc, chunk) acc + nrow(chunk), .init = 0L)

# Accumulate the normal-equation pieces X'X and X'y for an exact OLS fit
# of mpg ~ wt + hp, in one streaming pass.
acc <- collect_chunked(
  tbl(f) |> select(mpg, wt, hp),
  function(acc, chunk) {
    X <- cbind(1, chunk$wt, chunk$hp)
    y <- chunk$mpg
    list(XtX = acc$XtX + crossprod(X), Xty = acc$Xty + crossprod(X, y))
  },
  .init = list(XtX = matrix(0, 3, 3), Xty = matrix(0, 3, 1))
)
solve(acc$XtX, acc$Xty)            # same as coef(lm(mpg ~ wt + hp, mtcars))
unlink(f)
```

---

contours *Extract contour iso-lines from a streamed raster*

Description

Traces contour lines at one or more levels from a `.vec` raster with marching squares, reading the raster one tile-row strip at a time (each strip expanded by one row so a cell straddling the strip boundary is traced once). Each strip contributes line segments, which are accumulated into a lazy `vectra_node` carrying a `level` column and hex-WKB geometry. With `merge = TRUE` the segments of each level are joined into continuous lines.

Usage

```
contours(x, levels, band = 1L, merge = TRUE, crs = NA, flush_rows = NULL)
```

Arguments

x	A vectra_raster (from vec_open_raster()) or a path to a .vec raster.
levels	Numeric vector of contour levels to trace.
band	Band to contour (1-based). Default 1.
merge	If TRUE (default) join each level's segments into continuous lines with sf::st_line_merge(); if FALSE return the raw per-cell segments. Merging collects the full segment set into memory (usually small relative to the raster, but proportional to the grid for a surface that oscillates finely around a level); merge = FALSE stays streamed.
crs	Coordinate reference system recorded on the node. Defaults to the raster's EPSG, else unknown.
flush_rows	Rows buffered before a spill flush. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

Extraction is the *sort / partition* tier of the spatial toolbox: bounded to one haloed strip at a time. The optional final merge collects the segment set, which is small relative to the raster, and joins it per level; this is the small all-to-all step on the output, not on the grid. Geometry assembly and the merge are delegated to **sf** (an optional dependency).

Value

A vectra_node with a level column and a hex-WKB geometry column, materialise it with collect().

See Also

polygonize() for area features, terrain() for the DEM derivatives contours often accompany, collect() to materialise as sf.

Examples

```
z <- outer(1:20, 1:20, function(r, c) r + c)
f <- tempfile(fileext = ".vec")
vec_write_raster(z, f, dtype = "f64", extent = c(0, 0, 20, 20))

iso <- contours(f, levels = c(15, 25, 35))
collect(iso)
unlink(f)
```

count *Count observations by group*

Description

Count observations by group

Usage

```
count(x, ..., wt = NULL, sort = FALSE, name = NULL)

tally(x, wt = NULL, sort = FALSE, name = NULL)
```

Arguments

x	A vectra_node object.
...	Grouping columns, resolved as in group_by().
wt	Column to weight by (unquoted). If NULL, counts rows.
sort	If TRUE, sort output in descending order of n.
name	Name of the count column (default "n").

Details

Equivalent to group_by(...) |> summarise(n = n()). When wt is provided, uses sum(wt) instead of n(). When sort = TRUE, results are sorted in descending order of the count column.

Value

A vectra_node with group columns and a count column.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> count(cyl) |> collect()
unlink(f)
```

`create_index` *Create a hash index on a .vtr file column*

Description

Builds a persistent hash index stored as a `.vtri` sidecar file alongside the `.vtr` file. The index maps key hashes to row group indices, so an equality predicate (`filter(col == value)`) names the row groups that may hold a key without reading any column data.

Usage

```
create_index(path, column, ci = FALSE)
```

Arguments

`path`	Path to a `.vtr` file.
`column`	Character vector. Name(s) of column(s) to index.
`ci`	Logical. Build a case-insensitive index? Default `FALSE`.

Details

For composite indexes on multiple columns, pass a character vector. Composite indexes accelerate AND-combined equality predicates (e.g., `filter(col1 == "a", col2 == "b")`). The columns may be named in any order.

A query opens the index for the column it filters on, so a store can carry an index on each of several columns and a query pays only for the one it uses. `explain()` reports the index a scan will probe. The index composes with zone-map pruning and binary search on sorted columns.

The index holds one entry per distinct key per row group rather than one per row, so an index over a column with few distinct values stays small however many rows the store holds – which is what keeps a lookup off the size of the store.

Building one is bounded too: the entries are sorted through the streaming memory budget (`vectra_mem()`) and written in a single pass, so an index over a store larger than memory costs disk rather than RAM.

`append_vtr()` leaves the existing row groups where they are, so an index stays valid across an append: it takes in the row groups just appended and keeps the rest, reading only the new data rather than the whole store. `write_vtr()` replaces a store, and removes the indexes of the store it replaces.

An index records the store it was built on, by the store's row and row-group counts and a fingerprint of its bytes. An index left behind by any other change of the store – including a store replaced outside vectra by one of the same shape, such as a download or a file renamed over the old path – is reported as absent by `has_index()` and ignored by queries rather than pruning row groups that may now hold matching rows. The same goes for one that cannot be read at all: an index only ever saves a scan work, so an unusable one costs speed and never rows. Indexes written by vectra 0.12.3 and earlier are superseded and read as absent; call `create_index()` again to rebuild them.

A store written by vectra 0.12.3 or earlier carries no digest of its bytes, so its fingerprint covers its layout (row-group sizes, block sizes and column statistics) only. Such a store cannot be told apart

from a replacement whose blocks agree with it on all of those; rewriting it with `write_vtr()` gives it a digest.

Value

Invisible `NULL`. The index is written as a `.vtri` sidecar file.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(id = letters, val = 1:26, stringsAsFactors = FALSE), f)
create_index(f, "id")
tbl(f) |> filter(id == "m") |> collect()
unlink(c(f, paste0(f, ".id.vtri")))
```

`cross_join` *Cross join two vectra tables*

Description

Returns every combination of rows from `x` and `y` (Cartesian product). Both tables are collected before joining.

Usage

```
cross_join(x, y, suffix = c(".x", ".y"), ...)
```

Arguments

`x`	A `vectra_node` object or data.frame.
`y`	A `vectra_node` object or data.frame.
`suffix`	Suffixes for disambiguating column names (default `c(".x", ".y")`).
`...`	Ignored.

Value

A data.frame with `nrow(x) * nrow(y)` rows.

Examples

```
f1 <- tempfile(fileext = ".vtr")
f2 <- tempfile(fileext = ".vtr")
write_vtr(data.frame(a = 1:2), f1)
write_vtr(data.frame(b = c("x", "y", "z"), stringsAsFactors = FALSE), f2)
cross_join(tbl(f1), tbl(f2))
unlink(c(f1, f2))
```

delete_vtr *Logically delete rows from a .vtr file*

Description

Marks the specified 0-based physical row indices as deleted by writing (or updating) a tombstone side file (<path>.del). The original .vtr file is never modified. The next call to tbl() on the same path will automatically exclude the deleted rows.

Usage

```
delete_vtr(path, row_ids)
```

Arguments

path	File path of the .vtr file to delete rows from.
row_ids	A numeric vector of **0-based** physical row indices to delete. Out-of-range indices are silently ignored on read (they will never match a real row).

Details

Tombstone files are cumulative: calling delete_vtr() multiple times on the same file merges all deletions (union, deduplicated). To undo deletions, remove the .del file manually with unlink(paste0(path, ".del")).

Value

Invisible NULL.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)

# Delete the first and third rows (0-based indices 0 and 2)
delete_vtr(f, c(0, 2))

result <- tbl(f) |> collect()
stopifnot(nrow(result) == nrow(mtcars) - 2L)

unlink(c(f, paste0(f, ".del")))
```

desc *Mark a column for descending sort order*

Description

Used inside `arrange()` to sort a column in descending order.

Usage

```
desc(x)
```

Arguments

x	A column name.

Value

A marker used by `arrange()`.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> arrange(desc(mpg)) |> collect() |> head()
unlink(f)
```

diff_vtr *Compute the logical diff between two .vtr files*

Description

Streams both files and computes a set-level diff keyed on `key_col`. Returns a list with two elements:

Usage

```
diff_vtr(old_path, new_path, key_col)
```

Arguments

old_path	Path to the older `.vtr` file.
new_path	Path to the newer `.vtr` file.
key_col	Name of the column to use as the row key (must exist in both files with the same type).

Details

- added: a vectra_node (lazy tbl()) of rows present in new_path but not old_path (matched on key_col). Call collect() to materialise. The underlying temp file is deleted when the node is garbage-collected **or** when the calling R session ends via on.exit().
- deleted: a vector of key values present in old_path but not new_path.

This is a **logical diff** (key-based set difference), not a binary file diff. Rows with the same key that have changed values are not reported as modified — use added and deleted together to detect updates (a key that appears in both means a row was replaced).

key_col is treated as a **primary key**: keys are assumed unique within each file, so if the same key appears on several rows of new_path only one is reported in added.

Both files are streamed through the external sort (keyed by key_col) and merged in a single forward pass, so peak memory is bounded by the sort's spill budget (vectra_mem()) rather than by the number of distinct keys. The added rows stream to a temp file; only the returned deleted key vector is materialised (its size is the number of deleted keys).

Value

A named list with elements added (a vectra_node) and deleted (a vector of key values).

Examples

```
f1 <- tempfile(fileext = ".vtr")
f2 <- tempfile(fileext = ".vtr")
df1 <- data.frame(id = 1:5, val = letters[1:5], stringsAsFactors = FALSE)
df2 <- data.frame(id = c(3L, 4L, 5L, 6L, 7L),
                  val = c("C", "d", "e", "f", "g"),
                  stringsAsFactors = FALSE)
write_vtr(df1, f1)
write_vtr(df2, f2)

d <- diff_vtr(f1, f2, "id")
# Rows 1 and 2 deleted; rows 6 and 7 added
stopifnot(all(d$deleted %in% c(1, 2)))
stopifnot(all(collect(d$added)$id %in% c(6, 7)))

unlink(c(f1, f2))
```

---

dim.vectra_node *Dimensions of a lazy query*

Description

Reports the shape of a vectra_node from plan metadata, without running the query. Defining dim() is what makes base R's base::nrow() and base::ncol() work on a node, since both read dim(x).

Usage

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

Arguments

x	A vectra_node object.

Details

The column count always comes from the plan's schema. The row count is available when it can be read from metadata: a `.vtr` table reports the count stored in its row-group index (minus any rows `delete_vtr()` has tombstoned), and the row-preserving verbs carry it through – `select()`, `mutate()`, `rename()`, `arrange()`, `relocate()`, window functions, `utils::head()`, `slice_head()`, `slice_min()`/`slice_max()`, and `bind_rows()` over counted inputs.

Verbs whose output length depends on the data – `filter()`, the joins, `summarise()`, `distinct()` – report `NA` rows. Counting those means running the query, which on a larger-than-RAM table is a full pass, so `nrow()` reports what it knows rather than starting one. To get the exact count, run the query:

```
tbl(f) |> filter(x > 0) |> count() |> collect()
```

A CSV, SQLite, or TIFF source reports `NA` rows too: those formats carry no row count to read.

Value

A length-2 vector `c(rows, cols)`, integer unless the row count exceeds the largest integer R can hold, in which case both are doubles. `rows` is `NA` when the count is not derivable from metadata.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)

dim(tbl(f))
nrow(tbl(f))                       # 32, straight from the row-group index
ncol(tbl(f) |> select(mpg, cyl))   # 2
nrow(tbl(f) |> head(5))            # 5
nrow(tbl(f) |> filter(cyl == 4))   # NA: needs the query to run

# exact count for a filtered query
tbl(f) |> filter(cyl == 4) |> count() |> collect()

unlink(f)
```

distinct *Keep distinct/unique rows*

Description

Keep distinct/unique rows

Usage

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

Arguments

.data	A vectra_node object.
...	Column names (unquoted). If empty, uses all columns.
.keep_all	If TRUE, keep all columns (not just those in ...).

Details

Uses hash-based grouping with zero aggregations. When .keep_all = TRUE with a column subset, falls back to R's duplicated() with a message.

This is a materializing operation.

Value

A vectra_node with unique rows.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> distinct(cyl) |> collect()
unlink(f)
```

embedding_distance *Embedding distance functions*

Description

Distance and similarity functions over embedding columns (see as_embedding()), usable inside mutate() / filter() like any other expression. The query side is either another embedding column or a constant numeric vector. Decoding and the arithmetic run in C, one row at a time, parallelized over rows.

Usage

```
cosine(x, y)

l2(x, y)

dot(x, y)
```

Arguments

x	An embedding column.
y	An embedding column, or a constant numeric query vector.

Details

`cosine()` returns cosine distance (`1 - similarity`) and `l2()` Euclidean distance, so smaller means nearer – pair them with `slice_min()` for nearest-neighbour search. `dot()` returns the inner product, where larger means nearer (`slice_max()`).

Value

A double column.

See Also

`as_embedding()`

Examples

```
## Not run:
q <- rnorm(128)
tbl("vecs.vtr") |>
  mutate(d = cosine(emb, q)) |>
  slice_min(d, n = 10) |>
  collect()

## End(Not run)
```

---

explain *Print the execution plan for a vectra query*

Description

Shows the node types, column schemas, and structure of the lazy query plan.

Usage

```
explain(x, ...)
```

Arguments

x	A vectra_node object.
...	Ignored.

Value

Invisible x.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> filter(cyl > 4) |> select(mpg, cyl) |> explain()
unlink(f)
```

---

feature_knn *Nearest neighbours of a streamed layer in predictor space*

Description

Streams a query side x through the engine and, for each row, returns the mean distance to its nearest neighbours in a resident reference cloud y – where distance is measured in *predictor* (attribute) space, not on coordinates. This is the continuous half of the MOP transferability metric (Owens et al. 2013): the mean environmental distance from a projection cell to the nearest part of a calibration cloud. Where spatial_knn() measures geographic proximity with GEOS, feature_knn() measures environmental novelty with an L2 or Mahalanobis distance in n-variable space.

Usage

```
feature_knn(
  x,
  y,
  vars = NULL,
  k = NULL,
  percentage = NULL,
  metric = c("euclidean", "mahalanobis"),
  dist_col = "knn_distance",
  nthreads = NULL,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_csv(), ...): the streamed query side. Its predictor columns are read one batch at a time.
y	A data.frame or numeric matrix: the resident reference cloud, one column per predictor. Rows with any NA are dropped.
vars	Character vector of predictor column names present in both x and y. Defaults to the column names of y.
k	Number of nearest neighbours to average over. Supply exactly one of k or percentage.
percentage	Percent of the reference cloud to average over (the nearest ceil(percentage/100 * nrow(y)) neighbours). Supply exactly one of k or percentage.
metric	"euclidean" (default) for straight L2 distance in predictor units, or "mahalanobis" for distance whitened by the reference cloud's covariance.
dist_col	Name of the appended distance column. Default "knn_distance".
nthreads	Threads for the per-batch distance scan. NULL (default) uses all available (capped to two under R CMD check).
flush_rows	Rows to buffer before spilling a run file. NULL (default) spills by the streaming memory budget instead.

Details

The reference cloud is materialized once, whitened for the chosen metric, and held resident; the query side streams one batch at a time, so the projection side can exceed memory while peak memory stays at one batch plus the resident cloud. The neighbour count is either an absolute k or the nearest percentage% of the cloud (ceil(percentage/100 * nrow(y))), matching MOP's proportion-of-reference formulation.

Value

A vectra_node of x's columns plus dist_col, backed by temporary .vtr spills removed when the node is garbage-collected.

References

Owens, H.L. et al. (2013) Constraints on interpretation of ecological niche models by limited environmental ranges on calibration areas. *Ecological Modelling* 263:10-18.

See Also

rast_feature_distance() for the same distance computed out-of-core over a projection raster, spatial_knn() for geographic nearest neighbours.

Examples

```
set.seed(1)
ref <- data.frame(bio1 = rnorm(500, 10, 2), bio12 = rnorm(500, 800, 50))
qy  <- data.frame(bio1 = c(10, 20), bio12 = c(800, 400))
f <- tempfile(fileext = ".vtr")
write_vtr(qy, f)

# Row 1 sits in the cloud (small distance); row 2 is far outside it.
tbl(f) |>
  feature_knn(ref, percentage = 5) |>
  collect()
unlink(f)
```

`filter` *Filter rows of a vectra query*

Description

Filter rows of a vectra query

Usage

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

Arguments

`.data`	A `vectra_node` object.
`...`	Filter expressions (combined with `&`).

Details

Filter uses zero-copy selection vectors: matching rows are indexed without copying data. Multiple conditions are combined with `&`. Supported expression types: arithmetic (`+`, `-`, `*`, `/`, `%%`), comparison (`==`, `!=`, `<`, `<=`, `>`, `>=`), boolean (`&`, `|`, `!`), `is.na()`, and string functions (`nchar()`, `substr()`, `grepl()`; patterns are regex by default, as in base R, or literal with `fixed = TRUE`).

NA comparisons return NA (SQL semantics). Use `is.na()` to filter NAs explicitly.

This is a streaming operation (constant memory per batch).

Value

A new `vectra_node` with the filter applied.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> filter(cyl > 4) |> collect() |> head()
unlink(f)
```

`floor_time` *Floor a datetime column to a calendar grid*

Description

Truncates a `Date` or `POSIXct` column down to a unit boundary – the basis for time bucketing. Usable inside `mutate()` / `filter()`; `resample()` calls it for you.

Usage

```
floor_time(t, unit)
```

Arguments

`t`	A `Date` or `POSIXct` column (stored as days / seconds since the epoch).
`unit`	A bucket size as a string: a count and a unit, e.g. `"hour"`, `"15 min"`, `"day"`, `"week"`, `"3 months"`, `"quarter"`, `"year"`.

Details

The result is returned in the column's own scale (days for `Date`, seconds for `POSIXct`), so it remains a valid instant. The engine does not re-attach the `Date`/`POSIXct` class to a computed column, so a floored column collects as the underlying numeric epoch; wrap with `as.POSIXct(x, origin = "1970-01-01", tz = "UTC")` or `as.Date(x, origin = "1970-01-01")` if you need the class back.

Value

A numeric (epoch) column.

See Also

`resample()`

`focal` *Moving-window (focal) statistics over a streamed raster*

Description

Applies a moving window to a `.vec` raster, reading the input one tile-row strip at a time – each strip expanded by the kernel radius (a halo read) so window neighbours are available without ever holding the whole grid resident. The per-window statistic is computed in C. When `path` is given the output is streamed straight back to a new `.vec` one tile-row at a time, so neither the input nor the output band is ever fully in memory; this is the raster op that runs out of core where an in-memory engine needs the whole raster at once.

Usage

```
focal(
  x,
  w = matrix(1, 3, 3),
  fun = c("mean", "sum", "min", "max", "sd", "median"),
  na.rm = TRUE,
  band = 1L,
  path = NULL,
  dtype = "f32",
  compression = c("fast", "balanced", "max")
)
```

Arguments

`x`	A `vectra_raster` (from `vec_open_raster()`) or a path to a `.vec` raster.
`w`	A numeric weight matrix with odd dimensions, or a single positive odd integer `k` for a `k x k` window of ones. Default `matrix(1, 3, 3)`.
`fun`	Window statistic: one of `"sum"`, `"mean"`, `"min"`, `"max"`, `"sd"`, `"median"`. Default `"mean"`.
`na.rm`	Skip nodata cells inside the window (`TRUE`, default) or let them propagate `NA` (`FALSE`).
`band`	Band to read (1-based). Default 1.
`path`	Optional output `.vec` path. When given the result is streamed to disk and the opened `vec_open_raster()` handle is returned invisibly; when `NULL` the result is returned as an in-memory matrix.
`dtype`	Storage dtype for `.vec` output (see `vec_write_raster()`). Default `"f32"`.
`compression`	Compression effort for `.vec` output. Default `"fast"`.

Details

This is the *sort / partition* tier of the spatial toolbox: bounded to one haloed strip at a time, exploiting tile locality.

The window `w` is a numeric weight matrix with odd dimensions (or a single odd integer `k`, shorthand for a `k x k` matrix of ones). `NA` weights mark cells outside the window. For `fun = "sum"/"mean"` the weights scale the values (sum is `sum(w * x)`, mean is `sum(w * x) / sum(w)`); for the other statistics a finite weight only marks membership. With `na.rm = TRUE` (the default) nodata cells inside the window are skipped; with `na.rm = FALSE` any nodata cell – including a window that runs off the raster edge – makes the result `NA`, matching the resident behaviour.

Value

When `path` is `NULL`, a numeric matrix (row 1 northmost) carrying `gt`, `extent`, `crs`, and `fun` attributes. When `path` is given, the written `vectra_raster` handle (invisibly).

See Also

`terrain()` for DEM derivatives built on the same strip pass, `zonal()` for per-zone summaries.

Examples

```
m <- matrix(1:36, 6, 6, byrow = TRUE)
f <- tempfile(fileext = ".vec")
vec_write_raster(m, f, dtype = "f64", extent = c(0, 0, 6, 6))

# 3x3 mean smoother; edge cells see off-raster neighbours.
focal(f, w = matrix(1, 3, 3), fun = "mean")
unlink(f)
```

---

fuzzy_join *Fuzzy join two vectra tables by string distance*

Description

Joins two tables using approximate string matching on key columns. Optionally blocks by a second column (e.g., genus) for performance — only rows sharing the same blocking key are compared.

Usage

```
fuzzy_join(
  x,
  y,
  by,
  method = "dl",
  max_dist = 0.2,
  block_by = NULL,
```

```
  n_threads = 4L,
  suffix = ".y"
)
```

Arguments

x	A vectra_node object (probe / query side).
y	A vectra_node object (build / reference side).
by	A named character vector of length 1: c("probe_col" = "build_col"). The columns to compute string distance on.
method	Character. Distance algorithm: "dl" (Damerau-Levenshtein, default), "levenshtein", or "jw" (Jaro-Winkler).
max_dist	Numeric. Maximum normalized distance (0-1) to keep a match. Default 0.2.
block_by	Optional named character vector of length 1: c("probe_col" = "build_col"). Rows must match exactly on these columns before distance is computed. Dramatically reduces comparisons.
n_threads	Integer. Number of OpenMP threads for parallel distance computation over partitions. Default 4L.
suffix	Character. Suffix appended to build-side column names that collide with probe-side names. Default ".y".

Value

A vectra_node with all probe columns, all build columns (suffixed on collision), and a fuzzy_dist column (double).

---

geom_expressions *Geometry functions inside mutate(), filter(), and summarise()*

Description

vectra recognizes a family of st_* geometry functions directly inside expression verbs. They run on the GEOS C library straight off the hex-WKB geometry column, one row at a time, with no per-batch round-trip through **sf**: tbl(f) |> filter(st_area(geometry) > 1e6) prunes the stream in C, and mutate(centroid = st_centroid(geometry)) adds a new hex-WKB geometry column. The computation is planar, in the geometry's own coordinate units, exactly as the streaming spatial verbs are.

Details

These names are interpreted by the expression engine; they are not exported R functions and are not called as such. They are available only inside mutate(), transmute(), filter(), and a grouped summarise() over a vectra_node. The geometry argument is the hex-WKB column (named geometry by convention). A function that returns a geometry produces another hex-WKB column; materialize it with collect() (point it at the column with geom =), or write it with write_tiff()/sf::st_write().

Measures (return a number)

`st_area(g)` Area of polygonal geometry (0 for lines and points).

`st_length(g)`, `st_perimeter(g)` Length of a line, or the perimeter (boundary length) of a polygon. The two names are aliases.

`st_x(g)`, `st_y(g)` Coordinate of a point geometry; `NA` for a non-point.

`st_npoints(g)` Number of coordinates in the geometry.

`st_ngeometries(g)` Number of sub-geometries in a collection or multi-geometry (1 for a single geometry).

`st_distance(a, b)` Shortest planar distance between two geometries (see the binary second argument below).

