Package ‘tractor.base’

February 27, 2024

Version  3.4.2
Date  2024-02-27
Title  Read, Manipulate and Visualise Magnetic Resonance Images
Author  Jon Clayden
Maintainer  Jon Clayden <code@clayden.org>
Imports  methods, ore (>= 1.3.0), reportr, shades, RNifti
Suggests  mmmand, loder, divest, jsonlite, yaml, tinytest
Enhances  oro.nifti
Description  Functions for working with magnetic resonance images. Reading and writing of popular file formats (DICOM, Analyze, NIfTI-1, NIfTI-2, MGH); interactive and non-interactive visualisation; flexible image manipulation; metadata and sparse image handling.
Encoding  UTF-8
License  GPL-2
BugReports  https://github.com/tractor/tractor/issues
RoxygenNote  7.2.3
NeedsCompilation  no
Repository  CRAN
Date/Publication  2024-02-27 19:40:02 UTC

R topics documented:

  allEqual ................................................................. 2
  asMriImage ............................................................. 3
  augmentedInfoPanel .................................................... 5
  createNeighbourhoodInfo ............................................. 6
  createSliceGraphic ..................................................... 7
  deduplicate ............................................................ 9
  DicomMetadata-class .................................................. 10
allEqual

Test whether all elements of a vector are equal

Description

This function tests whether all elements of the specified vector are equal to each other, i.e., whether the vector contains only a single unique value. For lists, equality is determined using equivalent.

Usage

allEqual(x, ignoreMissing = FALSE, ...)

Index

allEqual  Test whether all elements of a vector are equal
asMriImage

Arguments

- \( x \) A vector of any mode, including a list.
- \( \text{ignoreMissing} \) If TRUE, missing elements will be ignored. Otherwise the presence of missing values will result in a return value of FALSE.
- ... Additional arguments to `all.equal`, via `equivalent`.

Value

TRUE if all elements test equivalent; FALSE otherwise.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:


See Also

equivalent for elementwise equivalence of two vectors.

Examples

```r
allEqual(c(1,1,1)) # TRUE
allEqual(c(1,1,NA)) # FALSE
allEqual(c(1,1,NA), ignoreMissing=TRUE) # TRUE
```

Description

Functions for creating MriImage objects from data, including other images. All of these functions use data from arrays or MriImage objects to create a new MriImage object. `asMriImage` is the basic function for creating an object from its constituents: an array of voxel values and some metadata (and/or a template image).
Usage

asMriImage(data, templateImage = nilObject(), imageDims = NA,
voxelDims = NA, voxelDimUnits = NA, origin = NA, tags = NA,
reordered = NA)

extractMriImage(image, dim, loc)

trimMriImage(image, clearance = 4, indices = NULL)

reorderMriImage(image)

Arguments

data
An array of pixel/voxel data.

templateImage
An optional MriImage object, to be used as a metadata template.

imageDims, voxelDims, voxelDimUnits, origin, tags, reordered
Metadata for the new image object. These values override any from the metadata
object or data array. See MriImage class documentation for details.

image
An MriImage object.

dim, loc
The dimension and location along that dimension for which data should be ex-
tracted.

clearance
The number of voxels' clearance left around a trimmed image.

indices
A list of indices to keep along each dimension. Determined from the specified
clearance if NULL.

Details

eextractMriImage reduces the dimensionality of the source image by one, by extracting a sin-
gle “slice” of data along one dimension. trimMriImage trims empty space from the edges of
an image, reducing the dimensions of the image and thus avoiding the storage of lots of zeroes.
reorderMriImage reorders the image data (and corresponding metadata) to the LAS convention,
an operation which is usually performed when an image is read from file.

Value

An MriImage object.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

J.D. Clayden, S. Muñoz Maniega, A.J. Storkey, M.D. King, M.E. Bastin & C.A. Clark (2011). Trac-
toR: Magnetic resonance imaging and tractography with R. Journal of Statistical Software 44(8):1-
18. doi:10.18637/jss.v044.i08.
See Also

MriImage

augmentedInfoPanel

A simple interactive viewer for MriImage objects

Description

The viewImages function provides a simple interactive viewer for MriImage objects. 3D and 4D images may be used.

Usage

augmentedInfoPanel(indexNames = NULL)

polarPlotPanel(directions, bValues = NULL)

viewImages(images, colourScales = NULL, point = NULL, interactive = TRUE,
crosshairs = TRUE, orientationLabels = TRUE,
infoPanel = RNifti::defaultInfoPanel, ...)

Arguments

indexNames A list whose elements are either NULL or a named character vector giving the names associated with each index in the image.
directions A matrix of 3D acquisition direction vectors, one per row.
bValues A vector of b-values, if the image is diffusion-weighted.
images An MriImage object, or list of MriImage objects.
colourScales A list of colour scales to use for each image, which will be recycled to the length of images. See getColourScale for details. The default is to use greyscale.
point A length-3 integer vector giving the initial location of the crosshairs, in voxels.
interactive A single logical value. If TRUE, the plot is interactive.
crosshairs A single logical value. If TRUE, the crosshairs are displayed.
orientationLabels A single logical value. If TRUE, orientation labels are displayed.
infoPanel A function with at least three arguments, which must plot something to fill the bottom-right panel of the viewer after each change of crosshair location. The three mandatory arguments correspond to the current location in the image, the image values at that location, and the names of each image. The defaultInfoPanel and timeSeriesPanel functions from package RNifti are valid examples.
...

