

# Package: nat.templatebrains (via r-universe)

September 26, 2026

**Type** Package

**Title** NeuroAnatomy Toolbox ('nat') Extension for Handling Template Brains

**Version** 1.2.2

**Description** Extends package 'nat' (NeuroAnatomy Toolbox) by providing objects and functions for handling template brains.

**License** GPL-3

**URL** <http://natverse.org/nat.templatebrains/>,  
<https://github.com/natverse/nat.templatebrains>

**Depends** nat (>= 1.8.6), R (>= 2.10), rgl

**Imports** digest, igraph, memoise, rappdirs

**Suggests** spelling, git2r (>= 0.22.1), nabor, testthat (>= 2.1.0),  
covr, Morpho

**Encoding** UTF-8

**RoxygenNote** 7.3.2

**BugReports** <https://github.com/natverse/nat.templatebrains/issues>

**Language** en-GB

**Config/pak/sysreqs** cmake libfreetype6-dev libglpk-dev libglu1-mesa-dev make texlive libicu-dev libpng-dev libuv1-dev libxml2-dev libgl1-mesa-dev zlib1g-dev

**Repository** <https://natverse.r-universe.dev>

**Date/Publication** 2026-03-21 15:00:03 UTC

**RemoteUrl** <https://github.com/natverse/nat.templatebrains>

**RemoteRef** HEAD

**RemoteSha** 12597ac0cd2b53ced8145d8b11bf53c28bc1ecc4

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|                 |                                                                                  |
|-----------------|----------------------------------------------------------------------------------|
| add_reg_folders | <i>Set or list local folders containing registrations for nat.templatebrains</i> |
|-----------------|----------------------------------------------------------------------------------|

---

Description

add\_reg\_folders sets options('nat.templatebrains.regdirs') appropriately so that registrations can be found by e.g. xform\_brain.

extra\_reg\_folders lists extra registration folders present in standard location

Usage

```
add_reg_folders(dir = extra_reg_folders(), first = TRUE)

extra_reg_folders(full.names = TRUE)
```

Arguments

|            |                                                                                                                                                                                            |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| dir        | Path to one or more folders containing registrations. Default value will scan for registration folders in a standard location. (Please see <b>Details</b> and <b>File layout</b> sections) |
| first      | Whether the new folder should be added to the start (default) or end of the search list.                                                                                                   |
| full.names | Whether to list full path to registration folders                                                                                                                                          |

**Details**

When `dir` is unset then it will default to the value of `extra_reg_folders()` i.e. any folders / cloned repositories in the standard location

**Value**

This function is principally called for its side effect. A path to the location on disk containing added registrations is returned invisibly.

**File layout**

You must pass a folder containing one or more registrations, not the registration folder itself. So if you have this situation on disk

- myregistrations/
- myregistrations/reg1.list
- myregistrations/reg2.list

you should write `add_reg_folders("/path/to/myregistrations")`

**Examples**

```
## Not run:
  add_reg_folders("myextraregistrations")

## End(Not run)
# adding a non-existent folder will generate an error
tools::assertError(add_reg_folders(tempfile()))
```

---

add\_reglist

---

Add reglist object describing a bridging/mirroring registration

---

**Description**

By specifying either `reference`, `sample` or `mirror` arguments, you can add a bridging or mirroring registration, respectively, to the list of those in use for `xform_brain` and `mirror_brain`.

**Usage**

```
add_reglist(
  x,
  reference = NULL,
  sample = NULL,
  mirror = NULL,
  temp = TRUE,
  ...
)
```

**Arguments**

|                   |                                                                                                                                            |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| x                 | A single <a href="#">reglist</a> object (which )                                                                                           |
| reference, sample | The reference and sample brains (in character or templatebrain form) for a bridging registration.                                          |
| mirror            | The reference brain (in character or templatebrain form) for a mirroring registration.                                                     |
| temp              | Whether to store the on disk representation in a session-specific temporary folder (that will be removed when R closes). Defaults to TRUE. |
| ...               | Additional arguments passed to <a href="#">saveRDS</a> e.g. to control compression when the reglist object is saved to disk.               |

**Value**

This function is called for its side effect and has no return value.

