

# Package ‘VisiumIO’

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**Title** Import Visium data from the 10X Space Ranger pipeline

**Version** 1.9.5

**Description** The package allows users to readily import spatial data obtained from either the 10X website or from the Space Ranger pipeline. Supported formats include tar.gz, h5, and mtx files. Multiple files can be imported at once with \*List type of functions. The package represents data mainly as SpatialExperiment objects.

**License** Artistic-2.0

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**Author** Marcel Ramos [aut, cre] (ORCID:  
<https://orcid.org/0000-0002-3242-0582>),  
 Estella YiXing Dong [aut, ctb],  
 Dario Righelli [aut, ctb],  
 Helena Crowell [aut, ctb],  
 NCI [fnd] (GrantNo.: U24CA289073)

**Maintainer** Marcel Ramos <marcel.ramos@sph.cuny.edu>

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| VisiumIO-package | <i>VisiumIO: Import Visium data from the 10X Space Ranger pipeline</i> |
|------------------|--|

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## Description

The package allows users to readily import spatial data obtained from either the 10X website or from the Space Ranger pipeline. Supported formats include tar.gz, h5, and mtx files. Multiple files can be imported at once with \*List type of functions. The package represents data mainly as SpatialExperiment objects.

## Author(s)

**Maintainer:** Marcel Ramos <marcel.ramos@sph.cuny.edu> (ORCID)

Authors:

- Marcel Ramos <marcel.ramos@sph.cuny.edu> (ORCID)
- Estella YiXing Dong [contributor]
- Dario Righelli [contributor]
- Helena Crowell [contributor]

Other contributors:

- NCI (GrantNo.: U24CA289073) [funder]

**See Also**

Useful links:

- <https://github.com/waldronlab/VisiumIO>
- Report bugs at <https://github.com/waldronlab/VisiumIO/issues>

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compareBarcodes

*Compare barcodes between raw and filtered data*

---

**Description**

This function compares the barcodes between raw and filtered data **depending** on the order of processing. Typically, the "raw" barcodes are compared to the "filtered" ones. The presence of raw barcodes in the filtered data are marked as TRUE in the resulting data.frame.

**Usage**

```
compareBarcodes(
  from_resource,
  to_resource,
  spacerangerOut,
  format = c("mtx", "h5"),
  processing = c("raw", "filtered"),
  ...
)
```

**Arguments**

|                |  |
|----------------|--|
| from_resource  | character(1) The path to the resource file whose barcodes are used as the basis of the comparison; typically, the "raw" feature barcodes are used.   |
| to_resource    | character(1) The path to the resource file whose barcodes are compared to the from_resource; typically, the "filtered" feature barcodes.   |
| spacerangerOut | character(1) A single string specifying the path to the directory where the output of spaceranger_count is located; typically (but not necessarily), this is the outs directory. The directory must contain the (processing)_feature_bc_matrix and spatial sub directories.  |
| format         | The format of the output. If missing and con is a file name, the format is derived from the file extension. This argument is unnecessary when con is a derivative of BiocFile.   |
| processing     | character(2) A vector of length 2 that corresponds to the processing type. The processing types are typically "raw" and "filtered". These are the prefixes of the folder names raw_feature_bc_matrix and filtered_feature_bc_matrix. The order of the vector determines the comparison. By default, processing = c("raw", "filtered"), which means barcodes in the raw data are compared to the filtered data. |
| ...            | Additional arguments passed to TENxH5 or TENxFileList.   |

**Value**

A data.frame with barcodes of the first element in the processing data type as the first column and a logical vector indicating whether the barcodes are found in the second element in processing. For example, if processing is c("raw", "filtered"), then the first column will be the barcodes in the raw data and the second column will be a logical vector indicating whether the barcodes are found in the filtered data.

**Examples**

```
if (interactive()) {
  compareBarcodes(
    from_resource = "V1_Adult_Mouse_Brain_raw_feature_bc_matrix.tar.gz",
    to_resource =
      "V1_Adult_Mouse_Brain_filtered_feature_bc_matrix.tar.gz",
  )

  compareBarcodes(
    from_resource =
      "V1_Adult_Mouse_Brain_raw_feature_bc_matrix.h5",
    to_resource =
      "V1_Adult_Mouse_Brain_filtered_feature_bc_matrix.h5"
  )

  compareBarcodes(spacerangerOut = "~/data/outs", format = "h5")

  compareBarcodes(
    spacerangerOut = "~/data/feature_bc_matrix", format = "mtx"
  )

  compareBarcodes(
    spacerangerOut = "~/data/folder_feature_bc_matrix", format = "mtx"
  )
}
```

---

st\_invert\_y

*Flip the Y-axis of cell or nucleus segmentations to align with H&E image*


---

**Description**

This function flips the Y-axis of cell or nucleus segmentations stored in an sf object to align with the H&E image. The Y-axis flipping is necessary because the origin (0,0) in image coordinates is at the top-left corner, while in Cartesian coordinates, the origin is at the bottom-left corner. The function takes into account the image height and scaling factor to accurately flip the Y-coordinates of the segmentations.