Predicates (return TRUE / FALSE)

Unary: `st_is_valid(g)`, `st_is_empty(g)`, `st_is_simple(g)`.

Binary topological relations, each taking a second geometry: `st_intersects`, `st_within`, `st_contains`, `st_overlaps`, `st_touches`, `st_crosses`, `st_equals`, `st_disjoint`, `st_covers`, `st_covered_by`. Used in `filter()` they keep the rows where the relation holds.

Type (returns a string)

`st_geometry_type(g)` gives the GEOS geometry type name (`"Point"`, `"Polygon"`, `"MultiPolygon"`, ...).

Transforms (return a geometry)

`st_centroid(g)` Area (or length, or vertex) centroid.

`st_point_on_surface(g)` A point guaranteed to lie on the geometry.

`st_boundary(g)` The topological boundary.

`st_envelope(g)` The axis-aligned bounding rectangle.

`st_convex_hull(g)` The convex hull.

`st_make_valid(g)` Repair an invalid geometry.

`st_buffer(g, dist)` Buffer by `dist` (round joins, 8 segments per quadrant).

`st_simplify(g, tol)` Topology-preserving Douglas-Peucker simplification with tolerance `tol`.

The second geometry of a binary op

For `st_distance` and the binary predicates, the second argument can be another geometry column (compared row by row), a constant `sf`/`sfc` object (a multi-feature object is unioned to one geometry), or a hex-WKB string. A constant is parsed once and reused across every row, so testing a whole stream against one area of interest stays cheap.

Missing geometry

A missing (`NA`) or unparseable geometry, or an operation that has no answer (a coordinate of a non-point, distance to a missing geometry), yields `NA` for that row rather than an error.

See Also

mutate(), filter(), collect() to materialize a geometry result as sf; spatial_map() for an arbitrary per-feature **sf** transform; spatial_filter() and spatial_join() for relating a stream to a resident reference layer.

Examples

```
if (requireNamespace("sf", quietly = TRUE)) {
  nc <- sf::st_read(system.file("shape/nc.shp", package = "sf"), quiet = TRUE)
  f <- tempfile(fileext = ".vtr")
  write_vtr(data.frame(
    NAME     = nc$NAME,
    geometry = sf::st_as_binary(sf::st_geometry(nc), hex = TRUE)
  ), f)

  # measures: add area and perimeter columns
  tbl(f) |>
    mutate(area = st_area(geometry), perim = st_perimeter(geometry)) |>
    select(NAME, area, perim) |>
    collect() |>
    head()

  # predicate: keep counties intersecting an area of interest
  aoi <- sf::st_as_sfc(sf::st_bbox(
    c(xmin = -81.5, ymin = 36.2, xmax = -80.5, ymax = 36.6)))
  tbl(f) |> filter(st_intersects(geometry, aoi)) |> collect() |> nrow()

  # transform: replace each county with its centroid, materialize as sf
  tbl(f) |>
    mutate(geometry = st_centroid(geometry)) |>
    select(NAME, geometry) |>
    collect()

  unlink(f)
}
```

---

glimpse *Get a glimpse of a vectra table*

Description

Shows column names, types, and a preview of the first few values without collecting the full result.

Usage

```
glimpse(x, width = 5L, ...)
```

Arguments

x	A vectra_node object.
width	Maximum number of preview rows to fetch (default 5).
...	Ignored.

Value

Invisible x.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> glimpse()
unlink(f)
```

---

grid *Define a uniform grid for a partitioned spatial join*

Description

Describes the regular grid that spatial_join() uses to partition two streamed layers for the both-sides-larger-than-RAM case. Cell (cx, cy) covers [origin_x + cx * cellsize_x, origin_x + (cx + 1) * cellsize_x) and likewise in y, so a coordinate maps to the cell floor((coord - origin) / cellsize). Pick a cellsize comparable to the scale of the join (large enough that most cells hold a workable shard, small enough that one cell's features fit in memory); for an extended-on-extended join choose it larger than the left features.

Usage

```
grid(cellsize, origin = c(0, 0))
```

Arguments

cellsize	Cell size: a single number for square cells, or c(cellsize_x, cellsize_y).
origin	Grid origin c(x0, y0) (a cell corner). Default c(0, 0).

Value

A vectra_grid specification to pass as spatial_join(partition =).

See Also

spatial_join() for the join it partitions.

Examples

```
grid(1000)
grid(c(0.5, 0.25), origin = c(-180, -90))
```

---

group_by *Group a vectra query by columns*

Description

Group a vectra query by columns

Usage

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

Arguments

.data	A vectra_node object.
...	Grouping columns. Bare column names, injected symbols (!!rlang::sym(k), !!!rlang::syms(ks)), the .data pronoun (.data[[k]]), across()/pick() with a tidyselect selection (across(all_of(ks))), or expressions, which add a computed column first (group_by(decade = year %/% 10); an unnamed expression is named after its text, as in dplyr).
.add	If FALSE (default), replace the existing grouping; if TRUE, add to it.

Value

A vectra_node with grouping information stored.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> group_by(cyl) |> summarise(avg = mean(mpg)) |> collect()
unlink(f)
```

group_map *Apply a function to each shard of a partition*

Description

Run a function once per shard of a partition (`offload(x, by = ...)`) and gather the results. Each shard is read into memory as a data.frame and passed to `.f` together with its key, so a model that couples rows within a group becomes a set of independent per-shard fits. This is the per-group counterpart to `collect_chunked()`, which instead merges every shard into a single accumulator.

Usage

```
group_map(.data, .f, ...)

## S3 method for class 'vectra_partition'
group_map(.data, .f, ...)

group_modify(.data, .f, ...)

## S3 method for class 'vectra_partition'
group_modify(.data, .f, ...)
```

Arguments

`.data`	A `vectra_partition` from `offload()` with a `by` key.
`.f`	A function applied to each shard. It receives the shard as a data.frame and the shard key (a string) as its first two arguments; any further arguments in `...` follow. A purrr-style formula such as `~ lm(y ~ x, .x)` also works, with `.x` the shard data and `.y` the key. For `group_modify()`, `.f` must return a data.frame.
`...`	Additional arguments passed on to `.f`.

Details

`group_map()` returns a named list, one element per shard keyed by the shard key, and places no constraint on what `.f` returns. Use it for per-group results that do not rebind into a table, such as fitted models.

`group_modify()` expects `.f` to return a data.frame for each shard and binds those frames into one. When a shard's result does not already carry the partition key column, the key is added as a leading column (named after the partition's `by`), so every row records the shard it came from. Use it for per-group summaries that recombine into a single table.

Each shard is materialized in full before `.f` sees it, so partition the query on a key whose groups fit in memory. For a reduction that stays bounded without ever holding a whole group, fold the partition with `collect_chunked()` instead.

Value

group_map() returns a named list with one element per shard. group_modify() returns a single data.frame: the per-shard results row-bound, with the shard key restored as a column when .f dropped it.

See Also

offload() to build a partition, and collect_chunked() for the partitioned monoidal reduce.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
p <- offload(tbl(f), by = "cyl")

# One fit per shard, returned as a named list keyed by cyl.
fits <- group_map(p, function(d, cyl) coef(lm(mpg ~ wt, data = d)))
fits

# Per-shard summaries recombined into one table, key restored as a column.
group_modify(p, function(d, cyl)
  data.frame(n = nrow(d), mean_mpg = mean(d$mpg)))
unlink(f)
```

---

has_index *Check whether a .vtr column has a usable hash index*

Description

TRUE when the .vtri sidecar is present, readable, in the current format, and built against the store as it now stands. An index that no longer matches the store, or that cannot be read, reads as FALSE, because queries ignore it and fall back to a scan; create_index() rebuilds it.

Usage

```
has_index(path, column)
```

Arguments

path	Path to a .vtr file.
column	Character vector. Name(s) of column(s), in any order.

Value

Logical scalar: TRUE if the index exists and can be used.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(id = letters, val = 1:26, stringsAsFactors = FALSE), f)
has_index(f, "id")   # FALSE
create_index(f, "id")
has_index(f, "id")   # TRUE
unlink(c(f, paste0(f, ".id.vtri")))
```

`head.vectra_node` *Limit results to first n rows*

Description

Limit results to first n rows

Usage

```
## S3 method for class 'vectra_node'
head(x, n = 6L, ...)
```

Arguments

`x`	A `vectra_node` object.
`n`	Number of rows to return.
`...`	Ignored.

Value

A data.frame with the first `n` rows.

`interval_join` *Interval (range overlap) join of two vectra tables*

Description

Joins each row of `x` to every row of `y` whose `[start, end]` interval overlaps it – the one-dimensional analogue of a spatial bounding-box join (`data.table::foverlaps`, `GenomicRanges::findOverlaps`). An optional equality key in `by` restricts overlap testing to rows that share that key (a chromosome, a sensor id), the same role a regular join's `by` plays.

Usage

```
interval_join(
  x,
  y,
  start,
  end,
  by = NULL,
  type = c("inner", "left"),
  closed = TRUE,
  n_threads = 4L,
  suffix = ".y"
)
```

Arguments

x	A vectra_node (the streamed / probe side).
y	A vectra_node (the resident / build side).
start	The interval start columns, as c("x_col" = "y_col") or a single name shared by both sides.
end	The interval end columns, in the same form as start.
by	Optional equality key restricting overlap to rows that match on it, as c("x_col" = "y_col") or a single shared name. NULL (default) tests every pair.
type	"inner" (default) keeps only overlapping pairs; "left" keeps every x row, filling y columns with NA where nothing overlaps.
closed	Logical. TRUE (default) counts intervals that touch at an endpoint as overlapping; FALSE requires a strictly positive overlap.
n_threads	Integer. OpenMP threads for the per-group sweep. Default 4L.
suffix	Character. Suffix appended to y column names that collide with x names. Default ".y".

Details

Both sides are read into memory, then within each by group a sweep over the interval endpoints emits each overlapping pair once, scaling with the number of overlaps rather than the product of the row counts.

Value

A vectra_node with all x columns followed by all y columns (suffixed on collision).

kmer *k-mer spectrum of a sequence column*

Description

Counts every fixed-length subsequence (k-mer) of a nucleotide string column, grouped by zero or more key columns. The result is one row per distinct (group, k-mer): the grouping columns, a `kmer` column, and an integer `count`. This is the set-wise counterpart to the per-row seq_expressions family — it materializes the whole spectrum, so it is a blocking step like `summarise()`, but the k-mer table is the only state held, not the input.

Usage

```
kmer(x, seq, k = 4, by = NULL, canonical = FALSE)
```

Arguments

`x`	A `vectra_node` object.
`seq`	The sequence column (unquoted). Defaults to `seq`, the column `tbl_fasta()` and `tbl_fastq()` produce.
`k`	k-mer length, an integer in `1:32` (default 4).
`by`	Grouping column(s): an unquoted name, `c(col1, col2)`, or a character vector. `NULL` (default) counts one spectrum over the whole input.
`canonical`	If `TRUE`, collapse each k-mer with its reverse complement (default `FALSE`).

Details

Each k-mer is packed into 2 bits per base (`A`/`C`/`G`/`T`) and counted in a native hash table, so `k` is limited to `1:32`. A window containing any non-`ACGT` base (`N`, an IUPAC ambiguity code, or a gap) is skipped, matching the convention of dedicated k-mer counters. With `canonical = TRUE`, a k-mer and its reverse complement are counted together under the lexicographically smaller of the two — the usual choice for strand-agnostic data.

Row order in the result is unspecified; pipe into `arrange()` for a stable order.

Value

A `vectra_node` with the grouping columns, a `kmer` column, and a `count` column.

See Also

seq_expressions, `tbl_fasta()`

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(id = c("a", "b"),
                     seq = c("ACGTACGT", "AAAAT"),
                     stringsAsFactors = FALSE), f)
tbl(f) |> kmer(seq, k = 3, by = id) |> arrange(id, kmer) |> collect()
unlink(f)
```

`left_join` *Join two vectra tables*

Description

Join two vectra tables

Usage

```
left_join(
  x,
  y,
  by = NULL,
  suffix = c(".x", ".y"),
  na_matches = c("na", "never"),
  ...
)

inner_join(
  x,
  y,
  by = NULL,
  suffix = c(".x", ".y"),
  na_matches = c("na", "never"),
  ...
)

right_join(
  x,
  y,
  by = NULL,
  suffix = c(".x", ".y"),
  na_matches = c("na", "never"),
  ...
)

full_join(
  x,
```

```
  y,
  by = NULL,
  suffix = c(".x", ".y"),
  na_matches = c("na", "never"),
  ...
)

semi_join(x, y, by = NULL, na_matches = c("na", "never"), ...)

anti_join(x, y, by = NULL, na_matches = c("na", "never"), ...)
```

Arguments

x	A vectra_node object (left table).
y	A vectra_node object (right table).
by	A character vector of column names to join by, or a named vector like c("a" = "b"). NULL for natural join (common columns).
suffix	A character vector of length 2 for disambiguating non-key columns with the same name (default c(".x", ".y")).
na_matches	How to match NA keys: "na" (default, as in dplyr) treats NA as matching NA; "never" uses SQL semantics where NA never matches.
...	Ignored.

Details

All joins use a build-right, probe-left hash join. The entire right-side table is materialized into a hash table; left-side batches stream through. Memory cost is proportional to the right-side table size.

By default NA keys match NA (dplyr's na_matches = "na"); pass na_matches = "never" for SQL NULL semantics. Key types are auto-coerced following the bool < int64 < double hierarchy. Joining string against numeric keys is an error.

Value

A vectra_node with the joined result.

Examples

```
f1 <- tempfile(fileext = ".vtr")
f2 <- tempfile(fileext = ".vtr")
write_vtr(data.frame(id = c(1, 2, 3), x = c(10, 20, 30)), f1)
write_vtr(data.frame(id = c(1, 2, 4), y = c(100, 200, 400)), f2)
left_join(tbl(f1), tbl(f2), by = "id") |> collect()
unlink(c(f1, f2))
```

link *Define a link between a fact table and a dimension table*

Description

Creates a link descriptor that specifies how to join a dimension table to a fact table via one or more key columns.

Usage

```
link(key, node)
```

Arguments

key	A character vector or named character vector specifying join keys. Unnamed: same column name in both tables. Named: `c("fact_col" = "dim_col")`.
node	A `vectra_node` object (the dimension table). Must be file-backed (created via `tbl()`, `tbl_csv()`, or `tbl_sqlite()`).

Value

A `vectra_link` object.

Examples

```
f_obs <- tempfile(fileext = ".vtr")
f_sp  <- tempfile(fileext = ".vtr")
write_vtr(data.frame(sp_id = 1:3, value = c(10, 20, 30)), f_obs)
write_vtr(data.frame(sp_id = 1:3, name = c("A", "B", "C")), f_sp)
lnk <- link("sp_id", tbl(f_sp))
unlink(c(f_obs, f_sp))
```

lookup *Look up columns from linked dimension tables*

Description

Resolves columns from dimension tables registered in a `vtr_schema()`, automatically building the necessary join tree. Reports unmatched keys as a diagnostic message.

Usage

```
lookup(.schema, ..., .join = "left", .report = TRUE)
```

Arguments

.schema	A vectra_schema object.
...	Column references: bare names for fact columns, or dimension$column for dimension columns.
.join	Join type: "left" (default, keeps all fact rows) or "inner" (drops unmatched fact rows).
.report	Logical. If TRUE (default), print a message with the number of unmatched keys per dimension.

Details

Column references use dimension$column syntax (e.g., species$name). Columns from the fact table can be referenced by name directly.

When .report = TRUE, each needed dimension is checked for unmatched keys by opening fresh scans of the fact and dimension tables. This adds one extra read pass per dimension but does not affect the lazy result node.

Only dimensions referenced in ... are joined. Unreferenced dimensions are never scanned.

Value

A vectra_node with the selected columns.

Examples

```
f_obs <- tempfile(fileext = ".vtr")
f_sp  <- tempfile(fileext = ".vtr")
f_ct  <- tempfile(fileext = ".vtr")
write_vtr(data.frame(sp_id = 1:4, ct_code = c("AT", "DE", "FR", "XX"),
                     value = 10:13), f_obs)
write_vtr(data.frame(sp_id = 1:3,
                     name = c("Oak", "Beech", "Pine")), f_sp)
write_vtr(data.frame(ct_code = c("AT", "DE", "FR"),
                     gdp = c(400, 3800, 2700)), f_ct)

s <- vtr_schema(
  fact    = tbl(f_obs),
  species = link("sp_id", tbl(f_sp)),
  country = link("ct_code", tbl(f_ct))
)

# Pull columns from any linked dimension
result <- lookup(s, value, species$name, country$gdp)
collect(result)

unlink(c(f_obs, f_sp, f_ct))
```

mask *Mask a streamed raster to a polygon layer*

Description

Keeps the pixels of a `.vec` raster whose cell centre falls inside a resident polygon layer and sets the rest to `background`, reading the raster one tile-row strip at a time so the whole grid is never resident. It is the raster counterpart of `spatial_clip()`: the streamed side is the (large) raster and the small `mask` layer stays in memory. With `inverse = TRUE` the inside is cleared and the outside kept.

Usage

```
mask(
  x,
  mask,
  inverse = FALSE,
  band = NULL,
  background = NA_real_,
  path = NULL,
  dtype = "f32",
  compression = c("fast", "balanced", "max")
)
```

Arguments

`x`	A `vectra_raster` (from `vec_open_raster()`) or a path to a `.vec` raster.
`mask`	An `sf` or `sfc` polygon layer to clip against. When it carries no CRS it inherits the raster's EPSG.
`inverse`	If `FALSE` (default) keep pixels inside `mask`; if `TRUE` keep the pixels outside it.
`band`	Band(s) to mask (1-based). Default `NULL` masks every band.
`background`	Value written to cleared pixels. Default `NA_real_`.
`path`	Optional output `.vec` path. When given the result is streamed to disk and the opened `vec_open_raster()` handle is returned invisibly; when `NULL` the result is returned in memory (a matrix for one band, a list of matrices for several).
`dtype`	Storage dtype for `.vec` output (see `vec_write_raster()`). Default `"f32"`.
`compression`	Compression effort for `.vec` output. Default `"fast"`.

Details

This is the *monoid fold* tier of the spatial toolbox: bounded to one strip plus the resident mask, a single streaming pass, no spill. A pixel is tested against the mask only when its centre falls in the mask bounding box, so the point-in-polygon work stays proportional to the overlap rather than the whole grid. Point-in-polygon is delegated to **sf** (an optional dependency); topology and CRS handling are **sf**'s.

Value

When `path` is `NULL`, a numeric matrix (one band) or a list of matrices (several), each carrying `gt`, `extent`, and `crs` attributes (row 1 northmost). When `path` is given, the written `vectra_raster` handle (invisibly).

See Also

`spatial_clip()` for the vector analogue, `zonal()` for per-zone summaries over the same pixel-in-polygon assignment.

Examples

```
vals <- matrix(1:100, 10, 10, byrow = TRUE)
f <- tempfile(fileext = ".vec")
vec_write_raster(vals, f, dtype = "f64", extent = c(0, 0, 10, 10))

disc <- sf::st_buffer(sf::st_sfc(sf::st_point(c(5, 5))), 3)
inside <- mask(f, disc)
sum(!is.na(inside))
unlink(f)
```

`materialize` *Materialize a vectra node into a reusable in-memory block*

Description

Consumes a vectra node (pulling all batches) and stores the result as a persistent columnar block in memory. Unlike nodes, blocks can be probed repeatedly via `block_lookup()` without re-scanning.

Usage

```
materialize(.data)
```

Arguments

`.data`	A `vectra_node` (consumed; cannot be used after this call).

Value

A `vectra_block` object (external pointer to C-level ColumnBlock).

Examples

```
f <- tempfile(fileext = ".vtr")
df <- data.frame(taxonID = 1:3,
                 canonicalName = c("Quercus robur", "Pinus sylvestris",
                                   "Fagus sylvatica"))
write_vtr(df, f)
blk <- materialize(tbl(f) |> select(taxonID, canonicalName))
hits <- block_lookup(blk, "canonicalName",
                     c("Quercus robur", "Pinus sylvestris"))
unlink(f)
```

---

mosaic *Merge aligned rasters onto a common grid*

Description

Combines several `.vec` rasters that share a resolution and cell grid into one raster spanning their union, resolving overlap with `fun`. The output is walked one tile-row strip at a time and each input contributes only the window overlapping the current strip, so neither the inputs nor the output are held whole in memory.

Usage

```
mosaic(
  rasters,
  fun = c("first", "last", "mean", "sum", "min", "max"),
  band = 1L,
  path = NULL,
  dtype = "f32",
  compression = c("fast", "balanced", "max")
)
```

Arguments

`rasters`	A list of `vectra_raster` handles or `.vec` paths sharing resolution and grid alignment.
`fun`	Overlap rule where inputs cover the same cell: `"first"` (the earliest input in `rasters`, default), `"last"`, `"mean"`, `"sum"`, `"min"`, or `"max"`. Cells covered by no input come back `NA`.
`band`	Band read from every input (1-based). Default 1.
`path`	Optional output `.vec` path. When given the result is streamed to disk and the opened `vec_open_raster()` handle is returned invisibly; when `NULL` the result is returned as an in-memory matrix.
`dtype`	Storage dtype for `.vec` output (see `vec_write_raster()`). Default `"f32"`.
`compression`	Compression effort for `.vec` output. Default `"fast"`.

Details

This is the *monoid fold* tier of the spatial toolbox: each output strip folds the overlapping input windows, bounded memory, no spill. The inputs must share resolution and lie on a common cell grid; `warp()` them onto a shared grid first if they do not. No **sf** is needed.

Value

When `path` is `NULL`, a numeric matrix on the union grid (row 1 northmost) carrying `gt`, `extent`, and `crs` attributes. When `path` is given, the written `vectra_raster` handle (invisibly).

See Also

`warp()` to bring rasters onto a shared grid, `rast_calc()` for cellwise combination of already-aligned rasters.

Examples

```
a <- matrix(1, 4, 4); b <- matrix(2, 4, 4)
fa <- tempfile(fileext = ".vec"); fb <- tempfile(fileext = ".vec")
vec_write_raster(a, fa, dtype = "f64", extent = c(0, 0, 4, 4))
vec_write_raster(b, fb, dtype = "f64", extent = c(2, 2, 6, 6))

m <- mosaic(list(fa, fb), fun = "mean")
dim(m)
unlink(c(fa, fb))
```

`mutate` *Add or transform columns*

Description

Add or transform columns

Usage

```
mutate(.data, ...)
```

Arguments

`.data`	A `vectra_node` object.
`...`	Named expressions for new or transformed columns.

Details

Supported expression types: arithmetic (+, -, *, /, %%), comparison, boolean, is.na(), nchar(), substr(), grepl() (fixed match only). Window functions (row_number(), rank(), dense_rank(), lag(), lead(), cumsum(), cummean(), cummin(), cummax()) are detected automatically and routed to a dedicated window node.

When grouped, window functions respect partition boundaries.

This is a streaming operation for regular expressions; window functions materialize all rows within each partition.

Value

A new vectra_node with mutated columns.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> mutate(kpl = mpg * 0.425144) |> collect() |> head()
unlink(f)
```

---

offload *Spill a query to disk and stream it back (the offload functor)*

Description

Materializes a query once to disk and returns a stream that holds the same rows, so every later pass is a disk scan instead of a re-run of the upstream pipeline. The materialization streams batch by batch, so peak memory stays at one batch regardless of result size. This is the bridge from the bounded single-pass world of collect_chunked() to out-of-core fits.