**See Also**

[add\\_reg\\_folders](#)

**Examples**

```
## Not run:
library(nat.flybrains)
# mirroring registration for a specific template brain object
add_reglist(mirroring, mirror=JFRC2013)
# equivalent but without needing to construct the template
add_reglist(mirroring, mirror="JFRC2013")

# add a bridging registration between two brains
add_reglist(bridging, reference=JFRC2, sample=JFRC2013)

## End(Not run)
```

---

|                    |                                                                        |
|--------------------|------------------------------------------------------------------------|
| all_templatebrains | <i>Find all template brains or those matching a given image volume</i> |
|--------------------|------------------------------------------------------------------------|

---

**Description**

`all_templatebrains` returns a data.frame detailing all templatebrain objects on the search path (including those inside packages).

**Usage**

```
all_templatebrains(cached = TRUE, remove.duplicates = FALSE)

guess_templatebrain(
  x,
  rval = c("templatebrain", "name"),
  cached = TRUE,
  mustWork = FALSE
)
```

**Arguments**

|                   |                                                                                                                                                                              |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| cached            | When TRUE returns precomputed (memoised) results, otherwise rescans searching for all template brains.                                                                       |
| remove.duplicates | Whether to remove duplicate template brains (as determined by md5 hash) from the result list                                                                                 |
| x                 | A <a href="#">im3d</a> image object, array or matrix compatible with <a href="#">as.templatebrain</a> OR a 2 or 3-vector defining the dimensions of an image or image stack. |
| rval              | Whether to return the <a href="#">templatebrain</a> object itself or just its name.                                                                                          |
| mustWork          | Whether to insist that exactly one template brain is found                                                                                                                   |

**Value**

For `all_templatebrains`, a `data.frame` containing the following columns:

- object The name of the templatebrain object
- pos An integer specifying the environment
- package Character vector naming the environment
- md5 md5 hash of the templatebrain object
- name
- W,H,D Width, height and depth of image stack (pixels)

`guess_templatebrain` returns a [templatebrain](#) object when `rval='templatebrain'` or a character vector when `rval='name'`.

**See Also**

[templatebrain](#)

**Examples**

```
## Not run:
all_templatebrains()

guess_templatebrain(im3d(dims=c(30,40,50)))
# or
```

```

guess_templatebrain(c(30,40,50))
guess_templatebrain('path/to/my/image.nrrd')

if(require('nat.flybrains')){
  guess_templatebrain(im3d(dims=c(1024,512,218)), rval = 'name')
  # get the matching template brain
  tb=guess_templatebrain(im3d(dims=c(1024,512,218)))
  # get its voxel dimensions
  voxdims(tb)

  tb=guess_templatebrain(c(1024,512))
  tb
}

## End(Not run)

```

---

|                  |                                                          |
|------------------|----------------------------------------------------------|
| allreg_dataframe | <i>Make data.frame with details of all registrations</i> |
|------------------|----------------------------------------------------------|

---

## Description

Make data.frame with details of all registrations

## Usage

```
allreg_dataframe(regdirs = getOption("nat.templatebrains.regdirs"))
```

## Arguments

regdirs                      Character vector of directories to search for registrations (see details)

## Details

by default regdirs is set to `getOption('nat.templatebrains.regdirs')`

## Value

data.frame with one row for each observed registration and columns

- path
- name
- dup
- bridge
- reference
- sample

If there are no registrations, there will be a data.frame with 0 rows and these columns.

**Examples**

```
## Not run:
allreg_dataframe()

## End(Not run)
```

---

|                  |                                                                    |
|------------------|--------------------------------------------------------------------|
| as.templatebrain | <i>Use image file or other object to initialise template brain</i> |
|------------------|--------------------------------------------------------------------|

---

**Description**

Use image file or other object to initialise template brain

**Usage**

```
as.templatebrain(x, ...)

## S3 method for class 'character'
as.templatebrain(x, ...)

## S3 method for class 'im3d'
as.templatebrain(x, regName = NULL, name = regName, ...)

## S3 method for class 'templatebrain'
as.templatebrain(x, ...)
```

**Arguments**

|               |                                                                                                                                                     |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| x             | object used to construct the templatebrain, either a character vector with the path to a file or an <a href="#">im3d</a> object.                    |
| ...           | additional named arguments passed to methods and then on to <a href="#">templatebrain</a> that will be added as fields to the templatebrain object. |
| name, regName | name and short name of the template brain. Will use the filename (minus final extension) by default for both fields.                                |

**Details**

as.templatebrain can extract the key fields defining an template space from an image file. This is generally a much more convenient approach to defining a templatebrain object than specifying all fields by hand.

