

Package ‘MultiAssaySpatialExperiment’

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Description Extends MultiAssayExperiment with spatial context elements (images, labels, points, shapes) for integrative analysis of spatially resolved multi-omics data. Supports coercion to and from SpatialExperiment and SpatialFeatureExperiment.

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URL <https://github.com/Genentech/MultiAssaySpatialExperiment>

BugReports <https://github.com/Genentech/MultiAssaySpatialExperiment/issues>

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'MultiAssaySpatialExperiment-SpatialFeatureExperiment.R'
'MultiAssaySpatialExperiment-combine.R'
'MultiAssaySpatialExperiment-spatialMap.R'
'MultiAssaySpatialExperiment-helpers.R'
'MultiAssaySpatialExperiment-package.R'
'MultiAssaySpatialExperiment-read-components.R'
'MultiAssaySpatialExperiment-read-config.R'
'MultiAssaySpatialExperiment-read-cosmx.R'
'MultiAssaySpatialExperiment-read-generics.R'
'MultiAssaySpatialExperiment-read-helpers.R'
'MultiAssaySpatialExperiment-read-merscope.R'
'MultiAssaySpatialExperiment-read-visium.R'

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Author Patrick Aboyoun [aut, cre],
 Genentech, Inc. [cph]

Maintainer Patrick Aboyoun <aboyounp@gene.com>

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MultiAssaySpatialExperiment-package

MultiAssaySpatialExperiment: Multi-Assay Experiment with Spatial Context

Description

Extends MultiAssayExperiment with spatial context elements (images, labels, points, shapes) for integrative analysis of spatially resolved multi-omics data. Supports coercion to and from SpatialExperiment and SpatialFeatureExperiment.

Author(s)

Maintainer: Patrick Aboyoun <aboyounp@gene.com>

Authors:

- Patrick Aboyoun <aboyounp@gene.com>

Other contributors:

- Genentech, Inc. [copyright holder]

See Also

Useful links:

- <https://github.com/Genentech/MultiAssaySpatialExperiment>
- Report bugs at <https://github.com/Genentech/MultiAssaySpatialExperiment/issues>

aggregateByRegion

Aggregate assay values by shape region

Description

Aggregate assay values (e.g., counts, expression) by shape region. Each assay column is linked to a point via spatialMap; the annotation column (from [annotateWithRegions](#)) links points to shapes. Values are aggregated within each shape.

Usage

```
aggregateByRegion(x, by, assays = NULL, FUN = "sum")
```

Arguments

x	A MultiAssaySpatialExperiment .
by	Character. Name of the region column in spatialMap that holds the shape instance IDs (the regionCol from annotateWithRegions , default is the shapes layer name).
assays	Character. Assay names to aggregate (default: all assays in spatialMap).
FUN	Character or function. For character values, one of "sum", "mean", or "count". For "count", returns the number of points per shape; for "sum" and "mean", aggregates assay values. When a function, it is applied to each feature-by-observation submatrix (features as rows, observations in the same shape as columns) and must return a numeric vector of length nrow(submatrix).

Details

Run [annotateWithRegions](#) first to add the by column to spatialMap. Rows with NA in by are dropped.

For "sum" and "mean", the assay matrix (features x columns) is grouped by shape: columns that map to the same shape are aggregated. The result is a list of matrices (one per assay), each with features as rows and shape instance IDs as columns.

Value

A list of matrices (or for FUN = "count" a single DataFrame with columns by and count), one element per assay. Each matrix has features (rows) and shape instance IDs (columns).

Polymorphism

Uses S3/S4 generics only. Table-like elements (spatialMap, experiments) use nrow, colnames, rownames, [[, [, unique, and split. Assay data use [assay](#) for SummarizedExperiment-like objects; plain matrices are passed through. Layer lists use names. Consistent with [annotateWithRegions](#) and [subsetByPolygon](#); see vignette *Working with MultiAssaySpatialExperiment*.

Author(s)

Patrick Aboyoun

Examples

```
pts <- S4Vectors::DataFrame(
  x = c(1.5, 2.5, 3.5),
  y = c(1.5, 2.5, 3.5),
  instance_id = c("A", "B", "C"))
shp_df <- S4Vectors::DataFrame(
  instance_id = c("cell1", "cell2", "cell3"),
  geometry = sf::st_sfc(
    sf::st_polygon(list(matrix(c(1,1,2,1,2,2,1,2,1,1), ncol=2, byrow=TRUE))),
    sf::st_polygon(list(matrix(c(2,1,3,1,3,2,2,2,2,1), ncol=2, byrow=TRUE))),
    sf::st_polygon(list(matrix(c(2,2,3,2,3,3,2,3,2,2), ncol=2, byrow=TRUE)))))
mase <- MultiAssaySpatialExperiment(
  experiments = ExperimentList(assay1 = matrix(1:9, 3, 3,
    dimnames = list(paste0("G", 1:3), c("A", "B", "C")))),
  colData = S4Vectors::DataFrame(row.names = "s1"),
  sampleMap = S4Vectors::DataFrame(
```

```

    assay = "assay1", primary = "s1", colname = c("A", "B", "C")),
  points = PointsLayerList(centroids = pts),
  shapes = ShapesLayerList(cells = shp_df),
  spatialMap = S4Vectors::DataFrame(
    assay = "assay1", colname = c("A", "B", "C"),
    element_type = "points", region = "centroids", instance_id = c("A", "B", "C")))
mase <- annotateWithRegions(mase, points = "centroids", shapes = "cells")
agg <- aggregateByRegion(mase, by = "cells", FUN = "sum")
agg[["assay1"]]

```

annotateWithRegions *Annotate points with shape regions*

Description

Perform a spatial join between a points layer and a shapes layer. For each point, the matched shape's `instance_id` is recorded. This annotation is added to `spatialMap` and enables [aggregateByRegion](#).

Usage

```

annotateWithRegions(
  x,
  points,
  shapes,
  spatialCoordsNames = c("x", "y"),
  regionCol = NULL,
  join = st_intersects
)

```

Arguments

<code>x</code>	A MultiAssaySpatialExperiment .
<code>points</code>	Character. Name of the points layer (in <code>spatialPoints(x)</code>).
<code>shapes</code>	Character. Name of the shapes layer (in <code>spatialShapes(x)</code>).
<code>spatialCoordsNames</code>	Character vector. Names of the x and y coordinate columns in the points layer (default <code>c("x", "y")</code>).
<code>regionCol</code>	Character or NULL. Name of the column to add to <code>spatialMap</code> with the shape instance IDs. Default is the shapes name.
<code>join</code>	Function. Spatial join to use, matching st_join . Default st_intersects (point-in-polygon). Use st_nearest_feature to assign each point to the nearest shape when no shape contains it.

Details

For each row in the points layer, `join` determines which shape (if any) matches. The shape's `instance_id` is written to a new column in `spatialMap`. Only `spatialMap` rows that reference the given points layer are updated; other rows get NA for the new column.

With `join = st_intersects` (default), points not falling within any shape receive NA. With `join = st_nearest_feature`, every point is assigned to its nearest shape. The user is responsible for ensuring `instance_id` types match between points and shapes (no coercion).

Value

x with spatialMap updated to include the new annotation column. If spatialMap is NULL or the required layers are missing, x is returned unchanged.