**Usage**

```
st_invert_y(sf, type = c("POINT", "POLYGON"), img_height, scalef)
```

**Arguments**

|                         |  |
|-------------------------|--|
| <code>sf</code>         | <code>sf</code> an <code>sf</code> class object read from a <code>.geojson</code> file.  |
| <code>type</code>       | <code>character(1)</code> "POINT" for cell centroid, or "POLYGON" for cell segmentation mask. Default is "POINT".  |
| <code>img_height</code> | <code>numeric(1)</code> The total length along the Y axis of the image. Obtained by reading in hires or lowres <code>.png</code> under <code>/spatial</code> folder with <code>magick::image_read()</code> . |
| <code>scalef</code>     | <code>numeric(1)</code> The scaling factor from a <code>/spatial/scalefactors_json.json</code> file  |

**Value**

an `sf` object with Y-axis of the points or polygons flipped

**Author(s)**

Estella YiXing Dong

**Examples**

```
geojson_file <- system.file(
  file.path("extdata", "segmented_outputs", "cell_segmentations.geojson"),
  mustWork = TRUE, package = "VisiumIO"
)
geo_data <- sf::st_read(geojson_file, quiet = TRUE)
st_invert_y(
  sf = geo_data, type = "POLYGON", img_height = 3886, scalef = 0.079
)
```

---

TENxGeoJSON-class

*Import 10X Genomics GeoJSON files*

---

**Description**

TENxGeoJSON is a class to represent and import GeoJSON files from 10X Genomics. It is a composed class of [TENxIO::TENxFile](#).

**Usage**

```
TENxGeoJSON(resource)
```

```
## S4 method for signature 'TENxGeoJSON,ANY,ANY'
import(con, format, text, ...)
```

**Arguments**

|                       |  |
|-----------------------|--|
| <code>resource</code> | <code>character(1)</code> The path to the file   |
| <code>con</code>      | The connection from which data is loaded or to which data is saved. If this is a character vector, it is assumed to be a file name and a corresponding file connection is created and then closed after exporting the object. If it is a <a href="#">BiocFile</a> derivative, the data is loaded from or saved to the underlying resource. If missing, the function will return the output as a character vector, rather than writing to a connection. |

|        |   |
|--------|---|
| format | The format of the output. If missing and con is a file name, the format is derived from the file extension. This argument is unnecessary when con is a derivative of <a href="#">BiocFile</a> . |
| text   | If con is missing, this can be a character vector directly providing the string data to import.   |
| ...    | Additional inputs to the low level class generator functions  |

### Details

Typically, the user will not create an object of this class directly but rather use the [TENxVisium\(\)](#) constructor function to create an object of this class in the background.

### Value

TENxGeoJSON(): An object of class [TENxGeoJSON](#)

import-method: An sf and data.frame with the GeoJSON data

### See Also

<https://www.10xgenomics.com/support/software/xenium-ranger/3.0/analysis/segmentation-inputs>

### Examples

```
segout_folder <- system.file(
  file.path("extdata", "segmented_outputs"),
  package = "VisiumIO"
)

## import cell boundaries
cellsegs <- file.path(segout_folder, "cell_segmentations.geojson")

TENxGeoJSON(cellsegs)

TENxGeoJSON(cellsegs) |>
  import()

## import nucleus boundaries
nucsegs <- file.path(segout_folder, "nucleus_segmentations.geojson")

TENxGeoJSON(nucsegs) |>
  import()
```

---

TENxParquet-class      *Represent and import Parquet data from 10X Genomics*

---

### Description

TENxParquet is a virtual class to represent and import Parquet files from 10X Genomics. It is a composed class of [TENxIO::TENxFile](#).

TENxSpatialParquet is a class to represent and import spatial Parquet files from 10X Genomics. It is a composed class of [TENxIO::TENxFile](#).

