Package ‘MerfishData’

March 7, 2024

Title Collection of public MERTISH datasets

Version 1.4.1

Description MerfishData is an ExperimentHub package that serves publicly available datasets obtained with Multiplexed Error-Robust Fluorescence in situ Hybridization (MERTISH). MERTISH is a massively multiplexed single-molecule imaging technology capable of simultaneously measuring the copy number and spatial distribution of hundreds to tens of thousands of RNA species in individual cells. The scope of the package is to provide MERTISH data for benchmarking and analysis.

License Artistic-2.0

VignetteBuilder knitr

LazyData false

URL https://github.com/ccb-hms/MerfishData

BugReports https://github.com/ccb-hms/MerfishData/issues

Depends R (>= 4.2.0), EBIImage, SpatialExperiment

Imports grDevices, AnnotationHub, BumpyMatrix, ExperimentHub, S4Vectors, SingleCellExperiment, SummarizedExperiment

Suggests grid, ggplot2, ggpubr, knitr, rmarkdown, testthat, BiocStyle, DropletUtils

biocViews ExperimentHub, ExpressionData, HighThroughputImagingData, Mus_musculus_Data, SingleCellData, SpatialData

Encoding UTF-8

Roxygen list(markdown = TRUE)

RoxygenNote 7.2.2

git url https://git.bioconductor.org/packages/MerfishData

git branch RELEASE_3_18

git_last_commit a2aa191

git_last_commit_date 2023-10-28

Repository Bioconductor 3.18

Date/Publication 2024-03-07
addHolesToPolygons

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**R topics documented:**

- MerfishData-package .................................................. 2
- addHolesToPolygons .................................................. 2
- MouseHypothalamusMoffitt2018 ...................................... 3
- MouseIleumPetukhov2021 ............................................. 4
- plotRasterImage ...................................................... 6
- plotTabset ............................................................. 6
- plotXY ................................................................. 7

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**MerfishData-package**  
*Collection of public MERFISH datasets*

**Description**

MerfishData is an ExperimentHub package that serves publicly available datasets obtained with Multiplexed Error-Robust Fluorescence in situ Hybridization (MERFISH). MERFISH is a massively multiplexed single-molecule imaging technology capable of simultaneously measuring the copy number and spatial distribution of hundreds to tens of thousands of RNA species in individual cells. The scope of the package is to provide MERFISH data for benchmarking and analysis.

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**addHolesToPolygons**  
*Add holes to polygons*

**Description**

Add holes to a data.frame of cell polygon coordinates

**Usage**

addHolesToPolygons(poly)
Arguments

poly A data.frame storing cell polygon coordinates. Expected columns include

- "cell" storing the cell ID,
- "x" storing x-coordinates of the polygon corners,
- "y" storing the y-coordinates of the polygon corners.

Value

A data.frame

Examples

x <- c(2053, 2053, 2053, 2056, 2059, 2059)
y <- c(51, 54, 57, 57, 57, 54)
poly <- data.frame(cell = 1, x = x, y = y)
poly <- addHolesToPolygons(poly)

Description

Obtain the MERFISH mouse hypothalamic preoptic region dataset from Moffitt et al., 2018

Usage

MouseHypothalamusMoffitt2018(center.coords = TRUE)

Arguments

center.coords logical. Should spatial x- and y-coordinates be centered for each z-layer (bregma slice)? This is useful for making coordinates comparable between bregma slices for visualization and analysis. Defaults to TRUE. Use FALSE to obtain the coordinates as provided in the data release.

Details

The hypothalamus controls essential social behaviors and homeostatic functions. However, the cellular architecture of hypothalamic nuclei, including the molecular identity, spatial organization, and function of distinct cell types, is not well understood.

Moffitt et al., 2018, developed an imaging-based cell type identification and mapping method and combined it with single-cell RNA-sequencing to create a molecularly annotated and spatially resolved cell atlas of the mouse hypothalamic preoptic region.

The MERFISH measurements were obtained via combinatorial smFISH imaging for 135 genes (main experiment named "smFISH"), followed by sequential rounds of non-combinatorial seqFISH
for 20 additional genes (stored as an altExp named "seqFISH"). These genes were considered neuronal markers and important for discriminating neuronal cell populations. For behavioral measurements, cFos was added to the set of genes measured with sequential rounds of FISH. The barcoding scheme contained 140 possible barcodes; 135 of them were used to code the RNAs of the genes assayed via combinatorial smFISH; 5 of these barcodes were left unassigned ("blank"), providing a direct measure of the false-positive rate in MERFISH. Measurements for these 5 blank barcodes is stored in an altExp named "blank".

Value
An object of class SpatialExperiment.