Additional arguments to infoPanel.
Value

These functions are called for their side effects.

Note

The `defaultInfoPanel` and `timeSeriesPanel` functions are not intended to be called directly. They are simple examples of valid values for the `infoPanel` argument to `viewImages`.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:


See Also

`getColourScale`

---

**createNeighbourhoodInfo**

*Image neighbourhoods*

**Description**

This function calculates information about a cuboidal region of an image, with a centre and a fixed voxel width.

**Usage**

```r
createNeighbourhoodInfo(width, dim = 3, centre = rep(0, dim))
```

**Arguments**

- `width`: An integer voxel width. Must be odd.
- `dim`: An integer giving the dimensionality of the neighbourhood. Currently must be 3.
- `centre`: A numeric vector giving the centre voxel of the neighbourhood. Must have exactly `dim` elements.
createSliceGraphic

Value

createNeighbourhoodInfo returns a list with class "neighbourhoodInfo" and elements

- **width**: Copied from the width argument.
- **dim**: Copied from the dim argument.
- **centre**: Copied from the centre argument.
- **vectors**: \( \text{dim} \times \text{width} \times \text{dim} \) matrix whose columns give the locations of each point in the neighbourhood.
- **innerProducts**: A square, symmetric matrix of inner products between every location in the neighbourhood and every other.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:


createSliceGraphic  Visualise MriImage objects

Description

Visualise MriImage objects noninteractively using an R graphics device. See viewImages for an interactive alternative. These functions create 2D visualisations of 3D images by slicing or maximum intensity projection.

Usage

```r
createSliceGraphic(image, x = NA, y = NA, z = NA,
                    device = c("internal", "png"), colourScale = 1, add = FALSE,
                    file = NULL, zoomFactor = 1, windowLimits = NULL)

createProjectionGraphic(image, axis, device = c("internal", "png"),
                        colourScale = 1, add = FALSE, file = NULL, zoomFactor = 1,
                        windowLimits = NULL)

createContactSheetGraphic(image, axis, device = c("internal", "png"),
                           colourScale = 1, add = FALSE, file = NULL, zoomFactor = 1,
                           windowLimits = NULL, clearance = NULL, nColumns = NULL)
```
createSliceGraphic

Arguments

- **image**: An `MriImage` object.
- **x, y, z**: Integer vectors, each of length 1. Exactly one of these must be specified to indicate the plane of interest.
- **device**: Either "internal" for display on the default graphics device, or "png" for creating PNG format image file(s). Abbreviations are fine.
- **colourScale**: A colour scale definition, of the sort generated by `getColourScale`.
- **add**: Overlay the graphic on a previous one. Used only when device is "internal".
- **file**: A file name, to be used when device is "png".
- **zoomFactor**: Factor by which to enlarge the image. Applies only when device is "png".
- **windowLimits**: Numeric vector of length 2 giving the limits of the colour scale, or NULL for limits matching the range of the image data. Passed as the zlim argument to `image`.
- **axis**: A vector of axes along which slice/projection images should be created. 1 is left-right, 2 is anterior-posterior, 3 is superior-inferior.
- **clearance**: Number of voxels' clearance to leave around each slice image in the contact sheet. Passed to `trimMriImage`.
- **nColumns**: Number of slices per row in the contact sheet grid. If NULL, the function will aim for a square grid.

Value

These functions are called for their side effects.

Note

When the device option is set to "png", the "png" and "mmand" packages are required by these functions.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

See Also

See `viewImages` for an interactive alternative, and `getColourScale` for details of how colour scales are specified. Also `image`, which is used as the underlying plot function.
**deduplicate**

---

**Concatenate and deduplicate vectors**

**Description**

This function returns its arguments, after concatenating them using `c` and then removing elements with duplicate names. The first element with each name will remain, possibly with subsequent elements’ content appended to it. Unnamed elements are retained.

**Usage**

```r
deduplicate(..., merge = FALSE)
```

**Arguments**

- `...` One or more vectors of any mode, usually named.
- `merge` If `FALSE`, the default, duplicate elements will simply be discarded. If `TRUE`, additional elements with the same name will be appended to the retained one. This does not apply to unnamed elements. If this kind of deduplication actually happens, the return value will be a list, regardless of the source type.

**Value**

The concatenated and deduplicated vector.

**Author(s)**

Jon Clayden

**References**

Please cite the following reference when using TractoR in your work:

**DicomMetadata-class**

*The DicomMetadata class*

**Description**

This class represents DICOM metadata, which typically contains detailed information about the scan parameters and subject.

**Fields**

- `source` String naming the source file
- `tags` Data frame of tag information
- `tagOffset` Starting offset for tags in the file
- `dataOffset` Starting offset for pixel data in the file
- `dataLength` Pixel data length
- `explicitTypes` Logical value indicating whether explicit types are used in the file
- `endianness` String naming the endianness of the file
- `asciiFields` Character vector containing the contents of the ASCII header, if requested and present in the file.
- `transferSyntax` Transfer syntax string, if specified in the file; otherwise the empty string.