Usage

```
offload(
  x,
  by = NULL,
  n = NULL,
  method = c("auto", "level", "range", "hash"),
  path = NULL,
  compress = c("fast", "small", "none"),
  flush_rows = NULL
)
```

Arguments

x	A vectra_node to materialize.
by	Optional name (string) of a partition key column. When supplied, the result is a partition rather than a single node.
n	Number of buckets for method = "range" or "hash". Ignored for a one-shard-per-value partition.
method	Partition strategy: "auto" (default; one shard per value for a discrete key, n ranges for a numeric key), "level" (one shard per distinct value), "range" (n equal-width value ranges), or "hash" (n buckets by a stable hash of the key, co-locating each key).
path	Optional file path for a durable replay-cache spill (used only when by is NULL). When NULL a temporary file is used and removed when the returned node is garbage-collected.
compress	Compression for spill files, passed to write_vtr(): "fast" (default), "small", or "none".
flush_rows	Row cap on each shard buffer during partition routing. NULL (the default) instead flushes once the buffered bytes cross the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

With no by, offload() returns a **replay cache**: a vectra_node backed by one .vtr file. Feed it to a pull-based consumer such as biglm::bigglm() through chunk_feeder(), which accepts an offloaded node directly, so each iteratively reweighted pass reads the prepared columns from disk rather than rebuilding them. Bake the selects and mutates into the query you offload, and replay does no further work.

With by, offload() returns a **partition**: the rows split into disjoint shards, one per key value (discrete key) or per value range (method = "range", or any numeric key), written in a single streaming pass. A partition prints as a list of shards and behaves like one: length(), names() (the keys), p[["key"]] (a shard node), and lapply(p, ...) all work. Fold it with collect_chunked() (supplying combine). The union of the shards reproduces the input; row totals are checked.

Value

A vectra_node (no by) or a vectra_partition (with by), each carrying a cost grade shown by print() and explain().

See Also

chunk_feeder() (accepts an offloaded node), collect_chunked() for the partitioned monoidal reduce, and arrange() for the external-sort instance.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
```

```
# Replay cache: same rows, now on disk.
s <- offload(tbl(f) |> filter(cyl > 4) |> select(mpg, wt, hp))
nrow(collect(s))

# Partition by a key: a list of per-shard nodes.
p <- offload(tbl(f), by = "cyl")
names(p)
length(p)
nrow(collect(p[[1]]))
unlink(f)
```

`polygonize` *Vectorise a raster into polygons*

Description

Converts a `.vec` raster into polygon features, the inverse of `rasterize()`. The raster is read one tile-row strip at a time; within each strip equal-valued cells along a row collapse to a rectangle, and (with `dissolve = TRUE`) the rectangles are then merged by value through `spatial_dissolve()` so each distinct value becomes a single polygon spanning the whole raster. The result is a lazy `vectra_node` carrying a value column and hex-WKB geometry.

Usage

```
polygonize(
  x,
  band = 1L,
  dissolve = TRUE,
  na_rm = TRUE,
  values = "value",
  crs = NA,
  flush_rows = NULL
)
```

Arguments

`x`	A `vectra_raster` (from `vec_open_raster()`) or a path to a `.vec` raster.
`band`	Band to vectorise (1-based). Default 1.
`dissolve`	If `TRUE` (default) merge cells of equal value into one polygon per value; if `FALSE` emit one square polygon per cell.
`na_rm`	Drop nodata cells (`TRUE`, default) or vectorise them as a value.
`values`	Name of the output value column. Default `"value"`.
`crs`	Coordinate reference system recorded on the node. Defaults to the raster's EPSG, else unknown.

`flush_rows` Rows buffered before a spill flush. `NULL` (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of `vectra_mem()`, set with `options(vectra.memory = )`); an explicit value caps each buffer at that many rows.

Details

Extraction is the *monoid fold* tier (one strip at a time); the by-value dissolve rides the *sort / partition* tier of `spatial_dissolve()`, localising each value to a shard before the union. Geometry assembly is delegated to **sf** (an optional dependency).

Value

A `vectra_node` with the value column and a hex-WKB `geometry` column, materialise it with `collect()`.

See Also

`rasterize()` for the inverse, `contours()` for iso-lines, `collect()` to materialise as `sf`.

Examples

```
m <- matrix(c(1, 1, 2, 2, 1, 1, 2, 2, 3, 3, 3, 3, 3, 3, 3, 3), 4, 4,
            byrow = TRUE)
f <- tempfile(fileext = ".vec")
vec_write_raster(m, f, dtype = "f64", extent = c(0, 0, 4, 4))

polys <- polygonize(f)
collect(polys)
unlink(f)
```

---

print.vectra_node *Print a vectra query node*

Description

Print a vectra query node

Usage

```
## S3 method for class 'vectra_node'
print(x, ...)
```

Arguments

`x` A `vectra_node` object.

`...` Ignored.

Value

Invisible x.

---

proximity *Euclidean distance to the nearest feature (proximity)*

Description

Computes, for every cell of a .vec raster, the straight-line Euclidean distance to the nearest feature cell, in CRS units. Feature cells are the non-NA cells by default, or the cells whose value is in target. This is the raster proximity / Euclidean-distance staple, the distance companion to rasterize().

Usage

```
proximity(
  x,
  target = NULL,
  band = 1L,
  path = NULL,
  dtype = "f32",
  compression = c("fast", "balanced", "max")
)
```

Arguments

x	A vectra_raster (from vec_open_raster()) or a path to a .vec raster.
target	Optional numeric vector of feature values. When NULL (default) every non-NA cell is a feature; otherwise a cell is a feature when its value is in target.
band	Band to read (1-based). Default 1.
path	Optional output .vec path. When given the result is streamed to disk and the opened vec_open_raster() handle is returned invisibly; when NULL the result is returned as an in-memory matrix.
dtype	Storage dtype for .vec output (see vec_write_raster()). Default "f32".
compression	Compression effort for .vec output. Default "fast".

Details

The exact Euclidean distance transform is separable (Felzenszwalb and Huttenlocher 2012): a one-dimensional lower-envelope-of-parabolas transform along the rows, then the same transform along the columns, each linear in the line length and each line independent. vectra runs it as four streamed passes over tile-row strips, with an out-of-core transpose between the row pass and the column pass, so the whole grid is never resident. The row pass scales squared distances by the x resolution and the column pass by the y resolution, so the result is exact on anisotropic (non-square) cells. This places proximity on the sort / partition tier of the spatial toolbox.

Distances are straight-line Euclidean in the raster CRS units. Cost-distance, which accumulates a per-cell friction along the path, is a global shortest-path problem and stays resident: `collect()` the raster and run a resident solver for that.

Value

When `path` is `NULL`, a numeric matrix (row 1 northmost) carrying `gt`, `extent`, and `crs` attributes, with distance in CRS units and `NA` where the raster holds no feature anywhere. When `path` is given, the written `vectra_raster` handle (invisibly).

See Also

`rasterize()` to build a raster from streamed points, `mask()` to clip a raster to a polygon layer.

Examples

```
m <- matrix(NA_real_, 12, 12)
m[3, 4] <- 1; m[9, 10] <- 1
f <- tempfile(fileext = ".vec")
vec_write_raster(m, f, dtype = "f64", extent = c(0, 0, 12, 12))

d <- proximity(f)
round(d[1:3, 1:3], 2)
unlink(f)
```

---

pull *Extract a single column as a vector*

Description

Extract a single column as a vector

Usage

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

Arguments

`.data`	A `vectra_node` object.
`var`	Column name (unquoted) or positive integer position.

Value

A vector.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> pull(mpg) |> head()
unlink(f)
```

`rast_calc` *Cellwise calculation over aligned rasters (map algebra)*

Description

Evaluates an expression cell by cell across one or more `.vec` rasters that share a grid, reading every input one tile-row strip at a time so no whole band is ever resident. Inside `expr` each name in `rasters` refers to that raster's strip as a numeric vector, so ordinary vectorised R expresses the calculation: a band index `(nir - red) / (nir + red)`, a reclassification `cut(dem, breaks)`, a threshold `ifelse(slope > 30, 1L, 0L)`, or arithmetic across layers. The result is written one strip at a time to a single-band output.

Usage

```
rast_calc(
  rasters,
  expr,
  band = 1L,
  path = NULL,
  dtype = "f32",
  compression = c("fast", "balanced", "max")
)
```

Arguments

`rasters`	A named list of `vectra_raster` handles or `.vec` paths sharing a grid. The names are the variables available inside `expr`.
`expr`	An expression in those names producing one value per cell (or a scalar, recycled). Evaluated against each strip with the caller's environment as the enclosing scope.
`band`	Band read from every input (1-based). Default 1.
`path`	Optional output `.vec` path. When given the result is streamed to disk and the opened `vec_open_raster()` handle is returned invisibly; when `NULL` the result is returned as an in-memory matrix.
`dtype`	Storage dtype for `.vec` output (see `vec_write_raster()`). Default `"f32"`.
`compression`	Compression effort for `.vec` output. Default `"fast"`.

Details

This is the *monoid fold* tier of the spatial toolbox: bounded to one strip per input, a single streaming pass, no spill. The rasters must share dimensions and geotransform; `warp()` them onto a common grid first if they do not. No **sf** is needed.

Value

When `path` is `NULL`, a numeric matrix (row 1 northmost) carrying `gt`, `extent`, and `crs` attributes. When `path` is given, the written `vectra_raster` handle (invisibly).

See Also

`warp()` to align rasters onto a shared grid first, `focal()` for neighbourhood rather than cellwise calculation.

Examples

```
nir <- matrix(c(40, 50, 60, 70), 2, 2)
red <- matrix(c(10, 20, 30, 40), 2, 2)
fn <- tempfile(fileext = ".vec"); fr <- tempfile(fileext = ".vec")
vec_write_raster(nir, fn, dtype = "f64", extent = c(0, 0, 2, 2))
vec_write_raster(red, fr, dtype = "f64", extent = c(0, 0, 2, 2))

ndvi <- rast_calc(list(nir = fn, red = fr), (nir - red) / (nir + red))
round(ndvi, 3)
unlink(c(fn, fr))
```

---

rast_feature_distance *Predictor-space nearest-neighbour distance surface over a raster*

Description

Computes, aligned to the grid of a projection raster `x`, a surface of the mean distance in predictor space from each cell to the nearest cells of a reference raster `reference`. Both are multi-band environmental rasters with one band per predictor. This is the raster, out-of-core counterpart of `feature_knn()`: the reference raster is read once into memory and indexed, while `x` is walked one tile-row strip at a time and streamed to the sink, so the projection side is larger-than-RAM. `x` and `reference` need not share a grid – the output follows `x`.

Usage

```
rast_feature_distance(
  x,
  reference,
  vars = NULL,
  k = NULL,
  percentage = NULL,
```

```
  metric = c("euclidean", "mahalanobis"),
  path = NULL,
  dtype = "f32",
  nthreads = NULL,
  compression = c("fast", "balanced", "max")
)
```

Arguments

x, reference	vectra_raster handles or paths to .vec rasters: the raster to score and the reference raster, with matching bands (predictors) in the same order.
vars	Predictors to use: band names, band indices, or NULL (default, all bands). Names resolve against x's band names.
k	Number of nearest reference cells to average over. Supply exactly one of k or percentage.
percentage	Percent of the reference cells to average over (the nearest ceil(percentage/100 * N)). Supply exactly one of k or percentage.
metric	"euclidean" (default) or "mahalanobis" (whitened by the reference covariance).
path	Optional output .vec path. When given the surface is streamed to disk and the opened vec_open_raster() handle is returned invisibly; when NULL the surface is returned as an in-memory matrix.
dtype	Storage dtype for .vec output. Default "f32".
nthreads	Threads for the distance scan. NULL (default) uses all available (capped to two under R CMD check).
compression	Compression effort for .vec output. Default "fast".

Details

The distance is the mean distance to the nearest k, or nearest percentage% of the reference cells (ceil(percentage/100 * N)), under a Euclidean or Mahalanobis metric. Supply exactly one of k or percentage.

This is the streaming distance surface behind an environmental-novelty or transferability diagnostic such as MOP (Owens et al. 2013). The strict non-analogous-conditions layers (per-predictor out-of-range counts) are a separate, already-native computation – a per-band range reduce plus rast_calc() – and are shown alongside this surface in the vignette("sdm"); this function is the continuous-distance piece only.

x and reference must be .vec rasters (or paths to them); bring GeoTIFFs onto the .vec grid with warp() first.

Value

With path = NULL, a numeric matrix on x's grid (row 1 northmost) carrying gt, extent, and crs attributes. With path given, the written single-band vectra_raster handle (invisibly). Cells with any NA predictor come back NA.

References

Owens, H.L. et al. (2013) Constraints on interpretation of ecological niche models by limited environmental ranges on calibration areas. *Ecological Modelling* 263:10-18.

See Also

`feature_knn()` for the table-level primitive, `warp()` to bring rasters onto a shared grid, `rast_calc()` for cellwise raster algebra.

Examples

```
# Two-band reference and projection rasters.
set.seed(1)
r1 <- matrix(rnorm(400, 10, 2), 20, 20)
r2 <- matrix(rnorm(400, 800, 40), 20, 20)
x1 <- r1 + 3              # projection shifted warmer/drier -> more novel
x2 <- r2 - 60
fr <- tempfile(fileext = ".vec"); fx <- tempfile(fileext = ".vec")
vec_write_raster(array(c(r1, r2), c(20, 20, 2)), fr, dtype = "f64",
                 extent = c(0, 0, 20, 20), band_names = c("bio1", "bio12"))
vec_write_raster(array(c(x1, x2), c(20, 20, 2)), fx, dtype = "f64",
                 extent = c(0, 0, 20, 20), band_names = c("bio1", "bio12"))

d <- rast_feature_distance(fx, fr, percentage = 10)
round(mean(d), 2)
unlink(c(fr, fx))
```

`rasterize` *Rasterize a streamed point layer onto a fixed grid*

Description

Folds a larger-than-RAM stream of points into a fixed raster grid one batch at a time. The grid (`template`) is held resident in memory while the points flow past the engine, so peak memory is the grid plus one batch regardless of how many points there are – the streaming counterpart to running `terra::rasterize()` on a point set that has to fit in RAM. Each point's coordinate is mapped to its grid cell through the raster geotransform and the per-cell value is accumulated in C.

Usage

```
rasterize(
  x,
  template = NULL,
  field = NULL,
  fun = c("count", "sum", "mean", "min", "max"),
  extent = NULL,
  res = NULL,
```

```
  dims = NULL,
  coords = c("x", "y"),
  geom = NULL,
  crs = NA,
  background = NA_real_,
  path = NULL,
  dtype = "f32"
)
```

Arguments

x	A vectra_node streaming the points (from tbl(), tbl_csv(), any verb chain). It is consumed by the stream.
template	Optional grid to borrow geometry and CRS from: a vectra_raster (from vec_open_raster()), or a numeric c(xmin, ymin, xmax, ymax) extent. When omitted, supply extent with res or dims.
field	Name of a numeric column to aggregate. Required for every fun except "count" (which ignores it).
fun	Reduction over the points in each cell: one of "count", "sum", "mean", "min", "max". NA values in field are skipped.
extent	Numeric c(xmin, ymin, xmax, ymax) defining the grid extent when no template is given.
res	Cell size: a single number for square cells, or c(xres, yres). The cell counts are rounded to fit extent exactly. Supply res or dims.
dims	Grid shape c(nrow, ncol), an alternative to res.
coords	Length-2 character vector naming the x and y coordinate columns. Default c("x", "y"). Ignored when geom is supplied.
geom	Name of a hex-WKB point-geometry column to rasterize instead of coordinate columns. Requires **sf**.
crs	Coordinate reference system recorded on the output, in any form sf::st_crs() accepts or a bare EPSG integer. Defaults to the template's, then the node's, else unknown.
background	Value for cells that receive no point. Default NA_real_.
path	Optional output path. When given, the grid is written to a .vec raster via vec_write_raster() and the opened vec_open_raster() handle is returned invisibly. When NULL, the grid is returned in memory.
dtype	Storage dtype for the .vec output (see vec_write_raster()). Default "f32".

Details

The reduction fun is a monoid over the points falling in each cell: "count" tallies points (no field needed); "sum", "mean", "min", "max" aggregate a numeric field. Cells that receive no point take the background value (NA by default). This is the *monoid fold* tier of the spatial toolbox: bounded memory, a single streaming pass, no spill.

Points arrive either as two numeric coordinate columns (`coords`, the default and fully **sf**-free path – the headline larger-than-RAM case) or decoded from a hex-WKB point-geometry column (`geom`, which needs **sf**). Geometry input is expected to be points (one coordinate per row); line and polygon coverage rasterization is out of scope here.

Value

When `path` is `NULL`, a numeric matrix with `nrow` grid rows (row 1 northmost) and `ncol` grid columns, carrying `gt`, `extent`, `res`, `crs`, and `fun` attributes. When `path` is given, the written `vectra_raster` handle (invisibly).

See Also

`vec_write_raster()` and `vec_to_tiff()` for raster output, `spatial_join()` to instead tag points with polygon attributes.

Examples

```
set.seed(1)
n <- 1e4
pts <- data.frame(x = runif(n, 0, 10), y = runif(n, 0, 10), z = rnorm(n))
f <- tempfile(fileext = ".vtr")
write_vtr(pts, f)

# Point density on a 10x10 grid, streamed: the grid is resident, the
# points are not.
counts <- tbl(f) |> rasterize(extent = c(0, 0, 10, 10), dims = c(10, 10))
counts

# Mean of z per cell.
zmean <- tbl(f) |>
  rasterize(extent = c(0, 0, 10, 10), dims = c(10, 10),
            field = "z", fun = "mean")
unlink(f)
```

`reframe` *Summarise with variable-length output per group*

Description

Like `summarise()` but allows expressions that return more than one row per group. Currently implemented via `collect()` fallback.

Usage

```
reframe(.data, ...)
```

Arguments

.data	A vectra_node object.
...	Named expressions.

Value

A data.frame (not a lazy node).

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(g = c("a", "a", "b"), x = c(1, 2, 3)), f)
tbl(f) |> group_by(g) |> reframe(range_x = range(x))
unlink(f)
```

---

relocate *Relocate columns*

Description

Relocate columns

Usage

```
relocate(.data, ..., .before = NULL, .after = NULL)
```

Arguments

.data	A vectra_node object.
...	Column names to move.
.before	Column name to place before (unquoted).
.after	Column name to place after (unquoted).

Value

A new vectra_node with reordered columns.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> relocate(hp, wt, .before = cyl) |> collect() |> head()
unlink(f)
```

rename *Rename columns*

Description

Rename columns

Usage

```
rename(.data, ...)
```

Arguments

.data	A vectra_node object.
...	Rename pairs: new_name = old_name.

Value

A new vectra_node with renamed columns.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> rename(miles_per_gallon = mpg) |> collect() |> head()
unlink(f)
```

resample *Resample a time series to a calendar grid*

Description

Buckets a datetime column to a grid (every) and aggregates within each bucket – the time-series form of group_by() + summarise(). Equivalent to mutate(<time> = floor_time(<time>, every)), group_by(<time>), then summarise(...).

Usage

```
resample(.data, time, every, ..., .name = NULL)
```

Arguments

.data	A vectra_node.
time	The datetime column to bucket (unquoted).
every	Bucket size as a string, e.g. "1 hour", "15 min", "day", "month" (see floor_time()).
...	Named aggregation expressions, as in summarise() (e.g. mean_temp = mean(temp)).
.name	Optional name for the bucket column. Defaults to the name of time (the original column, replaced by its floored value).

Value

A vectra_node with one row per occupied bucket: the bucket column followed by the aggregates. The bucket collects as a numeric epoch value (see floor_time() on restoring the date class).

See Also

floor_time(), summarise()

Examples

```
## Not run:
tbl("readings.vtr") |>
  resample(timestamp, "1 hour", mean_temp = mean(temp), n = n()) |>
  collect()

## End(Not run)
```

---

rolling *Time-based rolling aggregates*

Description

Trailing rolling aggregates over a datetime window, usable inside mutate(). For each row, the aggregate covers the rows whose time falls in (time - every, time] – the row itself and everything within one window before it. With an upstream group_by(), windows are computed within each group. NA values are skipped.

Usage

```
roll_sum(x, time, every)

roll_mean(x, time, every)

roll_min(x, time, every)

roll_max(x, time, every)

roll_n(time, every)
```

Arguments

x	Value column to aggregate (not needed for roll_n).
time	Datetime column defining the window.
every	Window span as a fixed-width duration string.

Details

time must be a Date or POSIXct column; every is a fixed-width duration string ("15 min", "1 hour", "7 days") – calendar units (month, year) are not allowed because their length varies.

Value

A double column.

See Also

resample()

Examples

```
## Not run:
tbl("readings.vtr") |>
  group_by(sensor) |>
  mutate(avg_1h = roll_mean(temp, t, "1 hour"),
         n_1h   = roll_n(t, "1 hour")) |>
  collect()

## End(Not run)
```

---

select *Select columns from a vectra query*

Description

Select columns from a vectra query

Usage

```
select(.data, ...)
```

Arguments

.data	A vectra_node object.
...	Column names (unquoted).

Value

A new `vectra_node` with only the selected columns.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> select(mpg, cyl) |> collect() |> head()
unlink(f)
```

`seq_expressions` *Biological-sequence functions inside mutate(), filter(), and summarise()*

Description

vectra recognizes a family of `seq_*` functions directly inside expression verbs. A DNA, RNA, or protein sequence rides through the engine as an ordinary ASCII string column; these functions decode it in C one row at a time and compute a measure, a transformed sequence, or an edit distance straight off it, streaming at engine speed with no round-trip through **Biostrings**. `tbl_fasta("reads.fa") |> mutate(gc = seq_gc(seq))` adds a GC-content column; `filter(seq_dist(seq, ref) <= 3)` prunes the stream in C.

Details

These names are interpreted by the expression engine; they are not exported R functions and are not called as such. They are available only inside `mutate()`, `transmute()`, `filter()`, and a grouped `summarise()` over a `vectra_node`. The sequence argument is an ordinary string column.

Measures

`seq_length(x)` Number of characters in the sequence (integer).

`seq_gc(x)` GC fraction: the count of `G` and `C` divided by the sequence length, in `[0, 1]` (double). Case-insensitive; only literal `G`/`C` are counted, so an ambiguity code such as `S` does not contribute.

Transforms (return a sequence)

`seq_revcomp(x)` Reverse complement.

`seq_complement(x)` Complement, DNA alphabet (`A<->T`), with the IUPAC ambiguity codes mapped to their complements and case preserved. A `U` is complemented to `A`; transcribe first for an RNA-alphabet complement.

`seq_reverse(x)` Reverse the sequence (no complement).

`seq_transcribe(x)` Swap `T<->U`, turning DNA into RNA and RNA into DNA (case preserved).

`seq_translate(x, table = 1)` Translate in reading frame 1 to a protein sequence using the standard genetic code (NCBI `transl_table` 1; `table` currently accepts only 1). A trailing partial codon is dropped; a codon containing any non-`ACGTU` base yields `X`, a stop codon `*`.

`seq_subseq(x, start, width)` Substring of `width` characters starting at 1-based `start`, clamped to the sequence. `start` and `width` may be columns or constants.

Distance

`seq_dist(x, ref, method = "levenshtein")` Edit distance between each sequence and a reference (integer). `ref` is another sequence column (compared row by row) or a single constant string (compared against every row). `method` is `"levenshtein"` (default; also `"lv"`, `"edit"`), `"dl"` / `"damerau"` / `"osa"` for the optimal-string-alignment Damerau-Levenshtein distance, or `"hamming"` (substitutions only; `NA` when the two sequences differ in length).

Missing sequence

A missing (`NA`) cell yields `NA` for that row rather than an error, matching the `st_*` and embedding-distance contract. Unexpected characters are processed as-is (passed through by complement, translated to `X`).

See Also

`mutate()`, `filter()`; geom_expressions and the embedding distances (`cosine`, `l2`, `dot`) for the other per-row blob-column families.

Examples

```
reads <- data.frame(
  id  = c("r1", "r2", "r3"),
  seq = c("ATGGCCATTGTA", "GGGCCCTTTAAA", "ATGTAA"),
  stringsAsFactors = FALSE
)
f <- tempfile(fileext = ".vtr")
write_vtr(reads, f)

tbl(f) |>
  mutate(
    len = seq_length(seq),
    gc  = seq_gc(seq),
    rc  = seq_revcomp(seq),
    aa  = seq_translate(seq),
    d   = seq_dist(seq, "ATGGCCATTGTA")
  ) |>
  collect()

unlink(f)
```

slice *Select rows by position*

Description

Select rows by position

Usage

```
slice(.data, ...)
```

Arguments

.data	A vectra_node object.
...	Integer row indices (positive or negative).