Polymorphism

Uses S3/S4 generics only. Table-like elements (spatialMap, points, shapes) use nrow, colnames, [[, and [. Spatial operations use the supplied join function and [st_as_sfc](#). Layer lists use names. Consistent with [subsetByPolygon](#); see vignette *Working with MultiAssaySpatialExperiment*.

Author(s)

Patrick Aboyoun

Examples

```
pts <- S4Vectors::DataFrame(
  x = c(1.5, 2.5, 3.5),
  y = c(1.5, 2.5, 3.5),
  instance_id = c("A", "B", "C"))
shp_df <- S4Vectors::DataFrame(
  instance_id = c("cell1", "cell2", "cell3"),
  geometry = sf::st_sfc(
    sf::st_polygon(list(matrix(c(1,1,2,1,2,2,1,2,1,1), ncol=2, byrow=TRUE))),
    sf::st_polygon(list(matrix(c(2,1,3,1,3,2,2,2,2,1), ncol=2, byrow=TRUE))),
    sf::st_polygon(list(matrix(c(2,2,3,2,3,3,2,3,2,2), ncol=2, byrow=TRUE)))))
mase <- MultiAssaySpatialExperiment(
  experiments = ExperimentList(assay1 = matrix(1:9, 3, 3,
    dimnames = list(NULL, c("A", "B", "C")))),
  colData = S4Vectors::DataFrame(row.names = "s1"),
  sampleMap = S4Vectors::DataFrame(
    assay = "assay1", primary = "s1", colname = c("A", "B", "C")),
  points = PointsLayerList(centroids = pts),
  shapes = ShapesLayerList(cells = shp_df),
  spatialMap = S4Vectors::DataFrame(
    assay = "assay1", colname = c("A", "B", "C"),
    element_type = "points", region = "centroids", instance_id = c("A", "B", "C")))
mase <- annotateWithRegions(mase, points = "centroids", shapes = "cells")
spatialMap(mase)
```

buildSpatialMap

Build a spatialMap table from sampleMap

Description

Assemble a spatialMap [DataFrame](#) linking assay observations to spatial layer instances, analogous to [listToMap](#) for sampleMap.

Usage

```
buildSpatialMap(
  sampleMap,
  region,
  element_type = c("points", "shapes"),
  assays = NULL,
  instance_from = "colname"
)
```

Arguments

sampleMap	A DataFrame with MAE columns assay, primary, and colname.
region	Character. Name of the points or shapes layer (must match a name in spatialPoints or spatialShapes when the object is constructed).
element_type	Character. "points" or "shapes".
assays	Optional character vector limiting which assays from sampleMap are included.
instance_from	Character. Column of sampleMap used for instance_id values (default "colname", i.e. observation id equals spatial instance id).

Value

A [DataFrame](#) with columns assay, colname, element_type, region, and instance_id.

See Also

[prepMASE](#), [listToMap](#)

Examples

```
sm <- S4Vectors::DataFrame(
  assay = factor(rep("rna", 3), "rna"),
  primary = c("S1", "S1", "S2"),
  colname = paste0("spot", 1:3))
buildSpatialMap(sm, region = "tissue1", element_type = "points")
```

checkSpatialMap	<i>Check spatialMap consistency</i>
-----------------	-------------------------------------

Description

Run spatialMap diagnostics without constructing a [MultiAssaySpatialExperiment](#). Returns a character vector of problems (empty if valid).

Usage

```
checkSpatialMap(
  spatialMap,
  sampleMap,
  points = PointsLayerList(),
  shapes = ShapesLayerList()
)
```

Arguments

spatialMap	A spatialMap DataFrame or NULL.
sampleMap	A MAE sampleMap DataFrame .
points	A PointsLayerList or named list of point layers.
shapes	A ShapesLayerList or named list of shape layers.

Value

Character vector of error messages (length zero if no problems).

Examples

```
sm <- S4Vectors::DataFrame(
  assay = factor("rna", "rna"),
  primary = "S1",
  colname = "spot1")
spmap <- buildSpatialMap(sm, "coords", "points")
spmap[["instance_id"]] <- "missing"
checkSpatialMap(spmap, sm, points = PointsLayerList(
  coords = S4Vectors::DataFrame(
    x = 1, y = 1, instance_id = "spot1")))
```

labelsToShapes	<i>Convert label rasters to polygon shapes</i>
----------------	--

Description

Dissolve contiguous cells with the same label value into polygons. Thin wrapper around [terra::as.polygons](#) for segmentation masks stored in [spatialLabels\(\)](#) or vendor TIFFs.

Usage

```
labelsToShapes(x, dissolve = TRUE, ...)
```

Arguments

x	A SpatRaster , 2-D matrix/array, or a single element from a RasterLayerList .
dissolve	Logical; dissolve adjacent cells with the same value (default TRUE).
...	Additional arguments passed to terra::as.polygons .

Value

An [sf](#) object with dissolved label polygons.

See Also

[shapesToLabels](#), [spatialLabels](#)

Examples

```
if (requireNamespace("terra", quietly = TRUE)) {
  mat <- matrix(c(1L, 1L, 2L, 2L), 2, 2)
  labelsToShapes(mat)
}
```

MultiAssaySpatialExperiment-class

MultiAssaySpatialExperiment objects

Description

The MultiAssaySpatialExperiment class extends [MultiAssayExperiment](#) with spatial context: raster data (images, labels), points, and shapes.

Details

MultiAssaySpatialExperiment provides slots for spatial layers that complement the ExperimentList. The sampleMap links experiment columns to primary identifiers; the optional spatialMap provides instance-level mapping (assay, colname, element_type, region, instance_id) linking experiment columns to rows in the spatial point or shape layers via explicit foreign key.

Terminology: a *specimen* is a row in colData (sampleMap\$primary); an *observation* is a column in an assay (sampleMap\$colname).

Value

The MultiAssaySpatialExperiment() constructor returns a [MultiAssaySpatialExperiment](#). The layer accessors return the corresponding container: spatialImages() / spatialLabels() a [RasterLayerList](#), spatialPoints() a [PointsLayerList](#), and spatialShapes() a [ShapesLayerList](#); the single-layer accessors (spatialImage(), spatialPoint(), and so on) return one layer, and the *Names() accessors a character vector. imgData() and spatialMap() return a DataFrame or NULL. Replacement methods (the <- forms) return the updated object, and show() returns NULL invisibly.

Slots

ExperimentList, colData, sampleMap, drops Inherited from [MultiAssayExperiment](#).

images A [RasterLayerList](#) of user-attached image rasters (not the same as imgData, which stores specimen-level image metadata from vendor readers).

labels A [RasterLayerList](#) of label/mask layers.

points A [PointsLayerList](#) of point layers.

shapes A [ShapesLayerList](#) of shape layers.

imgData Optional DataFrame linking specimens to images (same structure as SpatialExperiment, including sample_id, image_id, and scaleFactor). Populated by vendor readers; distinct from spatialImages() raster layers.

spatialMap Optional DataFrame for instance-level mapping with required columns:

assay Experiment name (factor; must be in names(experiments))

colname Column identifier within that experiment

element_type Spatial slot discriminator; one of "points" or "shapes"
 region Layer name within that element type (e.g., "cells", "nuclei")
 instance_id Row identifier in that layer (character or integer; no NAs)

The element_type column disambiguates spatial layers with the same name in different slots (e.g., points\$cells vs. shapes\$cells). This explicit routing eliminates ambiguity and enables robust foreign key validation.