**Usage**

```
TENxParquet(resource, type = c("spatial", "mapping"))

TENxMappingParquet(resource, colnames = .MAPPING_POS_COLS)

## S4 method for signature 'TENxMappingParquet,ANY,ANY'
import(con, format, text, ...)
```

**Arguments**

|          |  |
|----------|--|
| resource | character(1) The path to the file  |
| type     | character(1) A scalar specifying the type of Parquet file to import, either "spatial" or "mapping". If not provided, the type is determined by whether or not there is a "mapping" keyword in the file name.   |
| colnames | character() A vector specifying the column names of the Parquet, defaults to all columns in the dataset.   |
| con      | The connection from which data is loaded or to which data is saved. If this is a character vector, it is assumed to be a file name and a corresponding file connection is created and then closed after exporting the object. If it is a <a href="#">BiocFile</a> derivative, the data is loaded from or saved to the underlying resource. If missing, the function will return the output as a character vector, rather than writing to a connection. |
| format   | The format of the output. If missing and con is a file name, the format is derived from the file extension. This argument is unnecessary when con is a derivative of <a href="#">BiocFile</a> .  |
| text     | If con is missing, this can be a character vector directly providing the string data to import.  |
| ...      | Additional inputs to the low level class generator functions   |

**Details**

Typically, the user will not create an object of this class directly but rather use the `TENxParquet` constructor function to create an object of either [TENxSpatialParquet](#) or [TENxMappingParquet](#) class in the background.

**Value**

`TENxParquet()`: An object of class [TENxSpatialParquet](#) or [TENxMappingParquet](#)  
`TENxMappingParquet()`: An object of class [TENxMappingParquet](#)

**Examples**

```
sample_dir <- system.file(
  file.path("extdata", "binned_outputs", "square_002um", "spatial"),
  package = "VisiumIO"
)
spatial_dir <- Filter(
  function(x) endsWith(x, "spatial"), list.dirs(sample_dir)
)
parquetres <- file.path(spatial_dir, "tissue_positions.parquet")
TENxParquet(parquetres)
```

```

parq_file <- system.file(
  "extdata", "barcode_mappings.parquet",
  package = "VisiumIO", mustWork = TRUE
)
TENxMappingParquet(parq_file)

```

---

TENxSpatialCSV-class *Represent and import spatial CSV data from 10X Genomics*

---

## Description

TENxSpatialCSV is a class to represent and import spatial CSV files with specific column names. It is a composed class of [TENxIO::TENxFile](#) and contains additional slots for the column names and whether the CSV is a list-type of file.

## Usage

```
TENxSpatialCSV(resource, colnames = .TISSUE_POS_COLS)
```

```
## S4 method for signature 'TENxSpatialCSV,ANY,ANY'
import(con, format, text, ...)
```

## Arguments

|          |  |
|----------|--|
| resource | character(1) The path to the file  |
| colnames | character() A vector specifying the column names of the CSV, defaults to <code>c("barcode", "in_tissue", "array_row", "array_col", "pxl_row_in_fullres", "pxl_col_in_fullres")</code> . Mainly used for the "positions" CSV type of file which does not include column names in the file.  |
| con      | The connection from which data is loaded or to which data is saved. If this is a character vector, it is assumed to be a file name and a corresponding file connection is created and then closed after exporting the object. If it is a <a href="#">BiocFile</a> derivative, the data is loaded from or saved to the underlying resource. If missing, the function will return the output as a character vector, rather than writing to a connection. |
| format   | The format of the output. If missing and con is a file name, the format is derived from the file extension. This argument is unnecessary when con is a derivative of <a href="#">BiocFile</a> .  |
| text     | If con is missing, this can be a character vector directly providing the string data to import.  |
| ...      | Additional inputs to the low level class generator functions   |

## Details

Typically, the user will not create an object of this class directly but rather use the [TENxVisium\(\)](#) constructor function to create an object of this class in the background. The column names are set to the default values of `c("barcode", "in_tissue", "array_row", "array_col", "pxl_row_in_fullres", "pxl_col_in_fullres")`. The column names can be changed by specifying the colnames argument in the constructor function.

Set the option "VisiumIO.csvreader" to either "data.table" or "readr" to use the `data.table::fread` or `readr::read_csv` functions, respectively. These options are useful when the CSV file is relatively large and the user wants to use faster read-in options. Note that the outputs will still be converted to `DataFrame` when incorporated to the `SpatialExperiment` or `SingleCellExperiment` object.

### Value

TENxSpatialCSV: An object of class `TENxSpatialCSV`

import-method: A `DataFrame` object containing the data from the CSV file

### Slots

`isList` `logical(1)` A scalar specifying whether the CSV is a list-type of file

`colnames` `character()` A vector specifying the column names of the CSV

`variant` `character(1)` A scalar specifying the variant of the CSV file "positions", "cell\_boundaries", or "other". The variant is determined by the name of the CSV file within the constructor function. Values include "positions", "cell\_boundaries", and "other".

`compressed` `logical(1)` A scalar specifying whether the CSV is compressed (mainly with a `.gz` file extension).