**Value**

A list with class [templatebrain](#)

**See Also**

[templatebrain](#), [im3d](#)

## Examples

```
# Make templatebrain object using image info from the template brain NRRD file
nhdr=system.file('images','FCWB.nhdr', package='nat.templatebrains')
as.templatebrain(nhdr, name = "FlyCircuit Whole Brain")
```

---

bridging\_graph

---

*Make or query connected graph of bridging registrations*


---

## Description

These functions are designed for expert use. In general it is recommended to use `xform_brain`.

`bridging_graph` creates an `igraph::graph` representing all known template brains (vertices) and the bridging registrations connecting them (edges).

`shortest_bridging_seq` finds the shortest bridging sequence on a graph of all available bridging registrations, subject to constraints defined by graph connectivity and the reciprocal parameter.

## Usage

```
bridging_graph(
  regdirs = getOption("nat.templatebrains.regdirs"),
  reciprocal = NA
)

shortest_bridging_seq(
  sample,
  reference,
  via = NULL,
  checkboth = TRUE,
  imagedata = FALSE,
  reciprocal = NA,
  ...
)
```

## Arguments

|                         |                                                                                                                                          |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <code>regdirs</code>    | Character vector of directories to search for registrations (see details)                                                                |
| <code>reciprocal</code> | Sets the weight of reciprocal edges in the graph (and thereby whether inverse registrations will be considered).                         |
| <code>sample</code>     | Source template brain (e.g. IS2) that data is currently in. Specified either as character vector or a <code>templatebrain</code> object. |
| <code>reference</code>  | Target template brain (e.g. IS2) that data should be transformed into.                                                                   |
| <code>via</code>        | (optional) intermediate template brain that the registration sequence must pass through.                                                 |
| <code>checkboth</code>  | When TRUE will look for registrations in both directions. See details.                                                                   |

|           |                                                                                                                             |
|-----------|-----------------------------------------------------------------------------------------------------------------------------|
| imagedata | Whether x should be treated as image data (presently only supported as a file on disk) or 3D object vertices - see details. |
| ...       | additional arguments passed on to <a href="#">bridging_graph</a>                                                            |

### Details

When reciprocal != NA we create a graph where each forward transformation is matched by a corresponding inverse transformation with the specified edge weight. The edge weight for forward transforms will always be 1.0.

By default regdirs is set to `getOption('nat.templatebrains.regdirs')`

### See Also

[allreg\\_dataframe](#), [xform\\_brain](#)

### Examples

```
## Not run:
plot(bridging_graph(), vertex.size=25, edge.arrow.size=0.5)
# with reciprocal edges
plot(bridging_graph(reciprocal=3), vertex.size=25)

## End(Not run)
## Not run:
shortest_bridging_seq(FCWB, IS2)
# or
shortest_bridging_seq('FCWB', 'IS2')

shortest_bridging_seq(sample='FCWB', reference='IS2', via="JFRC2")

## End(Not run)
```

---

|                   |                                                            |
|-------------------|------------------------------------------------------------|
| bridging_sequence | <i>Find sequence of one or more bridging registrations</i> |
|-------------------|------------------------------------------------------------|

---

### Description

This function is primarily intended for developer use (it is used inside `xform_brain`) but may be useful for end users.

### Usage

```
bridging_sequence(
  sample,
  reference,
  via = NULL,
  imagedata = FALSE,
  checkboth = !imagedata,
  mustWork = FALSE
)
```

**Arguments**

|           |                                                                                                                                                            |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| sample    | Source template brain (e.g. IS2) that data is currently in. Specified either as character vector or a templatebrain object.                                |
| reference | Target template brain (e.g. IS2) that data should be transformed into.                                                                                     |
| via       | (optional) intermediate template brain that the registration sequence must pass through.                                                                   |
| imagedata | Whether x should be treated as image data (presently only supported as a file on disk) or 3D object vertices - see details.                                |
| checkboth | whether to look for registrations in both directions. The default (checkboth=FALSE) will only return registrations in the forward direction (see details). |
| mustWork  | whether to error out if appropriate registrations are not found.                                                                                           |

**Details**

When checkboth=FALSE, only registrations that can be directly used to map image data from sample to reference are returned. When working with 3D points, use checkboth=TRUE. Note that all possible directories will first be scanned for registrations in the preferred direction and then rescanned for the opposite direction if nothing is found.