**Methods**

- `getAsciiFields(regex = NULL)` Retrieve the value of one or more fields in the ASCII header. Returns NA if no fields match
- `getTagValue(group, element)` Retrieve the value of a given tag, using an appropriate R type. Returns NA if the tag is missing

---

**embrace**

*Combine similar strings into one*

**Description**

Merge a vector of strings with a common prefix and/or suffix into one string with the unique parts in braces, comma-separated.

**Usage**

`embrace(strings)`

**Arguments**

- `strings` A vector, which will be coerced to mode character.
emptyMatrix

Value
A single merged string, with the common prefix and suffix as attributes.

Author(s)
Jon Clayden

References
Please cite the following reference when using TractoR in your work:

Examples
embrace(c("image.hdr", "image.img"))

---

emptyMatrix | The empty matrix

Description
The empty matrix is a standard matrix of dimensions 0 x 0. It is intended to be used as a placeholder where a matrix is required but no information is stored.

Usage
emptyMatrix()

is.emptyMatrix(object)

Arguments
object | Any object.

Value
emptyMatrix returns the empty matrix, equivalent to matrix(NA,0,0). is.emptyMatrix returns TRUE if its argument is identical to the empty matrix.

Author(s)
Jon Clayden
References

Please cite the following reference when using TractoR in your work:


equivalent

Test two numeric vectors for equivalence

Description

This function is a wrapper for `isTRUE(all.equal(x, y, ...))`, but with the additional capability of doing sign-insensitive comparison.

Usage

equivalent(x, y, signMatters = TRUE, ...)

Arguments

- `x` The first numeric vector.
- `y` The second numeric vector.
- `signMatters` Logical value: if FALSE then equivalence in absolute value is sufficient.
- `...` Additional arguments to `all.equal`, notably `tolerance`.

Value

TRUE if all elements of `x` match all elements of `y` to within tolerance, ignoring signs if required.
FALSE otherwise.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:


See Also

- `all.equal`
Examples

equivalent(c(-1,1), c(1,1))  # FALSE
equivalent(c(-1,1), c(1,1), signMatters=FALSE)  # TRUE
equivalent(1:2, 2:3, tolerance=2)  # TRUE

fx

Shorthand anonymous functions

Description

These functions provide a shorthand route to simple anonymous functions.

Usage

fx(expr)

fxy(expr)

fxyz(expr)

fi(expr)

Arguments

expr A (single or compound) expression forming the body of the function.

Value

The function constructed.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

getColourScale

Description

The getColourScale function can be used to obtain a standard or customised colour scale for use in the package’s image visualisation functions.

Usage

getColourScale(n)

Arguments

n

A number, colour name or list (see Details).

Details

Colour scales can be specified in any of three ways. Firstly, by a single number, representing a predefined colour scale. Currently valid values are 1 (greyscale, black background), 2 (red to yellow heat scale, red background), 3 (blue to red rainbow scale, blue background), 4 (blue to white to red diverging scale, white background), 5 (white to red, white background), 6 (white to blue, white background), 7 (yellow to orange to red) and 8 (purple to green to yellow, perceptually uniform). Secondly, a single colour name can be given (see colours); in this case the background will be black. This is useful for binary images. Thirdly, and most flexibly, a list with two named elements can be given: colours, a vector of colours representing the colour scale, perhaps created using using the shades package; and background, a single colour representing the background.

Value

A list with elements

- colours  A character-mode vector representing the colours in the scale, usually of length 100. This can be passed as a colour scale to R’s plotting functions.
- background  A single character string representing the background colour.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

See Also

colours, rgb, colorRamp, and the shades package for colour manipulation.

Examples

gColourScale(1)
... For `identifyImageFileNames`, additional arguments to `resolvePath`. Elsewhere, additional arguments to `identifyImageFileNames`.

`overwrite` Logical value: overwrite an existing image file? For `writeImageFile`, an error will be raised if there is an existing file and this is set to FALSE.

`relative` Logical value: if TRUE, the path stored in the symlink will be relative (e.g. ".../some_dir/some_image.nii") rather than absolute (e.g. "/path/to/some_dir/some_image.nii")

`deleteOriginals` Logical value: if TRUE, `copyImageFiles` performs a move rather than a copy.

`metadataOnly` Logical value: if TRUE, only metadata are read into the object.

`volumes` An optional integer vector specifying a subset of volumes to read (generally to save memory). If given, only the requested volumes in the 4D file will be read.

`sparse` Logical value: should the image data be stored in a `SparseArray` object?

`mask` An optional `MriImage` object representing a mask, outside of which the image to be read should be considered to be zero. This can be used to save memory when only a small part of a large image is of interest. Ignored if `sparse` is not TRUE.

`reorder` Logical value: should the image data be reordered to LAS? This is recommended in most circumstances.

`image` An `MriImage` object.

`datatype` A datatype string, such as "uint8" or "float", specifying the pixel datatype to use when storing the data. If specified, this must be a type supported by the requested (or default) file format. The default, "fit", results in a datatype being chosen that is wide enough to fit the range of the data elements. An error will arise if there's no such type.

`writeTags` Logical value: should tags be written in YAML format to an auxiliary file?