### Examples

```
sample_dir <- system.file(
  file.path("extdata", "10xVisium", "section1"),
  package = "VisiumIO"
)
spatial_dir <- Filter(
  function(x) endsWith(x, "spatial"), list.dirs(sample_dir)
)
csvresource <- file.path(spatial_dir, "tissue_positions_list.csv")
TENxSpatialCSV(csvresource)
head(import(TENxSpatialCSV(csvresource)), 4)

import(TENxSpatialCSV(csvresource)) |>
  attr("metadata") |>
  lapply(names)
```

---

TENxSpatialList-class *A class to represent and import spatial Visium data*

---

### Description

This class is a composed class of `TENxFileList`, which can contain a list of `TENxFile` objects, and a `TENxSpatialList` object. It is meant to handle spatial Visium data from 10X Genomics.

**Usage**

```
TENxSpatialList(
  resources,
  sample_id = "sample01",
  images = c("lowres", "hires", "detected", "aligned", "aligned_fiducials", "cytassist"),
  jsonFile = .SCALE_JSON_FILE,
  tissuePattern = "tissue_positions.*",
  bin_size = c("008", "016", "002"),
  loadImage = FALSE,
  ...
)

## S4 method for signature 'TENxSpatialList,ANY,ANY'
import(con, format, text, ...)
```

**Arguments**

|               |   |
|---------------|---|
| resources     | A <a href="#">TENxFileList</a> object or a file path to the tarball containing the matrix / assay data resources.   |
| sample_id     | character(1) A single string specifying the sample ID.  |
| images        | character() A vector specifying the images to be imported; can be one or multiple of "lowres", "hires", "detected", "aligned".  |
| jsonFile      | character(1) A single string specifying the name of the JSON file containing the scale factors.   |
| tissuePattern | character(1) A single string specifying the pattern to match the tissue positions file.   |
| bin_size      | character(1) An <i>optional</i> scalar indicating the image bin size in microns, e.g., '008' for 8 microns. When provided, the function will look for a subfolder in the <code>binned_outputs</code> folder that corresponds to the specified bin size, e.g., <code>square_008um</code> for an input value of '008'. Bin sizes '002', '008', and '016' are typical of the space ranger pipeline but custom bin sizes may be used. If the <code>bin_size</code> argument is not provided, it is set to an empty character value i.e., "" and the function will not look for any data in <code>binned_outputs</code> and will only import data from the main <code>spacerangerOut</code> directory. |
| loadImage     | logical(1) A single logical value indicating whether to load the image data into the resulting <code>SpatialExperiment</code> object. This argument requires the <code>magick</code> package.   |
| ...           | Parameters to pass to the format-specific method.   |
| con           | The connection from which data is loaded or to which data is saved. If this is a character vector, it is assumed to be a file name and a corresponding file connection is created and then closed after exporting the object. If it is a <a href="#">BiocFile</a> derivative, the data is loaded from or saved to the underlying resource. If missing, the function will return the output as a character vector, rather than writing to a connection.  |
| format        | The format of the output. If missing and <code>con</code> is a file name, the format is derived from the file extension. This argument is unnecessary when <code>con</code> is a derivative of <a href="#">BiocFile</a> .   |
| text          | If <code>con</code> is missing, this can be a character vector directly providing the string data to import.  |

**Details**

Typically, the user will not create an object of this class directly but rather use the `TENxVisium()` constructor function to create an object of this class.

**Value**

A `SpatialExperiment` object

**Methods (by generic)**

- `import(con = TENxSpatialList, format = ANY, text = ANY)`: Import a `TENxSpatialList` object

**Slots**

`images` `character()` The image name(s) to use with `grep` and include in the list of files. Can be one of "lowres", "hires", "lowres", "hires", "detected", "aligned", "aligned\_fiducials", or "cytassist".

`scaleJSON` `character(1)` The file name of the scale factors JSON file, defaults to 'scalefactors\_json.json'.

`tissuePos` `character(1)` An optional slot indicating the file name of the tissue positions file; typically a .parquet or .csv file. To avoid import, this slot can be set to an empty character value i.e., "".

`sampleId` `character(1)` A scalar specifying the sample identifier.

`binSize` `character(1)` An optional slot to store the image bin size when importing. The default slot value is an empty character i.e., "". When present, the value must be a character scalar, e.g., '008' for 8 microns, and will match the directory name e.g., square\_008um.

`loadImage` `logical(1)` Whether to load the images into memory as `SpatialImage` objects. If `FALSE`, the images are stored as file paths and loaded as `StoredSpatialImage` objects when the `TENxSpatialList` object is imported. The default is `FALSE` to avoid loading large images into memory. This functionality requires the `magick` package.