**Registration direction**

When mapping points from JFRC2 -> IS2 -> FCWB (i.e. sample=JFRC2, via=IS2, ref=FCWB) the command line passed to CMTK's streamxform should look like: streamxform -- JFRC2\_IS2.list --inverse FCWB\_IS2.list. However when mapping image data the command line for CMTK's reformatx should look like: reformatx -o out.nrrd --floating JFRC2.nrrd FCWB.nrrd FCWB\_IS2.list --inverse JFRC2\_IS2.list. bridging\_sequence produces output like

```
list(JFRC2 = structure(
  "/GD/dev/R/nat.flybrains/inst/extdata/bridgingregistrations/JFRC2_IS2.list",
  swap = TRUE),
  IS2 = "/GD/dev/R/nat.flybrains/inst/extdata/bridgingregistrations/FCWB_IS2.list")
```

in these circumstances, which xformpoints.cmtkreg turns into "- JFRC2\_IS2.list -inverse FCWB\_IS2.list".

**Examples**

```
## Not run:
bridging_sequence(sample=JFRC2, ref=FCWB, checkboth = TRUE)
bridging_sequence(sample=JFRC2, via=IS2, ref=FCWB, checkboth = TRUE)

## End(Not run)
```

---

|               |                                     |
|---------------|-------------------------------------|
| display_slice | <i>Display an image slice in 3D</i> |
|---------------|-------------------------------------|

---

**Description**

Display an image slice in 3D

**Usage**

```
display_slice(brain, slice, ...)
```

**Arguments**

|       |                                                      |
|-------|------------------------------------------------------|
| brain | template brain (e.g. IS2) of the slice.              |
| slice | Path to PNG image containing slice to display.       |
| ...   | extra arguments to pass to <a href="#">persp3d</a> . |

**Value**

This function is principally called for its side effect of adding to the plot. A vector of rgl shape IDs is returned invisibly.

---

|                   |                                                                      |
|-------------------|----------------------------------------------------------------------|
| download_reg_repo | <i>Download and register git repository containing registrations</i> |
|-------------------|----------------------------------------------------------------------|

---

**Description**

Note that these extra registrations will be downloaded to a standard location on your hard drive that will be used for one session to the next. See examples and [local\\_reg\\_dir\\_for\\_url](#).

**Usage**

```
download_reg_repo(url, localdir = NULL, ...)
```

**Arguments**

|          |                                                                                                                                                     |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| url      | Location of one or more remote git repositories. Can accept partial github specifications of the form "<user>/<repo>".                              |
| localdir | Full path to local checkout location of git repository. When localdir=NULL, the default, a sensible location is chosen using the rappdirs function. |
| ...      | additional arguments passed to <code>git2r::clone</code> e.g. credentials for private repo.                                                         |

**Value**

This function is principally called for its side effect. A path to the location on disk containing added registrations is returned invisibly.

See Also

```
add_reg_folders, local_reg_dir_for_url, git2r::clone
update_reg_repos
```

Examples

```
## find the root location of all registration directories
local_reg_dir_for_url()
## Not run:
## Add the two main jefferislab bridging and mirroring registration
# collections for Drosophila brains from github.com.
download_reg_repo("jefferislab/BridgingRegistrations")
download_reg_repo("jefferislab/MirrorRegistrations")

## update all current registration repositories
update_reg_repos()

## End(Not run)
```

---

|           |                                                      |
|-----------|------------------------------------------------------|
| FCWB.demo | <i>Sample template brain: FlyCircuit Whole Brain</i> |
|-----------|------------------------------------------------------|

---

Description

This is a sample template brain for testing purposes which is equivalent to the FCWB template brain defined by the `nat.flybrains`, which should be considered the canonical version.

---

|           |                                                                              |
|-----------|------------------------------------------------------------------------------|
| fit_xform | <i>Fit affine or thin plate spline transform to arbitrary transformation</i> |
|-----------|------------------------------------------------------------------------------|

---

Description

Fit affine or thin plate spline transform to arbitrary transformation

Usage

```
fit_xform(
  reg,
  samplepts,
  refpts = NULL,
  type = c("affine", "rigid", "similarity", "tps"),
  subsample = FALSE,
  scale = c(1, 1),
  ...
)
```