Value

A data.frame with the selected rows.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> slice(1, 3, 5)
unlink(f)
```

slice_head *Select first or last rows*

Description

Select first or last rows

Usage

```
slice_head(.data, n = 1L)

slice_tail(.data, n = 1L)

slice_min(.data, order_by, n = 1L, with_ties = TRUE)

slice_max(.data, order_by, n = 1L, with_ties = TRUE)
```

Arguments

.data	A vectra_node object.
n	Number of rows to select.
order_by	Column to order by (for slice_min/slice_max).
with_ties	If TRUE (default), includes all rows that tie with the nth value. If FALSE, returns exactly n rows.

Details

When slice_min()/slice_max() follow group_by(), the n smallest/largest rows are taken within each group and the whole winning row is kept (every column, including geometry carried as a string). with_ties = FALSE returns exactly n rows per group; with_ties = TRUE keeps rows tied at the nth value via min-rank. The n = 1, with_ties = FALSE case streams: it holds only the running winner per group, so memory scales with the number of groups (the result size), not the input. Other grouped cases buffer their input.

Value

A vectra_node for slice_head(), for grouped slice_min()/slice_max(), and for ungrouped slice_min/max(..., with_ties = FALSE). A data.frame for slice_tail() and ungrouped slice_min/max(..., with_ties = TRUE) (the default), since these must materialize all rows.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> slice_head(n = 3) |> collect()
tbl(f) |> slice_min(order_by = mpg, n = 3) |> collect()
tbl(f) |> slice_max(order_by = mpg, n = 3) |> collect()
# earliest row per group, geometry/attrs preserved:
tbl(f) |> group_by(cyl) |> slice_min(mpg, n = 1, with_ties = FALSE) |> collect()
unlink(f)
```

---

spatial_centerline *Trace the centerline (medial axis) of streamed polygons*

Description

Approximates the centerline of every polygon in a streamed layer, one batch at a time – the medial axis a per-feature transform such as a buffer cannot produce. Each polygon's boundary is densified and its Voronoi diagram taken; the Voronoi edges that fall inside the polygon trace the points equidistant from two stretches of boundary, which is its skeleton, and they are merged into maximal lines. This is the usual approximation for river or road centerlines from a filled shape; prune drops the short branches that the skeleton grows toward convex corners. A non-polygon geometry passes through unchanged.

Usage

```
spatial_centerline(
  x,
  density = NULL,
  prune = 0,
  geom = "geometry",
  crs = NA,
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
density	Boundary sampling spacing in CRS units: the polygon outline is densified to at most this vertex spacing before the Voronoi diagram is built. NULL (default) uses one-hundredth of each polygon's bounding-box diagonal.
prune	Drop centerline branches shorter than this length (CRS units), removing the short spurs the skeleton grows toward convex corners. 0 (default) keeps every branch.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
out_geom	Name of the output geometry column. Defaults to geom (or "geometry" when coords is used).
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

The centerline is an approximation whose detail is set by density (the boundary sampling spacing): finer sampling traces the axis more closely at more cost. Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; the Voronoi construction is **sf**/GEOS and expects projected or unprojected planar data. The **sf** package is an optional dependency (Suggests).

Value

A vectra_node of the centerlines, each carrying its source polygon's attributes (replicated if the centerline is several lines) and the input CRS, backed by temporary .vtr spills removed when the node is garbage-collected.

See Also

spatial_construct() with kind = "pole" for the single deepest interior point, spatial_simplify() to simplify a coverage, collect() to materialize as sf.

Examples

```
road <- sf::st_polygon(list(rbind(
  c(0, 0), c(10, 0), c(10, 2), c(0, 2), c(0, 0))))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  geometry = sf::st_as_binary(sf::st_sfc(road), hex = TRUE)
), f)

# The centerline runs down the middle of the strip.
tbl(f) |> spatial_centerline(density = 0.25, prune = 0.5) |> collect()
unlink(f)
```

---

spatial_clip *Clip or erase a streamed layer against a resident mask*

Description

Streams a large layer x through the engine and cuts each batch's geometry against a small resident mask (a study boundary, a buffer, a set of patches). By default this clips – the intersection with the mask, the GIS "Clip" tool – keeping only the parts of x that fall inside mask. With erase = TRUE it instead erases – the difference, the "Erase"/"Difference" tool – keeping the parts of x outside mask. The mask is dissolved to a single geometry once and held resident while the billion-row left stream flows past one batch at a time.

Usage

```
spatial_clip(
  x,
  mask,
  erase = FALSE,
  geom = "geometry",
  coords = NULL,
  crs = NA,
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.

mask	An sf or sfc object whose dissolved geometry clips (or, with erase = TRUE, erases) the stream.
erase	If TRUE, keep the parts of x *outside* mask (difference) rather than inside (intersection). Default FALSE.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
coords	Optional length-2 character vector naming the x and y coordinate columns to assemble point geometry from (e.g. c("x", "y")), for inputs such as tiff_extract_points() output. The coordinate columns are retained.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
out_geom	Name of the output geometry column. Defaults to geom (or "geometry" when coords is used).
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; use collect() to materialize. On projected or unprojected planar data the cut runs natively on the GEOS C API straight off the hex-WKB column (the mask parsed once); geographic coordinates with spherical geometry on (sf::sf_use_s2()) and coordinate-assembled (coords) input cut through **sf** instead. When mask carries no CRS it inherits the stream's.

Value

A vectra_node of the cut geometry with x's attributes, backed by temporary .vtr spills and carrying the input CRS.

See Also

spatial_filter() to keep whole features by location without cutting them, spatial_map() for per-feature transforms, collect().

Examples

```
nc <- sf::st_read(system.file("shape/nc.shp", package = "sf"), quiet = TRUE)
mask <- sf::st_union(nc[nc$NAME %in% c("Ashe", "Alleghany"), ])

f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  NAME = nc$NAME,
  geometry = sf::st_as_binary(sf::st_geometry(nc), hex = TRUE)
), f)
```

```
# Clip every county polygon to the two-county mask, streaming.
clipped <- tbl(f) |> spatial_clip(mask, crs = sf::st_crs(nc))
collect(clipped)
unlink(f)
```

`spatial_construct` *Build a set-wise geometry construction, optionally per group*

Description

Constructs one geometry (or a tessellation) from a whole set of features – the constructions a per-feature `spatial_map()` cannot express because they need every feature in scope at once. Like `spatial_dissolve()` it rides the **partition tier**: `x` is spilled once and routed into one disjoint shard per `by` group in a single bounded pass, then each shard's geometry is combined and the construction built with **sf**. With no `by`, the whole layer yields one construction. Peak memory is the routing budget during the pass, then one group's geometry while it is built – partition on a key whose groups fit in memory.

Usage

```
spatial_construct(
  x,
  kind = .CONSTRUCT_KINDS,
  by = NULL,
  geom = "geometry",
  crs = NA,
  ratio = 0.3,
  allow_holes = FALSE,
  tolerance = 0,
  flush_rows = NULL
)
```

Arguments

`x`	A `vectra_node` (from `tbl()`, `tbl_tiff()`, any verb chain, ...). It is consumed by the stream.
`kind`	The construction to build; one of the values above.
`by`	Character vector of attribute columns to construct within: one construction (or tessellation) per distinct combination of their values. `NULL` (default) builds a single construction from the whole layer.
`geom`	Name of the input geometry column holding hex-WKB or WKT strings. Default `"geometry"`. Ignored when `coords` is given.
`crs`	Coordinate reference system of the input geometry, in any form `sf::st_crs()` accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.

ratio	For kind = "concave_hull", the concaveness in [0, 1] (1 is the convex hull). Default 0.3.
allow_holes	For kind = "concave_hull", whether the hull may contain holes. Default FALSE.
tolerance	Distance tolerance for the kinds that take one ("inscribed_circle", "pole", "voronoi", "delaunay"). 0 (default) lets the inscribed-circle kinds derive a tolerance from the extent and the tessellations use the GEOS default.
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

kind selects the construction:

"convex_hull" the convex hull of the set.

"concave_hull" the concave hull (ratio, allow_holes).

"envelope" the axis-aligned bounding rectangle.

"oriented_box" the minimum-area rotated bounding rectangle.

"enclosing_circle" the minimum bounding circle.

"inscribed_circle" the maximum inscribed circle (largest circle that fits inside the set's union).

"pole" the pole of inaccessibility – the centre of the maximum inscribed circle, the point inside the shape farthest from its edges.

"voronoi" the Voronoi tessellation, one polygon per cell.

"delaunay" the Delaunay triangulation, one polygon per triangle.

The enclosing kinds and pole emit one feature per group; voronoi and delaunay emit one feature per cell, each carrying the group's by values.

Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; use collect() to materialize. Topology is **sf**/GEOS throughout (an optional dependency, Suggests); some constructions need projected coordinates.

Value

A vectra_node of the construction – one row per group for the enclosing kinds, one row per cell for the tessellations – carrying the by columns and the input CRS, backed by temporary .vtr spills removed when the node is garbage-collected.

See Also

spatial_dissolve() to merge a group into one feature, spatial_map() for per-feature transforms, collect() to materialize.

Examples

```
nc <- sf::st_read(system.file("shape/nc.shp", package = "sf"), quiet = TRUE)
nc$band <- nc$SID74 > 5
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  band = nc$band,
  geometry = sf::st_as_binary(sf::st_geometry(nc), hex = TRUE)
), f)

# One convex hull per band.
tbl(f) |>
  spatial_construct("convex_hull", by = "band", crs = sf::st_crs(nc)) |>
  collect()
unlink(f)
```

---

spatial_dissolve *Dissolve geometries by group*

Description

Unions the geometries within each by group into a single feature (the GIS "Dissolve" tool), optionally summarising attributes. Unlike the streamed per-batch verbs, dissolve needs every geometry of a group together to union them, so it rides the **partition tier**: `x` is spilled once and routed into one disjoint shard per group in a single bounded pass, then each shard is read in and unioned with **sf**. Peak memory is the routing budget during the pass, then one group's geometries while it is unioned – partition the input on a key whose groups fit in memory. With no `by`, the whole layer dissolves into one feature.

Usage

```
spatial_dissolve(
  x,
  by = NULL,
  ...,
  geom = "geometry",
  crs = NA,
  .fun = NULL,
  flush_rows = NULL
)
```

Arguments

`x`	A `vectra_node` (from `tbl()`, `tbl_tiff()`, any verb chain, ...). It is consumed by the stream.
`by`	Character vector of attribute columns to dissolve within: one output feature per distinct combination of their values. `NULL` (default) dissolves the entire layer into a single feature.

`...`	Further arguments passed to `sf::st_union()` (e.g. `is_coverage = TRUE`).
`geom`	Name of the input geometry column holding hex-WKB or WKT strings. Default `"geometry"`. Ignored when `coords` is given.
`crs`	Coordinate reference system of the input geometry, in any form `sf::st_crs()` accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
`.fun`	Optional named list of attribute summaries. Each element is a function taking the group's data.frame and returning a length-1 value; the list name becomes the output column (e.g. `.fun = list(total = function(d) sum(d$pop))`). Default `NULL` keeps only the by columns and the dissolved geometry.
`flush_rows`	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. `NULL` (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of `vectra_mem()`, set with `options(vectra.memory = )`); an explicit value caps each buffer at that many rows.

Details

Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; use `collect()` to materialize. On projected or unprojected planar data each group is unioned natively on the GEOS C API straight off the hex-WKB column; geographic coordinates with spherical geometry on (`sf::sf_use_s2()`), or any extra `sf::st_union()` arguments (e.g. `is_coverage = TRUE`), union through **sf** instead. The **sf** package is an optional dependency (Suggests).

Value

A `vectra_node` of one row per group – the by columns, any `.fun` summaries, and the dissolved geometry – backed by temporary `.vtr` spills removed when the node is garbage-collected, carrying the input CRS for `collect()`.

See Also

`spatial_overlay()` to split overlaps apart rather than merge them, `offload()` for the partition tier this rides on, `collect()`.

Examples

```
nc <- sf::st_read(system.file("shape/nc.shp", package = "sf"), quiet = TRUE)
nc$band <- nc$SID74 > 5            # an attribute to dissolve within
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  band = nc$band, BIR74 = nc$BIR74,
  geometry = sf::st_as_binary(sf::st_geometry(nc), hex = TRUE)
), f)

# Merge the counties into two features by `band`, summing births.
merged <- tbl(f) |>
  spatial_dissolve(by = "band", crs = sf::st_crs(nc),
```

```
                    .fun = list(births = function(d) sum(d$BIR74)))
collect(merged)
unlink(f)
```

`spatial_eliminate` *Merge sliver polygons into a neighbour*

Description

Cleans a polygon coverage by absorbing every feature whose area is below `max_area` into an adjacent feature (the QGIS "Eliminate Selected Polygons"): the sliver removal a per-feature transform cannot do, because the target a sliver merges into is one of its neighbours, not the sliver itself. Each small feature is joined to the neighbour it shares the longest border with (or the largest-area neighbour, with `into = "largest_area"`); chains of slivers collapse so a connected run of small features flows to its single largest member, whose attribute row survives. A small feature with no neighbour is kept unchanged, so nothing vanishes. Like `spatial_dissolve()` it rides the **partition tier**: `x` is spilled once and routed into one disjoint shard per `by` group in a single bounded pass, and each group is cleaned as an independent coverage. Peak memory is the routing budget during the pass, then one group's geometry while its slivers are merged – partition on a key whose groups fit in memory. With no `by`, the whole layer is one coverage.

Usage

```
spatial_eliminate(
  x,
  max_area,
  by = NULL,
  into = c("longest_border", "largest_area"),
  geom = "geometry",
  crs = NA,
  flush_rows = NULL
)
```

Arguments

`x`	A `vectra_node` (from `tbl()`, `tbl_tiff()`, any verb chain, ...). It is consumed by the stream.
`max_area`	Area threshold in CRS units squared: a feature smaller than this is a sliver and is merged into a neighbour. Larger values absorb more.
`by`	Character vector of attribute columns whose groups are each cleaned as an independent coverage. `NULL` (default) treats the whole layer as one coverage.
`into`	How to pick the neighbour a sliver merges into: `"longest_border"` (default) the neighbour sharing the longest boundary, or `"largest_area"` the neighbour with the greatest area.
`geom`	Name of the input geometry column holding hex-WKB or WKT strings. Default `"geometry"`. Ignored when `coords` is given.

`crs` Coordinate reference system of the input geometry, in any form `sf::st_crs()` accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.

`flush_rows` Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. `NULL` (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of `vectra_mem()`, set with `options(vectra.memory = )`); an explicit value caps each buffer at that many rows.

Details

Adjacency and shared-border length are **sf**/GEOS (sf::st_intersects, sf::st_boundary, sf::st_intersection) and expect projected or unprojected planar data; `max_area` is in CRS units squared. Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node. The **sf** package is an optional dependency (Suggests).

Value

A `vectra_node` of the cleaned coverage – one row per surviving feature, each carrying its (largest member's) attributes and the input CRS, backed by temporary `.vtr` spills removed when the node is garbage-collected.

See Also

`spatial_dissolve()` to merge geometries by attribute, `spatial_simplify()` for coverage-preserving simplification, `spatial_topology()` for the shared-edge adjacency, `collect()` to materialize as `sf`.

Examples

```
big    <- sf::st_polygon(list(rbind(
  c(0, 0), c(10, 0), c(10, 10), c(0, 10), c(0, 0))))
sliver <- sf::st_polygon(list(rbind(
  c(10, 0), c(10.3, 0), c(10.3, 10), c(10, 10), c(10, 0))))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  id = c("keep", "sliver"),
  geometry = sf::st_as_binary(sf::st_sfc(big, sliver), hex = TRUE)
), f)

# The thin sliver is absorbed into the square it borders.
tbl(f) |> spatial_eliminate(max_area = 5) |> collect()
unlink(f)
```

spatial_explode *Explode multipart geometries into single-part features*

Description

Streams a lazy vectra query and splits every multipart geometry into its component single-part geometries: a MULTIPOLYGON becomes one row per polygon, a MULTILINESTRING one row per linestring, a MULTIPOINT one row per point, and a GEOMETRYCOLLECTION one row per member (recursively). The attributes of the source feature are copied onto each part. Already single-part geometries pass through unchanged, as does an empty geometry (kept as one row). This is the streaming counterpart of the QGIS "multipart to singleparts" tool and of sf::st_cast() to a single-part type.

Usage

```
spatial_explode(
  x,
  geom = "geometry",
  crs = NA,
  out_geom = NULL,
  part = NULL,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
out_geom	Name of the output geometry column. Defaults to geom (or "geometry" when coords is used).
part	Optional name of an integer column numbering the parts within each source feature, 1-based. Default NULL adds no such column.
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

One batch is decoded, exploded, and spilled at a time, so peak memory tracks one batch and its parts, not the whole layer.

Value

A vectra_node of single-part features, backed by temporary .vtr spills (removed when the node is garbage-collected) and carrying the input CRS.

See Also

spatial_map() for per-feature transforms, spatial_dissolve() to merge features the other way, collect() to materialize as sf.

Examples

```
mp <- sf::st_multipolygon(list(
  list(rbind(c(0, 0), c(1, 0), c(1, 1), c(0, 1), c(0, 0))),
  list(rbind(c(2, 2), c(3, 2), c(3, 3), c(2, 3), c(2, 2)))))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  id = 1L,
  geometry = sf::st_as_binary(sf::st_sfc(mp), hex = TRUE)
), f)

# One row per polygon, attributes copied, parts numbered.
tbl(f) |> spatial_explode(part = "part_id") |> collect()
unlink(f)
```

---

spatial_filter *Keep streamed rows by their spatial relation to a resident layer*

Description

Streams a large left side x through the engine and keeps each row whose geometry satisfies an **sf** binary predicate against a small resident layer y (select by location). This is the spatial counterpart to a semi_join(): rows are filtered, never duplicated, and no columns are added, so the output carries x's schema unchanged. With negate = TRUE it keeps the rows that do *not* match (select by location, inverted). The billion-row left stream never materializes; y (a study region, habitat patches, a coastline buffer, ...) stays resident.

Usage

```
spatial_filter(
  x,
  y,
  predicate = NULL,
  negate = FALSE,
  geom = "geometry",
  coords = NULL,
  crs = NA,
  flush_rows = NULL,
```

```
  ...
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
y	An sf or sfc object: the resident locator layer to test against.
predicate	An **sf** binary predicate function, e.g. sf::st_intersects (default), sf::st_within, sf::st_covered_by, sf::st_is_within_distance. A left row is kept when the predicate reports at least one match against y.
negate	If TRUE, keep the rows with no match instead (the inverted select-by-location). Default FALSE.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
coords	Optional length-2 character vector naming the x and y coordinate columns to assemble point geometry from (e.g. c("x", "y")), for inputs such as tiff_extract_points() output. The coordinate columns are retained.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.
...	Further arguments passed to predicate, e.g. dist = for sf::st_is_within_distance.

Details

For the recognised predicates – the topological ones (intersects, within, contains, overlaps, covers, covered by, touches, crosses), equals, disjoint, and within-distance (sf::st_is_within_distance, whose radius is passed as dist =) – on projected or unprojected planar data, the test runs natively on the GEOS C API straight off the hex-WKB column: y is parsed once into a spatial index and each batch is tested in C, with no per-batch round-trip through **sf**. Coordinate-assembled (coords) point input runs natively too, building each point in C rather than through **sf**; disjoint is the one exception there (its matches are the bounding boxes the index prunes away) and keeps the **sf** loop, as it does for the join. Geographic coordinates with spherical geometry on (sf::sf_use_s2()) and any other predicate use **sf** instead, preserving its semantics. When y carries no CRS it inherits the stream's so the predicate does not reject on a mismatch.

Value

A vectra_node of the kept rows with x's schema, backed by temporary .vtr spills and carrying the input CRS.

See Also

spatial_join() to tag rows with y's attributes, spatial_clip() to cut geometry against a mask, filter() for attribute predicates.

Examples

```
nc <- sf::st_read(system.file("shape/nc.shp", package = "sf"), quiet = TRUE)
region <- nc[nc$NAME %in% c("Ashe", "Alleghany", "Surry"), "NAME"]

set.seed(1)
pts <- sf::st_coordinates(sf::st_sample(nc, 300))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(id = seq_len(nrow(pts)), x = pts[, 1], y = pts[, 2]), f)

# Keep only the points that fall inside the three-county region, streaming.
inside <- tbl(f) |>
  spatial_filter(region, coords = c("x", "y"), crs = sf::st_crs(nc))
nrow(collect(inside))
unlink(f)
```

---

spatial_join *Spatial join a streamed query against a resident sf object*

Description

Streams a large left side x through the engine and joins each batch against a small right side y held resident in memory, using an **sf** binary predicate (st_intersects by default). This is the spatial analogue of a hash join with the small side on the build side: the billion-row left stream never materializes, while y (admin polygons, habitat patches, ...) stays in RAM. The dominant real workload it serves is tagging huge point sets with the polygon they fall in.