**Examples**

```
spatial_dir <- system.file(
  file.path("extdata", "10xVisium", "section1", "outs", "spatial"),
  package = "VisiumIO"
)
```

```
TENxSpatialList(resources = spatial_dir, images = "lowres")
```

```
TENxSpatialList(resources = spatial_dir, images = "lowres") |>
  metadata() |> lapply(names)
```

```
TENxSpatialList(resources = spatial_dir, images = "lowres") |>
  import()
```

---

TENxSpatialParquet-class

*Represent and import spatial Parquet data from 10X Genomics*

---

## Description

TENxSpatialParquet is a class to represent and import spatial Parquet files with specific column names. It is a composed class of [TENxIO::TENxFile](#) and contains additional slots for the column names and whether the Parquet is a list-type of file.

## Usage

```
TENxSpatialParquet(resource, colnames)
```

```
## S4 method for signature 'TENxSpatialParquet,ANY,ANY'
import(con, format, text, ...)
```

## Arguments

|          |  |
|----------|--|
| resource | character(1) The path to the file  |
| colnames | character() A vector specifying the column names of the Parquet, defaults to all columns in the dataset.   |
| con      | The connection from which data is loaded or to which data is saved. If this is a character vector, it is assumed to be a file name and a corresponding file connection is created and then closed after exporting the object. If it is a <a href="#">BiocFile</a> derivative, the data is loaded from or saved to the underlying resource. If missing, the function will return the output as a character vector, rather than writing to a connection. |
| format   | The format of the output. If missing and con is a file name, the format is derived from the file extension. This argument is unnecessary when con is a derivative of <a href="#">BiocFile</a> .  |
| text     | If con is missing, this can be a character vector directly providing the string data to import.  |
| ...      | Additional inputs to the low level class generator functions   |

## Details

Typically, the user will not create an object of this class directly but rather use the [TENxVisium\(\)](#) constructor function to create an object of this class in the background. The column names are set to the default values of `c("barcode", "in_tissue", "array_row", "array_col", "pxl_row_in_fullres", "pxl_col_in_fullres")`. The column names can be changed by specifying the `colnames` argument in the constructor function.

## Value

`TENxSpatialParquet()`: An object of class [TENxSpatialParquet](#)

`import-method`: A tibble object containing the data from the Parquet file

**Examples**

```

sample_dir <- system.file(
  file.path("extdata", "binned_outputs", "square_002um", "spatial"),
  package = "VisiumIO"
)
spatial_dir <- Filter(
  function(x) endsWith(x, "spatial"), list.dirs(sample_dir)
)
parquetres <- file.path(spatial_dir, "tissue_positions.parquet")
TENxSpatialParquet(parquetres)
TENxSpatialParquet(parquetres) |>
  import()

## metadata in attributes
TENxSpatialParquet(parquetres) |>
  import() |>
  attr("metadata") |>
  lapply(names)

```

---

|                  |   |
|------------------|---|
| TENxVisium-class | <i>A class to represent and import a single Visium Sample</i> |
|------------------|---|

---

**Description**

This class is a composed class of [TENxFileList](#) which can contain a list of [TENxFile](#) objects and a [TENxSpatialList](#) object. It is meant to handle a single Visium sample from 10X Genomics.

**Usage**

```

TENxVisium(
  resources,
  spatialResource,
  spacerangerOut,
  sample_id = "sample01",
  processing = c("filtered", "raw"),
  format = c("mtx", "h5"),
  images = c("lowres", "hires", "detected", "aligned", "cytassist"),
  jsonFile = .SCALE_JSON_FILE,
  tissuePattern = "tissue_positions.*\\.csv",
  spatialCoordsNames = c("pxl_col_in_fullres", "pxl_row_in_fullres"),
  loadImage = FALSE,
  ...
)

## S4 method for signature 'TENxVisium,ANY,ANY'
import(con, format, text, ...)

