Package ‘WhiteStripe’

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Type Package

Title White Matter Normalization for Magnetic Resonance Images using WhiteStripe

Version 2.4.0

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Description Shinohara (2014) <doi:10.1016/j.nicl.2014.08.008> introduced 'WhiteStripe', an intensity-based normalization of T1 and T2 images, where normal appearing white matter performs well, but requires segmentation. This method performs white matter mean and standard deviation estimates on data that has been rigidly-registered to the 'MNI' template and uses histogram-based methods.

License GPL-3

Depends R (>= 2.10), methods

Imports graphics, stats, utils, oro.nifti (>= 0.5.0), mgcv, neurobase

LazyData true

BugReports https://github.com/muschelli2/WhiteStripe/issues

RoxygenNote 7.1.1

Suggests knitr, rmarkdown

VignetteBuilder knitr

Encoding UTF-8

LazyDataCompression xz

NeedsCompilation no

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Repository CRAN

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download_img_data

Description

Download T1 and T2 data for Examples

Usage

```
download_img_data(lib.loc = NULL)
```

Arguments

- `lib.loc` a character vector with path names of R libraries. Passed to `img_data`

Value

Logical indicator if the files were downloaded.
get.deriv.smooth.hist  *Gets nth* derivative of smoothed histogram

**Description**

This function outputs the nth derivative of a histogram smooth.

**Usage**

```r
get.deriv.smooth.hist(x, coefs, knots, deg = 4, deriv.deg = 1)
```

**Arguments**

- `x`: values from `smooth_hist`
- `coefs`: Coefficients from GAM from `smooth_hist`
- `knots`: Number of knots fit for GAM
- `deg`: Degree of polynomials
- `deriv.deg`: The degree of the derivative.

**Value**

Derivative of smoothed histogram

**Examples**

```r
data(smoothed_histogram)
dy<-get.deriv.smooth.hist(xvals, coefs=s.hist$coefs, knots=s.hist$knots, deg=s.hist$deg, deriv.deg=1)
```

---

generate.mode  *Get First Peak*

**Description**

This function grabs the first peak or shoulder.

**Usage**

```r
get.first.mode(x, y, rare.prop = 1/5, verbose = TRUE, remove.tail = TRUE, ...)
```
get.largest.mode

Arguments

- **x**: values of midpoints from `hist`
- **y**: values of counts from `hist`
- **rare.prop**: Proportion used to remove rare intensity tail
- **verbose**: print diagnostic output
- **remove.tail**: Remove rare intensity tail
- **...**: arguments to be passed to `smooth_hist`

Value

Value of `x` that is the first peak

Examples

```r
data(t1.voi.hist)
system.time(
  y = t1.voi.hist$counts
  x = t1.voi.hist$mids
  x = x[!is.na(y)];
  y = y[!is.na(y)]
  # 20 used for speed of example
  nawm_peak = get.first.mode(x, y, k=20)
  plot(t1.voi.hist, border="red")
  abline(v=nawm_peak)
)
```

---

**get.largest.mode**  
*Grab largest peak*

Description

This function grabs the largest peak of the histogram

Usage

```r
get.largest.mode(x, y, verbose = TRUE, ...)
```

Arguments

- **x**: values of midpoints from `hist`
- **y**: values of counts from `hist`
- **verbose**: print diagnostic output
- **...**: arguments to be passed to `smooth_hist`
**get.last.mode**

**Value**

Value of x that is the largest peak

**Examples**

data(t2.voi.hist)
system.time(
  y = t2.voi.hist$counts
  x = t2.voi.hist$mids
  x = x[!is.na(y)];
  y = y[!is.na(y)]
  # 30 used for speed of example
  nawm_peak = get.largest.mode(x, y, k=30)
  plot(t2.voi.hist, border="red")
  abline(v=nawm_peak)
)

**Description**

This function grabs the last peak or shoulder.

**Usage**

get.last.mode(x, y, rare.prop = 1/5, verbose = TRUE, remove.tail = TRUE, ...)

**Arguments**

- **x**  
  values of midpoints from `hist`
- **y**  
  values of counts from `hist`
- **rare.prop**  
  Proportion used to remove rare intensity tail
- **verbose**  
  print diagnostic output
- **remove.tail**  
  Remove rare intensity tail
- **...**  
  arguments to be passed to `smooth_hist`

**Value**

Value of x that is the last peak
Examples

```r
data(t1.voi.hist)
system.time({
y = t1.voi.hist$counts
x = t1.voi.hist$mids
x = x[!is.na(y)];
y = y[!is.na(y)]
# 20 used for speed of example
nawm_peak = get.last.mode(x, y, k=20)
plot(t1.voi.hist, border="red")
abline(v=nawm_peak)
})
```