**Arguments**

|           |                                                                                                                                                                                                                                                                                                                        |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| reg       | Any registration compatible with <code>nat::xform</code> , including non-rigid and multi-step registrations. You must either supply this or the <code>refpts</code> argument.                                                                                                                                          |
| samplepts | A set of points in the sample (floating) space. Can be any object compatible with <code>nat::xyzmatrix</code> .                                                                                                                                                                                                        |
| refpts    | An optional set of points in the target (fixed) space matching <code>samplepts</code> . You must either supply this or the <code>reg</code> argument.                                                                                                                                                                  |
| type      | A character string specifying the type of registration. See <code>Morpho::computeTransform</code> for details.                                                                                                                                                                                                         |
| subsample | A number of points to subsample from <code>samplepts</code> , <code>refpts</code> . The default value of <code>FALSE</code> means use all provided points to calculate the new transform.                                                                                                                              |
| scale     | a 2-vector indicating the amount to scale the sample and reference points. You can supply one vector if this is the same. If the transform expects points in microns and returns points in microns then you would need <code>scale=c(1000,1)</code> if you want the input to be in microns and the output to be in nm. |
| ...       | Additional arguments passed to <code>Morpho::computeTransform</code>                                                                                                                                                                                                                                                   |

**Details**

NB this function relies on installation of the suggested package `Morpho`.

**Value**

A homogeneous affine matrix or a `nat::tpsreg` object n.b. only in development `nat` ( $\geq 1.10.1$ )

**Examples**

```
## Not run:
library(nat.flybrains)
reg=shortest_bridging_seq(sample='FCWB', reference="JFRC2")
fit_xform(reg, nat::kcs20, subsample=200, type='affine')
# compute transform with translations in nm not microns
fit_xform(reg, nat::kcs20, subsample=200, type='affine', scale=1000)

## End(Not run)
```

---

|                 |                                                                         |
|-----------------|-------------------------------------------------------------------------|
| fit_xform_brain | <i>Fit a single transform to a bridging registration between brains</i> |
|-----------------|-------------------------------------------------------------------------|

---

**Description**

Fit a single transform to a bridging registration between brains

**Usage**

```
fit_xform_brain(
  sample,
  reference,
  via = NULL,
  type = c("affine", "rigid", "similarity", "tps"),
  pts = NULL,
  npts = if (is.null(pts)) 1000 else NULL,
  scale = c(1, 1),
  ...
)
```

**Arguments**

|           |                                                                                                                                                                                                                                                                                                                        |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| sample    | Source template brain (e.g. IS2) that data is currently in. Specified either as character vector or a <code>templatebrain</code> object.                                                                                                                                                                               |
| reference | Target template brain (e.g. IS2) that data should be transformed into.                                                                                                                                                                                                                                                 |
| via       | (optional) intermediate template brain that the registration sequence must pass through.                                                                                                                                                                                                                               |
| type      | A character string specifying the type of registration. See <code>Morpho::computeTransform</code> for details.                                                                                                                                                                                                         |
| pts       | Optional set of points to use for the fit. If they are not specified they will be randomly sampled (see details).                                                                                                                                                                                                      |
| npts      | Number of points to use for fit (defaults to 1000 when no <code>pts</code> argument is specified).                                                                                                                                                                                                                     |
| scale     | a 2-vector indicating the amount to scale the sample and reference points. You can supply one vector if this is the same. If the transform expects points in microns and returns points in microns then you would need <code>scale=c(1000,1)</code> if you want the input to be in microns and the output to be in nm. |
| ...       | Additional arguments passed to <a href="#">fit_xform</a>                                                                                                                                                                                                                                                               |

**Details**

If `pts` are supplied these will be used to construct the fit. This might be useful if you are focussing on a particular brain region and supply relevant neurons. But if you want to work with one registration to use for the whole brain then it's better to use points across the brain.

When points are not provided then `fit_xform_brain` will first check to see if it can find a neuropil surface model for the `sample`. If it can, it will sample a number of points that lie inside the surface model. If no surface model can be found, then it will look for a [templatebrain](#) object specifying a bounding box around the sample brain. If successful, it will sample `npts` within that bounding box. If not there will be an error and you will have to supply the points.