Details

NIfTI and Analyze are related formats for storing magnetic resonance images. NIfTI is a more recent extension of Analyze, and contains more specific information about, for example, the orientation of the image. Its use is therefore recommended where possible. MGH format is used by the popular image processing package FreeSurfer, and MRtrix format by the software of the same name. These formats use a number of different file extensions, but the details are abstracted away from the user by these functions.

TractoR does not allow for files with the same basic name using multiple Analyze/NIfTI/ MGH/MRtrix formats in a single directory (e.g. "foo.nii" AND "foo.img"), and these functions will produce an error if multiple compatible files exist.

Suitable values for `fileType` (and the `tractorFileType` option, which is used as a default for writing) are "NIFTI", "NIFTI_PAIR" (the two-file NIfTI format), "MGH", and corresponding gzipped versions of these with "_GZ" appended. File types "ANALYZE" and "MRTRIX", and "_GZ" variants, are additionally available for reading only. "NIFTI_GZ" is the default value for the `tractorFileType` option, but that can be changed using a call to `options`, or by setting the TRACTOR_FILETYPE environment variable before loading the `tractor.base` package.

Since multiple files may be involved, copying, moving or symlinking images is not trivial. `copyImageFiles` and `symlinkImageFiles` are wrappers around the standard functions `file.copy` and `file.symlink` which handle this complexity.
Value

readImageFile returns an \texttt{MriImage} object. imageFileExists returns \texttt{TRUE} if an existing file with the specified name exists (all file extensions are checked), and \texttt{FALSE} otherwise. removeImageFiles returns the result of \texttt{unlink} applied to all relevant files. writeImageFile and identifyImageFileNames return a list with the following elements, describing the identified or written files:

\begin{description}
\item[fileStem] The file name without extension.
\item[headerFile] The full header file name.
\item[imageFile] The full image file name.
\item[format] The format of the files ("Nifti", "Analyze" or "Mgh"). Not returned by writeImageFile.
\end{description}

copyImageFiles and symlinkImageFiles are called for their side effects.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

See Also

The NIfTI-1 standard (http://nifti.nimh.nih.gov/nifti-1) and \texttt{MriImage}.

---

\textbf{implode}

\textit{Create a character string by concatenating the elements of a vector}

\textbf{Description}

Create a character string by concatenating the elements of a vector, using a separator and optional final separator.

\textbf{Usage}

\texttt{implode(strings, sep = "", finalSep = NULL, ranges = FALSE)}

\textbf{Arguments}

\begin{description}
\item[\texttt{strings}] A vector, which will be coerced to mode character.
\item[\texttt{sep}] A unit length character vector giving the separator to insert between elements.
\item[\texttt{finalSep}] An optional unit length character vector giving the separator to insert between the final two elements.
\item[\texttt{ranges}] Logical value. If \texttt{TRUE} and \texttt{strings} can be interpreted as integers, collapse runs of consecutive numbers into range notation.
\end{description}
indexList

Value

A character vector of length one.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

See Also

paste

Examples

```r
implode(1:3, ",\n") # "1, 2, 3"
implode(1:3, ",\", ", and ") # "1, 2 and 3"
implode(1:2, ",\", ", and ") # "1 and 2"
implode(1:3, ",\", ranges=TRUE) # "1-3"
```

__indexList__

Extract one or more elements from a list

Description

Given a list-like first argument, this function extracts one or more of its elements. Numeric and character indexing are allowed.

Usage

```r
indexList(list, index = NULL)
```

Arguments

- **list**: A list-like object, with a [[ indexing method.
- **index**: A vector of integers or strings, or NULL.

Value

If index is NULL, the whole list is returned. Otherwise, if index has length one, the corresponding element is extracted and returned. Otherwise a list containing the requested subset is returned.
Note
This function is not type-safe, in the sense that its return type depends on its arguments. It should therefore be used with care.

Author(s)
Jon Clayden

References
Please cite the following reference when using TractoR in your work:

infix
Resolve a variable to a default when NULL

Description
This is a very simple infix function for the common TractoR idiom whereby NULL is used as a default argument value, but later needs to be resolved to a meaningful value if not overridden in the call. It returns its first argument unless it is NULL, in which case it falls back on the second argument.

Usage
\[
X \ %|\ % \ Y
\]

Arguments
\[
X, \ Y
\]
R objects, possibly NULL.

Value
\[
X, \text{ if it is not } \text{NULL}; \text{ otherwise } Y.
\]

Author(s)
Jon Clayden

References
Please cite the following reference when using TractoR in your work:
See Also

where, which resolves a value if an expression is TRUE. Several calls to that function can be conveniently chained together with this one.

isDeserialisable Reference object serialisation and deserialisation

Description

Rather than using R’s save and load functions directly for reference objects, TractoR uses the SerialisableObject class and these functions to save and load objects. The main difference is that this approach stores only the data in the object, and not the functions which operate on them. This helps backward compatibility when new member functions are added.

Usage

isDeserialisable(object, expectedClass = NULL)

serialiseReferenceObject(object, file = NULL)

deserialiseReferenceObject(file = NULL, object = NULL, raw = FALSE)

registerDeserialiser(className, deserialiser)

Arguments

object For serialiseReferenceObject, a list or object inheriting from SerialisableObject. For other functions, an object in (raw) serialised form. See Details.

expectedClass A class name which the object is expected to inherit. Any class is acceptable if this parameter is NULL.

file A file name to deserialise from.

raw If TRUE, the raw serialised object is returned; otherwise the object is converted back to its original class.

className A string naming a class to be handled by the specified deserialiser.

deserialiser A function taking as its argument a list of serialised fields, and returning a suitable deserialised object.