Terminology and spatialdata alignment

MASE adopts terminology from Python spatialdata where practical while following Bioconductor S4 conventions:

- **element_type**: Matches spatialdata's element type discriminator (values: "points", "shapes", "images", "labels"). Currently only "points" and "shapes" are supported in spatialMap linkage; images and labels are reference layers accessed via spatialImages() and spatialLabels().
- **region**: Corresponds to spatialdata's region (layer name within an element type).
- **instance_id**: Matches spatialdata's instance identifier (row ID within a region). Recommended types: integer, character, or factor. Must be unique within each (element_type, region) combination.
- **Class naming**: MASE uses "Layer" suffix (PointsLayerList, ShapesLayerList) rather than "Element" to avoid R naming collisions. See ?SpatialLayerList for details.
- **Accessor naming**: MASE uses spatialPoints(), spatialShapes() (with "spatial" prefix) as S4 generics, while spatialdata uses bare attribute access (sdata.points, sdata.shapes). This follows Bioconductor conventions and avoids conflicts with base R functions.

Constructor

MultiAssaySpatialExperiment(experiments = ExperimentList(), colData = DataFrame(), sampleMap = DataFrame())
 Creates a MultiAssaySpatialExperiment object.

experiments An [ExperimentList](#) or list of experiments.

colData A [DataFrame](#) of specimen-level metadata (one row per primary identifier in sampleMap\$primary).

sampleMap A [DataFrame](#) with columns assay, primary, colname.

metadata, drops Additional [MultiAssayExperiment](#) arguments.

images, labels [RasterLayerList](#) of user-attached raster layers (distinct from imgData, which vendor readers use for image metadata).

points, shapes [PointsLayerList](#) and [ShapesLayerList](#) of spatial layers.

imgData Optional [DataFrame](#) linking specimens to images (populated by vendor readers; use getImg() for SPE-compatible access).

spatialMap Optional [DataFrame](#) for instance-level mapping.

Accessors

In the code snippets below, x is a MultiAssaySpatialExperiment object:

spatialImages(x), spatialImages(x) <- value: Get or set the full [RasterLayerList](#) of image layers.

spatialLabels(x), spatialLabels(x) <- value: Get or set the full [RasterLayerList](#) of label layers.

spatialPoints(x), spatialPoints(x) <- value: Get or set the full [PointsLayerList](#) of point layers.

`spatialShapes(x)`, `spatialShapes(x) <- value`: Get or set the full [ShapesLayerList](#) of shape layers.
`spatialImage(x, i)`, `spatialImage(x, i) <- value`: Get or set a single image layer by index `i` (character or integer).
`spatialLabel(x, i)`, `spatialLabel(x, i) <- value`: Get or set a single label layer by index `i`.
`spatialPoint(x, i)`, `spatialPoint(x, i) <- value`: Get or set a single point layer by index `i`.
`spatialShape(x, i)`, `spatialShape(x, i) <- value`: Get or set a single shape layer by index `i`.
`spatialImageNames(x)`, `spatialLabelNames(x)`, `spatialPointNames(x)`, `spatialShapeNames(x)`:
 Get the names of the image, label, point, and shape layers, respectively.
`imgData(x)`, `imgData(x) <- value`: Get or set the optional `DataFrame` linking specimens to images (SpatialExperiment-compatible columns such as `sample_id`, `image_id`, and `scaleFactor`).
`spatialMap(x)`, `spatialMap(x) <- value`: Get or set the optional `DataFrame` for instance-level mapping.

Displaying

The `show()` method prints the inherited `MultiAssayExperiment` summary followed by counts of spatial images, labels, points, shapes, and whether `imgData` and `spatialMap` are present.

Author(s)

Patrick Aboyoun

See Also

- [MultiAssaySpatialExperiment-subset](#) for subsetting methods
- [MultiAssaySpatialExperiment-combine](#) for combining methods
- [RasterLayerList](#), [PointsLayerList](#), [ShapesLayerList](#) for spatial layer containers

Examples

```

mat <- matrix(rnorm(20), 5, 4,
  dimnames = list(paste0("G", 1:5), paste0("obs", 1:4)))
pts <- S4Vectors::DataFrame(
  x = 1:4, y = 1:4, instance_id = paste0("obs", 1:4))
mase <- MultiAssaySpatialExperiment(
  experiments = ExperimentList(rna = mat),
  colData = S4Vectors::DataFrame(
    tissue = c("core", "margin"),
    row.names = c("specimen_A", "specimen_B")),
  sampleMap = S4Vectors::DataFrame(
    assay = factor(rep("rna", 4), "rna"),
    primary = rep(c("specimen_A", "specimen_B"), each = 2),
    colname = paste0("obs", 1:4)),
  points = PointsLayerList(coords = pts),
  spatialMap = S4Vectors::DataFrame(
    assay = factor(rep("rna", 4), "rna"),
    colname = paste0("obs", 1:4),
    element_type = "points",
    region = "coords",
    instance_id = paste0("obs", 1:4))
)

```

```
mase
spatialPointNames(mase)
mase[, "specimen_A"]
```

MultiAssaySpatialExperiment-combine

MultiAssaySpatialExperiment combining

Description

Methods for combining [MultiAssaySpatialExperiment](#) objects. `c` merges two MASE objects (adding assays); `cbind` combines along columns (adding specimens); `complete.cases` identifies specimens with data in all assays.

Value

`c()` and `cbind()` return a combined [MultiAssaySpatialExperiment](#); `complete.cases()` returns a logical vector flagging specimens (primaries) present in all assays.

Combining

`c(x, ..., sampleMap = NULL, mapFrom = NULL)`: When ... is a single [MultiAssaySpatialExperiment](#), merges the two objects (experiments, colData, sampleMap, spatial layers, imgData, spatialMap). Experiment and spatial layer names must be unique across objects. Otherwise delegates to [c, MultiAssayExperiment-method](#).

`cbind(..., deparse.level = 1)`: Combines MASE objects column-wise (same assay names, adds specimens). Spatial layers with the same name are row-bound; imgData and spatialMap are row-bound.

`complete.cases(x)`: Returns a logical vector indicating which specimens (primaries) have data in all assays. Delegates to [complete.cases, MultiAssayExperiment-method](#).