Source
https://doi.org/10.5061/dryad.8t8s248

References

Examples
spe <- MouseHypothalamusMoffitt2018()

MouseIleumPetukhov2021

MERFISH mouse ileum dataset from Petukhov et al., 2021

Description
Obtain the MERFISH mouse ileum dataset from Petukhov et al., 2021

Usage
MouseIleumPetukhov2021(
  segmentation = c("baysor", "cellpose"),
  use.images = TRUE,
  use.polygons = TRUE
)

Arguments
segmentation character. Should be either "baysor" or "cellpose". Defaults to "baysor". See details.
use.images logical. Should DAPI and Membrane Na+/K+ - ATPase images be loaded into memory and annotated to the imgData slot of the returned SpatialExperiment? Defaults to TRUE. See details.
use.polygons logical. Should polygon cell boundaries be annotated to the metadata of the returned SpatialExperiment? Defaults to TRUE. Only available for Baysor segmentation.

Details

Spatial transcriptomics protocols based on in situ sequencing or multiplexed RNA fluorescent hybridization can reveal detailed tissue organization. Distinguishing the boundaries of individual cells in such data is challenging. Current segmentation methods typically approximate cells positions using nuclei stains.

Petukhov et al., 2021, describe Baysor, a segmentation method, which optimizes 2D or 3D cell boundaries considering joint likelihood of transcriptional composition and cell morphology. Baysor can also perform segmentation based on the detected transcripts alone.

Petukhov et al., 2021, compare the results of Baysor segmentation (mRNA-only) to the results of a deep learning-based segmentation method called Cellpose from Stringer et al., 2021. Cellpose applies a machine learning framework for the segmentation of cell bodies, membranes and nuclei from microscopy images.

The function allows to obtain segmented MERFISH mouse ileum data for both segmentation methods.

A note on storing images within a SpatialExperiment: The default use.images = TRUE reduces the 9-frame z-stack images for DAPI stain and Membrane Na+/K+ - ATPase fluorescence to single-frame images (taking the first frame). For working with the 9-frame z-stack images it is recommended to load the images individually from ExperimentHub.

Value

An object of class SpatialExperiment.

Source

https://doi.org/10.5061/dryad.jm63xsjb2

References


Examples

spe <- MouseIleumPetukhov2021()
**plotRasterImage**  
*Plot raster image*

Description

Small helper function to plot a raster image.

Usage

```r
plotRasterImage(img)
```

Arguments

- `img`  
a raster object representing a bitmap image.

Value

A ggplot object.

Examples

```r
hgrid <- hcl(0, 80, seq(50, 80, 10))
img <- as.raster(matrix(hgrid, nrow = 4, ncol = 5))
plotRasterImage(img)
```

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**plotTabset**  
*Plot a tabset*

Description

Plot a tabset of colData annotations of one or more SpatialExperiment objects over an image.

Usage

```r
plotTabset(spe.list, img)
```

Arguments

- `spe.list`  
A named list of SpatialExperiment objects.

- `img`  
a raster object representing a bitmap image.

Value

None. Produces a tabset for rendering with rmarkdown.
Examples

# create simulated data as described in the SpatialExperiment man page
example("SpatialExperiment", package = "SpatialExperiment", echo = FALSE)
spe <- spe_mol

# add simulated cell centroids
s <- cbind(x = runif(20), y = runif(20))
spatialCoords(spe) <- s

# add simulated cell type and cell cycle annotation
tc <- c("ct1", "ct2", "ct3")
cc <- c("G1", "G2", "S", "M")
spe$type <- sample(tc, ncol(spe), replace = TRUE)
spe$cycle <- sample(cc, ncol(spe), replace = TRUE)

# create an example image
hgrid <- hcl(0, 80, seq(50, 80, 10))
img <- as.raster(matrix(hgrid, nrow = 4, ncol = 5))

# plotTabset
spe.list <- list(myseg = spe)
plotTabset(spe.list, img)

plotXY

Plot spatial image with data overlay

Description

A helper function to overlay data onto a spatial image.

Usage

plotXY(df, col, img = NULL)

Arguments

df A data.frame storing the data to plot.

col character. A column of df to use for overlay onto the image.

img a raster object representing a bitmap image.

Value

A ggplot.
Examples

gene <- rep(c("Cd44", "Cd8b1", "Cd79b"), each = 2)
x <- c(1693, 1701, 1820, 3188, 1631, 1881)
y <- c(1831, 1666, 1855, 6612, 1533, 942)
df <- data.frame(gene = gene, x = x, y = y)
plotXY(df, "gene")
Index

addHolesToPolygons, 2

imgData, 4

MerfishData (MerfishData-package), 2
MerfishData-package, 2
metadata, 5
MouseHypothalamusMoffitt2018, 3
MouseIleumPetukhov2021, 4

plotRasterImage, 6
plotTabset, 6
plotXY, 7

SpatialExperiment, 4–6