**Value**

A homogeneous affine matrix or a `nat::tpsreg` object n.b. only in development nat ( $\geq 1.10.1$ )

**See Also**[fit\\_xform](#)**Examples**

```
## Not run:
library(nat.flybrains)
t1=fit_xform_brain(sample='FCWB', reference="JFRC2", type='affine')
t1
# the same but for points in nm
fit_xform_brain(sample='FCWB', reference="JFRC2", type='affine', scale=1000)
# run the fit based on a particular group of Kenyon cells
t2=fit_xform_brain(sample='FCWB', reference="JFRC2",
  pts=nat::kcs20, npts=300, type='affine')

nclear3d()
mfrow3d(1, 2, sharedMouse = TRUE)
plot3d(JFRC2)
plot3d(xform(FCWB.surf, t1))
next3d()
plot3d(JFRC2)
plot3d(xform(FCWB.surf, t2))
# the whole brain surfaces clearly match better when you fit on the whole brain

## End(Not run)
```

---

local\_reg\_dir\_for\_url *Standard local checkout location for extra registration directories*

---

**Description**

Standard local checkout location for extra registration directories

**Usage**

```
local_reg_dir_for_url(url = NULL)
```

**Arguments**

|     |                                                                                    |
|-----|------------------------------------------------------------------------------------|
| url | Character vector containing a url. When url=NULL defaults to giving the base path. |
|-----|------------------------------------------------------------------------------------|

**Details**

When called without any argument returns the root directory that will be inspected for extra registrations. You can put a sub-folder yourself there manually and then call `add_reg_folders`, but you are much better off in general using [download\\_reg\\_repo](#) to install from a github repository such as this one of ours: [jefferislab/BridgingRegistrations](#)

Note that this folder will always be the same place on a machine i.e. this defines a consistent, persistent location on disk to store data across sessions. You can modify the location of this folder by editing the `R_USER_DATA_DIR` environment variable. While this is not recommended on a personal machine, it may be necessary on a server. See `rappdirs::user_data_dir` for details.

When called with a url, a SHA1 hash will be calculated for the URL and appended to the basepath. This should ensure that locations derived from different URLs do not clash.

### Value

path(s) containing registrations on disk.

### See Also

`download_reg_repo`, `rappdirs::user_data_dir`

---

|              |                                                                                      |
|--------------|--------------------------------------------------------------------------------------|
| mirror_brain | <i>Mirror 3D object around a given axis, optionally using a warping registration</i> |
|--------------|--------------------------------------------------------------------------------------|

---

### Description

Mirror 3D object around a given axis, optionally using a warping registration

### Usage

```
mirror_brain(
  x,
  brain = regtemplate(x),
  mirrorAxis = c("X", "Y", "Z"),
  transform = c("warp", "affine", "flip"),
  ...
)
```

### Arguments

|                         |                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------------------------------------|
| <code>x</code>          | the 3D object to be mirrored.                                                                             |
| <code>brain</code>      | source template brain (e.g. IS2) that data is in.                                                         |
| <code>mirrorAxis</code> | the axis to mirror (default "X").                                                                         |
| <code>transform</code>  | whether to use warp (default) or affine component of registration, or simply flip about midplane of axis. |
| <code>...</code>        | extra arguments to pass to <code>mirror</code> .                                                          |

### Value

A transformed version of `x`

**See Also**[xform\\_brain](#), [regtemplate](#)**Examples**

```

data(FCWB.demo)
# Simple mirror along the x i.e. medio-lateral axis
kcs20.flip=mirror_brain(kcs20, FCWB.demo, transform='flip')

## Full non-rigid mirroring to account for differences in shape/centering of
## template brain.
## Depends on nat.flybrains package and system CMTK installation
## Not run:
library(nat.flybrains)
kcs20.right=mirror_brain(kcs20, FCWB, .progress='text')
plot3d(kcs20, col='red')
plot3d(kcs20.right, col='green')
# include surface plot of brain
plot3d(FCWB)

# Compare simple flip with full mirror
# This template brain is highly symmetric so these are almost identical
clear3d()
plot3d(kcs20.flip, col='blue')
plot3d(kcs20.right, col='green')

# Convert to JFRC2 and do the same
kcs20.jfrc2=xform_brain(kcs20, sample = FCWB, reference=JFRC2, .progress='text')
kcs20.jfrc2.right=mirror_brain(kcs20.jfrc2, JFRC2, .progress='text')
kcs20.jfrc2.flip=mirror_brain(kcs20.jfrc2, JFRC2, transform='flip')
clear3d()
# This time there is a bigger difference between the two transformations
plot3d(kcs20.jfrc2.flip, col='blue')
plot3d(kcs20.jfrc2.right, col='green')
# plot mushroom body neuropils as well
plot3d(JFRC2NP.surf, "MB.*_R", alpha=0.3, col='grey')

# Compare Euclidean distance between corresponding points in all neurons
diffs=xyzmatrix(kcs20.jfrc2.flip)-xyzmatrix(kcs20.jfrc2.right)
hist(sqrt(rowSums(diffs^2)), xlab='Distance /microns')

## End(Not run)