Author(s)

Patrick Aboyoun

See Also

- [MultiAssaySpatialExperiment](#) for the main class
- [MultiAssaySpatialExperiment-subset](#) for subsetting methods

Examples

```
mat1 <- matrix(rnorm(20), 5, 4,
  dimnames = list(paste0("G", 1:5), paste0("S", 1:4)))
mat2 <- matrix(rnorm(20), 5, 4,
  dimnames = list(paste0("G", 1:5), paste0("S", 1:4)))
sm1 <- S4Vectors::DataFrame(
  assay = factor(rep("assay1", 4), "assay1"),
  primary = paste0("S", 1:4),
  colname = paste0("S", 1:4))
sm2 <- S4Vectors::DataFrame(
```

```

    assay = factor(rep("assay2", 4), "assay2"),
    primary = paste0("S", 1:4),
    colname = paste0("S", 1:4))
cd <- S4Vectors::DataFrame(row.names = paste0("S", 1:4))
mase1 <- MultiAssaySpatialExperiment(
  ExperimentList(assay1 = mat1), cd, sm1)
mase2 <- MultiAssaySpatialExperiment(
  ExperimentList(assay2 = mat2), cd, sm2)
c(mase1, mase2)
complete.cases(mase1)

```

MultiAssaySpatialExperiment-SpatialExperiment

MultiAssaySpatialExperiment - SpatialExperiment integration

Description

Coercion between [SpatialExperiment](#) and [MultiAssaySpatialExperiment](#), plus methods for `spatialCoords`, `imgData`, `scaleFactors`, `getImg`, `addImg`, `rmvImg`, and related `SpatialExperiment`-derived functionality.

Value

Coercion returns the requested object: a [MultiAssaySpatialExperiment](#) from a [SpatialExperiment](#), or a [SpatialExperiment](#) from a MASE. `spatialCoords()` returns a numeric coordinate matrix and `scaleFactors()` a numeric vector. The image methods return image data (`getImg()`) or an updated MASE for the modifying methods (such as `addImg()`). `molecules()` returns the molecule data of the first assay, or `NULL`.

Coercion

`as(spe, "MultiAssaySpatialExperiment")`: Stores the assay data as a plain [SingleCellExperiment](#) (the [SpatialExperiment](#) class itself is not retained); `spatialCoords` are copied to points (with a matching `spatialMap`), and `imgData` is passed through. This keeps all spatial content in MASE's own layers, which is what `writeParquet()` understands.

`as(mase, "SpatialExperiment")`: Requires exactly one assay. Builds a [SpatialExperiment](#) from that assay's data plus `spatialCoords` resolved from `points(mase)` and `imgData(mase)`.

spatialCoords and scaleFactors

`spatialCoords(x, assay = 1L)`: Returns spatial coordinates from the assay (if a `SpatialExperiment`) or from `spatialPoints(x)`.

`spatialCoordsNames(x)`: Returns coordinate column names from the first assay or points layer.

`scaleFactors(x, sample_id = TRUE, image_id = TRUE)`: Returns scale factors from `imgData`.

imgData methods

`getImg(x, sample_id = NULL, image_id = NULL)`: Retrieves image(s) from `imgData`.

`addImg(x, imageSource, scaleFactor, sample_id, image_id, load = TRUE)`: Adds an image to `imgData`.

`rmvImg(x, sample_id = NULL, image_id = NULL)`: Removes image(s) from `imgData`.

`imgSource(x, sample_id = NULL, image_id = NULL, path = FALSE)`: Returns image source path(s).

`imgRaster(x, sample_id = NULL, image_id = NULL)`: Returns raster image(s).

`rotateImg(x, sample_id = NULL, image_id = NULL, degrees = 90)`: Rotates image(s) in place.

`mirrorImg(x, sample_id = NULL, image_id = NULL, axis = c("h", "v"))`: Mirrors image(s) in place.

molecules

`molecules(x, ...)`: Returns molecule data from the first assay if it is a `SpatialExperiment` with a `molecules` assay; otherwise `NULL`.

Author(s)

Patrick Aboyoun

See Also

- [MultiAssaySpatialExperiment](#) for the main class
- [SpatialExperiment](#) for single-assay spatial data

Examples

```
mat <- matrix(1:12, 3, 4,
  dimnames = list(paste0("G", 1:3), paste0("cell", 1:4)))
spe <- SpatialExperiment::SpatialExperiment(
  assays = list(counts = mat),
  spatialCoords = matrix(c(1:4, 1:4), 4, 2))
mase <- as(spe, "MultiAssaySpatialExperiment")
names(mase)
spatialCoords(mase)
as(mase, "SpatialExperiment")
```

MultiAssaySpatialExperiment-subset

MultiAssaySpatialExperiment subsetting

Description

Methods for subsetting a [MultiAssaySpatialExperiment](#). They extend [subsetBy](#) with propagation to spatial slots.

Value

`subsetByColData()` and `subsetByRow()` return a [MultiAssaySpatialExperiment](#) restricted to the selected specimens or rows; the linked spatial layers, `imgData`, and `spatialMap` are subset accordingly.

Subsetting

In the snippets below, `x` is a [MultiAssaySpatialExperiment](#):

`subsetByColData(x, y)`: Subset by primary identifiers (specimens). `spatialMap`, `imgData`, and linked points, shapes, images, and labels are filtered to retained specimens (via `sampleMap` and `spatialMap`).

`subsetByRow(x, y, i = TRUE, ...)`: Subset rows of experiments. Spatial layers are assay-level and unchanged.

`subsetByColumn(x, y)`: Subset assay columns (observations). When `y` is a list (one element per assay), each element may be column names, indices, or a logical vector — the usual [subsetByColumn](#) interface. `spatialMap`, `imgData`, and linked points, shapes, images, and labels are filtered to retained columns. To subset by assay `colData`, build a logical vector or column names and pass a list, e.g. `subsetByColumn(mase, list(rna = colData(experiments(mase)[["rna"]])$ == "tumor"))`.

`subsetByAssay(x, y)`: Subset assays. Points, shapes, images, labels, `spatialMap`, and `imgData` are filtered to layers and rows linked to retained assays via `spatialMap`. Auxiliary shape layers not referenced in `spatialMap` are dropped.

`x[i, j, k, ..., drop = FALSE]`: Subset by row (`i`), column (`j`), and assay (`k`) indices. Equivalent to composing `subsetByColData`, `subsetByColumn`, `subsetByRow`, and `subsetByAssay`. If `drop = TRUE`, empty assays are removed.

`subsetByBoundingBox(x, xmin, xmax, ymin, ymax, ...)`: Subset by bounding box. Filters points and shapes within the rectangle; propagates to assays via `spatialMap` when present. When `crop_rasters = TRUE` (default), `spatialImages` and `spatialLabels` are cropped to the same bounding box (single-scale, pixel coordinates for matrix rasters; **terra** extent for `SpatRaster` layers).

`subsetByPolygon(x, polygon, ...)`: Subset by polygon. Filters points and shapes within or intersecting the `sf` geometry; propagates to assays via `spatialMap` when present. Raster layers are cropped to the polygon bounding box when `crop_rasters = TRUE`.

Polymorphism

All subsetting uses S3/S4 generics only. Table-like elements (`spatialMap`, `sampleMap`, `imgData`, points, shapes) use `nrow`, `colnames`, `[[`, `[`, `unique`, and `split` (from **BiocGenerics**). Layer lists use names and length. Spatial filtering additionally requires `sf::st_intersects` (and `st_as_sf`, `st_bbox` for shapes / polygon). For spatial filtering, `instance_id` in points, shapes, and `spatialMap` must have matching types (no coercion). See vignette *Working with MultiAssaySpatialExperiment* for a per-operation propagation table.