Usage

```
spatial_join(
  x,
  y,
  join = NULL,
  geom = "geometry",
  coords = NULL,
  crs = NA,
  left = TRUE,
  suffix = c(".x", ".y"),
  partition = NULL,
  y_geom = NULL,
  y_coords = NULL,
  out_geom = NULL,
  keep_geom = TRUE,
```

```
  flush_rows = NULL,
  ...
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
y	The right side of the join: an sf object held resident (the default), or – when partition is given – a streamed vectra_node.
join	An **sf** binary predicate function, e.g. sf::st_intersects (default), sf::st_within, sf::st_contains, sf::st_nearest_feature.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
coords	Optional length-2 character vector naming the x and y coordinate columns to assemble point geometry from (e.g. c("x", "y")), for inputs such as tiff_extract_points() output. The coordinate columns are retained.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
left	If TRUE (default) keep every left row (left join); if FALSE keep only matches (inner join).
suffix	Length-2 character vector disambiguating columns present on both sides. Default c(".x", ".y").
partition	Optional grid() specification enabling the two-sided streamed path, in which y is itself a vectra_node. Default NULL keeps the resident-y path.
y_geom, y_coords	Geometry transport for a streamed y under partition: the name of y's hex-WKB geometry column (y_geom, default the left geom), or a length-2 character vector of y's coordinate columns (y_coords). Ignored without partition.
out_geom	Name of the output geometry column. Defaults to geom (or "geometry" when coords is used).
keep_geom	If TRUE (default) the output carries the left geometry column (the point geometry built from coords, when coords is given). FALSE drops it, for the common "tag, then aggregate the attributes" use where the geometry is never read; with coords the points are then never encoded at all.
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.
...	Further arguments passed to sf::st_join().

Details

For the recognised predicates – the topological ones (intersects, within, contains, overlaps, covers, covered by, touches, crosses), equals, within-distance (sf::st_is_within_distance, radius passed as `dist =`), and nearest feature (sf::st_nearest_feature) – on projected or unprojected planar data, the join is a lazy plan node that runs on the GEOS C API straight off the hex-WKB column: `y` is parsed once into a spatial index, and each streamed batch is matched and joined to `y`'s attributes in C, without decoding the left side to **sf**, passing it through R, or spilling it to disk. The result streams into the next verb, so tagging points and then aggregating (`spatial_join() |> count()`) holds one batch at a time. Coordinate-assembled (`coords`) point input runs natively too, building each point in C (the emitted point geometry is built in C as well, unless `keep_geom = FALSE`). Geographic coordinates with spherical geometry on (`sf::sf_use_s2()`), a disjoint join (whose matches are the bounding-box complement an index cannot prune), and other extra `sf::st_join()` arguments use **sf** instead, preserving its semantics.

When both sides are larger than RAM, pass `partition = grid(cellsize)` and a streamed `vectra_node` as `y`: both inputs are binned to a uniform spatial grid, then joined one shard at a time. Each left feature is assigned to the single grid cell of its reference point while each right feature is replicated to every cell its bounding box overlaps, so a left row is emitted exactly once and the result equals the resident join. This is exact for point left geometries (the dominant case – tagging a huge point set with the polygon it falls in) and finds, for an extended left feature, the matches whose right bounding box overlaps the left reference cell; choose a `cellsize` larger than the left features for an extended-on-extended join. The partition path serves topological predicates (intersects, within, contains, overlaps, covers, covered by). It also serves sf::st_nearest_feature: because nearest is not local to one cell, each left feature then searches its own cell and the eight around it, so the true nearest is found when it lies within one cell of the left reference cell (pick a `cellsize` at least the largest expected nearest distance). Topology and CRS handling are **sf**'s; vectra supplies the stream and the grid partition.

Value

A `vectra_node` of the joined stream carrying the left CRS. On the native path it is a lazy node that consumes `x` when run; on the **sf** and `partition` paths it is backed by temporary `.vtr` spills.

See Also

`spatial_map()` for per-feature transforms, `collect()` to materialize as `sf`, `offload()` to partition both-sides-huge joins.

Examples

```
nc <- sf::st_read(system.file("shape/nc.shp", package = "sf"), quiet = TRUE)

# A stream of points, stored with x/y coordinate columns.
set.seed(1)
pts <- sf::st_coordinates(sf::st_sample(nc, 200))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(id = seq_len(nrow(pts)), x = pts[, 1], y = pts[, 2]), f)

# Tag each point with the county it falls in, streaming.
tagged <- tbl(f) |>
```

```
  spatial_join(nc["NAME"], join = sf::st_intersects,
               coords = c("x", "y"), crs = sf::st_crs(nc))
head(collect(tagged))

# Tag, then count per county: the join streams into count() and the point
# geometry is never built.
tbl(f) |>
  spatial_join(nc["NAME"], coords = c("x", "y"), crs = sf::st_crs(nc),
               keep_geom = FALSE) |>
  count(NAME) |>
  collect()

# Both sides streamed: bin to a grid and join per shard. Here y is a
# vectra_node rather than a resident sf object.
g <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  NAME = nc$NAME,
  geometry = sf::st_as_binary(sf::st_geometry(nc), hex = TRUE)
), g)
tagged2 <- tbl(f) |>
  spatial_join(tbl(g), coords = c("x", "y"), crs = sf::st_crs(nc),
               partition = grid(0.5))
head(collect(tagged2))
unlink(c(f, g))
```

---

spatial_knn *k nearest neighbours of a streamed layer, with distances*

Description

Streams a large left side x through the engine and, for each feature, finds the k nearest features of a small resident layer y, returning one row per (left, neighbour) pair with the neighbour's rank, identifier, and distance. Where spatial_join() with sf::st_nearest_feature attaches only the single nearest match, this returns the top k and the distances themselves – the nearest-k query and the building block of a distance matrix. The billion-row left stream never materializes; y (the candidate neighbours) stays resident.

Usage

```
spatial_knn(
  x,
  y,
  k = 1L,
  geom = "geometry",
  coords = NULL,
  crs = NA,
  y_id = NULL,
  id_col = "neighbor",
```

```
  dist_col = "distance",
  rank_col = "rank",
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
y	An sf or sfc object: the resident candidate-neighbour layer.
k	Number of nearest neighbours to return per left feature (capped at the number of y features). Default 1.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
coords	Optional length-2 character vector naming the x and y coordinate columns to assemble point geometry from (e.g. c("x", "y")), for inputs such as tiff_extract_points() output. The coordinate columns are retained.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
y_id	Optional name of a column in y whose value identifies each neighbour in the output. Default NULL uses y's 1-based row index.
id_col, dist_col, rank_col	Names of the output columns holding the neighbour identifier, the distance, and the 1-based rank (1 = nearest). Defaults "neighbor", "distance", "rank".
out_geom	Name of the output geometry column. Defaults to geom (or "geometry" when coords is used).
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

Distances are **sf**'s sf::st_distance(): planar (CRS units) on projected or unprojected planar data, great-circle (metres) on geographic coordinates with spherical geometry on (sf::sf_use_s2()). Each batch forms its left-by-y distance matrix, so y should be the small side; when y carries no CRS it inherits the stream's. The left geometry rides through unchanged (replicated once per neighbour). The **sf** package is an optional dependency (Suggests).

Value

A vectra_node of one row per (left, neighbour) pair – x's columns (geometry included) plus the rank, neighbour identifier, and distance – backed by temporary .vtr spills (removed when the node is garbage- collected) and carrying the input CRS.

See Also

spatial_join() for a nearest-feature attribute join, collect() to materialize as sf.

Examples

```
nc <- sf::st_read(system.file("shape/nc.shp", package = "sf"), quiet = TRUE)
towns <- sf::st_centroid(sf::st_geometry(nc))[1:5]
towns <- sf::st_sf(town = nc$NAME[1:5], geometry = towns)

set.seed(1)
pts <- sf::st_coordinates(sf::st_sample(nc, 100))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(id = seq_len(nrow(pts)), x = pts[, 1], y = pts[, 2]), f)

# The two nearest towns to each point, with distances.
tbl(f) |>
  spatial_knn(towns, k = 2, coords = c("x", "y"), crs = sf::st_crs(nc),
              y_id = "town") |>
  collect() |> head()
unlink(f)
```

---

spatial_line_merge *Merge contiguous line segments into maximal lines*

Description

Sews the line segments of each group into the longest possible linestrings (sf::st_line_merge, the line counterpart of a dissolve): segments that meet end to end become one chain, and each chain is emitted as its own row. Where a plain union of lines returns a single multilinestring of all the parts, this joins the parts through their shared endpoints; at a crossing where more than two segments meet the merge is ambiguous and the segments stay separate. Like spatial_dissolve() it rides the **partition tier**: x is spilled once and routed into one disjoint shard per by group in a single bounded pass, then each group's segments are merged together. Peak memory is the routing budget during the pass, then one group's geometry while it is merged. With no by, the whole layer is merged at once.

Usage

```
spatial_line_merge(
  x,
  by = NULL,
  geom = "geometry",
  crs = NA,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
by	Character vector of attribute columns to merge within: one set of maximal lines per distinct combination of their values. NULL (default) merges the whole layer at once.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

Each merged line is new geometry built from the whole group, so it carries the by columns only, not the attributes of any single source segment. Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node. The **sf** package is an optional dependency (Suggests).

Value

A vectra_node of one row per maximal merged line, carrying the by columns and the input CRS, backed by temporary .vtr spills removed when the node is garbage-collected.

See Also

spatial_dissolve() to union geometries by group, spatial_explode() for the opposite direction (multipart to single part), collect() to materialize as sf.

Examples

```
seg <- sf::st_sfc(
  sf::st_linestring(rbind(c(0, 0), c(1, 0))),
  sf::st_linestring(rbind(c(1, 0), c(2, 0))),
  sf::st_linestring(rbind(c(2, 0), c(3, 0))))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  geometry = sf::st_as_binary(seg, hex = TRUE)
), f)

# The three end-to-end segments become one line.
tbl(f) |> spatial_line_merge() |> collect()
unlink(f)
```

spatial_locate *Locate streamed points along a resident line layer*

Description

Streams a large point layer `x` through the engine and, for each point, finds the nearest line of a small resident `line` layer and where the point falls along it – linear referencing (`sf::st_line_project`). Each point gets the identifier of its nearest line, the **measure** (distance along that line from its start to the point's projection), and the perpendicular distance to the line. With `snap = TRUE` the point geometry is moved onto the line at that measure. This is the two-layer companion to a per-feature `sf::st_line_interpolate`, which goes the other way (a measure back to a point); the billion-row point stream never materializes, while `line` (the reference network) stays resident.

Usage

```
spatial_locate(
  x,
  line,
  geom = "geometry",
  coords = NULL,
  crs = NA,
  y_id = NULL,
  id_col = "line",
  measure_col = "measure",
  dist_col = "distance",
  snap = FALSE,
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

`x`	A `vectra_node` (from `tbl()`, `tbl_tiff()`, any verb chain, ...). It is consumed by the stream.
`line`	An `sf` or `sfc` object of the reference lines (the resident layer).
`geom`	Name of the input geometry column holding hex-WKB or WKT strings. Default `"geometry"`. Ignored when `coords` is given.
`coords`	Optional length-2 character vector naming the x and y coordinate columns to assemble point geometry from (e.g. `c("x", "y")`), for inputs such as `tiff_extract_points()` output. The coordinate columns are retained.
`crs`	Coordinate reference system of the input geometry, in any form `sf::st_crs()` accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
`y_id`	Optional name of a column in `line` whose value identifies the matched line in the output. Default `NULL` uses `line`'s 1-based row index.

`id_col`, `measure_col`, `dist_col`
: Names of the output columns holding the matched-line identifier, the measure along the line, and the perpendicular distance. Defaults `"line"`, `"measure"`, `"distance"`.

`snap`
: If `TRUE`, replace each point's geometry with its projection onto the nearest line. Default `FALSE` keeps the original points.

`out_geom`
: Name of the output geometry column. Defaults to `geom` (or `"geometry"` when `coords` is used).

`flush_rows`
: Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. `NULL` (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of `vectra_mem()`, set with `options(vectra.memory = )`); an explicit value caps each buffer at that many rows.

Details

Nearest line and distance are **sf**'s sf::st_nearest_feature and sf::st_distance: planar (CRS units) on projected or unprojected planar data, great-circle (metres) on geographic coordinates with spherical geometry on (`sf::sf_use_s2()`). Points arrive either as a hex-WKB geometry column (`geom`) or as two coordinate columns (`coords`). The **sf** package is an optional dependency (Suggests).

Value

A `vectra_node` of `x`'s rows – geometry included (or snapped onto the line) – plus the matched-line identifier, the measure, and the perpendicular distance, backed by temporary `.vtr` spills (removed when the node is garbage-collected) and carrying the input CRS.

See Also

`spatial_knn()` for nearest neighbours with distances, `spatial_join()` for a nearest-feature attribute join, `spatial_map()` with `~ sf::st_line_interpolate(line, .x$m)` for the inverse, `collect()` to materialize as `sf`.

Examples

```
line <- sf::st_sfc(
  sf::st_linestring(rbind(c(0, 0), c(10, 0))),
  sf::st_linestring(rbind(c(0, 5), c(0, 15))))
line <- sf::st_sf(road = c("main", "side"), geometry = line)
pts  <- data.frame(id = 1:2, x = c(3, 1), y = c(1, 9))
f <- tempfile(fileext = ".vtr")
write_vtr(pts, f)

# Each point's position along its nearest road.
tbl(f) |>
  spatial_locate(line, coords = c("x", "y"), y_id = "road") |>
  collect()
unlink(f)
```

spatial_map *Stream a query through an sf transform*

Description

Applies a per-feature **sf** operation (buffer, centroid, area, CRS transform, simplify, ...) to a lazy vectra query one batch at a time and returns a new lazy node. The engine pulls one batch, hands it to `fn` as an `sf` object, encodes the result back into the stream, and spills to disk, so peak memory is one batch regardless of result size. This is the streaming, larger-than-RAM counterpart to running the same `sf` call on a whole in-memory table.

Usage

```
spatial_map(
  x,
  fn,
  geom = "geometry",
  coords = NULL,
  crs = NA,
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

`x`	A `vectra_node` (from `tbl()`, `tbl_tiff()`, any verb chain, ...). It is consumed by the stream.
`fn`	A function (or purrr-style formula such as `~ sf::st_buffer(.x, 1000)`) taking one `sf` batch and returning an `sf` object, `sfc`, or plain data.frame. The active geometry of the return becomes the output geometry.
`geom`	Name of the input geometry column holding hex-WKB or WKT strings. Default `"geometry"`. Ignored when `coords` is given.
`coords`	Optional length-2 character vector naming the x and y coordinate columns to assemble point geometry from (e.g. `c("x", "y")`), for inputs such as `tiff_extract_points()` output. The coordinate columns are retained.
`crs`	Coordinate reference system of the input geometry, in any form `sf::st_crs()` accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
`out_geom`	Name of the output geometry column. Defaults to `geom` (or `"geometry"` when `coords` is used).
`flush_rows`	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. `NULL` (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of `vectra_mem()`, set with `options(vectra.memory = )`); an explicit value caps each buffer at that many rows.

Details

Geometry travels through the engine as hex-encoded WKB in an ordinary string column (vectra has no native geometry type), and the coordinate reference system is carried on the returned node rather than in the `.vtr` file. Use `collect()` to materialize the result as an `sf` object, or `collect()` to get the underlying data.frame with the WKB string column.

Topology is delegated entirely to **sf**/GEOS; vectra only supplies the streaming. The `sf` package is an optional dependency (Suggests).

Value

A `vectra_node` backed by temporary `.vtr` spills (removed when the node is garbage-collected), carrying the output CRS for `collect()`.

See Also

`spatial_join()` to join a streamed side against a resident `sf` object, `collect()` to materialize as `sf`.

Examples

```
nc <- sf::st_read(system.file("shape/nc.shp", package = "sf"), quiet = TRUE)
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  NAME = nc$NAME,
  geometry = sf::st_as_binary(sf::st_centroid(sf::st_geometry(nc)),
                              hex = TRUE)
), f)

# Buffer every county centroid by 0.1 degree, streaming.
buffered <- tbl(f) |>
  spatial_map(~ sf::st_buffer(.x, 0.1), crs = sf::st_crs(nc))
collect(buffered)
unlink(f)
```

`spatial_network` *Build a routable network graph from a line layer*

Description

Builds the node-edge graph a shortest-path query needs: nodes at line endpoints, edges weighted by geometry length or a cost column. The graph is held resident in an external pointer and passed to `spatial_route()` and `spatial_service_area()`, which stream origin (and destination) batches past it. This is the network counterpart of a resident `sf` `y` in `spatial_knn()`: the graph is the resident budget (bounded by the network size), while the query side scales by streaming.

Usage

```
spatial_network(
  lines,
  weight = NULL,
  directed = FALSE,
  direction = NULL,
  weight_to = NULL,
  tolerance = 0,
  geom = "geometry",
  crs = NA
)
```

Arguments

lines	An sf or sfc object of (multi)linestrings, or a vectra_node carrying a hex-WKB line geometry column (it is materialised).
weight	Name of a column in lines holding each edge's traversal cost. NULL (default) uses the geometry length (sf::st_length()).
directed	If TRUE, edges are one-way (by direction, or the digitised from->to direction). FALSE (default) makes every edge two-way.
direction	Name of a column of one-way codes, used when directed: "B" two-way, "FT" from->to only, "TF" to->from only, "N" closed (the +/-/0 sign convention is also accepted). NULL uses "FT" for every line, or "B" when weight_to is given.
weight_to	Name of a column holding the reverse-direction cost on a two-way edge of a directed graph. NULL reuses weight.
tolerance	Endpoints within this distance (CRS units) are snapped to one node. 0 (default) joins only exactly-coincident endpoints.
geom, crs	Geometry column name and CRS, as in spatial_map(). The CRS defaults to the one lines carries.

Details

Endpoints within tolerance of each other are snapped to a single node, so a layer whose touching lines do not share exactly-equal endpoint coordinates still connects. The input must be (multi)linestrings; a MULTILINESTRING is split into its parts, each becoming one edge with the source attributes. Lines are treated as already split at their junctions (the usual road-network convention); two lines that merely cross in their interiors are not connected unless they share an endpoint. The graph and the Dijkstra solver are native C; **sf** (an optional dependency, Suggests) supplies only the geometry.

Value

A vectra_network object: the resident graph (an external pointer plus the node coordinates, edge table, and source-line geometry needed to snap queries and rebuild routes). Print it to see the node, edge, and connected-component counts.

See Also

spatial_route() for shortest paths and origin-destination costs, spatial_service_area() for reachability and isochrones.

Examples

```
# A small grid of streets.
mk <- function(x1, y1, x2, y2)
  sf::st_linestring(rbind(c(x1, y1), c(x2, y2)))
streets <- sf::st_sfc(
  mk(0, 0, 1, 0), mk(1, 0, 2, 0), mk(0, 0, 0, 1),
  mk(0, 1, 1, 1), mk(1, 0, 1, 1), mk(1, 1, 2, 1), mk(2, 0, 2, 1))
net <- spatial_network(streets)
net
```

---

spatial_overlay *Self-overlay a polygon layer into disjoint pieces (QGIS-style Union)*

Description

Splits a polygon layer along all its own overlaps into disjoint pieces and returns a lazy node with one row per piece per covering polygon: where k polygons overlap, that piece appears k times, each row carrying one source polygon's attributes. This is the union overlay GIS tools expose as "Union (single layer)", with the overlap retained once per contributing feature rather than dissolved. Resolve the duplicates with a grouped slice_min() / slice_max() – for example earliest designation year wins: group_by(piece_id) |> slice_min(year).

Usage

```
spatial_overlay(
  x,
  y = NULL,
  vars = NULL,
  vars_y = NULL,
  how = c("intersection", "union", "identity", "symdiff"),
  piece = "piece_id",
  geom = "geometry",
  grid = NULL,
  precision = NULL,
  dedup = TRUE,
  exact = FALSE,
  flush_rows = NULL,
  mem_limit = NULL,
  threads = NULL,
  quiet = TRUE,
  layer = NULL,
```

```
  query = NULL,
  layer_y = NULL,
  query_y = NULL,
  read_chunk = NULL
)
```

Arguments

x	An sf object with polygon or multipolygon geometry, or a single path to a vector file (e.g. a GeoPackage). A path is read in feature batches via layer / query, so the whole layer is never held in memory at once – peak memory then tracks the cleaned geometry, not the source size, which lets a larger-than-RAM layer overlay on a modest machine.
y	Optional second layer to overlay x against, in the same forms x accepts (an sf object or a file path read via layer_y / query_y). It must share the CRS of x. NULL (the default) self-unions x.
vars	Character vector of attribute columns of x to carry onto each piece. Default NULL keeps them all; name a subset to keep the streamed output narrow.
vars_y	Character vector of attribute columns of y to carry onto each piece (two-layer overlay only). Default NULL keeps them all. A name shared with an x column is disambiguated with a .x / .y suffix in the output.
how	For a two-layer overlay, which pieces to keep: "intersection" (covered by both layers; the default), "union" (every piece of either, the absent side's attributes filled with NA), "identity" (all of x, split by y, with y's attributes where it covers and NA elsewhere), or "symdiff" (pieces in exactly one layer). Ignored when y = NULL.
piece	Name of the integer piece-id column added to the output (the key you group by to resolve overlaps). Default "piece_id".
geom	Name of the output hex-WKB geometry column. Default "geometry".
grid	Fixed-precision snapping grid size in CRS units. Coordinates are snapped to this grid before noding so near-duplicate shared boundaries merge into one. NULL (the default) derives it from coordinate magnitude (max(abs(st_bbox(x))) * 3e-8), which suits projected layers. Pass a number to override when that default is too coarse for fine geometry (or too coarse because an outlier coordinate inflated the magnitude), or 0 to disable snapping entirely.
precision	Fixed-precision grid size, in CRS units, for noding the boundary linework. Noding on a fixed grid is deterministic and avoids the floating noder's repair-and-retry on dense overlapping linework, which is what makes a large dense layer feasible to overlay. It is far finer than grid so intersection points are not collapsed. NULL (the default) derives it from coordinate magnitude (max(abs(st_bbox(x))) * 1e-13); pass a number to override, or 0 to node in floating precision.
dedup	Overlay one representative per group of byte-identical cleaned geometries and fan the per-record attributes back onto its pieces afterwards. Duplicates add no faces, so the result is identical; this only removes the redundant noding when many records are stacked over one site (common in WDPA-style data). TRUE by default; set FALSE to overlay every record.

`exact` How a piece is credited to the inputs that cover it. Each piece is a face of the arrangement of all input boundaries, so it lies wholly inside or outside every input up to snap-rounding slivers along the boundary. With `FALSE` (the default) the whole face is credited to each input whose interior contains the face's representative point, and the piece geometry is the face; per-input covered area is then exact up to about the noding precision times the face perimeter. With `TRUE` each face is intersected with every partially covering input and credited that intersection area, giving areas exact to the snapping grid at the cost of extra geometry work and thin boundary slivers as separate pieces.

`flush_rows` Exploded rows buffered before a spill flush. `NULL` (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of `vectra_mem()`, set with `options(vectra.memory = )`); an explicit value caps each buffer at that many rows.

`mem_limit` Approximate peak working-set budget in bytes, bounding the per-tile size (`tile_bytes = mem_limit / (threads * 24)`). It is a throughput knob with an interior optimum, not "bigger is faster": too small replicates features across many tiles, too large nodes too much linework per tile (a superlinear cost), and a budget of tens of GB runs slower than the default on a dense layer. Lower it for tighter memory. `NULL` (the default) scales with `threads` to hold the per-tile size near its measured optimum, capped by the session budget `vectra_mem()` (`options(vectra.memory = )`).

`threads` Number of OpenMP threads for the per-component overlay within a chunk. `0` (the default, via `getOption("vectra.overlay_threads", 0)`) uses all available cores.

`quiet` If `FALSE`, show a text progress bar over the overlay chunks.

`layer` When `x` is a file path, the name of the layer to read. Ignored for an `sf` `x`. Supply this or `query`.

`query` When `x` is a file path, a SQL statement selecting the features to overlay (read in batches via `LIMIT/OFFSET`); use it instead of `layer` for a subset or join. With `query` and no `layer`, pass `grid` explicitly, since the layer extent cannot be read from the file metadata.

`layer_y, query_y`
The `layer` / `query` equivalents for a file-path `y`.

`read_chunk` Features per read/parse batch. `NULL` (default) sizes it from available RAM. Smaller batches lower peak memory; larger ones do fewer round trips.

Details

The topology is done once with **sf**/GEOS and tiled over connected overlap clusters (disjoint clusters never share a piece, so the tiling is exact and bounded in memory), then the exploded pieces are streamed to a `.vtr` and handed back as a lazy node. Geometry rides through the engine as hex-encoded WKB in a string column; the CRS is carried on the node for `collect()`.

The overlay runs on a fixed-precision model: coordinates are snapped to a grid derived from their own magnitude so the pieces come out disjoint and their areas reconstruct the union of the inputs, instead of drifting by the fraction of a percent that floating-point sliver artefacts on invalid input otherwise introduce. Inputs are also passed through `sf::st_make_valid()`.

With a second layer `y`, the same machinery overlays two layers instead of self-unioning one: both layers are noded together into one planar partition, and each piece carries the attributes of the `x` record and the `y` record that cover it. `how` selects which pieces to keep – the intersection (pieces covered by both), the union (every piece of either), `x` split by `y` (`"identity"`), or the parts in exactly one layer (`"symdiff"`). With `y = NULL` (the default) the function self-unions `x` and `how` is ignored.

Value

A `vectra_node` over the exploded overlay, backed by temporary `.vtr` spills removed when the node is garbage-collected, carrying the CRS of `x` for `collect()`. For a self-union it is one row per piece per covering polygon; for a two-layer overlay one row per piece per covering `x`-record / `y`-record pair, with the columns of both layers.

See Also

`slice_min()` / `slice_max()` to resolve each piece to one winner, `collect()` to materialize as `sf`.

Examples

```
# Two overlapping squares designated in different years.
sq <- function(a, b) sf::st_polygon(list(rbind(
  c(a, 0), c(b, 0), c(b, 1), c(a, 1), c(a, 0))))
polys <- sf::st_sf(year = c(1990L, 2010L),
                   geometry = sf::st_sfc(sq(0, 2), sq(1, 3)))

# Split into disjoint pieces; earliest year wins where they overlap.
first <- spatial_overlay(polys) |>
  group_by(piece_id) |>
  slice_min(year, n = 1, with_ties = FALSE) |>
  collect()
first

# Two-layer overlay: intersect the squares with a zone layer, keeping both
# sets of attributes on each overlapping piece.
zones <- sf::st_sf(zone = c("A", "B"),
                   geometry = sf::st_sfc(sq(0, 1.5), sq(1.5, 3)))
inter <- spatial_overlay(polys, zones, how = "intersection") |> collect()
inter
```

`spatial_polygonize` *Build polygonal faces from a line network*

Description

Forms the polygons enclosed by a set of lines (the QGIS "Polygonize", GEOS `Polygonize`): the inverse of taking polygon boundaries. The lines of each group are unioned and noded so every crossing becomes a shared vertex, then the faces of that planar arrangement are returned, one per

row. A pile of lines that does not close any area yields no faces. Like spatial_dissolve() and spatial_construct() it rides the **partition tier**: x is spilled once and routed into one disjoint shard per by group in a single bounded pass, then each group's lines are polygonized together. Peak memory is the routing budget during the pass, then one group's geometry while its faces are built – partition on a key whose groups fit in memory. With no by, the whole layer yields one set of faces.

Usage

```
spatial_polygonize(
  x,
  by = NULL,
  geom = "geometry",
  crs = NA,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
by	Character vector of attribute columns to polygonize within: one set of faces per distinct combination of their values. NULL (default) polygonizes the whole layer at once.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

Each face is new geometry built from the whole group, so it carries the by columns only, not the attributes of any single source line. Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; the noding is **sf**/GEOS and expects projected or unprojected planar data. The **sf** package is an optional dependency (Suggests).