```

---

plot3d.templatebrain    *Plot 3D surface of a template brain*

---

**Description**

Plot 3D surface of a template brain

**Usage**

```
## S3 method for class 'templatebrain'
plot3d(x, col = "grey", alpha = 0.3, ...)
```

**Arguments**

|       |                                                     |
|-------|-----------------------------------------------------|
| x     | the template brain to plot.                         |
| col   | the color of the surface.                           |
| alpha | the alpha value of the surface.                     |
| ...   | extra arguments to pass to <a href="#">plot3d</a> . |

**Details**

This function will work immediately for the standard [templatebrain](#) defined in the package documentation. If passed an object called e.g. FCWB it expects to find another object named FCWB.surf containing the surface information. If you follow this naming convention for user-defined refbrains it will work for them as well.

**Value**

This function is principally called for its side effect of adding to the plot. A vector of rgl shape IDs is returned invisibly.?

---

regtemplate

*Get or set the registration template space in which an object lives*


---

**Description**

Get or set the registration template space in which an object lives

**Usage**

```
regtemplate(x)

regtemplate(x) <- value
```

**Arguments**

|       |                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------|
| x     | The 3D object whose registration space will be set/returned                                                            |
| value | The registration template brain (either a character vector naming the space or a <a href="#">templatebrain</a> object) |

**Details**

In order to facilitate transformations between objects in defined anatomical spaces these functions allow the registration template for an object to be specified. Most of the time you will not need to use these functions manually since the appropriate space will be set by the function `xform_brain` and friends.

**Value**

Either a templatebrain object or the newly tagged object

**Examples**

```
## Not run:
library(nat.flybrains)
kcs3=kcs20[1:3]
regtemplate(kcs3)=FCWB
regtemplate(kcs3)

kcs3m=mirror_brain(kcs3, brain=regtemplate(kcs20))
plot3d(kcs3, col='red')
plot3d(kcs3m, col='green')

## End(Not run)
```

---

templatebrain

---

*Construct templatebrain object for an image registration template*


---

**Description**

templatebrain objects encapsulate key information for the reference brain in an image registration. Usually this will be a standard template brain used for many registrations. **It will normally be much more convenient to use [as.templatebrain](#) methods to convert an image file or an im3d object into a templatebrain.**

**Usage**

```
templatebrain(
  name,
  regName = name,
  type = NULL,
  sex = NULL,
  dims = NULL,
  BoundingBox = NULL,
  voxdims = NULL,
  origin = NULL,
  units = NULL,
  description = NULL,
  doi = NULL,
  ...
)
```

## Arguments

|             |                                                                                                                                                                                                |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| name        | the full name of the template.                                                                                                                                                                 |
| regName     | the short name. This will be the stem used to prefix registrations (e.g. JFRC2_someimage.list) for this template brain and likely also the stem of the template brain image (e.g. JFRC2.nrrd). |
| type        | one of c('single brain', 'average'), indicating whether the template brain has been created from just one image, or is the average of multiple images.                                         |
| sex         | the sex of the template brain. For templates with type=='average', the possibility of sex='intersex' exists.                                                                                   |
| dims        | dimensions of the image (number of voxels).                                                                                                                                                    |
| BoundingBox | physical dimensions of the image (see <a href="#">boundingbox</a> ).                                                                                                                           |
| voxdims     | physical spacing between voxels.                                                                                                                                                               |
| origin      | the physical location of the first voxel                                                                                                                                                       |
| units       | units of physical measurements (e.g. microns).                                                                                                                                                 |
| description | details of the template.                                                                                                                                                                       |
| doi         | a DOI for the original template brain image.                                                                                                                                                   |
| ...         | additional named arguments that will be added as fields to the templatebrain object.                                                                                                           |

## Details

A variety of methods are available to work on templatebrain objects. See [templatebrain-meths](#) for basic methods. The two main functions that are available for using template brains are [xform\\_brain](#) and [mirror\\_brain](#).

templatebrain objects are only useful for transformation processes when the BoundingBox is specified to define the physical extent of the volume. We use the definition of the Amira 3D visualisation and analysis software. This corresponds to the **node** centers option in the **NRRD format**. The bounding box can be obtained from NRRD or AmiraMesh format files. See [boundingbox](#) for details.