Details

The serialiseReferenceObject function, or the serialise member function of the SerialisableObject class can be used to create and/or save a version of an object which contains a hierarchical representation of the data embedded in it. These serialised objects are standard R lists, with an “originalClass” attribute describing the class of the original object. The deserialiseReferenceObject function can be used to deserialise them. Custom deserialisers can be specified using registerDeserialiser, typically for legacy classes.
Note that this should generally NOT be used as the primary mechanism for saving and loading \texttt{MriImage} objects. Saving to standard NIfTI/Analyze format is usually preferable, and can be done using \texttt{writeImageFile}.

**Value**

\texttt{isDeserialisable} returns \texttt{TRUE} if the object is deserialisable and inherits from the specified class. \texttt{deserialiseReferenceObject} returns a raw or reconstituted object after deserialisation.

**Author(s)**

Jon Clayden

**References**

Please cite the following reference when using TractoR in your work:


**See Also**

\texttt{SerialisableObject, save, load, writeImageFile}.

\begin{knitrout}
\definecolor{shadecolor}{rgb}{1,1,1}
\begin{tabular}{ll}
\textbf{locateExecutable} & \emph{Find or run an external executable file} \\
\hline
\end{tabular}
\end{knitrout}

**Description**

The execute function is a wrapper around the \texttt{system2} function in base, which additionally echoes the command being run (including the full path to the executable) if the reportr output level is Debug. \texttt{locateExecutable} simply returns the path to an executable file on the system \texttt{PATH}.

**Usage**

\begin{verbatim}
locateExecutable(fileName, errorIfMissing = TRUE)
execute(executable, params = NULL, errorOnFail = TRUE, silent = FALSE, ...
\end{verbatim}

**Arguments**

\begin{verbatim}
executable, fileName
    Name of the executable to run.
params
    A character vector giving the parameters to pass to the executable, if any. Elements will be separated by a space.
errorOnFail, errorIfMissing
    Logical value: should an error be produced if the executable can’t be found?
\end{verbatim}
silent Logical value: should the executable be run without any output?
...
Additional arguments to system.

Value
For execute, the return value of the underlying call to system2. For locateExecutable, the location of the requested executable, or NULL if it could not be found.

Note
These functions are designed for Unix systems and may not work on Windows.

Author(s)
Jon Clayden

References
Please cite the following reference when using TractoR in your work:

See Also
system2

mergeMriImages Merging MriImage objects

Description
This function concatenates the data from a series of MriImage objects, and then attempts to work out the final dimensions of the merged image and returns it.

Usage
mergeMriImages(..., bindDim = NULL, padTags = FALSE)

Arguments
...
MriImage objects. They do not need to have the same dimensionality.
bindDim
An integer specifying the dimension along which to bind the data, or NULL (the default). The latter case resolves to one number higher than the last dimension common to all images.
padTags
Logical value. If TRUE, NAs will be used to pad tags which appear to be partially missing in the merged dataset. If FALSE, incomplete tags will be dropped.
MriImage-class

Value
A merged image.

Note
Tags are retained as-is if they are identical in each image. Otherwise they are concatenated if their lengths match the number of blocks in each image, or concatenated with NAs for missing values if padTags is TRUE.

Author(s)
Jon Clayden

References
Please cite the following reference when using TractoR in your work:

See Also
MriImage

MriImage-class

The MriImage class

Description
This class represents an MRI image. An object of this class is made up of some voxel data, stored as a sparse or dense numeric array, and some metadata, such as the file it was read from, the voxel dimensions, and so on. The group generic functions Math, Ops and Summary are defined for this class, as are methods for coercing to and from a standard array.

Fields
imageDims Integer vector of dimensions
voxelDims Numeric vector of pixel/voxel spacings
voxelDimUnits Character vector of spatial and/or temporal spacing units. Millimetres and seconds (i.e., c("mm","s")) are typical
source String naming the file(s) that the image was read from. This is reset to the empty string if the image is modified
origin Numeric vector giving the spatial coordinate origin
xform Numeric matrix giving the NIfTI-style xform matrix associated with the image, which indicates its orientation
newSparseArrayWithData

Create a SparseArray object

Description

This function creates a SparseArray object from its constituent parts.

Usage

newSparseArrayWithData(data, coordinates, dims)
nilObject

Arguments

data
A vector of (nonzero) array elements.
coordinates
A matrix with as many rows as data has elements, containing the coordinates of each nonzero element in the array.
dims
The dimensions of the array.

Value

A SparseArray object.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

---

nilObject  The nil object

Description

The nil object is an empty object of class SerialisableObject. It can be used as a placeholder where such an object of this class, or one of its subclasses, is required. It serialises to the empty list.

Usage

nilObject()

is.nilObject(object)

Arguments

object
Any object.

Value

nilObject returns the nil object. is.nilObject returns TRUE if its argument is identical to the nil object, or if it is equivalent in the sense of serialising to an identical result.

Author(s)

Jon Clayden
pluralise

Number agreement with a vector

Description

This function chooses the singular or plural form of a word based on the length of an associated vector, or an integer.