```

**Arguments**

**resources** A [TENxFileList](#) object or a file path to the tarball containing the matrix / assay data resources.

|                    |  |
|--------------------|--|
| spatialResource    | A <a href="#">TENxSpatialList</a> object or a file path to the tarball containing the spatial data.  |
| spacerangerOut     | character(1) A single string specifying the path to the directory where the output of spaceranger count is located; typically (but not necessarily), this is the outs directory. The directory must contain the (processing)_feature_bc_matrix and spatial sub directories.  |
| sample_id          | character(1) A single string specifying the sample ID.   |
| processing         | character(1) A single string indicating the processing folder available e.g., "filtered_feature_barcode_matrix" in the spacerangerOut folder. It can be either "filtered" or "raw" (default "filtered"). Only used when spacerangerOut is specified.   |
| format             | The format of the output. If missing and con is a file name, the format is derived from the file extension. This argument is unnecessary when con is a derivative of <a href="#">BiocFile</a> .  |
| images             | character() A vector specifying the images to be imported; can be one or multiple of "lowres", "hires", "detected", "aligned".   |
| jsonFile           | character(1) A single string specifying the name of the JSON file containing the scale factors.  |
| tissuePattern      | character(1) A single string specifying the pattern to match the tissue positions file.  |
| spatialCoordsNames | character() A vector of strings specifying the names of the columns in the spatial data containing the spatial coordinates.  |
| loadImage          | logical(1) A single logical value indicating whether to load the image data into the resulting SpatialExperiment object. This argument requires the magick package.  |
| ...                | In the constructor, additional arguments passed to <a href="#">TENxFileList</a> ; otherwise, not used.   |
| con                | The connection from which data is loaded or to which data is saved. If this is a character vector, it is assumed to be a file name and a corresponding file connection is created and then closed after exporting the object. If it is a <a href="#">BiocFile</a> derivative, the data is loaded from or saved to the underlying resource. If missing, the function will return the output as a character vector, rather than writing to a connection. |
| text               | If con is missing, this can be a character vector directly providing the string data to import.  |

### Details

Typically, the user will not create an object of this class directly but rather use [TENxVisiumList](#) constructor function for multiple samples. Note that the images, jsonFile, tissuePattern, and spatialCoordsNames arguments are only considered when the spacerangerOut argument or both the resources and spatialResource arguments are paths to files.

### Value

A [SpatialExperiment](#) object

### Functions

- `import(con = TENxVisium, format = ANY, text = ANY)`: Import Visium data

**Slots**

resources A [TENxFileList](#) or [TENxH5](#) object containing the Visium data.

spatialList A [TENxSpatialList](#) object containing the spatial

coordNames character() A vector specifying the names of the columns in the spatial data containing the spatial coordinates.

sampleId character(1) A scalar specifying the sample identifier.

loadImage logical(1) Whether to load the images into memory as SpatialImage objects. If FALSE, the images are stored as file paths and loaded as StoredSpatialImage objects when the TENxSpatialList object is imported. The default is FALSE to avoid loading large images into memory. This functionality requires the magick package.

**See Also**

<https://support.10xgenomics.com/spatial-gene-expression/software/pipelines/latest/output/overview>

**Examples**

```
outs_dir <- system.file(
  file.path("extdata", "10xVisium", "section1", "outs"),
  package = "VisiumIO"
)

## using spacerangerOut folder
tv <- TENxVisium(
  spacerangerOut = outs_dir, processing = "raw", images = "lowres"
)

import(tv)

## with TENxFileList spacerangerOut input
tvfl <- TENxVisium(
  spacerangerOut = TENxFileList(outs_dir),
  format = "mtx",
  processing = "raw",
  images = "lowres"
)

import(tvfl)

## check metadata of the object
import(tvfl) |>
  metadata() |>
  lapply(names)

## importing h5 format
tvfl <- TENxVisium(
  spacerangerOut = outs_dir,
  format = "h5",
  processing = "raw",
  images = "lowres"
)

import(tvfl)
```

```

rffolder <- file.path(outs_dir, "raw_feature_bc_matrix")
## using resources and spatialResource inputs
tvfl <- TENxVisium(
  resources = rffolder,
  spatialResource = file.path(dirname(rffolder), "spatial"),
  format = "mtx",
  processing = "raw",
  images = "lowres"
)

import(tvfl)

```

---

TENxVisiumHD-class      *A class to represent and import multiple Visium HD samples*

---

## Description

This class contains a `SimpleList` of `TENxVisiumHD` objects each corresponding to one sample. The provided `spacerangerOut` folder should contain a `binned_outputs` folder where multiple `bin_size` subfolders are present, e.g., `square_002um`. Note that the `sf` package is required to import cell segmentation and nucleus segmentation data. If the `sf` package is not installed, the cell segmentation data will not be imported and an error is issued.

## Usage

```

TENxVisiumHD(
  resources,
  spatialResource,
  spacerangerOut,
  segmented_outputs,
  sample_id = "sample01",
  processing = c("filtered", "raw"),
  format = c("mtx", "h5"),
  images = c("lowres", "hires", "detected", "aligned_fiducials"),
  bin_size = c("008", "016", "002"),
  jsonFile = .SCALE_JSON_FILE,
  tissuePattern = "tissue_positions\\.parquet",
  spatialCoordsNames = c("pxl_col_in_fullres", "pxl_row_in_fullres"),
  mappingPattern = "barcode_mappings\\.parquet",
  boundary = c("cell_segmentations", "nucleus_segmentations", "both"),
  loadImage = FALSE,
  ...
)

## S4 method for signature 'TENxVisiumHD,ANY,ANY'
import(con, format, text, ...)