Value

A vectra_node of one row per face, carrying the by columns and the input CRS, backed by temporary .vtr spills removed when the node is garbage-collected.

See Also

spatial_split() to cut existing polygons by a blade, spatial_construct() for hulls and tessellations, spatial_dissolve() to merge geometries by group, collect() to materialize as sf.

Examples

```
grid <- sf::st_sfc(
  sf::st_linestring(rbind(c(0, 0), c(2, 0))),
  sf::st_linestring(rbind(c(0, 1), c(2, 1))),
  sf::st_linestring(rbind(c(0, 2), c(2, 2))),
  sf::st_linestring(rbind(c(0, 0), c(0, 2))),
  sf::st_linestring(rbind(c(1, 0), c(1, 2))),
  sf::st_linestring(rbind(c(2, 0), c(2, 2))))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  geometry = sf::st_as_binary(grid, hex = TRUE)
), f)

# The four unit cells enclosed by the grid of lines.
tbl(f) |> spatial_polygonize() |> collect()
unlink(f)
```

---

spatial_route *Shortest paths and origin-destination costs over a network*

Description

Streams a layer of origins x past a resident spatial_network() and, for each origin, finds the shortest path to one or more destinations to. Each origin and destination is snapped to its nearest graph node; the solver (native-C Dijkstra) returns one row per (origin, destination) pair with the total cost and, by default, the route geometry. With geometry = FALSE only the cost is returned, so a destination set per origin yields the origin-destination cost matrix in long form. The billion-origin stream never materialises; the graph stays resident.

Usage

```
spatial_route(
  x,
  network,
  to,
  to_id = NULL,
  geometry = TRUE,
  cost_col = "cost",
  dest_col = "destination",
  geom = "geometry",
  coords = NULL,
  crs = NA,
```

```
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node of origin features (point geometry, or coords).
network	A vectra_network from spatial_network().
to	An sf/sfc of destination points. One destination routes every origin to it; several produce one row per (origin, destination).
to_id	Optional column in to identifying each destination in the output. NULL (default) uses the 1-based destination index.
geometry	If TRUE (default) each row carries the route line; if FALSE only the cost column (the cost-matrix form, no geometry).
cost_col, dest_col	Names of the output cost and destination-identifier columns. Defaults "cost", "destination".
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
coords	Optional length-2 character vector naming the x and y coordinate columns to assemble point geometry from (e.g. c("x", "y")), for inputs such as tiff_extract_points() output. The coordinate columns are retained.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
out_geom	Name of the output geometry column. Defaults to geom (or "geometry" when coords is used).
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

An unreachable destination returns an infinite cost and an empty geometry rather than dropping the row, so a cost matrix stays rectangular. Snapping is to the nearest node, so place origins and destinations on or near the network; costs are in the units of the network's weight (or CRS length units when the graph was built from geometry length). The **sf** package is an optional dependency (Suggests).

Value

A vectra_node: one row per (origin, destination) carrying x's attributes, the destination id, the cost, and (when geometry = TRUE) the route geometry. Backed by temporary .vtr spills removed when the node is garbage-collected, and carrying the network CRS.

See Also

spatial_network() to build the graph, spatial_service_area() for reachability, collect() to materialize routes as sf.

Examples

```
mk <- function(x1, y1, x2, y2)
  sf::st_linestring(rbind(c(x1, y1), c(x2, y2)))
streets <- sf::st_sfc(
  mk(0, 0, 1, 0), mk(1, 0, 2, 0), mk(0, 0, 0, 1),
  mk(0, 1, 1, 1), mk(1, 0, 1, 1), mk(1, 1, 2, 1), mk(2, 0, 2, 1))
net <- spatial_network(streets)

f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(id = 1:2, x = c(0, 0), y = c(0, 1)), f)
dest <- sf::st_sfc(sf::st_point(c(2, 1)))

tbl(f) |>
  spatial_route(net, to = dest, coords = c("x", "y")) |>
  collect()
unlink(f)
```

---

spatial_service_area *Service areas and isochrones over a network*

Description

Streams a layer of origins x past a resident spatial_network() and, for each origin, finds every part of the network reachable within a cost budget - the service area, or, with several budgets, nested travel-cost isochrone bands. Each origin is snapped to its nearest graph node and a budget-bounded Dijkstra (native C) collects the reachable nodes; the reachable set is returned as the convex hull (output = "polygon", the generalised service area), the reachable edges ("lines"), or the reachable nodes ("nodes").

Usage

```
spatial_service_area(
  x,
  network,
  cost,
  output = c("polygon", "lines", "nodes"),
  band_col = "band",
  geom = "geometry",
  coords = NULL,
  crs = NA,
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node of origin features (point geometry, or coords).
network	A vectra_network from spatial_network().
cost	A cost budget (scalar), or several budgets for nested isochrone bands (e.g. c(5, 10, 15)).
output	"polygon" (default) for the convex hull of the reachable nodes, "lines" for the reachable edges, or "nodes" for the reachable nodes as a multipoint.
band_col	Name of the output column holding each row's budget. Default "band".
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
coords	Optional length-2 character vector naming the x and y coordinate columns to assemble point geometry from (e.g. c("x", "y")), for inputs such as tiff_extract_points() output. The coordinate columns are retained.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
out_geom	Name of the output geometry column. Defaults to geom (or "geometry" when coords is used).
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

A vector cost returns one row per (origin, band), each band the area reachable within that budget, so the rows nest from the smallest budget out. Costs are in the network's weight units. The convex-hull polygon is a generalisation; use output = "lines" for the exact reachable network. The **sf** package is an optional dependency (Suggests).

Value

A vectra_node: one row per (origin, band) carrying x's attributes, the band value, and the service-area geometry. Backed by temporary .vtr spills removed when the node is garbage-collected, and carrying the network CRS.

See Also

spatial_network() to build the graph, spatial_route() for shortest paths, collect() to materialize as sf.

Examples

```
mk <- function(x1, y1, x2, y2)
  sf::st_linestring(rbind(c(x1, y1), c(x2, y2)))
streets <- sf::st_sfc(
  mk(0, 0, 1, 0), mk(1, 0, 2, 0), mk(0, 0, 0, 1),
  mk(0, 1, 1, 1), mk(1, 0, 1, 1), mk(1, 1, 2, 1), mk(2, 0, 2, 1))
net <- spatial_network(streets)

f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(id = 1L, x = 0, y = 0), f)

tbl(f) |>
  spatial_service_area(net, cost = c(1, 2), output = "lines",
                       coords = c("x", "y")) |>
  collect()
unlink(f)
```

`spatial_simplify` *Simplify a polygon coverage without tearing shared edges*

Description

Simplifies polygon boundaries while keeping a shared border between two polygons identical on both sides, so adjacent polygons stay edge-matched with no slivers or gaps – the topology-preserving simplification that a per-feature `spatial_map(~ sf::st_simplify(.x))` cannot give, because it simplifies each polygon's copy of a shared border independently. The boundaries of each group are unioned so a shared border is one line, noded into arcs at every junction, each arc simplified once (its junction endpoints pinned), and the arcs re-polygonized; each resulting face inherits the attributes of the source polygon containing it. Like `spatial_dissolve()` it rides the **partition tier**: `x` is spilled once and routed into one disjoint shard per `by` group in a single bounded pass, and each group is simplified as an independent coverage. Peak memory is the routing budget during the pass, then one group's geometry while it is simplified – partition on a key whose groups fit in memory. With no `by`, the whole layer is one coverage.

Usage

```
spatial_simplify(
  x,
  tolerance,
  by = NULL,
  geom = "geometry",
  crs = NA,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
tolerance	Distance tolerance for the boundary simplification, in CRS units: vertices that deviate less than this from the simplified line are dropped. Larger values simplify more.
by	Character vector of attribute columns whose groups are each simplified as an independent coverage. NULL (default) treats the whole layer as one coverage.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

The simplification is topology-preserving Douglas-Peucker (dTolerance = tolerance) on the noded boundary arcs. Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; the noding is **sf**/GEOS and expects projected or unprojected planar data. The **sf** package is an optional dependency (Suggests).

Value

A vectra_node of the simplified polygons, each carrying its source feature's attributes and the input CRS, backed by temporary .vtr spills removed when the node is garbage-collected.

See Also

spatial_map() with ~ sf::st_simplify(.x) for independent per-feature simplification, spatial_smooth() for Chaikin corner-rounding, collect() to materialize as sf.

Examples

```
p1 <- sf::st_polygon(list(rbind(
  c(0, 0), c(1, 0), c(1, 0.5), c(1, 1), c(0, 1), c(0, 0))))
p2 <- sf::st_polygon(list(rbind(
  c(1, 0), c(2, 0), c(2, 1), c(1, 1), c(1, 0.5), c(1, 0))))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  id = c("a", "b"),
  geometry = sf::st_as_binary(sf::st_sfc(p1, p2), hex = TRUE)
), f)
```

```
# The shared edge is simplified once, so the two polygons stay edge-matched.
tbl(f) |> spatial_simplify(tolerance = 0.6) |> collect()
unlink(f)
```

`spatial_smooth` *Smooth streamed line and polygon geometry*

Description

Rounds the corners of every line and polygon in a streamed layer by Chaikin corner-cutting, one batch at a time. Each iteration replaces every vertex with two points a quarter and three-quarters of the way along its adjacent edges, so sharp angles become a sequence of short chamfers that read as a smooth curve; more `iterations` give a smoother result with more vertices. Open lines keep their endpoints (`keep_ends`); polygon rings are cut cyclically and shrink slightly, as Chaikin smoothing does. Point geometry passes through unchanged.

Usage

```
spatial_smooth(
  x,
  iterations = 2L,
  keep_ends = TRUE,
  geom = "geometry",
  crs = NA,
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

`x`	A `vectra_node` (from `tbl()`, `tbl_tiff()`, any verb chain, ...). It is consumed by the stream.
`iterations`	Number of corner-cutting passes (a positive integer). Each pass roughly doubles the vertex count. Default `2`.
`keep_ends`	If `TRUE` (default), pin the first and last vertex of an open line so it is not shortened at its tips. Ignored for closed rings.
`geom`	Name of the input geometry column holding hex-WKB or WKT strings. Default `"geometry"`. Ignored when `coords` is given.
`crs`	Coordinate reference system of the input geometry, in any form `sf::st_crs()` accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
`out_geom`	Name of the output geometry column. Defaults to `geom` (or `"geometry"` when `coords` is used).

`flush_rows` Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. `NULL` (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of `vectra_mem()`, set with `options(vectra.memory = )`); an explicit value caps each buffer at that many rows.

Details

The smoothing is computed directly on the coordinates (no GEOS call), so it is dependency-light; **sf** is used only to decode and rebuild each batch. Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; use `collect()` to materialize.

Value

A `vectra_node` of the smoothed geometry with `x`'s attributes, backed by temporary `.vtr` spills (removed when the node is garbage-collected) and carrying the input CRS.

See Also

`spatial_map()` for per-feature transforms such as densifying with `~ sf::st_segmentize(.x, dfMaxLength)` or sampling points along a line with `~ sf::st_line_sample(.x, n)`, `collect()` to materialize as `sf`.

Examples

```
zig <- sf::st_linestring(rbind(c(0, 0), c(1, 1), c(2, 0), c(3, 1), c(4, 0)))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  id = 1L, geometry = sf::st_as_binary(sf::st_sfc(zig), hex = TRUE)
), f)

# Smooth the zig-zag with three corner-cutting passes.
tbl(f) |> spatial_smooth(iterations = 3) |> collect()
unlink(f)
```

---

spatial_snap *Snap a streamed layer toward a resident reference layer*

Description

Streams a large layer `x` through the engine and snaps each batch's vertices toward a small resident reference layer `y` when they lie within `tolerance` (in CRS units), one batch at a time (the QGIS "snap geometries to layer"). Vertices and edges of `x` closer than `tolerance` to `y` are pulled onto `y`, which closes the small gaps and overshoots between two layers that should share a boundary. The reference layer stays resident while the billion-row left stream flows past; the snap itself is **sf**'s `sf::st_snap()`.

Usage

```
spatial_snap(
  x,
  y,
  tolerance,
  geom = "geometry",
  coords = NULL,
  crs = NA,
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
y	An sf or sfc object: the resident reference layer to snap toward.
tolerance	Snapping distance in CRS units (a positive number). Vertices and edges of x within this distance of y are moved onto y.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
coords	Optional length-2 character vector naming the x and y coordinate columns to assemble point geometry from (e.g. c("x", "y")), for inputs such as tiff_extract_points() output. The coordinate columns are retained.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
out_geom	Name of the output geometry column. Defaults to geom (or "geometry" when coords is used).
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; use collect() to materialize. When y carries no CRS it inherits the stream's. The **sf** package is an optional dependency (Suggests).

Value

A vectra_node of the snapped geometry with x's attributes, backed by temporary .vtr spills (removed when the node is garbage-collected) and carrying the input CRS.

See Also

spatial_snap_grid() to snap to a grid instead of a layer, spatial_clip() for the resident-mask streaming pattern, collect().

Examples

```
ref <- sf::st_sfc(sf::st_linestring(rbind(c(0, 0), c(10, 0))))
line <- sf::st_linestring(rbind(c(0, 0.2), c(5, 0.1), c(10, 0.2)))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  id = 1L, geometry = sf::st_as_binary(sf::st_sfc(line), hex = TRUE)
), f)

# Pull the near-zero vertices down onto the reference line.
tbl(f) |> spatial_snap(ref, tolerance = 0.5) |> collect()
unlink(f)
```

---

spatial_snap_grid *Snap a streamed layer's coordinates to a fixed grid*

Description

Rounds every coordinate of a streamed layer to a regular grid of spacing size (in CRS units) and repairs the result, one batch at a time. This is the fixed-precision snap-rounding the overlay noder (spatial_overlay()) applies internally, exposed as a standalone verb: it merges near-coincident vertices and removes the slivers that floating-point coordinates leave between shared boundaries, so a layer can be cleaned (or pre-noded to a common precision) without running a full overlay. Snapping is done in C straight off the hex-WKB column; one cleaned geometry comes back per input feature, so attributes ride through untouched.

Usage

```
spatial_snap_grid(
  x,
  size,
  geom = "geometry",
  crs = NA,
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
size	Grid spacing in CRS units (a positive number). Coordinates are rounded to the nearest multiple; a larger size snaps more aggressively.

geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
out_geom	Name of the output geometry column. Defaults to geom (or "geometry" when coords is used).
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; use collect() to materialize. The **sf** package is an optional dependency (Suggests).

Value

A vectra_node of the snapped geometry with x's attributes, backed by temporary .vtr spills (removed when the node is garbage-collected) and carrying the input CRS.

See Also

spatial_snap() to snap toward another layer instead of a grid, spatial_overlay() whose noding uses the same snap-rounding, collect().

Examples

```
p <- sf::st_polygon(list(rbind(c(0.04, 0.03), c(1.02, 0.01),
                               c(0.98, 1.03), c(0.01, 0.97), c(0.04, 0.03))))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  id = 1L, geometry = sf::st_as_binary(sf::st_sfc(p), hex = TRUE)
), f)

# Snap the jittered corners back onto a 0.1 grid.
tbl(f) |> spatial_snap_grid(0.1) |> collect()
unlink(f)
```

spatial_split *Split a streamed layer by a resident blade, or return its crossing points*

Description

Streams a large layer `x` through the engine and cuts each batch's geometry against a small resident `blade` layer (the QGIS "split with lines"), one batch at a time. With `extract = "pieces"` (the default) every feature is divided where the blade crosses it – a polygon into the faces the blade carves out, a line into the arcs between crossings – and each piece is emitted as its own row with the source attributes copied; a feature the blade does not cross passes through as a single piece. With `extract = "points"` the verb instead returns, per feature, the points where it meets the blade (the "line intersections" tool), dropping features that do not cross.

Usage

```
spatial_split(
  x,
  blade,
  extract = c("pieces", "points"),
  geom = "geometry",
  crs = NA,
  out_geom = NULL,
  flush_rows = NULL
)
```

Arguments

`x`	A `vectra_node` (from `tbl()`, `tbl_tiff()`, any verb chain, ...). It is consumed by the stream.
`blade`	An `sf` or `sfc` object whose geometry cuts the stream (typically lines, but any geometry whose boundary can node `x`).
`extract`	`"pieces"` (default) to emit the split pieces, or `"points"` to emit the intersection points of each feature with the blade.
`geom`	Name of the input geometry column holding hex-WKB or WKT strings. Default `"geometry"`. Ignored when `coords` is given.
`crs`	Coordinate reference system of the input geometry, in any form `sf::st_crs()` accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
`out_geom`	Name of the output geometry column. Defaults to `geom` (or `"geometry"` when `coords` is used).
`flush_rows`	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. `NULL` (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of `vectra_mem()`, set with `options(vectra.memory = )`); an explicit value caps each buffer at that many rows.

Details

The split is built from **sf**/GEOS noding and polygonization, so it expects projected or unprojected planar data; geographic coordinates are best projected first. The blade is dissolved to one geometry once and held resident while the left stream flows past. Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; when `blade` carries no CRS it inherits the stream's. The **sf** package is an optional dependency (Suggests).

Value

A `vectra_node`: with `extract = "pieces"`, one row per piece carrying `x`'s attributes; with `extract = "points"`, one row per crossing feature carrying its intersection points. Backed by temporary `.vtr` spills (removed when the node is garbage-collected) and carrying the input CRS.

See Also

`spatial_clip()` to cut against a mask without dividing into pieces, `spatial_overlay()` to node two polygon layers into a partition, `collect()` to materialize as `sf`.

Examples

```
sq <- sf::st_polygon(list(rbind(c(0, 0), c(4, 0), c(4, 4), c(0, 4), c(0, 0))))
blade <- sf::st_sfc(sf::st_linestring(rbind(c(2, -1), c(2, 5))))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  id = 1L, geometry = sf::st_as_binary(sf::st_sfc(sq), hex = TRUE)
), f)

# Split the square into two halves along the blade.
tbl(f) |> spatial_split(blade) |> collect()
unlink(f)
```

---

spatial_topology *Build the shared-edge topology of a polygon coverage*

Description

Decomposes a polygon coverage into the arcs of its planar topology: each border is returned once, tagged with the polygons on either side. Where the raw boundaries of adjacent polygons each carry their own copy of a shared edge, this nodes the unioned boundaries so a shared border is a single arc carrying the identifiers of both neighbours – the "build topology" of a GIS, and the adjacency a dissolve or a coverage edit needs. An internal arc names two faces; an outer arc names one and leaves the other side `NA`. Like `spatial_dissolve()` it rides the **partition tier**: `x` is spilled once and routed into one disjoint shard per `by` group in a single bounded pass, and each group is treated as an independent coverage. Peak memory is the routing budget during the pass, then one group's geometry while its arcs are built.

Usage

```
spatial_topology(
  x,
  id = NULL,
  by = NULL,
  geom = "geometry",
  crs = NA,
  face_cols = c("face1", "face2"),
  flush_rows = NULL
)
```

Arguments

x	A vectra_node (from tbl(), tbl_tiff(), any verb chain, ...). It is consumed by the stream.
id	Optional name of a column of x whose value identifies each polygon in the face columns. NULL (default) uses the 1-based feature order within the group.
by	Character vector of attribute columns whose groups are each built as an independent coverage. NULL (default) treats the whole layer as one coverage.
geom	Name of the input geometry column holding hex-WKB or WKT strings. Default "geometry". Ignored when coords is given.
crs	Coordinate reference system of the input geometry, in any form sf::st_crs() accepts (EPSG integer, WKT, proj string). Defaults to the CRS the upstream node carries, or unknown.
face_cols	Length-2 character vector naming the two output columns that hold the identifiers of the polygons on either side of each arc. Default c("face1", "face2").
flush_rows	Transformed rows buffered before a spill flush. Larger values mean fewer, bigger temporary files. NULL (the default) instead flushes once a spill buffer's size crosses the streaming memory budget (a fraction of vectra_mem(), set with options(vectra.memory =)); an explicit value caps each buffer at that many rows.

Details

Geometry travels through the engine as hex-encoded WKB in a string column and the CRS is carried on the returned node; the noding is **sf**/GEOS and expects projected or unprojected planar data. The **sf** package is an optional dependency (Suggests).

Value

A vectra_node of one row per arc – the arc geometry plus the two face-identifier columns (and any by columns) – carrying the input CRS and backed by temporary .vtr spills removed when the node is garbage-collected.

See Also

spatial_polygonize() to rebuild faces from arcs, spatial_dissolve() to merge geometries by group, collect() to materialize as sf.

Examples

```
p1 <- sf::st_polygon(list(rbind(c(0, 0), c(1, 0), c(1, 1), c(0, 1), c(0, 0))))
p2 <- sf::st_polygon(list(rbind(c(1, 0), c(2, 0), c(2, 1), c(1, 1), c(1, 0))))
f <- tempfile(fileext = ".vtr")
write_vtr(data.frame(
  id = c("a", "b"),
  geometry = sf::st_as_binary(sf::st_sfc(p1, p2), hex = TRUE)
), f)

# The shared edge appears once, tagged with both neighbours.
tbl(f) |> spatial_topology(id = "id") |> collect()
unlink(f)
```

---

st_write.vectra_node *Stream a vectra node's geometry to a vector file*

Description

An sf::st_write() method (also reached through sf::write_sf()) for a vectra_node: writes the result a batch at a time, appending each, so the whole layer is never held in memory. This is the streaming counterpart to collect(x) |> sf::st_write(...) – that route materializes every feature as an sf object first, which for a multi-million-feature result dominates memory; this route's peak is one batch.

Usage

```
## S3 method for class 'vectra_node'
st_write(
  obj,
  dsn,
  layer = NULL,
  ...,
  geom = "geometry",
  crs = NULL,
  delete_dsn = FALSE,
  quiet = TRUE
)
```

Arguments

obj	A vectra_node whose rows carry a hex-WKB geometry column (from spatial_overlay(), a grouped slice_min() / slice_max() resolution, a .vtr scan, ...). It is consumed by the stream.
dsn	Destination data source name (file path).
layer	Layer name. NULL lets **sf** derive it from dsn.
...	Unused; for S3 generic compatibility.

geom	Name of the hex-WKB geometry column. Default "geometry".
crs	CRS to tag the output with. NULL takes the CRS carried on the node.
delete_dsn	If TRUE, remove an existing dsn before writing.
quiet	Passed to sf::st_write().

Value

The dsn, invisibly.

See Also

collect() to materialize the whole result as one sf object.

---

summarise *Summarise grouped data*

Description

Summarise grouped data

Usage

```
summarise(.data, ..., .groups = NULL)

summarize(.data, ..., .groups = NULL)
```

Arguments

.data	A grouped vectra_node (from group_by()).
...	Named aggregation expressions using n(), sum(), mean(), min(), max(), sd(), var(), first(), last(), any(), all(), median(), n_distinct().
.groups	How to handle groups in the result. One of "drop_last" (default), "drop", or "keep".