Usage

pluralise(singular, x = NULL, n = NULL, plural = NULL)

Arguments

singular The singular form of the word.  
x A vector of any mode, whose length is used to choose the correct word form, unless n is specified.  
n An integer which is used to choose the correct word form (singular if n = 1, plural otherwise). Take priority over x if not NULL.  
plural The plural form of the word. If NULL, an ‘s’ is simply appended to the singular form.

Value

Either singular or plural, as appropriate.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

**printLabelledValues**

Pretty print labelled information

### Description

This is a simple function to print a series of labels and associated data values, or key-value pairs.

### Usage

```r
printLabelledValues(labels, values, outputLevel = OL$Info,
                     leftJustify = FALSE)
```

### Arguments

- **labels**: A character vector of labels.
- **values**: A character vector of values. Must have the same length as `labels`.
- **outputLevel**: The output level to print the output to. See `setOutputLevel`, in the reportr package.
- **leftJustify**: Logical value: if TRUE the labels will be left justified; otherwise they will be right justified.

### Value

This function is called for its side effect.

### Author(s)

Jon Clayden

### References

Please cite the following reference when using TractoR in your work:


### See Also

`setOutputLevel` for the reportr output level system.
The `promote` function promotes a vector argument to a single-column or single-row matrix. Matrix arguments are returned unmodified.

Usage

```
promote(x, byrow = FALSE)
```

Arguments

- `x`: A vector or matrix.
- `byrow`: Logical value: if TRUE, a vector will be promoted to a single-row matrix; otherwise a single-column matrix will result.

Value

A matrix version of the `x` argument.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:


See Also

`matrix`
**readDicomDirectory**  
*Read a directory of DICOM files*

**Description**
This function scans a directory for files in DICOM format, and converts them to a single Analyze/NIfTI-format image of the appropriate dimensionality.

**Usage**
```
readDicomDirectory(dicomDir, method = c("internal", "divest"),
                   readDiffusionParams = FALSE, untileMosaics = TRUE, ...)
```

**Arguments**
- `dicomDir` Character vector of length one giving the name of a directory containing DICOM files.
- `method` Character string specifying whether to use the internal DICOM reading code or use the `divest` package.
- `readDiffusionParams` Logical value. Should diffusion MRI parameters (b-values and gradient directions) be retrieved from the files if possible?
- `untileMosaics` Logical value. Should Siemens mosaic images be converted into 3D volumes? This may occasionally be performed in error, which can be prevented by setting this value to `FALSE`.
- `...` Additional arguments to `readDicom`, if the `divest` method is used.

**Value**
A list containing elements

- **image** An `MriImage` object.
- **bValues** Diffusion b-values, if requested. Will be `NA` if the information could not be found in files.
- **bVectors** Diffusion gradient vectors, if requested. Will be `NA` if the information could not be found in the files.

**Author(s)**
Jon Clayden

**References**
Please cite the following reference when using TractoR in your work:
Description

This function reads a DICOM file into a `DicomMetadata` object. Only DICOM files from magnetic resonance scanners are supported.

Usage

```r
readDicomFile(fileName, checkFormat = TRUE, stopTag = NULL,
               ignoreTransferSyntax = FALSE, ascii = TRUE)
```

Arguments

- `fileName`: The name of a DICOM file.
- `checkFormat`: If `TRUE`, the function will check for the magic string "DICM" at byte offset 128. This string should be present, but in reality not all files contain it.
- `stopTag`: An integer vector giving the group and element numbers (in that order) of a DICOM tag, or `NULL`. If not `NULL`, the function will stop parsing the DICOM file if the specified tag is encountered. This can be used to speed up the process if a specific tag is required.
- `ignoreTransferSyntax`: If `TRUE`, any transfer syntax stored in the file will be ignored, and the code will try to deduce the transfer syntax using heuristics. This may occasionally be necessary for awkward DICOM files, but is not generally recommended.
- `ascii`: If `TRUE`, the function will attempt to read an embedded Siemens ASCII header, if one exists.

Value

`readDicomFile` returns a `DicomMetadata` object, or `NULL` on failure.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

### See Also

The DICOM standard, found online at [https://www.dicomstandard.org/](https://www.dicomstandard.org/). (Warning: may produce headaches!) Also `readDicomDirectory` for information on how to create `MriImage` objects from DICOM files.

### Description

Functions for expanding file paths, finding relative paths and ensuring that a file name has the required suffix.

### Usage

```r
descPath(path, ...)  
relativePath(path, referencePath)  
matchPaths(path, referencePath)  
registerPathHandler(regex, handler)  
expandFileName(fileName, base = getwd())  
ensureFileSuffix(fileName, suffix, strip = NULL)
```

### Arguments

- `path, referencePath`  
  Character vectors whose elements represent file paths (which may or may not currently exist).
- `...`  
  Additional arguments to custom path handlers.
- `regex`  
  A Ruby-style regular expression.
- `handler`  
  A function taking and returning a string.
- `fileName`  
  A character vector of file names.
- `base`  
  If `fileName` is a relative path, this option gives the base directory which the path is relative to. If `fileName` is an absolute path, this argument is ignored.
- `suffix`  
  A character vector of file suffixes, which will be recycled if shorter than `fileName`.
- `strip`  
  A character vector of suffixes to remove before appending `suffix`. The intended suffix does not need to be given here, as the function will not append it if the specified file name already has the correct suffix.
Details

The `resolvePath` function passes its arguments elementwise through any matching path handler, and returns the resolved paths. Nonmatching elements are returned as-is. `registerPathHandler` registers a new path handler for special syntaxes, and is for advanced use only. `relativePath` returns the specified path, expressed relative to `referencePath`. `matchPaths` resolves a vector of paths against a vector of reference paths. `expandFileName` returns the full path to the specified file name, collapsing ".." elements if appropriate. `ensureFileSuffix` returns the specified file names with the requested suffixes appended (if they are not already).

