

# Package ‘WhiteStripe’

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**Type** Package

**Title** White Matter Normalization for Magnetic Resonance Images using WhiteStripe

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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

**BugReports** <https://github.com/muschelli.j2/WhiteStripe/issues>

**RoxygenNote** 6.0.1.9000

**Suggests** knitr, rmarkdown

**VignetteBuilder** knitr

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download_img_data	<i>Download T1 and T2 data</i>
-------------------	--------------------------------

---

## 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  $n^{\text{th}}$  derivative of smoothed histogram*

---

### Description

This function outputs the  $n$ th derivative of a histogram smooth.

### Usage

```
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

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

---

get.first.mode *Get First Peak*

---

### Description

This function grabs the first peak or shoulder.

### Usage

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

**Arguments**

x	values of midpoints from <a href="#">hist</a>
y	values of counts from <a href="#">hist</a>
rare.prop	Proportion used to remove rare intensity tail
verbose	print diagnostic output
remove.tail	Remove rare intensity tail
...	arguments to be passed to <a href="#">smooth_hist</a>

**Value**

Value of x that is the first peak

**Examples**

```
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**

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

**Arguments**

x	values of midpoints from <a href="#">hist</a>
y	values of counts from <a href="#">hist</a>
verbose	print diagnostic output
...	arguments to be passed to <a href="#">smooth_hist</a>

**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)
})
```

---

get.last.mode

*Get Last 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 <a href="#">hist</a>
y	values of counts from <a href="#">hist</a>
rare.prop	Proportion used to remove rare intensity tail
verbose	print diagnostic output
remove.tail	Remove rare intensity tail
...	arguments to be passed to <a href="#">smooth_hist</a>

**Value**

Value of x that is the last peak

## Examples

```
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)
})
```

---

make\_img\_voi

*Make Image VOI*

---

## Description

Creates a VOI of Image for the specified slices

## Usage

```
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	<i>smoothed_histogram</i>
--------	---------------------------

---

**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	<i>Histogram smoothing for whitestripe</i>
-------------	--

---

**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 <a href="#">hist</a>
y	values of counts from <a href="#">hist</a>
deg	degree of polynomials used
k	Number of knots
method	Method for smoothing for GAM
...	Arguments passed to <a href="#">gam</a>

**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

*t1.voi.hist*

---

**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**

```
## 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

*t2.voi.hist*

---

## Description

Histogram of VOI of T2 template image

## Usage

```
t2.voi.hist
```

## Format

A histogram volume of interest from a T2 image for smoothing

## Examples

```
## 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	<i>Performs White Stripe of T1 or T2 Images</i>
-------------	---

---

### 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

<code>img</code>	Image (T1, T2, FA, or MD). Array or object of class <code>nifti</code>
<code>type</code>	T1, T2, FA, or MD image whitestripe
<code>breaks</code>	Number of breaks passed to <code>hist</code>
<code>whitestripe.width</code>	Radius of the white stripe
<code>whitestripe.width.l</code>	Lower Radius of the white stripe
<code>whitestripe.width.u</code>	Upper Radius of the white stripe
<code>arr.ind</code>	Whether indices should be array notation or not, passed to <code>which</code>
<code>verbose</code>	Print diagnostic information
<code>stripped</code>	Applying to skull-stripped image. NOTE: This does NOT do a subset of slices, as <code>make_img_voi</code> .
<code>slices</code>	slices to use for <code>make_img_voi</code> if only a subset to estimate the distribution.
<code>...</code>	Arguments to be passed to <code>get.last.mode</code>

### 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**

```

## 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, ...)
```

**Arguments**

t1	T1 image, array or class nifti
t2	T2 image, array or class nifti
...	arguments passed to <a href="#">whitestripe</a>

**Value**

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

**See Also**

whitestripe

**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)
}

## End(Not run)
```

---

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**

img	Array or class nifti that corresponds to dimensions of the images the indices were generated from
indices	indices from <a href="#">whitestripe</a>
writeimg	logical to write image or not
...	arguments to be passed to <a href="#">writeNIFTI</a> for writing image

**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	<i>Normalize Image using white stripe</i>
------------------	---

---

## 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 <a href="#">whitestripe</a> . Can also be a mask (indices where mask > 0 are used.)
...	arguments to be passed to <a href="#">mean</a> and <a href="#">sd</a>

## Value

Object of same class as img, but normalized

---

ws_img_data	<i>Return Filenames of T1 and T2 data</i>
-------------	---

---

**Description**

Return filenames T1 and T2 data for example and vignettes

**Usage**

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

**Arguments**

lib.loc	a character vector with path names of R libraries. Passed to <a href="#">system.file</a>
warn	Should a warning be printed if the images were not there

**Value**

Vector of filenames

---

xvals	<i>midpoints of VOI histogram</i>
-------	-----------------------------------

---

**Description**

Points from VOI histogram

**Usage**

```
xvals
```

**Format**

x values from histogram for VOI

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