Author(s)

Patrick Aboyoun

See Also

- [MultiAssaySpatialExperiment](#) for the main class
- [MultiAssaySpatialExperiment-combine](#) for combining methods

Examples

```
mat <- matrix(rnorm(20), 5, 4,
  dimnames = list(paste0("G", 1:5), paste0("obs", 1:4)))
pts <- S4Vectors::DataFrame(
  x = 1:4, y = 1:4, instance_id = paste0("obs", 1:4))
sm <- S4Vectors::DataFrame(
  assay = factor(rep("rna", 4), "rna"),
  primary = rep(c("specimen_A", "specimen_B"), each = 2),
  colname = paste0("obs", 1:4))
mase <- MultiAssaySpatialExperiment(
  experiments = ExperimentList(rna = mat),
  colData = S4Vectors::DataFrame(row.names = c("specimen_A", "specimen_B")),
  sampleMap = sm,
  points = PointsLayerList(coords = pts),
  spatialMap = buildSpatialMap(sm, "coords", "points"))
subsetByColData(mase, "specimen_A")
subsetByBoundingBox(mase, xmin = 1.5, xmax = 3.5, ymin = 1.5, ymax = 3.5)
```

```
prepMASE
```

Prepare components for a MultiAssaySpatialExperiment

Description

Wraps [prepMultiAssay](#) and harmonizes spatial slots. Returns a list suitable for [MultiAssaySpatialExperiment](#) or `do.call`.

Usage

```
prepMASE(
  ExperimentList,
  colData,
  sampleMap,
  points = PointsLayerList(),
  shapes = ShapesLayerList(),
  images = RasterLayerList(),
  labels = RasterLayerList(),
  imgData = NULL,
  spatialMap = NULL,
  ...
)
```

Arguments

<code>ExperimentList</code>	A ExperimentList or named list of assays passed to prepMultiAssay .
<code>colData</code>	A DataFrame of specimen-level metadata (one row per <code>sampleMap\$primary</code>), passed to prepMultiAssay .
<code>sampleMap</code>	A DataFrame with MAE columns <code>assay</code> , <code>primary</code> , and <code>colname</code> , passed to prepMultiAssay .
<code>points</code>	A PointsLayerList or named list of point layers.
<code>shapes</code>	A ShapesLayerList or named list of shape layers.

images	A RasterLayerList of image layers (default empty).
labels	A RasterLayerList of label layers (default empty).
imgData	Optional specimen-level image metadata DataFrame .
spatialMap	Optional instance-level mapping DataFrame .
...	Additional arguments passed to <code>prepMultiAssay</code> (metadata, drops).

Value

A list with elements `experiments`, `colData`, `sampleMap`, `metadata`, `drops`, and `spatial slot components`.

See Also

[buildSpatialMap](#), [prepMultiAssay](#)

Examples

```
mat <- matrix(1:6, 2, 3, dimnames = list(c("G1", "G2"), paste0("spot", 1:3)))
sm <- S4Vectors::DataFrame(
  assay = factor(rep("rna", 3), "rna"),
  primary = c("S1", "S1", "S2"),
  colname = paste0("spot", 1:3))
pts <- S4Vectors::DataFrame(
  x = 1:3, y = 1:3, instance_id = paste0("spot", 1:3))
prepared <- prepMASE(
  ExperimentList(rna = mat),
  S4Vectors::DataFrame(row.names = c("S1", "S2")),
  sm,
  points = PointsLayerList(tissue1 = pts),
  spatialMap = buildSpatialMap(sm, "tissue1", "points"))
do.call(MultiAssaySpatialExperiment, prepared)
```

readCosMxMASE

Read NanoString CosMx SMI Spatial Data

Description

Load a NanoString CosMx output directory into a [MultiAssaySpatialExperiment](#).

Usage

```
readCosMxMASE(
  data_dir,
  sample_id = NULL,
  fov_ids = NULL,
  load_transcripts = FALSE,
  images = TRUE,
  load_images = FALSE,
  min_area = NULL
)
```

Arguments

<code>data_dir</code>	Character. Path to CosMx output directory.
<code>sample_id</code>	Character. Optional sample identifier (default: directory name).
<code>fov_ids</code>	Character vector or NULL. FOV IDs to load (default: NULL loads all).
<code>load_transcripts</code>	Logical. Whether to load transcript data (default: FALSE).
<code>images</code>	Logical. Whether to load image metadata (default: TRUE).
<code>load_images</code>	Logical. Whether to load image data (default: FALSE).
<code>min_area</code>	Numeric. Minimum polygon area for filtering (default: NULL).

Details

Supports multi-FOV datasets. Use `fov_ids` to load specific fields of view, or NULL to load all FOVs into one object. Transcript coordinates are optional (`load_transcripts`).

Value

A [MultiAssaySpatialExperiment](#) object.

See Also

[readMERSCOPEMASE](#), [readXeniumMASE](#)

Examples

```
## A minimal mock CosMx output directory is bundled for a runnable example;
## in practice, point 'data_dir' at a real CosMx output directory.
dir <- system.file("extdata", "cosmx_mock",
  package = "MultiAssaySpatialExperiment")
mase <- readCosMxMASE(dir, images = FALSE, load_transcripts = FALSE)
names(mase)
```

<code>readCSVForMASE</code>	<i>Read CSV Files for MASE</i>
-----------------------------	--------------------------------

Description

Read a CSV file into a [DataFrame](#) for MASE component assembly.

Usage

```
readCSVForMASE(file_path, ...)

## S4 method for signature 'character'
readCSVForMASE(file_path, ...)
```

Arguments

<code>file_path</code>	Character path to CSV file
<code>...</code>	Additional arguments passed to format-specific methods

Value

DataFrame

Examples

```
tmp <- tempfile(fileext = ".csv")
df <- data.frame(
  cell_id = paste0("C", 1:3),
  x_centroid = 1:3,
  y_centroid = 1:3)
write.csv(df, tmp, row.names = FALSE)
readCSVForMASE(tmp)
unlink(tmp)
```

readGeoJSONForMASE	<i>Read GeoJSON Files for MASE</i>
--------------------	------------------------------------

Description

Read a GeoJSON file via **sf** for shape layers in MASE readers.

Usage

```
readGeoJSONForMASE(file_path, ...)

## S4 method for signature 'character'
readGeoJSONForMASE(file_path, quiet = TRUE, ...)
```

Arguments

file_path	Character path to GeoJSON file
...	Additional arguments passed to format-specific methods
quiet	Logical, suppress sf reading messages

Value

sf or equivalent object

Examples

```
tmp <- tempfile(fileext = ".geojson")
pt <- sf::st_point(c(10, 20))
sf_obj <- sf::st_sf(id = "C1", geometry = sf::st_sfc(pt))
sf::st_write(sf_obj, tmp, quiet = TRUE, delete_dsn = TRUE)
readGeoJSONForMASE(tmp, quiet = TRUE)
unlink(tmp)
```

readGeoParquetForMASE *Read GeoParquet Files for MASE*

Description

Read a GeoParquet file via **sfarrow** for geometry layers in MASE readers.