```

## Arguments

`resources`      A `TENxFileList` object or a file path to the tarball containing the matrix / assay data resources.

|                    |   |
|--------------------|---|
| spatialResource    | A <a href="#">TENxSpatialList</a> object or a file path to the tarball containing the spatial data.   |
| spacerangerOut     | character(1) A single string specifying the path to the directory where the output of spaceranger count is located; typically (but not necessarily), this is the outs directory. The directory must contain the (processing)_feature_bc_matrix and spatial sub directories.   |
| segmented_outputs  | character(1) The path to the segmented_outputs directory  |
| sample_id          | character(1) A single string specifying the sample ID.  |
| processing         | character(1) A single string indicating the processing folder available e.g., "filtered_feature_barcode_matrix" in the spacerangerOut folder. It can be either "filtered" or "raw" (default "filtered"). Only used when spacerangerOut is specified.  |
| format             | The format of the output. If missing and con is a file name, the format is derived from the file extension. This argument is unnecessary when con is a derivative of <a href="#">BiocFile</a> .   |
| images             | character() A vector specifying the images to be imported; can be one or multiple of "lowres", "hires", "detected", "aligned".  |
| bin_size           | character(1) An <i>optional</i> scalar indicating the image bin size in microns, e.g., '008' for 8 microns. When provided, the function will look for a subfolder in the binned_outputs folder that corresponds to the specified bin size, e.g., square_008um for an input value of '008'. Bin sizes '002', '008', and '016' are typical of the space ranger pipeline but custom bin sizes may be used. If the bin_size argument is not provided, it is set to an empty string "" and the function will not look for any data in binned_outputs and will only import data from the main spacerangerOut directory. |
| jsonFile           | character(1) A single string specifying the name of the JSON file containing the scale factors.   |
| tissuePattern      | character(1) A single string specifying the pattern to match the tissue positions file.   |
| spatialCoordsNames | character() A vector of strings specifying the names of the columns in the spatial data containing the spatial coordinates.   |
| mappingPattern     | character(1) The pattern used in list.files that identifies the mapping file. The default is "barcode_mappings\\.parquet".  |
| boundary           | character(1) The type of segmentation boundary to use. The options are "cell_segmentations" (default), "nucleus_segmentations", or "both". When "both" is specified, "cell_segmentations" are added to the spatialCoords and the nucleus_segmentations centroids (labeled x.nuc and y.nuc) are added to the colData of the returned object.   |
| loadImage          | logical(1) A single logical value indicating whether to load the image data into the resulting SpatialExperiment object. This argument requires the magick package.   |
| ...                | In the constructor, additional arguments passed to <a href="#">TENxFileList</a> ; otherwise, not used.  |
| con                | The connection from which data is loaded or to which data is saved. If this is a character vector, it is assumed to be a file name and a corresponding file connection is created and then closed after exporting the object. If it is a <a href="#">BiocFile</a> derivative, the data is loaded from or saved to the underlying resource.  |

|      |   |
|------|---|
|      | If missing, the function will return the output as a character vector, rather than writing to a connection. |
| text | If con is missing, this can be a character vector directly providing the string data to import.             |

### Details

Typically, the user will provide a path to a directory containing the output of the `spaceranger count` command. The `spaceranger count` command outputs a folder containing the "raw" or "filtered" `()_feature_bc_matrix`.

Note that `nucleus_segmentations.geojson` file must be in the same folder as the `cell_segmentations.geojson` file for the nucleus centroids to be imported correctly when selecting the "both" for the boundary argument.

### Value

A [SpatialExperiment](#) object

### Functions

- `import(con = TENxVisiumHD, format = ANY, text = ANY)`: Import Visium HD data from multiple bin sizes