Description

Creates a VOI of Image for the specified slices

Usage

```r
make_img_voi(img, slices = 80:120, na.rm = TRUE, ...)
```

Arguments

- `img` Image (T1 usually or T2). Array or object of class nifti
- `slices` Slices to take for the image voi
- `na.rm` Remove NAs from mean. This is for double checking
- `...` Arguments passed from other methods (not used)

Value

VOI of image.
s.hist  

Smoothed histogram of image

Description

Smoothed histogram of image

Usage

s.hist

Format

A GAM from mgcv for x and y from histograms

Examples

## Not run:
data(t2.voi.hist)
y = t2.voi.hist$counts
x = t2.voi.hist$mids
x = x[!is.na(y)];
y = y[!is.na(y)]
# 70 used for speed of example
s.hist = smooth_hist(x, y, k=70)

## End(Not run)

smooth_hist  

Histogram smoothing for whitestripe

Description

Uses a generalized additive model (GAM) to smooth a histogram for whitestripe

Usage

smooth_hist(  
  x,  
y,  
deg = 4,  
k = floor(min(250, length(x)/2)),  
method = "REML",  
...  
)
Arguments

- **x**: values of midpoints from `hist`
- **y**: values of counts from `hist`
- **deg**: degree of polynomials used
- **k**: Number of knots
- **method**: Method for smoothing for GAM
- **...**: Arguments passed to `gam`

Value

List of objects: x and y coordinates of histogram, coefficients from GAM, fitted values from GAM, the GAM model, the knots fitted, and degrees of polynomials

See Also

gam

Examples

data(t2.voi.hist)
y = t2.voi.hist$counts
x = t2.voi.hist$mids
x = x[!is.na(y)];
y = y[!is.na(y)]
# 30 used for speed of example
s.hist = smooth_hist(x, y, k=30)
plot(t2.voi.hist, border="red")
lines(s.hist)

---

**t1.voi.hist**  
*Histogram of VOI of T1 template image*

Description

Histogram of VOI of T1 template image

Usage

t1.voi.hist

Format

A volume of interest histogram from a T1 image for smoothing
Examples

```r
## Not run:
lib.loc = tempdir()
if (download_img_data(lib.loc = lib.loc)){
  t1 = readNIfTI(system.file("T1Strip.nii.gz", package="WhiteStripe",
    lib.loc = lib.loc))
  t1.voi = make_img_voi(t1)
  any(is.na(t1.voi))
  # FALSE
  t1.voi.hist = hist(t1.voi,
    breaks=2000,
    plot=FALSE)
  #save(t1.voi.hist, file="data/t1.voi.hist.rda", compress = TRUE,
  # compression_level=9)
}
## End(Not run)
```

t2.voi.hist

**Histogram of VOI of T2 template image**

Description

Histogram of VOI of T2 template image

Usage

```r
t2.voi.hist
```

Format

A histogram volume of interest from a T2 image for smoothing

Examples

```r
## Not run:
lib.loc = tempdir()
if (download_img_data(lib.loc = lib.loc)){
  t2 = readNIfTI(system.file("T2Strip.nii.gz", package="WhiteStripe",
    lib.loc = lib.loc))
  t2.voi = make_img_voi(t2)
  any(is.na(t2.voi))
  # FALSE
  t2.voi.hist = hist(t2.voi,
    breaks=2000,
    plot=FALSE)
  #save(t2.voi.hist, file="data/t2.voi.hist.rda", compress = TRUE,
  # compression_level=9)
}
## End(Not run)
```
whitestripe  

Performs White Stripe of T1 or T2 Images

Description

Returns the mean/sd of the whitestripe and indices for them on the image

Usage

whitestripe(
  img,
  type = c("T1", "T2", "FA", "MD", "first", "last", "largest"),
  breaks = 2000,
  whitestripe.width = 0.05,
  whitestripe.width.l = whitestripe.width,
  whitestripe.width.u = whitestripe.width,
  arr.ind = FALSE,
  verbose = TRUE,
  stripped = FALSE,
  slices = NULL,
  ...
)

Arguments

img  Image (T1, T2, FA, or MD). Array or object of class nifti

breaks  Number of breaks passed to hist

whitestripe.width  Radius of the white stripe

whitestripe.width.l  Lower Radius of the white stripe

whitestripe.width.u  Upper Radius of the white stripe

darr.ind  Whether indices should be array notation or not, passed to which

verbose  Print diagnostic information

stripped  Applying to skull-stripped image. NOTE: This does NOT do a subset of slices, as make_img_voi.

slices  slices to use for make_img_voi if only a subset to estimate the distribution.