Usage

```
readGeoParquetForMASE(file_path, ...)

## S4 method for signature 'character'
readGeoParquetForMASE(file_path, ...)
```

Arguments

file_path	Character path to GeoParquet file
...	Additional arguments passed to format-specific methods

Value

sf object or equivalent object

Examples

```
if (requireNamespace("sfarrow", quietly = TRUE) &&
    requireNamespace("sf", quietly = TRUE)) {
  tmp <- tempfile(fileext = ".parquet")
  pt <- sf::st_sfc(sf::st_point(c(1, 2)))
  sf_obj <- sf::st_sf(id = 1L, geometry = pt)
  sfarrow::st_write_parquet(sf_obj, tmp)
  readGeoParquetForMASE(tmp)
  unlink(tmp)
}
```

readHDF5ForMASE *Read HDF5 Files for MASE*

Description

Read an HDF5 matrix file (10x or AnnData/h5ad) into a [SummarizedExperiment](#) for MASE assembly.

Usage

```
readHDF5ForMASE(file_path, type = c("10x", "anndata"), ...)

## S4 method for signature 'character,character'
readHDF5ForMASE(file_path, type = c("10x", "anndata"), ...)
```

Arguments

file_path	Character path to HDF5 file
type	Character: "10x" for 10x HDF5, "anndata" for h5ad
...	Additional arguments passed to format-specific methods

Value

SummarizedExperiment

Examples

```
## Requires DropletUtils and a 10x filtered_feature_bc_matrix.h5 file
readHDF5ForMASE("filtered_feature_bc_matrix.h5", type = "10x")
```

readMERSCOPEMASE	<i>Read Vizgen MERSCOPE Spatial Data</i>
------------------	--

Description

Load a Vizgen MERSCOPE (MERFISH) output directory into a [MultiAssaySpatialExperiment](#).

Usage

```
readMERSCOPEMASE(
  data_dir,
  sample_id = NULL,
  fov_ids = NULL,
  segmentation = c("cellpose", "watershed", "both"),
  load_transcripts = FALSE,
  images = TRUE,
  load_images = FALSE,
  min_area = NULL,
  min_qv = 20
)
```

Arguments

data_dir	Character. Path to MERSCOPE output directory.
sample_id	Character. Optional sample identifier (default: directory name).
fov_ids	Character vector or NULL. FOV IDs to load (default: NULL loads all).
segmentation	Character. Segmentation method: "cellpose", "watershed", or "both" (default: "cellpose").
load_transcripts	Logical. Whether to load transcript data (default: FALSE).
images	Logical. Whether to load image metadata (default: TRUE).
load_images	Logical. Whether to load image data (default: FALSE).
min_area	Numeric. Minimum polygon area for filtering (default: NULL).
min_qv	Numeric. Minimum quality value for transcripts (default: 20).

Details

Supports multi-FOV datasets and multiple segmentation methods (segmentation: "cellpose", "watershed", or "both"). Transcript coordinates are optional (load_transcripts).

Value

A [MultiAssaySpatialExperiment](#) object.

See Also

[readCosMxMASE](#), [readXeniumMASE](#)

Examples

```
## A minimal mock MERSCOPE output directory is bundled for a runnable
## example; in practice, point 'data_dir' at a real MERSCOPE region directory.
dir <- system.file("extdata", "merscope_mock",
                  package = "MultiAssaySpatialExperiment")
mase <- readMERSCOPEMASE(dir, segmentation = "cellpose",
                        images = FALSE, load_transcripts = FALSE)
names(mase)
```

readParquetForMASE	<i>Read Parquet Files for MASE</i>
--------------------	------------------------------------

Description

Read a Parquet file into a [DataFrame](#) for use in MASE component assembly or custom readers.

Usage

```
readParquetForMASE(file_path, ...)

## S4 method for signature 'character'
readParquetForMASE(file_path, col_select = NULL, ...)
```

Arguments

file_path	Character path to Parquet file
...	Additional arguments passed to format-specific methods
col_select	Optional character vector of column names to select

Value

DataFrame

Examples

```
if (requireNamespace("arrow", quietly = TRUE)) {
  tmp <- tempfile(fileext = ".parquet")
  df <- data.frame(cell_id = paste0("C", 1:3), x = 1:3, y = 1:3)
  arrow::write_parquet(df, tmp)
  readParquetForMASE(tmp)
  unlink(tmp)
}
```

readVisiumHDMASE	<i>Read 10x Genomics Visium HD Spatial Data</i>
------------------	---

Description

Load a 10x Genomics Visium HD Space Ranger output directory into a [MultiAssaySpatialExperiment](#).

Usage

```
readVisiumHDMASE(
  data_dir,
  sample_id = NULL,
  bin_size = c("008", "002", "016"),
  load_boundaries = FALSE,
  images = TRUE,
  load_images = FALSE,
  min_area = NULL
)
```

Arguments

<code>data_dir</code>	Character. Path to Space Ranger output directory.
<code>sample_id</code>	Character. Optional sample identifier (default: directory name).
<code>bin_size</code>	Character vector. Bin sizes to load: "002", "008", "016" (default: "008").
<code>load_boundaries</code>	Logical. Whether to load cell segmentation boundaries (default: FALSE).
<code>images</code>	Logical. Whether to load image metadata (default: TRUE).
<code>load_images</code>	Logical. Whether to load image data (default: FALSE).
<code>min_area</code>	Numeric. Minimum polygon area for filtering (default: NULL).

Details

Visium HD provides binned expression at 2 μm , 8 μm , and 16 μm resolution (codes "002", "008", "016"). Each requested bin size becomes a separate assay in the returned object.

Value

A [MultiAssaySpatialExperiment](#) with one experiment per requested bin size.

See Also

[readVisiumMASE](#), [readXeniumMASE](#)

Examples

```
## Requires a Visium HD Space Ranger output directory
mase <- readVisiumHDMASE("path/to/visium_hd", bin_size = "008")
names(mase)
```

readVisiumMASE	<i>Read 10x Genomics Visium Spatial Data</i>
----------------	--

Description

Load a 10x Genomics Visium Space Ranger output directory into a [MultiAssaySpatialExperiment](#).

Usage

```
readVisiumMASE(
  data_dir,
  sample_id = NULL,
  type = c("HDF5", "sparse"),
  data = c("filtered", "raw"),
  images = TRUE,
  load_images = FALSE,
  unit = c("pixel", "micron"),
  min_area = NULL,
  block_size = NULL
)
```

Arguments

<code>data_dir</code>	Character. Path to Space Ranger output directory.
<code>sample_id</code>	Character. Optional sample identifier (default: directory name).
<code>type</code>	Character. Matrix format: "HDF5" or "sparse" (default: "HDF5").
<code>data</code>	Character. Data type: "filtered" or "raw" (default: "filtered").
<code>images</code>	Logical. Whether to load image metadata (default: TRUE).
<code>load_images</code>	Logical. Whether to load image data (default: FALSE).
<code>unit</code>	Character. Coordinate units: "pixel" or "micron" (default: "pixel").
<code>min_area</code>	Numeric. Minimum polygon area for filtering (default: NULL).
<code>block_size</code>	Numeric. Block size for chunked reading (default: 100MB).

Details

Reads spot-by-gene counts, tissue positions, spot geometries, and optional H&E image metadata (images). Coordinates may be returned in pixels or microns (`unit`). For Visium HD data, use [readVisiumHDMASE](#).

Value

A [MultiAssaySpatialExperiment](#) object.