Details

Aggregation is hash-based by default. When the engine detects it is advantageous, it switches to a sort-based path that can spill to disk, keeping memory bounded regardless of group count.

All aggregation functions accept na.rm = TRUE to skip NA values. Without na.rm, any NA in a group poisons the result (returns NA). R-matching edge cases: sum(na.rm = TRUE) on all-NA returns 0, mean(na.rm = TRUE) on all-NA returns NaN, min/max(na.rm = TRUE) on all-NA returns Inf/-Inf with a warning.

This is a materializing operation.

Value

A vectra_node with one row per group.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> group_by(cyl) |> summarise(avg_mpg = mean(mpg)) |> collect()
unlink(f)
```

`tbl` *Create a lazy table reference from a .vtr file*

Description

Opens a vectra1 file and returns a lazy query node. No data is read until `collect()` is called.

Usage

```
tbl(path)
```

Arguments

`path`	Path to a `.vtr` file.

Value

A `vectra_node` object representing a lazy scan of the file.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
node <- tbl(f)
print(node)
unlink(f)
```

`tbl_bed` *Create a lazy table reference from a BED file*

Description

Streams a BED (Browser Extensible Data) file of genomic features as rows, one row per feature. Columns follow the BED specification in order: `chrom`, `start`, `end`, `name`, `score`, `strand`, `thickStart`, `thickEnd`, `itemRgb`, `blockCount`, `blockSizes`, `blockStarts`; any fields beyond the twelfth (a "BED N+" file) are read as strings named `V13`, `V14`, ... The column count is fixed by the first feature line and every later line must match it. Features stream one batch at a time, so a genome-scale interval set never fully materializes. Gzip-compressed files (`.bed.gz`) are read transparently. No data is read until `collect()` is called.

Usage

```
tbl_bed(path, batch_size = .DEFAULT_BATCH_SIZE, quiet = FALSE)
```

Arguments

path	Path to a .bed file, optionally gzip-compressed.
batch_size	Number of features per batch (default 65536).
quiet	If FALSE (default), report the feature count when the scan completes.

Details

Fields are whitespace-delimited (tab or space), and blank lines, # comments, and UCSC track/browser directive lines are skipped. chrom, start, and end are required; start and end are integers (a non-integer there stops the scan). Optional integer fields (score, thickStart, thickEnd, blockCount) accept . or NA as missing. When the scan reaches the end of the file it reports the number of features read (suppress with quiet = TRUE).

Coordinates are read faithfully. BED start is 0-based and end is half-open (the first position past the feature), and both are returned exactly as stored — no coordinate is rewritten. Two features that abut (end of one equal to start of the next) share no base. To overlap-join BED tables with those half-open semantics — matching bedtools and GenomicRanges::findOverlaps() — pass closed = FALSE to interval_join(), which requires a strictly positive overlap and so does not pair abutting features:

```
peaks <- tbl_bed("peaks.bed")
genes <- tbl_bed("genes.bed")
interval_join(peaks, genes, start = "start", end = "end",
              by = "chrom", closed = FALSE)
```

Value

A vectra_node object representing a lazy scan of the BED file.

See Also

interval_join(), tbl_fasta()

Examples

```
f <- tempfile(fileext = ".bed")
writeLines(c("chr1\t100\t200\tfeatA\t0\t+",
             "chr1\t150\t400\tfeatB\t0\t-",
             "chr2\t500\t900\tfeatC\t0\t+"), f)
node <- tbl_bed(f, quiet = TRUE)
node |> filter(chrom == "chr1") |> collect()
unlink(f)
```

tbl_csv *Create a lazy table reference from a delimited text file*

Description

Opens a delimited text file (CSV, TSV, or any single-character separator) for lazy, streaming query execution. Column types are inferred from the first `guess_max` rows (default 1000). No data is read until `collect()` is called. Gzip-compressed files (`.csv.gz`, `.tsv.gz`) are supported transparently.

Usage

```
tbl_csv(
  path,
  batch_size = .DEFAULT_BATCH_SIZE,
  delim = ",",
  guess_max = 1000,
  col_types = NULL
)
```

Arguments

`path`	Path to a delimited text file, optionally gzip-compressed.
`batch_size`	Number of rows per batch (default 65536).
`delim`	Single-character field separator (default `","`). Use `"\t"` for tab-separated and `";"` for semicolon-separated files.
`guess_max`	Number of rows scanned to infer column types (default 1000). A value that only reveals a column's true type later in the file (for example an integer column that turns out to hold a decimal past row 1000) is otherwise read as `NA`; pass a larger value, or `Inf` to scan the whole file, at the cost of an extra read pass.
`col_types`	Optional named character vector forcing the type of specific columns, overriding inference. Names are column names; values are one of `"character"`, `"double"`, `"integer"`, or `"logical"`. Use this to keep a zero-padded identifier column (ZIP codes, accession IDs) as text instead of letting it be read as a number, e.g. `col_types = c(zip = "character")`.

Details

The field separator is set by `delim`, so tab-separated files (GBIF occurrence exports, TSV dumps) and semicolon-separated files (many European exports) are read natively without a transcode step. Quoting follows RFC 4180 for every delimiter: a field wrapped in double quotes may contain the delimiter, newlines, and doubled quotes.

Value

A `vectra_node` object representing a lazy scan of the file.

Examples

```
f <- tempfile(fileext = ".csv")
write.csv(mtcars, f, row.names = FALSE)
node <- tbl_csv(f)
print(node)
unlink(f)

# Tab-separated (e.g. a GBIF occurrence export)
g <- tempfile(fileext = ".tsv")
write.table(mtcars, g, sep = "\t", row.names = FALSE, quote = FALSE)
tbl_csv(g, delim = "\t") |> collect() |> head()
unlink(g)
```

---

tbl_fasta *Create a lazy table reference from a FASTA file*

Description

Streams a FASTA file of biological sequences as rows: one row per record with columns `id`, `desc`, and `seq`. `id` is the first whitespace-delimited token of the header line, `desc` is the remainder (an empty string when the header carries no description), and `seq` is the sequence with line breaks removed. Records stream one batch at a time, so a read set larger than RAM never fully materializes. Gzip-compressed files (`.fasta.gz`, `.fa.gz`) are read transparently. No data is read until `collect()` is called.

Usage

```
tbl_fasta(path, batch_size = .DEFAULT_BATCH_SIZE, quiet = FALSE)
```

Arguments

`path`	Path to a `.fasta`/`.fa` file, optionally gzip-compressed.
`batch_size`	Number of records per batch (default 65536).
`quiet`	If `FALSE` (default), report the record count when the scan completes.

Details

The `seq_*` expression family (`seq_revcomp()`, `seq_gc()`, `seq_translate()`, `seq_dist()`, ...) operates on the `seq` column directly inside `mutate()`/`filter()`. See seq_expressions.

A record cut short is a loud error, not a silent drop: a header that is not the first non-blank token, or a byte where a > is expected, stops the scan. When the scan reaches the end of the file it reports the number of records read (suppress with `quiet = TRUE`).

Value

A `vectra_node` object representing a lazy scan of the FASTA file.

See Also

tbl_fastq(), seq_expressions

Examples

```
f <- tempfile(fileext = ".fasta")
writeLines(c(">seq1 first", "ACGTACGT", ">seq2 second", "GGGGCCCC"), f)
node <- tbl_fasta(f, quiet = TRUE)
node |> mutate(gc = seq_gc(seq)) |> collect()
unlink(f)
```

---

tbl_fastq *Create a lazy table reference from a FASTQ file*

Description

Streams a FASTQ file as rows: one row per record with columns `id`, `desc`, `seq`, and `qual` (the raw quality string, same length as `seq`). `id` and `desc` are split from the header as in `tbl_fasta()`. Records stream one batch at a time, so a read set larger than RAM never fully materializes. Gzip-compressed files (`.fastq.gz`, `.fq.gz`) are read transparently. No data is read until `collect()` is called.

Usage

```
tbl_fastq(path, batch_size = .DEFAULT_BATCH_SIZE, quiet = FALSE)
```

Arguments

`path`	Path to a `.fastq`/`.fq` file, optionally gzip-compressed.
`batch_size`	Number of records per batch (default 65536).
`quiet`	If `FALSE` (default), report the record count when the scan completes.

Details

Records are parsed in the standard four-line form (header, sequence, + separator, quality). A record cut short — a missing sequence, separator, or quality line, or a quality string whose length does not match the sequence — is a loud error, not a silent drop. When the scan reaches the end of the file it reports the number of records read (suppress with `quiet = TRUE`).

Value

A `vectra_node` object representing a lazy scan of the FASTQ file.

See Also

tbl_fasta(), seq_expressions

Examples

```
f <- tempfile(fileext = ".fastq")
writeLines(c("@r1 read one", "ACGT", "+", "IIII",
             "@r2 read two", "GGCC", "+", "!!!!"), f)
node <- tbl_fastq(f, quiet = TRUE)
node |> mutate(len = seq_length(seq)) |> collect()
unlink(f)
```

---

tbl_parquet *Create a lazy table reference from Parquet files*

Description

Streams one or more Apache Parquet files as a single lazy table. The reader is native: no Arrow installation is needed. Only the columns a query uses are read from disk, and a `filter()` directly above the scan skips row groups whose footer statistics (min, max, null count) show that no row can match. Row groups are decoded one page at a time into batches of at most `batch_size` rows, so a row group larger than RAM still streams. No data is read until `collect()` is called.

Usage

```
tbl_parquet(path, batch_size = .DEFAULT_BATCH_SIZE, list_sep = ";")
```

Arguments

`path`	Path to a Parquet file, a character vector of files, or a directory of Parquet files.
`batch_size`	Maximum number of rows per batch (default 65536).
`list_sep`	Separator placed between the elements of a list column (default `";"`).

Details

`path` may name several files, or a directory. A directory is read recursively; files whose name starts with `_` or `.` (Spark/Hive markers such as `_SUCCESS`, checksum files) are skipped, so a partitioned dataset directory or a GBIF snapshot folder can be passed as is. All files must share the first file's columns and types; extra columns in later files are ignored.

Supported. Data pages v1 and v2; `PLAIN`, `PLAIN_DICTIONARY` / `RLE_DICTIONARY`, `RLE`, `DELTA_BINARY_PACKED`, `DELTA_LENGTH_BYTE_ARRAY`, `DELTA_BYTE_ARRAY` and `BYTE_STREAM_SPLIT` encodings; `UNCOMPRESSED`, `SNAPPY`, `GZIP`, `ZSTD`, `LZ4_RAW` and (Hadoop-framed) `LZ4` compression. `BROTLI` and `LZO` are not supported and raise an error naming the column.

Types. Booleans become logical; `INT32` (and 8/16-bit and unsigned 8/16-bit integers) becomes integer; unsigned 32-bit integers and `INT64` become 64-bit integers (returned as double); unsigned 64-bit integers, `FLOAT`, `DOUBLE`, decimals of any width and half floats become double; `DATE` becomes `Date`; `TIMESTAMP` and legacy `INT96` timestamps become `POSIXct` in seconds (UTC when the file marks them adjusted to UTC, otherwise without a time zone), with nanosecond timestamps rounded

to double precision; TIME becomes seconds since midnight as double; byte arrays (strings, JSON, ENUM, and unannotated binary) become character, and UUIDs their canonical text form.

Nested columns. Struct fields are flattened into one column each, named by their path (address.city). A list column (one level of repetition, including a map's keys and values) becomes one character column whose elements are written as text and joined by list_sep: a null list is NA, an empty list "", a null element "NA". Lists of lists cannot be read; such a column stays in the schema, and reading it raises an error naming it, so drop it with select(-name) first.

Value

A vectra_node object representing a lazy scan of the files.

See Also

tbl(), tbl_csv(), bind_rows()

Examples

```
f <- system.file("extdata", "example.parquet", package = "vectra")
tbl_parquet(f) |> collect() |> head()
tbl_parquet(f) |> filter(id > 95) |> select(id, species) |> collect()
```

---

tbl_sqlite *Create a lazy table reference from a SQLite database*

Description

Opens a SQLite database and lazily scans a table. Column types are inferred from declared types in the CREATE TABLE statement. All filtering, grouping, and aggregation is handled by vectra's C engine — no SQL parsing needed. No data is read until collect() is called.

Usage

```
tbl_sqlite(path, table, batch_size = .DEFAULT_BATCH_SIZE)
```

Arguments

path	Path to a SQLite database file.
table	Name of the table to scan.
batch_size	Number of rows per batch (default 65536).

Value

A vectra_node object representing a lazy scan of the table.

Examples

```
f <- tempfile(fileext = ".sqlite")
write_sqlite(mtcars, f, "cars")
node <- tbl_sqlite(f, "cars")
node |> filter(cyl == 6) |> collect()
unlink(f)
```

---

tbl_tiff *Create a lazy table reference from a GeoTIFF raster*

Description

Opens a GeoTIFF file and returns a lazy query node. Each pixel becomes a row with columns `x`, `y`, `band1`, `band2`, etc. Coordinates are pixel centers derived from the affine geotransform. NoData values become `NA`.

Usage

```
tbl_tiff(path, batch_size = .TIFF_BATCH_SIZE)
```

Arguments

`path`	Path to a GeoTIFF file.
`batch_size`	Number of raster rows per batch (default 256).

Details

Strip and tiled files are read, uncompressed or compressed with DEFLATE or LZW, with the horizontal-differencing (2) and floating-point (3) predictors undone on read.

Use `filter(x >= ..., y <= ...)` for extent-based cropping and `filter(band1 > ...)` for value-based cropping. Results can be converted back to a raster with `terra::rast(df, type = "xyz")`.

Value

A `vectra_node` object representing a lazy scan of the raster.

Examples

```
f <- tempfile(fileext = ".tif")
df <- data.frame(x = as.double(rep(1:4, 3)),
                 y = as.double(rep(1:3, each = 4)),
                 band1 = as.double(1:12))
write_tiff(df, f)
node <- tbl_tiff(f)
node |> filter(band1 > 6) |> collect()
unlink(f)
```

`tbl_xlsx` *Create a lazy table reference from an Excel (.xlsx) file*

Description

Reads a sheet from an Excel workbook into a vectra node for lazy query execution. The sheet is read into memory via `openxlsx2::read_xlsx()` and then converted to vectra's internal format. Requires the **openxlsx2** package.

Usage

```
tbl_xlsx(path, sheet = 1L, batch_size = .DEFAULT_BATCH_SIZE)
```

Arguments

`path`	Path to an `.xlsx` file.
`sheet`	Sheet to read: either a name (character) or 1-based index (integer). Default `1L` (first sheet).
`batch_size`	Number of rows per batch (default 65536).

Value

A `vectra_node` object representing a lazy scan of the sheet.

Examples

```
if (requireNamespace("openxlsx2", quietly = TRUE)) {
  f <- tempfile(fileext = ".xlsx")
  openxlsx2::write_xlsx(mtcars, f)
  node <- tbl_xlsx(f)
  node |> filter(cyl == 6) |> collect()
  unlink(f)
}
```

terrain *Terrain derivatives from a streamed elevation raster*

Description

Computes DEM derivatives from a .vec elevation raster with Horn's 3x3 method, on the same haloed tile-row strip pass as focal() – the input is read one strip at a time and, when path is given, the outputs are streamed straight back to a multi-band .vec. Matches **terra**'s terrain() / shade() conventions.

Usage

```
terrain(
  x,
  v = c("slope", "aspect", "hillshade", "TPI", "roughness", "TRI"),
  unit = c("degrees", "radians"),
  azimuth = 315,
  altitude = 45,
  band = 1L,
  path = NULL,
  dtype = "f32",
  compression = c("fast", "balanced", "max")
)
```

Arguments

x	A vectra_raster (from vec_open_raster()) or a path to a .vec elevation raster.
v	Derivatives to compute, any of "slope", "aspect", "hillshade", "TPI" (topographic position index), "roughness", "TRI" (terrain ruggedness index). The return follows the input: one matrix for a single v, a named list for several.
unit	Angular unit for slope and aspect: "degrees" (default) or "radians".
azimuth, altitude	Sun position for "hillshade", in degrees. Defaults 315 (NW) and 45.
band	Band to read (1-based). Default 1.
path	Optional output .vec path (one band per v, named after v). When given the result is streamed to disk and the opened vec_open_raster() handle is returned invisibly; when NULL the result is returned in memory.
dtype	Storage dtype for .vec output (see vec_write_raster()). Default "f32".
compression	Compression effort for .vec output. Default "fast".

Details

Slope and aspect use the Horn (1981) finite-difference gradient over the 3x3 neighbourhood; `aspect` is degrees clockwise from north (flat cells return 90). `hillshade` is the cosine of the incidence angle for the given sun position, clamped at 0. `TPI` is the cell minus the mean of its eight neighbours; `roughness` is the range over the 3x3; `TRI` is the mean absolute difference to the eight neighbours. Cells whose 3x3 neighbourhood touches a nodata value or the raster edge return `NA`.

Value

When `path` is `NULL`: a numeric matrix for a single `v`, or a named list of matrices for several, each carrying `gt`, `extent`, and `crs` attributes (row 1 northmost). When `path` is given, the written multi-band `vectra_raster` handle (invisibly).

See Also

`focal()` for arbitrary moving windows.

Examples

```
# A tilted surface so slope and aspect are well defined.
z <- outer(1:8, 1:8, function(r, c) 10 + 2 * c + r)
f <- tempfile(fileext = ".vec")
vec_write_raster(z, f, dtype = "f64", extent = c(0, 0, 8, 8))

slp <- terrain(f, v = "slope")
deriv <- terrain(f, v = c("slope", "aspect", "hillshade"))
names(deriv)
unlink(f)
```

`tiff_band_names` *Read per-band names from a GeoTIFF*

Description

Returns the band names embedded in the file's GDAL_METADATA XML (TIFF tag 42112). GDAL writes per-band names as `<Item name="DESCRIPTION" sample="N" role="description">...</Item>` entries, where `sample` is the 0-based band index. Bands without a name in the XML are reported as `NA`. Files with no GDAL_METADATA tag at all return a length-`nbands` vector of `NA_character_`.

Usage

```
tiff_band_names(path)
```

Arguments

`path`	Path to a GeoTIFF file.

Details

This is a small, dependency-free scanner intended for the common case (`terra::names(r) <- ...` and similar). For arbitrary XML, parse the raw string from `tiff_metadata()` yourself.

Value

A character vector of length `nbands`. Element `i` is the name of band `i` (or `NA_character_` if the file does not name it).

Examples

```
f <- tempfile(fileext = ".tif")
df <- data.frame(x = rep(1:2, 2), y = rep(1:2, each = 2),
                 band1 = as.double(1:4), band2 = as.double(5:8))
xml <- paste0(
  "<GDALMetadata>",
  "<Item name=\"DESCRIPTION\" sample=\"0\" role=\"description\">temperature</Item>",
  "<Item name=\"DESCRIPTION\" sample=\"1\" role=\"description\">humidity</Item>",
  "</GDALMetadata>")
write_tiff(df, f, metadata = xml)
tiff_band_names(f)
unlink(f)
```

---

tiff_crs *Read CRS metadata from a GeoTIFF*

Description

Returns the spatial reference system embedded in a GeoTIFF, parsed from the GeoKey directory (TIFF tag 34735). The projected CRS EPSG (`PCSTypeGeoKey` 3072) is preferred over the geographic CRS EPSG (`GeographicTypeGeoKey` 2048). Citation strings are read from `GeoAsciiParams` (tag 34737) with priority PCS > GeoTIFF > geographic.

Usage

```
tiff_crs(path)
```

Arguments

`path`	Path to a GeoTIFF file.

Details

Files written without a GeoKey directory return `NA` for both fields.

Value

A list with elements epsg (integer or NA_integer_) and citation (character or NA_character_).

Examples

```
f <- tempfile(fileext = ".tif")
df <- data.frame(x = 1:4, y = rep(1:2, each = 2), band1 = as.double(1:4))
write_tiff(df, f)
tiff_crs(f)  # epsg = NA, citation = NA — vectra writer omits GeoKeys
unlink(f)
```

---

tiff_extract_points *Extract raster values at point coordinates*

Description

Samples band values from a GeoTIFF at specific (x, y) locations using the file's affine geotransform. Only the strips containing query points are read, making this efficient for sparse point sets on large rasters.

Usage

```
tiff_extract_points(path, x, y = NULL)
```

Arguments

path	Path to a GeoTIFF file.
x	Numeric vector of x coordinates, or a data.frame / matrix with columns named x and y.
y	Numeric vector of y coordinates (ignored if x is a data.frame).

Details

Points that fall outside the raster extent return NA for all bands. Pixel assignment uses nearest-pixel rounding (i.e., the point is assigned to the pixel whose center is closest).

Value

A data.frame with columns x, y, band1, band2, etc. One row per input point, in the same order as the input.

Examples

```
f <- tempfile(fileext = ".tif")
df <- data.frame(x = as.double(rep(1:4, 3)),
                 y = as.double(rep(1:3, each = 4)),
                 band1 = as.double(1:12))
write_tiff(df, f)

# Sample at specific locations via data.frame
pts <- data.frame(x = c(2, 3), y = c(1, 2))
tiff_extract_points(f, pts)

# Or pass x and y separately
tiff_extract_points(f, x = c(2, 3), y = c(1, 2))
unlink(f)
```

---

tiff_metadata *Read GDAL_METADATA from a GeoTIFF*

Description

Returns the GDAL_METADATA XML string (TIFF tag 42112) embedded in a GeoTIFF file. Returns NA if the tag is not present.

Usage

```
tiff_metadata(path)
```

Arguments

path	Path to a GeoTIFF file.

Value

A single character string containing the XML, or NA_character_.

Examples

```
f <- tempfile(fileext = ".tif")
df <- data.frame(x = 1:4, y = rep(1:2, each = 2), band1 = as.double(1:4))
write_tiff(df, f, metadata = "<GDALMetadata></GDALMetadata>")
tiff_metadata(f)
unlink(f)
```

transmute *Keep only columns from mutate expressions*

Description

Like `mutate()` but drops all other columns.

Usage

```
transmute(.data, ...)
```

Arguments

`.data`	A `vectra_node` object.
`...`	Named expressions.

Value

A new `vectra_node` with only the computed columns.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> transmute(kpl = mpg * 0.425) |> collect() |> head()
unlink(f)
```

ungroup *Remove grouping from a vectra query*

Description

Remove grouping from a vectra query

Usage

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

Arguments

`x`	A `vectra_node` object.
`...`	Ignored.

Value

An ungrouped `vectra_node`.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)
tbl(f) |> group_by(cyl) |> ungroup()
unlink(f)
```

`vec_build_overviews` *Build overview pyramids for a .vec raster*

Description

Appends `n_levels - 1` reduced-resolution copies of the raster to the file. Each level is computed by 2x downsampling the previous level with the chosen kernel. Reading via `vec_read_window(level = L)` picks tiles at level L; the file's `n_levels` is updated in place.

Usage

```
vec_build_overviews(
  path,
  levels,
  resampling = c("average", "nearest", "bilinear", "mode", "gauss"),
  compression = c("fast", "balanced", "max")
)
```

Arguments

`path`	Path to a `.vec` raster file. The file is modified in place.
`levels`	Total levels including level 0 (so `levels = 5` adds four overviews: levels 1..4). Must be in `[2, 16]`.
`resampling`	One of `"nearest"`, `"average"`, `"bilinear"`, `"mode"`, `"gauss"`. `"average"` is the right choice for continuous rasters; `"mode"` for categorical/land-cover.
`compression`	Compression effort for the new tiles. Defaults to `"fast"` because overview tiles are usually one-shot writes.

Details

Unlike the streamed raster verbs, this decodes every band of the base raster into memory at once to build the pyramid, so peak memory is on the order of the full base raster (all bands). Build overviews before a raster grows past what fits in RAM, or on a per-band basis for very large stacks.

Value

Invisible `NULL`.

vec_close_raster *Close a .vec raster handle*

Description

Idempotent. The handle is also auto-released by R's garbage collector.

Usage

```
vec_close_raster(r)
```

Arguments

r	A vectra_raster returned by vec_open_raster().