...  Arguments to be passed to get.last.mode
whitestripe_hybrid

Details

This function takes in an image and computes a window of the distribution called the white stripe. If you wish to pass in values you have subset, such as single from a skull-stripped image, you can pass in `img` and set the class to `img_voi` (class(img) = "img_voi") and this will not rerun `make_img_voi`.

Value

List of indices of whitestripe, last mode of histogram, array/nifti of 0/1 corresponding to the mask, mean of whitestripe, standard deviation of whitestripe

Examples

```r
## Not run:
library(WhiteStripe)
lib.loc = tempdir()
if (WhiteStripe::download_img_data(lib.loc = lib.loc)){
  library(oro.nifti)
  set.seed(1)
  t1 = readNIfTI(system.file("T1Strip.nii.gz", package="WhiteStripe",
  lib.loc = lib.loc))
  t1.ind = whitestripe(t1, "T1")
  set.seed(2)
  t1_2 = readNIfTI(system.file("T1Strip.nii.gz", package="WhiteStripe",
  lib.loc = lib.loc))
  t1_2.ind = whitestripe(t1_2, "T1")
  t1.mask = whitestripe_ind_to_mask(t1, t1.ind$whitestripe.ind)
  t1.mask[t1.mask == 0] = NA
  orthographic(t1, t1.mask, col.y="red")
  t2 = readNIfTI(system.file("T2Strip.nii.gz", package="WhiteStripe",
  lib.loc = lib.loc))
  t2.ind = whitestripe(t2, "T2")
  t2.mask = whitestripe_ind_to_mask(t2, t2.ind$whitestripe.ind)
  t2.mask[t2.mask == 0] = NA
  orthographic(t2, t2.mask, col.y="red")
}
## End(Not run)
```

whitestripe_hybrid  Hybrid WhiteStripe

Description

Uses t1 and t2 WhiteStripe to get an intersection of the two masks for a hybrid approach

Usage

`whitestripe_hybrid(t1, t2, ...)"`
whitestripe_ind_to_mask

WhiteStripe Indices to Mask

Description

Uses WhiteStripe indices to create image mask

Usage

whitestripe_ind_to_mask(img, indices, writeimg = FALSE, ...)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>img</td>
<td>Array or class nifti that corresponds to dimensions of the images the indices were generated from</td>
</tr>
<tr>
<td>indices</td>
<td>indices from whitestripe</td>
</tr>
<tr>
<td>writeimg</td>
<td>logical to write image or not</td>
</tr>
<tr>
<td>...</td>
<td>arguments to passed to writeNIfTI for writing image</td>
</tr>
</tbody>
</table>

Value

List of indices of overlap mask, and overlap of class array or nifti

See Also

whitestripe

Examples

```r
## Not run:
lib.loc = tempdir()
if (download_img_data(lib.loc = lib.loc)){
t1 = readNIfTI(system.file("T1Strip.nii.gz", package="WhiteStripe", lib.loc = lib.loc))
t2 = readNIfTI(system.file("T2Strip.nii.gz", package="WhiteStripe", lib.loc = lib.loc))
ind = whitestripe_hybrid(t1, t2)
}
## End(Not run)
```
whitestripe_norm

Value

Class of array or nifti depending on img input

See Also

whitestripe, whitestripe_hybrid

Examples

## Not run:
lib.loc = tempdir()

if (download_img_data(lib.loc = lib.loc)){
t1 = readNIfTI(system.file("T1Strip.nii.gz", package="WhiteStripe", lib.loc = lib.loc))
t2 = readNIfTI(system.file("T2Strip.nii.gz", package="WhiteStripe", lib.loc = lib.loc))
ind = whitestripe_hybrid(t1, t2)
mask = whitestripe_ind_to_mask(t1, ind$whitestripe.ind)
orthographic(mask)
}

## End(Not run)

whitestripe_norm  Normalize Image using white stripe

Description

Taking the indices from white stripe to normalize the intensity values of the brain

Usage

whitestripe_norm(img, indices, ...)

Arguments

img  Array or object of class nifti
indices  Indices of white stripe from whitestripe. Can also be a mask (indices where mask > 0 are used.)
...  arguments to be passed to mean and sd

Value

Object of same class as img, but normalized
### ws_img_data

*Return Filenames of T1 and T2 data*

**Description**

Return filenames T1 and T2 data for example and vignettes

**Usage**

```r
ws_img_data(lib.loc = NULL, warn = TRUE)
```

**Arguments**

- `lib.loc`: a character vector with path names of R libraries. Passed to `system.file`
- `warn`: Should a warning be printed if the images were not there

**Value**

Vector of filenames

### xvals

*Midpoints from VOI histogram*

**Description**

Midpoints from VOI histogram

**Usage**

```r
xvals
```

**Format**

x values from histogram for VOI
Index

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