See Also

[readVisiumHDMASE](#), [readXeniumMASE](#)

Examples

```
## Requires a Space Ranger output directory (see package tests for mock layout)
mase <- readVisiumMASE("path/to/visium")
names(mase)
```

readXeniumMASE	<i>Read 10x Genomics Xenium Spatial Data</i>
----------------	--

Description

Load a 10x Genomics Xenium output directory into a [MultiAssaySpatialExperiment](#).

Usage

```
readXeniumMASE(
  data_dir,
  sample_id = NULL,
  segmentations = c("cell", "nucleus", "both"),
  images = TRUE,
  load_images = FALSE,
  add_transcripts = FALSE,
  min_area = NULL,
  min_phred = 20,
  block_size = NULL
)
```

Arguments

<code>data_dir</code>	Character. Path to Xenium output directory.
<code>sample_id</code>	Character. Optional sample identifier (default: directory name).
<code>segmentations</code>	Character. Segmentation type: "cell", "nucleus", or "both" (default: "cell").
<code>images</code>	Logical. Whether to load image metadata (default: TRUE).
<code>load_images</code>	Logical. Whether to load image data (default: FALSE).
<code>add_transcripts</code>	Logical. Whether to include transcript data (default: FALSE).
<code>min_area</code>	Numeric. Minimum polygon area for filtering (default: NULL).
<code>min_phred</code>	Integer. Minimum phred score for transcripts (default: 20).
<code>block_size</code>	Numeric. Block size for chunked reading (default: 100MB).

Details

Reads cell-by-gene counts, cell coordinates, optional segmentation polygons (segmentations), and optionally transcript-level coordinates (add_transcripts). Image metadata is included when images = TRUE; set load_images = TRUE to load raster data.

Value

A [MultiAssaySpatialExperiment](#) object with expression, coordinates, optional shapes, and spatialMap linkage.

See Also

[readVisiumMASE](#), [readVisiumHDMASE](#), [readCosMxMASE](#), [readMERSCOPEMASE](#)

Examples

```
## Requires a Xenium output directory (see package tests for mock layout)
mase <- readXeniumMASE("path/to/xenium")
names(mase)
```

shapesToLabels

Rasterize polygon shapes to a label image

Description

Burn shape geometries into a label raster. When template is NULL, an empty raster is created from the bounding box of x.

Usage

```
shapesToLabels(x, template = NULL, field = "instance_id", background = NA, ...)
```

Arguments

x	An sf object or data.frame with polygon geometries.
template	Optional SpatRaster defining extent and resolution.
field	Character; attribute column used as label values (default "instance_id").
background	Numeric background value (default NA).
...	Additional arguments passed to terra::rasterize.

Value

A SpatRaster label image.

See Also

[labelsToShapes](#), [spatialShapes](#)

Examples

```
if (requireNamespace("terra", quietly = TRUE)) {  
  mat <- matrix(c(1L, 1L, 2L, 2L), 2, 2)  
  polys <- labelsToShapes(mat)  
  polys$instance_id <- polys[["lyr.1"]]  
  shapesToLabels(polys, field = "instance_id", background = 0L)  
}
```

spatial-accessors	<i>Access spatial element slots</i>
-------------------	-------------------------------------

Description

Generic functions to access `spatialImages`, `spatialLabels`, `spatialPoints`, `spatialShapes`, and `spatialMap` slots of [MultiAssaySpatialExperiment](#). The `imgData` generic is imported from **Spatial-Experiment**.

Usage

```
spatialImages(x)  
  
spatialLabels(x)  
  
spatialPoints(x)  
  
spatialShapes(x)  
  
spatialMap(x)  
  
spatialImages(x) <- value  
spatialLabels(x) <- value  
spatialPoints(x) <- value  
spatialShapes(x) <- value  
spatialMap(x) <- value  
  
spatialImage(x, i)  
spatialLabel(x, i)  
spatialPoint(x, i)  
spatialShape(x, i)  
  
spatialImageNames(x)  
spatialLabelNames(x)
```

```

spatialPointNames(x)

spatialShapeNames(x)

spatialImage(x, i) <- value

spatialLabel(x, i) <- value

spatialPoint(x, i) <- value

spatialShape(x, i) <- value

```

Arguments

<code>x</code>	A MultiAssaySpatialExperiment object
<code>value</code>	Replacement value for the element
<code>i</code>	Index (character or integer) for the element name

Details

Slot accessors (`spatialImages`, `spatialLabels`, etc.) return the full element list. Single-element accessors (`spatialImage`, `spatialLabel`, etc.) take an index `i` (character or integer) and return the element. Name accessors return character vectors of element names. Replacement functions for slots take a full list; single- element replacements take an index and the new value.

For single-element accessors, a character index with no matching name (e.g., `spatialImage(x, "nonexistent")`) returns `NULL`. Integer indices that are out of bounds raise an error.

Value

For accessors: the slot or element contents. For replacement functions: the modified object.

Author(s)

Patrick Aboyoun

See Also

[MultiAssaySpatialExperiment](#), [RasterLayerList](#), [PointsLayerList](#), [ShapesLayerList](#)

Examples

```

mat <- matrix(rnorm(20), 5, 4, dimnames = list(paste0("G", 1:5), paste0("obs", 1:4)))
explist <- ExperimentList(rna = mat)
cd <- S4Vectors::DataFrame(sample = "specimen_1", row.names = "specimen_1")
sm <- S4Vectors::DataFrame(
  assay = factor(rep("rna", 4), "rna"),
  primary = rep("specimen_1", 4),
  colname = paste0("obs", 1:4))
mase <- MultiAssaySpatialExperiment(
  experiments = explist,
  colData = cd,
  sampleMap = sm,
  images = RasterLayerList(brightfield = matrix(1:12, 3, 4))

```

```

)
spatialImageNames(mase)
spatialImage(mase, 1L)
spatialImage(mase, "brightfield")
spatialImages(mase) <- RasterLayerList(fluorescent = matrix(20:31, 3, 4))
spatialImageNames(mase)

```

spatialJoin

Spatial join between spatial layer tables

Description

Join two spatial [DataFrame](#) layers on a spatial predicate. The `DataFrame` method uses `sf` attribute joins via `st_join`.

Usage

```
spatialJoin(x, y, join = st_intersects, sparse = TRUE, ...)
```

Arguments

<code>x</code>	A DataFrame with spatial data.
<code>y</code>	A spatial table to join against.
<code>join</code>	Spatial predicate function (default st_intersects).
<code>sparse</code>	Logical; when TRUE, request a sparse pair-table result where supported by methods (default TRUE for the generic signature; the <code>DataFrame</code> method materializes via <code>st_join</code>).
<code>...</code>	Additional arguments for methods.

Value

Join result. The `DataFrame` method returns an `sf` object from `st_join`.

Author(s)

Patrick Aboyoun

See Also

[spatialMatch](#) for first-match indexing without attaching attributes.