Value

A character vector.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:


See Also

`normalizePath` does most of the work for `expandFileName`.

---

| resolveVector | Miscellaneous vector functions |

Description

These functions provide the (Euclidean) length of a vector, the vector cross product or angle between two vectors.

Usage

```r
resolveVector(len, ...)
vectorLength(vector)
vectorCrossProduct(a, b)
angleBetweenVectors(v1, v2)
```
SerialisableObject-class

Arguments

- `len`  
  The expected length of the vector.
- `...`  
  Elements of the vector, to be concatenated together.
- `vector, v1, v2`  
  Numeric vectors of any length.
- `a, b`  
  Numeric 3-vectors.

Value

For `vectorLength`, the Euclidean norm or length of the specified vector, given by \( \sqrt{\text{sum}(\text{vector}^2)} \).
For `vectorCrossProduct`, the vector cross product of the two specified vectors; and for `angleBetweenVectors`, the angle (in radians) between the two specified vectors. The `resolveVector` function concatenates the values given in `...{}`, and if the result is a vector of length `len` then it is returned. If not, `NULL` is returned.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:

See Also

- `crossprod` for the matrix cross product.

---

SerialisableObject-class

*The SerialisableObject class*

Description

This reference class extends TractorObject by adding a function for simple serialisation of the data fields of an object, either to a list or a file. This is intended to be used for classes whose state can meaningfully be restored from a list of standard R objects (not including transient C/C++ pointers, for example). A serialised object may be deserialised using the deserialiseReferenceObject function.

Methods

- `serialise(file = NULL)`  
  Serialise the object to a list or file

See Also

- `save`
sortDicomDirectories

Sort a directory of DICOM files into series

Description

This function sorts a directory containing DICOM files into subdirectories by series UID (DICOM tag 0x0020,0x000e), subject name (0x0010,0x0010) and/or scan date (0x0008,0x0020). Each unique identifier, together with its description for series, will be used as the name for a new subdirectory, and all relevant files will be copied into that subdirectory. Duplicate file names are disambiguated if necessary.

Usage

sortDicomDirectories(directories, method = c("internal", "divest"),
                       deleteOriginals = FALSE, sortOn = "series", seriesId = c("UID",
                       "number", "time"), nested = TRUE, ...)

Arguments

directories A character vector giving the directories to search for DICOM files. Subdirectories will also be searched.

method Character string specifying whether to use the internal DICOM reading code or use the divest package.

deleteOriginals A single logical value. If TRUE, then the source files will be deleted after being copied to their new locations, making the operation a move rather than a copy. Nothing will be deleted if the copy fails.

sortOn The string "series", "subject" or "date", or any combination in the order desired. This will be the basis of the sort, which will be nested if more than one type is specified.

seriesId A string describing the kind of series identifier to use for sorting by series: "UID" (DICOM tag 0x0020,0x000e; the default), "number" (0x0020,0x0011) or "time" (0x0008,0x0031).

nested Logical value. If TRUE and directories is of length 1, subdirectories will be created within the specified original directory. Otherwise they will be created in the working directory.

... Additional arguments to pass to readDicomFile.

Value

This function is called for its side effect.

Author(s)

Jon Clayden
SparseArray-class

References

Please cite the following reference when using TractoR in your work:


See Also

readDicomDirectory for reading DICOM files into an MriImage object.

---

SparseArray-class

The SparseArray class

Description

This class represents an array with any number of dimensions, in which a significant proportion of entries are zero. The coordinates of nonzero entries are stored along with their values, with all remaining entries assumed to be zero. Methods are provided to index into the array in the standard way, using matrix or vector indices; and for coercing between SparseArray objects and standard (dense) arrays.

Fields

data  Vector of nonzero data values
coords Integer matrix of nonzero data locations, one per row
dims Integer vector of dimensions

Methods

aperm(perm) Permute the dimensions of the array
apply(margin, fun, ...) Apply a function to margins of the array
flip(dimsToFlip) Flip the array along one or more directions
setCoordinatesAndData(newCoords, newData) Update the nonzero locations and data values in the array
setDimensions(newDims) Change the dimensions of the image
summarise() Summarise key aspects of the object
threadSafeTempFile

Obtain thread-safe temporary file names

Description

This function is a wrapper around `tempfile`, which creates temporary file names whose path contains the process ID of the calling process. This avoids clashes between threads created by functions such as `mclapply` (in the “parallel” package), which can easily occur with the standard `tempfile` function.

Usage

```
threadSafeTempFile(pattern = "file")
```

Arguments

- `pattern`: Character vector giving the initial part of each file name.

Value

A character vector of temporary file names. No files are actually created.