Value

Invisible NULL.

vec_extract_points *Extract band values at (x, y) points from a .vec raster*

Description

Extract band values at (x, y) points from a .vec raster

Usage

```
vec_extract_points(r, x, y)
```

Arguments

r	A vectra_raster from vec_open_raster().
x	Numeric vector of x coordinates in CRS units.
y	Numeric vector of y coordinates, same length as x.

Value

A data.frame with columns x, y, then one column per band (named after r$band_names if recorded, otherwise band1, band2, ...). NA marks pixels outside the raster or matching nodata.

vec_open_raster *Open a .vec raster*

Description

Lazy open: parses the header and tile index but does not decode any tiles. Returns a list with metadata and an external pointer handle. The pointer is auto-finalized when garbage collected; call `vec_close_raster()` to release earlier.

Usage

```
vec_open_raster(path)
```

Arguments

`path`	Path to a `.vec` raster file.

Value

A `vectra_raster` list with elements: `ptr`, `width`, `height`, `n_bands`, `tile_size`, `dtype`, `gt`, `epsg`, `nodata`, `band_names`.

vec_raster_layout *Tile layout of an open .vec raster*

Description

Returns `"image"` (default Phase 6 layout — one tile per `(band, time, ty, tx)`) or `"pixel"` (Phase 6b transpose layout — one tile per `(band, ty, tx)` holding the full time stack).

Usage

```
vec_raster_layout(r)
```

Arguments

`r`	A `vectra_raster`.

Value

Character(1) `"image"` or `"pixel"`.

vec_raster_times *Distinct time stamps stored in a .vec time cube*

Description

Returns the ascending vector of time stamps recorded for the given (band, level). Pixel-major files store one consolidated table; image- major files derive the list from the per-tile time field.

Usage

```
vec_raster_times(r, band = 1L, level = 0L)
```

Arguments

r	A vectra_raster.
band	1-based band index.
level	Overview level.

Value

Numeric vector of stamps (length 0 when the file has no time information).

vec_read_pixel_series *Read the full time series at a single pixel from a .vec time cube*

Description

Returns a numeric vector of length n_time — one value per time step recorded in the file, in ascending time-stamp order.

Usage

```
vec_read_pixel_series(
  r,
  x = NULL,
  y = NULL,
  col = NULL,
  row = NULL,
  band = 1L,
  level = 0L
)
```

Arguments

r	A vectra_raster from vec_open_raster().
x, y	Pixel coordinates. Either both x and y (CRS units; the geotransform is used to map to col/row) or both col and row (1-based pixel indices).
col, row	1-based pixel coordinates (alternative to x/y).
band	Band index (1-based).
level	Overview level. Default 0.

Details

For pixel-major files (written with vec_write_time_cube(layout = "pixel")) this is the optimal access pattern: a single tile decode yields all time values for the pixel. For image-major files the reader scans the index for distinct time stamps, decodes one spatial tile per stamp, and extracts the pixel from each — correct but n_time slower than the optimal layout.

Value

A numeric vector of length n_time. NA marks pixels outside the raster or matching nodata. The corresponding time stamps can be obtained from vec_raster_times(r, band, level).

---

vec_read_time_slice *Read a single time slice from a .vec time cube*

Description

Performs a linear scan of the index for tiles with time == time and decodes the matching window. The lookup is O(n_tiles) per call — Phase 6's optimized hash-map lookup is a follow-up.

Usage

```
vec_read_time_slice(r, time, band = 1L, level = 0L, cols = NULL, rows = NULL)
```

Arguments

r	A vectra_raster from vec_open_raster().
time	Time value to match (numeric/integer).
band	Band index (1-based).
level	Overview level. Default 0.
cols, rows	1-based ranges, same as vec_read_window.

Value

A numeric matrix.

vec_read_window *Read a window of pixels from a .vec raster*

Description

Decodes only the tiles overlapping the requested window. Pixels outside the raster extent come back as NA.

Usage

```
vec_read_window(r, band = 1L, level = 0L, cols = NULL, rows = NULL)
```

Arguments

r	A vectra_raster from vec_open_raster().
band	Band index (1-based). Default 1.
level	Overview level — 0 = full resolution, 1 = half, 2 = quarter, etc. Must be < r$n_levels (which is 1 unless vec_build_overviews() has been run on the file).
cols	1-based column range c(col_min, col_max). Inclusive. Coordinates are in the chosen level's pixel grid (so at level 1 the raster is half as wide). Default c(1, level_width).
rows	1-based row range c(row_min, row_max). Inclusive. Default c(1, level_height).

Value

A numeric matrix with nrow = row_max - row_min + 1 and ncol = col_max - col_min + 1. Nodata pixels become NA.

vec_to_tiff *Export a .vec raster to GeoTIFF*

Description

Writes the level-0 pixels of a .vec raster to a GeoTIFF file. The TIFF inherits dtype, geotransform, EPSG, and nodata from the source. Strip layout; the writer supports "none", "deflate", and "lzw" compression. LZW also applies horizontal differencing (Predictor 2) for integer pixel types, which dramatically improves compression on smooth raster data and matches the layout most production GIS tools produce by default. tbl_tiff() reads all three back.

Usage

```
vec_to_tiff(r, path, compression = c("deflate", "lzw", "none"))
```

Arguments

r	Either a path to a .vec raster or a vectra_raster returned by vec_open_raster(). If a handle is passed it is left open.
path	Output .tif path.
compression	One of "deflate" (default), "lzw", or "none".

Value

Invisible NULL.

---

vec_write_raster *Write a raster matrix or 3D array to a .vec raster file*

Description

Writes a row-major raster (one band) or a band-major 3D array (multi-band) to the VECR raster format. Each tile is encoded as a self-describing tdc block (PRED_2D + BYTE_SHUFFLE + LZ).

Usage

```
vec_write_raster(
  x,
  path,
  dtype = "f32",
  tile_size = 512L,
  extent = NULL,
  gt = NULL,
  epsg = 0L,
  nodata = NA_real_,
  band_names = NULL,
  compression = c("fast", "balanced", "max")
)
```

Arguments

x	A numeric matrix c(rows, cols) for a single band, or a numeric 3D array c(rows, cols, bands) for multi-band.
path	Output file path.
dtype	Storage dtype, one of "f64", "f32", "i8", "u8", "i16", "u16", "i32", "u32", "i64", "u64". Defaults to "f32" for floating-point input — "f64" doubles file size with no information gain for typical climate rasters.
tile_size	Square tile edge in pixels. Default 512.
extent	Numeric vector c(xmin, ymin, xmax, ymax). Used together with the raster dimensions to derive the geotransform. Either extent or gt must be supplied for georeferenced output.

gt	Numeric(6) GDAL-style geotransform. Overrides extent if both are given.
epsg	EPSG code (integer) or 0L for none.
nodata	Nodata value, or NA_real_ to skip recording one.
band_names	Optional character vector of length equal to the number of bands.
compression	Compression effort, one of "fast" (single spec, fast encode), "balanced" (probe two entropy coders, ~2x encode time), or "max" (probe six candidate specs per tile, slowest encode but smallest file). Decode cost is unchanged across levels because each tile records its own codec spec. Default "fast".

Value

Invisible NULL.

---

vec_write_time_cube *Write a 4D time-cube raster to .vec*

Description

Each (band, time) combination becomes a stack of tiles tagged with the chosen time stamp. Stamps are stored as int64 in the per-tile index entry; a value of 0 is reserved for "untimed" so this writer remaps any caller-supplied 0 to 1 internally.

Usage

```
vec_write_time_cube(
  x,
  times,
  path,
  dtype = "f32",
  tile_size = 512L,
  layout = c("image", "pixel"),
  extent = NULL,
  gt = NULL,
  epsg = 0L,
  nodata = NA_real_,
  band_names = NULL,
  compression = c("fast", "balanced", "max")
)
```

Arguments

x	Numeric 4D array c(rows, cols, bands, time).
times	Numeric/integer vector with length(times) == dim(x)[4], in the unit of your choice (epoch ms, year, step index).
path	Output .vec path.

dtype	Storage dtype (see vec_write_raster).
tile_size	Tile edge in pixels.
layout	Tile layout — one of "image" (default; one tile per (band, time, ty, tx), optimal for "give me one full image at time T" reads) or "pixel" (Phase 6b; one tile per (band, ty, tx) holding the full time stack as [tw*th, n_time], optimal for "give me the time series at pixel (x, y)" reads).
extent, gt, epsg, nodata, band_names, compression	Same semantics as vec_write_raster().

Value

Invisible NULL.

---

vectra_mem *Resolve the vectra memory budget*

Description

The single memory ceiling every buffering subsystem derives its working budget from: the external sort's spill threshold, the self-overlay tile cap, spatial run-file flushes, partition routing, and the spilling hash join.

Usage

```
vectra_mem(limit = NULL)
```

Arguments

limit	Optional per-call override: a byte count or a string such as "8GB". NULL (the default) falls back to the option, then to auto-detection.

Details

The budget bounds a whole query, not each step of it. When a query holds several buffering steps at once (a join feeding a grouped summarise(), an arrange() over a join), they draw on one shared pool of this size. A step reserves what it actually allocates as it grows (buffered rows at their allocated capacity, the permutation and scratch a sort needs, the hash table a join builds) and spills when the pool refuses. A step that needs little leaves the rest to the others; each step is always guaranteed 1 / (4 * steps) of the budget, so none is starved. The process peak is then about the budget plus a fixed allowance for R itself, the batches in flight and the collected result.

Resolution order is an explicit limit, then getOption("vectra.memory"), then a default of half the detected system RAM. The auto-detected default is floored at 1 GB; an explicit limit or option is honored as given (down to 1 KB), so a smaller budget can be requested deliberately.

Set the session budget with options(vectra.memory = "8GB") (a string with a K/M/G/T suffix) or options(vectra.memory = 8e9) (a byte count). Row-group size (batch_size) is a separate cache-locality knob and is not affected.

Value

The budget in bytes, as a numeric scalar: at least 1 GB when auto-detected, and as given (down to 1 KB) when set explicitly.

Examples

```
vectra_mem()
vectra_mem("4GB")
```

`vtr_schema` *Create a star schema over linked vectra tables*

Description

Registers a fact table with named dimension links. The schema enables `lookup()` to resolve columns from dimension tables without writing explicit joins.

Usage

```
vtr_schema(fact, ...)
```

Arguments

`fact`	A `vectra_node` object (the central fact table). Must be file-backed (created via `tbl()`, `tbl_csv()`, or `tbl_sqlite()`).
`...`	Named `vectra_link` objects created by `link()`. Names become the dimension aliases used in `lookup()` (e.g., `species$name`).

Value

A `vectra_schema` object.

Examples

```
f_obs <- tempfile(fileext = ".vtr")
f_sp  <- tempfile(fileext = ".vtr")
f_ct  <- tempfile(fileext = ".vtr")
write_vtr(data.frame(sp_id = 1:3, ct_code = c("AT", "DE", "FR"),
                     value = 10:12), f_obs)
write_vtr(data.frame(sp_id = 1:3,
                     name = c("Oak", "Beech", "Pine")), f_sp)
write_vtr(data.frame(ct_code = c("AT", "DE", "FR"),
                     gdp = c(400, 3800, 2700)), f_ct)

s <- vtr_schema(
  fact    = tbl(f_obs),
  species = link("sp_id", tbl(f_sp)),
  country = link("ct_code", tbl(f_ct))
```

```
)
print(s)
unlink(c(f_obs, f_sp, f_ct))
```

`warp` *Resample or reproject a streamed raster onto a target grid*

Description

Warps a `.vec` raster onto a target grid, walking the *output* one tile-row strip at a time. For each strip the target pixel-centre coordinates are built, projected into the source coordinate reference system when the two CRSs differ (delegated to PROJ via **sf**), mapped through the source geotransform to fractional source pixels, and sampled from the bounded source window those coordinates fall in. The output is assembled in memory or streamed straight back to a new `.vec`, so the whole output grid is never resident; the source is read in bounded windows rather than held whole.

Usage

```
warp(
  x,
  template,
  method = c("near", "bilinear", "cubic"),
  band = 1L,
  path = NULL,
  dtype = "f32",
  compression = c("fast", "balanced", "max")
)
```

Arguments

`x`	A `vectra_raster` (from `vec_open_raster()`) or a path to a `.vec` raster to warp.
`template`	The target grid: a `vectra_raster` / `.vec` path whose grid and CRS are borrowed, or a list `list(crs =, extent =, res =, dims =)`. With `crs` and `res` but no `extent`, the target extent is the source's corners projected into `crs`.
`method`	Resampling method: `"near"`, `"bilinear"`, or `"cubic"`. Default `"near"`.
`band`	Band to warp (1-based). Default 1.
`path`	Optional output `.vec` path. When given the result is streamed to disk and the opened `vec_open_raster()` handle is returned invisibly; when `NULL` the result is returned as an in-memory matrix.
`dtype`	Storage dtype for `.vec` output (see `vec_write_raster()`). Default `"f32"`.
`compression`	Compression effort for `.vec` output. Default `"fast"`.

Details

This is the *sort / partition* tier of the spatial toolbox: each output strip reads the source window it projects onto. For a mild reprojection or a plain resample that window is a thin band; a strong reprojection can make it large, but the output stays streamed throughout.

Sampling follows the GDAL / **terra** convention (pixel centres at half-integer coordinates). `"near"` takes the nearest source cell; `"bilinear"` the 2x2 weighted mean; `"cubic"` the 4x4 cubic convolution (Catmull-Rom, a = -0.5). A target cell whose sampling kernel reaches outside the source extent, or touches a nodata cell, comes back `NA`.

Reprojection happens only when both rasters carry a known EPSG code and the codes differ; otherwise `warp()` resamples within a shared CRS and needs no **sf**.

Value

When `path` is `NULL`, a numeric matrix on the target grid (row 1 northmost) carrying `gt`, `extent`, and `crs` attributes. When `path` is given, the written `vectra_raster` handle (invisibly).

See Also

`rasterize()` to build a raster from streamed vector features, `focal()` for moving-window statistics.

Examples

```
z <- outer(1:8, 1:8, function(r, c) r + 2 * c)
f <- tempfile(fileext = ".vec")
vec_write_raster(z, f, dtype = "f64", extent = c(0, 0, 8, 8))

# Resample onto a finer grid over the same extent.
fine <- warp(f, list(extent = c(0, 0, 8, 8), res = 0.5), method = "bilinear")
dim(fine)
unlink(f)
```

---

write_csv *Write query results or a data.frame to a CSV file*

Description

For `vectra_node` inputs, data is streamed batch-by-batch to disk without materializing the full result in memory. For `data.frame` inputs, the data is written directly.

Usage

```
write_csv(x, path, ...)
```

Arguments

x	A vectra_node (lazy query) or a data.frame.
path	File path for the output CSV file.
...	Reserved for future use.

Value

Invisible NULL.

Examples

```
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars[1:5, ], f)
csv <- tempfile(fileext = ".csv")
tbl(f) |> write_csv(csv)
unlink(c(f, csv))
```

---

write_sqlite *Write query results or a data.frame to a SQLite table*

Description

For vectra_node inputs, data is streamed batch-by-batch to disk without materializing the full result in memory. For data.frame inputs, the data is written directly.

Usage

```
write_sqlite(x, path, table, ...)
```

Arguments

x	A vectra_node (lazy query) or a data.frame.
path	File path for the SQLite database.
table	Name of the table to create/write into.
...	Reserved for future use.

Value

Invisible NULL.

Examples

```
db <- tempfile(fileext = ".sqlite")
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars[1:5, ], f)
tbl(f) |> write_sqlite(db, "cars")
unlink(c(f, db))
```

write_tiff *Write query results to a GeoTIFF file*

Description

The data must contain x and y columns (pixel center coordinates) and one or more numeric band columns. Grid dimensions and geotransform are inferred from the x/y coordinate arrays. Missing pixels are written as NaN (or the type-appropriate nodata value for integer pixel types).

Usage

```
write_tiff(
  x,
  path,
  compress = FALSE,
  pixel_type = "float64",
  metadata = NULL,
  crs = NULL,
  tiled = FALSE,
  tile_size = 256L,
  bigtiff = "auto",
  ...
)
```

Arguments

x	A vectra_node (lazy query) or a data.frame.
path	File path for the output GeoTIFF file.
compress	Logical; use DEFLATE compression? Default FALSE.
pixel_type	Character string specifying the output pixel type. One of "float64" (default), "float32", "int16", "int32", "uint8", or "uint16".
metadata	Optional character string of GDAL_METADATA XML to embed in the file (tag 42112). Use tiff_metadata() to read it back.
crs	Optional CRS to embed as a GeoKey directory (TIFF tag 34735). Accepts an integer EPSG code, an "EPSG:xxxx" string, or a list with named fields epsg, geographic (TRUE/FALSE), and optionally citation. Codes that are not auto-classified as projected/geographic default to projected; pass geographic = TRUE to override. Use tiff_crs() to read it back.
tiled	Logical; write a tiled GeoTIFF (TIFF tags 322/323/324/325) instead of strips. Default FALSE. Tiled layout enables random-access block reads and is required for Cloud-Optimized GeoTIFF (COG).
tile_size	Integer; tile edge length in pixels. Must be a positive multiple of 16 (TIFF spec). Either a single value (square tiles) or a length-2 vector c(width, height). Default 256. Edge tiles at the right and bottom of the image are padded to full tile size with the NoData / NaN value.

bigtiff — Controls BigTIFF dispatch. "auto" (default) emits BigTIFF when the expected raw payload would exceed the classic-TIFF 4 GB ceiling, otherwise emits classic TIFF. TRUE forces BigTIFF (magic 0x002B, 64-bit offsets), useful for round-trip tests on small data. FALSE forces classic TIFF — beware that classic TIFF will silently corrupt outputs larger than 4 GB. Tiled BigTIFF is not yet supported.

... — Reserved for future use.

Value

Invisible NULL.

Examples

```
# Write as int16 with DEFLATE compression and an EPSG:4326 GeoKey
df <- data.frame(x = 1:4, y = rep(1:2, each = 2), band1 = c(100, 200, 300, 400))
f <- tempfile(fileext = ".tif")
write_tiff(df, f, compress = TRUE, pixel_type = "int16", crs = 4326L)
tiff_crs(f)
unlink(f)
```

---

write_vtr *Write data to a .vtr file*

Description

For vectra_node inputs (lazy queries from any format: CSV, SQLite, TIFF, or another .vtr), data is streamed batch-by-batch to disk without materializing the full result in memory. Each batch becomes one row group. The output file is written atomically (via temp file + rename) so readers never see a partial file.

Usage

```
write_vtr(
  x,
  path,
  compress = c("fast", "small", "none"),
  batch_size = NULL,
  col_types = NULL,
  quantize = NULL,
  spatial = NULL,
  ...
)
```

Arguments

x	A vectra_node (lazy query) or a data.frame.
path	File path for the output .vtr file.
compress	Compression level: "fast" (default, byte-shuffle + greedy LZ), "small" (per-block adaptive — tries greedy LZ, separated-streams LZ, and LZ + Huffman entropy coding, and writes whichever shrank the block the most; never worse than "fast" on any block, typically 10-25 percent smaller files at the cost of slower encode), or "none".
batch_size	Target number of rows per row group in the output file. Defaults to 131072 for data.frames (1 MB per double column, cache-friendly for decompression). For nodes, defaults to NULL (one row group per upstream batch).
col_types	Optional named character vector specifying narrow integer storage types. Names must match column names; values must be "int8", "int16", or "int32". Only applies to integer columns. Example: col_types = c(age = "int8", year = "int16").
quantize	Optional named list for lossy quantization of double columns. Each element is named after a column and is itself a named list with scale (or precision = 1/scale), type ("int8", "int16", "int32"; default "int16"), and optionally offset (default 0). Example: quantize = list(temp = list(precision = 0.001, type = "int16")).
spatial	Optional list for 2D spatial predictor encoding. Either a global spec applied to all numeric columns (list(nx = 2000, ny = 2000)) or per-column specs (list(temp = list(nx = 2000, ny = 2000))). When provided, a spatial predictor removes smooth 2D trends before compression, dramatically improving compression of raster data. Combines with quantize for maximum effect.
...	Additional arguments passed to methods.

Details

For data.frame inputs, the data is written directly from memory.

Writing over an existing .vtr replaces it, and removes the .vtri indexes built on the store it replaces (see create_index()).

Value

Invisible NULL.

Examples

```
# From a data.frame
f <- tempfile(fileext = ".vtr")
write_vtr(mtcars, f)

# Streaming format conversion (CSV -> VTR)
csv <- tempfile(fileext = ".csv")
write.csv(mtcars, csv, row.names = FALSE)
f2 <- tempfile(fileext = ".vtr")
```

```
tbl_csv(csv) |> write_vtr(f2)

unlink(c(f, f2, csv))
```

`zonal` *Summarise raster values within zones*

Description

Reduces a raster to one summary row per zone, streaming the raster one tile-row strip at a time so the whole grid never has to be resident. Zones come either from a second raster aligned to the value grid (each pixel's zone is that raster's value, the `terra::zonal` pattern) or from an **sf** polygon layer (each pixel is assigned the polygon its centre falls in). The per-zone running moments (count, sum, sum of squares, min, max) are folded in memory as strips arrive, so peak memory is one strip plus the small per-zone table regardless of raster size. This is the *monoid fold* tier of the spatial toolbox: bounded memory, a single streaming pass, no spill.

Usage

```
zonal(
  raster,
  zones,
  fun = "mean",
  band = 1L,
  zone_band = 1L,
  zone_field = NULL,
  na.rm = TRUE
)
```

Arguments

`raster`	A `vectra_raster` (from `vec_open_raster()`) or a path to a `.vec` raster holding the values to summarise.
`zones`	The zones to summarise within: a `vectra_raster` / `.vec` path aligned to `raster` (zone id per pixel), or an `sf`/`sfc` polygon layer.
`fun`	One or more of `"mean"`, `"sum"`, `"count"`, `"min"`, `"max"`, `"sd"`. Each becomes a column in the result. Default `"mean"`.
`band`	Band of the value `raster` to summarise (1-based). Default 1.
`zone_band`	Band of a raster `zones` holding the zone ids. Default 1.
`zone_field`	For an `sf` `zones` layer, the column giving each polygon's zone id. Default `NULL` uses the polygon row index `1:n`.
`na.rm`	If `TRUE` (default) skip nodata pixels; if `FALSE` let a nodata pixel propagate `NA` to its zone's statistics.

Details

`sd` is derived from the streamed moments (`sqrt((sum2 - sum^2 / n) / (n - 1))`), so it needs no second pass. With `na.rm = TRUE` (the default) nodata pixels are skipped; with `na.rm = FALSE` any nodata pixel in a zone makes that zone's `sum`/`mean`/`min`/`max`/`sd` `NA`, matching the resident behaviour. `count` always reports the number of non-nodata cells in the zone.

Polygon zones assign each pixel centre to a polygon natively on the GEOS C API (the polygons parsed once into a spatial index, every strip's centres located in C), so **sf** is touched only to read the polygons in; geographic polygons with spherical geometry on (`sf::sf_use_s2()`) keep the **sf** point-in-polygon path. Raster zones are fully **sf**-free. The zone raster must share the value raster's dimensions and geotransform.

Value

A data.frame with a `zone` column (sorted) followed by one column per `fun`, one row per zone.

See Also

`rasterize()` to build a value raster from streamed points, `vec_open_raster()` to open the inputs.

Examples

```
# A value raster and an aligned 2x2-block zone raster on a 4x4 grid.
vals <- matrix(1:16, 4, 4, byrow = TRUE)
zone <- matrix(c(1, 1, 2, 2, 1, 1, 2, 2,
                 3, 3, 4, 4, 3, 3, 4, 4), 4, 4, byrow = TRUE)
fv <- tempfile(fileext = ".vec"); fz <- tempfile(fileext = ".vec")
vec_write_raster(vals, fv, dtype = "f64", extent = c(0, 0, 4, 4))
vec_write_raster(zone, fz, dtype = "f64", extent = c(0, 0, 4, 4))

zonal(fv, fz, fun = c("mean", "sum", "count"))
unlink(c(fv, fz))
```

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