Examples

```

library(sf)
pts <- S4Vectors::DataFrame(
  spot = c("A", "B"),
  geometry = c("POINT (1 1)", "POINT (5 5)")
)
cells <- S4Vectors::DataFrame(
  cell = c("C1", "C2"),
  geometry = c(
    "POLYGON ((0 0, 3 0, 3 3, 0 3, 0 0))",

```

```
"POLYGON ((4 4, 6 4, 6 6, 4 6, 4 4)))"
spatialJoin(pts, cells)
```

SpatialLayerList-class

Spatial layer list objects

Description

The [SpatialLayerList](#) class is a virtual base extending [SimpleList](#). Concrete subclasses [RasterLayerList](#), [PointsLayerList](#), and [ShapesLayerList](#) provide typed containers for raster data (images, labels), point coordinates, and shape geometries.

Details

All layers must be named and have unique names. Element-type validity is enforced by each concrete class: [RasterLayerList](#) requires `dim()` with length ≥ 2 (e.g., matrix, array, DelayedArray, StoredSpatialImage); [PointsLayerList](#) requires `DataFrame` elements with at least 2 columns (typically x, y) and often an instance identifier; [ShapesLayerList](#) requires `DataFrame` elements (with `sf` a geometry column may be present).

Value

The constructors `RasterLayerList()`, `PointsLayerList()`, and `ShapesLayerList()` return an object of the corresponding class. Coercion via `as()` returns the requested `*LayerList`, and the `show()` method returns NULL invisibly.

Constructors

`RasterLayerList(...)`: Creates a [RasterLayerList](#). Accepts named arguments, a single named list, or a single [List](#). Each element must have `dim()` with length ≥ 2 .

`PointsLayerList(...)`: Creates a [PointsLayerList](#). Accepts named `DataFrame` elements or a single list/List. Each element must have at least 2 columns.

`ShapesLayerList(...)`: Creates a [ShapesLayerList](#). Accepts named `DataFrame` or `data.frame` elements (coerced to `DataFrame`); or a single list/List.

Coercion

`as(x, "RasterLayerList")`, `as(x, "PointsLayerList")`, `as(x, "ShapesLayerList")`: Coerce list or [List](#) to the target class. For `ShapesLayerList`, `data.frame` elements are converted to `DataFrame`.

Displaying

The `show()` method prints the class name, length, and for each layer: index, name, element class, and dimensions (raster) or row x col (points/shapes).

Note**Terminology alignment with spatialdata:**

MASE uses the "Layer" suffix (PointsLayerList, ShapesLayerList, RasterLayerList) rather than "Element" to avoid naming collisions with R base classes and Bioconductor conventions. The Python spatialdata package uses "element" as an internal discriminator (e.g., element_type column, sdata.points, sdata.shapes) but does not define List container classes.

MASE's element_type column in spatialMap corresponds to spatialdata's element type discriminator, routing to the appropriate spatial slot: "points" → PointsLayerList, "shapes" → ShapesLayerList. See ?MultiAssaySpatialExperiment for details on the spatialMap linkage model.

Other intentional differences: MASE uses spatialPoints(), spatialShapes(), etc. (with "spatial" prefix) as S4 generic accessors, while spatialdata uses bare attribute access (sdata.points, sdata.shapes). This follows Bioconductor S4 conventions and avoids conflicts with base R functions.

Author(s)

Patrick Aboyoun

See Also

- [MultiAssaySpatialExperiment](#) for usage in multi-assay context
- [SimpleList](#) for the base class

Examples

```
RasterLayerList()
RasterLayerList(img = matrix(1:12, 3, 4))

pts <- S4Vectors::DataFrame(x = c(1, 2), y = c(3, 4))
PointsLayerList(coords = pts)

ShapesLayerList()
df <- S4Vectors::DataFrame(id = 1:2, value = c("a", "b"))
ShapesLayerList(regions = df)
```

spatialMatch

Spatial match for DataFrame

Description

For each row of x, find the first matching row in table based on a spatial relationship. Analogous to match(x, table) from **S4Vectors**: returns an integer vector of positions in table.

Arguments

<code>x</code>	A DataFrame with coordinate columns representing point locations.
<code>table</code>	A DataFrame with a geometry column representing spatial regions.
<code>...</code>	Additional arguments passed to methods. Common arguments: <code>coords</code> Character vector of length 2 naming the coordinate columns in <code>x</code> . <code>geom</code> Character; name of the geometry column in <code>table</code> (default "geometry"). <code>join</code> A spatial join function (default <code>sf::st_intersects</code>). Must accept two geometry arguments and return either an <code>sfg</code> list or an integer vector.

Details

The `DataFrame` method builds point geometries from the coordinate columns of `x`, applies the `join` function against the geometry column of `table`, and returns the first match per row.

Downstream packages can define methods for their own `DataFrame` subclasses to push the spatial join to an alternative backend (e.g., SQL-based spatial joins, Arrow compute, in-memory acceleration).

Value

An integer vector of length `nrow(x)`. Each element is the row position in `table` of the first spatial match, or NA if no match is found.

Author(s)

Patrick Aboyoun

See Also

[spatialOverlaps](#) for the predicate analogue (like `is.na`).

Examples

```
library(sf)
pts <- S4Vectors::DataFrame(x = c(1, 5, 10), y = c(1, 5, 10))
shapes <- S4Vectors::DataFrame(
  geometry = st_as_sfc(c(
    "POLYGON((0 0, 6 0, 6 6, 0 6, 0 0))",
    "POLYGON((7 7, 12 7, 12 12, 7 12, 7 7))"))
  )
spatialMatch(pts, shapes, coords = c("x", "y"))
## 1 1 2
```

spatialOverlaps

Spatial overlap predicate for DataFrame

Description

Test which rows of a [DataFrame](#) spatially intersect a region. Analogous to `is.na` or duplicated from **S4Vectors**: returns a logical vector that can be used for subsetting via `x[spatialOverlaps(x, y, ...), ]`.

Arguments

<code>x</code>	A DataFrame with spatial data (coordinate columns or a geometry column).
<code>y</code>	A spatial region to test against. Typically an <code>sfc</code> , <code>sfg</code> , or similar geometry object from <code>sf</code> .
<code>...</code>	Additional arguments passed to methods. Common arguments: <code>coords</code> Character vector of length 2 naming the coordinate columns in <code>x</code> (e.g., <code>c("x", "y")</code>). When provided, point geometries are constructed from these columns and tested for intersection with <code>y</code> . <code>geom</code> Character; name of the geometry column in <code>x</code> (default <code>"geometry"</code>). Used when <code>coords</code> is not provided.

Details

The `DataFrame` method uses `sf` functions (`st_as_sfc`, `st_intersects`). Downstream packages can define methods for their own `DataFrame` subclasses to use alternative backends (e.g., SQL databases, Arrow, HDF5).

Two modes are supported based on the arguments:

Coordinate mode When `coords` is provided, point geometries are constructed from those columns and tested against `y`.

Geometry mode When `coords` is `NULL` (the default), the column named by `geom` is used directly.

Value

A logical vector of length `nrow(x)`. `TRUE` for rows whose spatial data intersects `y`.

Author(s)

Patrick Aboyoun

See Also

[spatialMatch](#) for the relational analogue (like `match`).

Examples

```
library(sf)
pts <- S4Vectors::DataFrame(x = c(1, 5, 10), y = c(1, 5, 10))
polygon <- st_as_sfc("POLYGON((0 0, 6 0, 6 6, 0 6, 0 0))")
spatialOverlaps(pts, polygon, coords = c("x", "y"))
## TRUE TRUE FALSE
```

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