### Author(s)

E. Y. Dong, M. Ramos

### Examples

```
vdir <- system.file(
  "extdata", package = "VisiumIO", mustWork = TRUE
)

## with spacerangerOut folder
TENxVisiumHD(spacerangerOut = vdir, bin_size = "002", images = "lowres")

TENxVisiumHD(spacerangerOut = vdir, bin_size = "002", images = "lowres") |>
  import()

## indicate h5 format
TENxVisiumHD(
  spacerangerOut = vdir, bin_size = "002",
  images = "lowres", format = "h5"
)

TENxVisiumHD(
  spacerangerOut = vdir, bin_size = "002",
  images = "lowres", format = "h5"
) |>
  import()

## use resources and spatialResource arguments as file paths
TENxVisiumHD(
  resources = file.path(
    vdir, "binned_outputs", "square_002um",
```

```

        "filtered_feature_bc_matrix.h5"
    ),
    spatialResource = file.path(
        vdir, "binned_outputs", "square_002um",
        "spatial"
    ),
    bin_size = "002", processing = "filtered",
    images = "lowres", format = "h5"
) |>
import()

## provide the spatialResource argument as a TENxFileList
TENxVisiumHD(
    resources = file.path(
        vdir, "binned_outputs", "square_002um",
        "filtered_feature_bc_matrix.h5"
    ),
    spatialResource = TENxFileList(
        file.path(
            vdir, "binned_outputs", "square_002um",
            "spatial"
        )
    ),
    bin_size = "002", images = "lowres", format = "h5"
) |>
import()

## with segmented_outputs folder
seg_outs <- system.file(
    "extdata", "segmented_outputs", package = "VisiumIO", mustWork = TRUE
)
TENxVisiumHD(
    segmented_outputs = seg_outs,
    format = "h5",
    images = "lowres"
) |>
import()

```

---

TENxVisiumList-class *A class to represent and import multiple Visium samples*

---

## Description

This class contains a SimpleList of [TENxVisium](#) objects each corresponding to one sample.

## Usage

```

TENxVisiumList(
    sampleFolders,
    sample_ids,
    processing = c("filtered", "raw"),
    images = c("lowres", "hires", "detected", "aligned"),
    format = c("mtx", "h5"),

```

```

    jsonFile = .SCALE_JSON_FILE,
    tissuePattern = "tissue_positions.*\\.csv",
    spatialCoordsNames = c("pxl_col_in_fullres", "pxl_row_in_fullres"),
    ...
)

## S4 method for signature 'TENxVisiumList,ANY,ANY'
import(con, format, text, ...)

```

### Arguments

|                    |              |  |
|--------------------|--------------|--|
| sampleFolders      | character()  | A vector of strings specifying the directories containing the output of the <code>spaceranger count</code> command.  |
| sample_ids         | character()  | A vector of strings specifying the sample IDs. If not provided, the sample IDs will be the names of the <code>sampleFolders</code> . Therefore, the <code>sample_ids</code> must be the same length as <code>sampleFolders</code> .  |
| processing         | character(1) | A single string indicating the processing folder available e.g., <code>"filtered_feature_barcode_matrix"</code> in the <code>spacerangerOut</code> folder. It can be either <code>"filtered"</code> or <code>"raw"</code> (default <code>"filtered"</code> ). Only used when <code>spacerangerOut</code> is specified.   |
| images             | character()  | A vector specifying the images to be imported; can be one or multiple of <code>"lowres"</code> , <code>"hires"</code> , <code>"detected"</code> , <code>"aligned"</code> .   |
| format             |              | The format of the output. If missing and <code>con</code> is a file name, the format is derived from the file extension. This argument is unnecessary when <code>con</code> is a derivative of <a href="#">BiocFile</a> .  |
| jsonFile           | character(1) | A single string specifying the name of the JSON file containing the scale factors.   |
| tissuePattern      | character(1) | A single string specifying the pattern to match the tissue positions file.   |
| spatialCoordsNames | character()  | A vector of strings specifying the names of the columns in the spatial data containing the spatial coordinates.  |
| ...                |              | In the constructor, additional arguments passed to <a href="#">TENxFileList</a> ; otherwise, not used.   |
| con                |              | The connection from which data is loaded or to which data is saved. If this is a character vector, it is assumed to be a file name and a corresponding file connection is created and then closed after exporting the object. If it is a <a href="#">BiocFile</a> derivative, the data is loaded from or saved to the underlying resource. If missing, the function will return the output as a character vector, rather than writing to a connection. |
| text               |              | If <code>con</code> is missing, this can be a character vector directly providing the string data to import.   |

### Details

Typically, the user will provide a path to a directory containing the output of the `spaceranger count` command. The `spaceranger count` command outputs a folder containing the `"raw"` or `"filtered"` `()_feature_bc_matrix`.

**Value**

A [SpatialExperiment](#) object

**Functions**

- `import(con = TENxVisiumList, format = ANY, text = ANY)`: Import multiple Visium samples

**See Also**

<https://support.10xgenomics.com/spatial-gene-expression/software/pipelines/latest/output/overview>

**Examples**

```
sample_dirs <- list.dirs(
  system.file(
    file.path("extdata", "10xVisium"),
    package = "VisiumIO"
  ),
  recursive = FALSE, full.names = TRUE
)

tv1 <- TENxVisiumList(
  sampleFolders = sample_dirs,
  sample_ids = c("sample01", "sample02"),
  processing = "raw",
  images = "lowres",
  format = "mtx"
)

import(tv1)
```

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