Author(s)

Jon Clayden

References

Please cite the following reference when using TractoR in your work:


See Also

- `tempfile`
**TractorObject-class**

**The TractorObject class**

**Description**

This reference class extends the standard envRefClass class, adding methods for finding all of the field or methods available for an object. There is also a method for summarising key elements of the object as a named character vector, which can be suitable overridden by inheriting classes. The show method prints this summary as a labelled list.

**Methods**

- **fields()** Retrieve a list of all field names
- **methods()** Retrieve a list of all method names
- **summarise()** Summarise key aspects of the object

**where**

**Compact conditional values**

**Description**

This simple function checks whether its first argument is a logical value that evaluates to TRUE. If so, it returns its second argument. If not, it returns its third argument.

**Usage**

where(condition, value, fallback = NULL)

**Arguments**

- **condition** An expression that resolves to a single logical value.
- **value, fallback** Any expression.

**Details**

This function differs from the standard ifelse function in that it does not act elementwise, and that the third argument is optional, defaulting to NULL.

**Value**

value, if condition evaluates to TRUE; otherwise fallback.

**Author(s)**

Jon Clayden
References

Please cite the following reference when using TractoR in your work:


See Also

ifelse

Indexing methods

Indexing methods for \SparseArray and \MriImage objects. For the latter class, arguments are passed to the equivalents for array or SparseArray, except where \(i\) is another \MriImage object, where its nonzero region will be used to provide the indices. For \SparseArray, indexing may be blank, or by numeric vector or matrix.

Usage

```
## S4 method for signature 'SparseArray,ANY,ANY'
x[i, j, ..., drop = TRUE]

## S4 replacement method for signature 'SparseArray,ANY,ANY'
x[i, j, ...] <- value

## S4 method for signature 'MriImage,missing,missing'
x[i, j, ..., drop = TRUE]

## S4 method for signature 'MriImage,ANY,missing'
x[i, j, ..., drop = TRUE]

## S4 method for signature 'MriImage,missing,ANY'
x[i, j, ..., drop = TRUE]

## S4 method for signature 'MriImage,ANY,ANY'
x[i, j, ..., drop = TRUE]

## S4 replacement method for signature 'MriImage,missing,missing'
x[i, j, ...] <- value
```
## S4 replacement method for signature 'MriImage,ANY,missing'
x[i, j, ...] <- value

## S4 replacement method for signature 'MriImage,missing,ANY'
x[i, j, ...] <- value

## S4 replacement method for signature 'MriImage,ANY,ANY'
x[i, j, ...] <- value

## S4 replacement method for signature 'MriImage,MriImage,missing'
x[i, j, ...] <- value

### Arguments

- **x**
  - An object of the appropriate type.

- **i, j, ...**
  - Indexing objects.

- **drop**
  - Scalar value: should unitary dimensions be dropped?

- **value**
  - New value(s) for replacement forms.

### Value

A vector, array or **SparseArray**.

### Author(s)

- Jon Clayden
Index

[,MriImage, ANY, ANY-method
  ([,SparseArray, ANY, ANY-method), 38
[,MriImage, ANY, missing-method
  ([,SparseArray, ANY, ANY-method), 38
[,MriImage, MriImage, missing-method
  ([,SparseArray, ANY, ANY-method), 38
[,MriImage, missing, ANY-method
  ([,SparseArray, ANY, ANY-method), 38
[,MriImage, missing, missing-method
  ([,SparseArray, ANY, ANY-method), 38
[,SparseArray, ANY, ANY-method, 38
<-,MriImage, ANY, ANY-method
  ([,SparseArray, ANY, ANY-method), 38
<-,MriImage, ANY, missing-method
  ([,SparseArray, ANY, ANY-method), 38
<-,MriImage, MriImage, missing-method
  ([,SparseArray, ANY, ANY-method), 38
<-,MriImage, missing, ANY-method
  ([,SparseArray, ANY, ANY-method), 38
<-,MriImage, missing, missing-method
  ([,SparseArray, ANY, ANY-method), 38
<-,SparseArray, ANY, ANY-method
  ([,SparseArray, ANY, ANY-method), 38
all.equal, 12
allEqual, 2
angleBetweenVectors (resolveVector), 32
array, 23
asMriImage, 3
augmentedInfoPanel, 5
colorRamp, 15
colours, 14, 15
copyImageFiles
  (identifyImageFileNames), 15
createContactSheetGraphic
  (createSliceGraphic), 7
createNeighbourhoodInfo, 6
createProjectionGraphic
  (createSliceGraphic), 7
createSliceGraphic, 7
crossprod, 33
deduplicate, 9
deserialiseReferenceObject, 33
deserialiseReferenceObject
  (isDeserialisable), 20
DicomMetadata, 30
DicomMetadata (DicomMetadata-class), 10
DicomMetadata-class, 10
ebrace, 10
emptyMatrix, 11
ensureFileSuffix (resolvePath), 31
eRefClass, 37
equivalent, 2, 3, 12
execute (locateExecutable), 21
expandFileName (resolvePath), 31
extractMriImage (asMriImage), 3
fi (fx), 13
file.copy, 16
file.symlink, 16
fx, 13
fxy (fx), 13
fxyz (fx), 13
getColourScale, 5, 6, 8, 14
identifyImageFileNames, 15