## Value

A list with class templatebrain.

## See Also

[as.templatebrain](#), [templatebrain-meths](#), [xform\\_brain](#), [mirror\\_brain](#).

## Description

`is.templatebrain` tests if object is of class `templatebrain`

`as.character.templatebrain` converts template brain to character vector representation (normally used to extract the short name i.e. `regName`).

`print.templatebrain` prints templatebrain information in human-readable form

`as.im3d` converts a template brain to a `nat::im3d` object; this is probably useful for developers.

`origin` extracts the space origin of a `templatebrain` object.

`dim` extracts the dimensions (in number of pixels) of the image associated with a `templatebrain` object.

`voxdims` extracts the dimensions (in calibrated spatial units, e.g. microns) of voxels in the image associated with a `templatebrain` object.

`boundingbox` extracts the boundingbox (in calibrated spatial units, e.g. microns) of the image associated with a `templatebrain` object. See [boundingbox](#) for details.

## Usage

```
is.templatebrain(x)
```

```
## S3 method for class 'templatebrain'  
as.character(x, field = c("regName", "name"), ...)
```

```
## S3 method for class 'templatebrain'  
print(x, ...)
```

```
## S3 method for class 'templatebrain'  
as.im3d(x, ...)
```

```
## S3 method for class 'templatebrain'  
origin(x, ...)
```

```
## S3 method for class 'templatebrain'  
dim(x, ...)
```

```
## S3 method for class 'templatebrain'  
voxdims(x, ...)
```

```
## S3 method for class 'templatebrain'  
boundingbox(x, ...)
```

**Arguments**

|                    |                                                           |
|--------------------|-----------------------------------------------------------|
| <code>x</code>     | an object (usually a <code>templatebrain</code> ).        |
| <code>field</code> | which field to use (defaults to <code>'regName'</code> ). |
| <code>...</code>   | additional arguments for methods.                         |

**Value**

Return values are documented in the generic methods. `is.templatebrain` returns a logical indicating whether or not the object is a `templatebrain`.

`as.character.templatebrain` returns a character vector with the name of the template brain.

`dim.templatebrain` returns a 3-value integer vector.

**See Also**

[im3d](#)  
[origin](#)  
[voxdims](#)  
[boundingbox](#)

**Examples**

```
data(FCWB.demo)
is.templatebrain(FCWB.demo)
origin(FCWB.demo)
dim(FCWB.demo)
voxdims(FCWB.demo)
boundingbox(FCWB.demo)
# print method
FCWB.demo
```

---

|                               |                                                                     |
|-------------------------------|---------------------------------------------------------------------|
| <code>update_reg_repos</code> | <i>Update local copy of git repository containing registrations</i> |
|-------------------------------|---------------------------------------------------------------------|

---

**Description**

When `x=NULL` all repositories listed in `options(nat.templatebrains.regdirs)` are checked to see if they are git repositories and, if yes, they are pulled to update.

**Usage**

```
update_reg_repos(x = NULL)
```

**Arguments**

|                |                                                                                              |
|----------------|----------------------------------------------------------------------------------------------|
| <code>x</code> | Path to local checkout of a registration git repository. See details for meaning of default. |
|----------------|----------------------------------------------------------------------------------------------|

**Value**

This function is principally called for its side effect, but does return a `git2r::repository` object containing the path on disk to the location of the git repository with registration.

**See Also**

[download\\_reg\\_repo](#)

---

xform\_brain

*Transform 3D object between template brains*


---

**Description**

Transform 3D object between template brains

**Usage**

```
xform_brain(
  x,
  sample = regtemplate(x),
  reference,
  via = NULL,
  imagedata = is.character(x),
  checkboth = NULL,
  target = NULL,
  Verbose = interactive(),
  ...
)
```

**Arguments**

|           |                                                                                                                                                                                                             |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x         | the 3D object to be transformed                                                                                                                                                                             |
| sample    | Source template brain (e.g. IS2) that data is currently in. Specified either as character vector or a templatebrain object.                                                                                 |
| reference | Target template brain (e.g. IS2) that data should be transformed into.                                                                                                                                      |
| via       | (optional) intermediate template brain that the registration sequence must pass through.                                                                                                                    |
| imagedata | Whether x should be treated as image data (presently only supported as a file on disk) or 3D object vertices - see details.                                                                                 |
| checkboth | When TRUE will look for registrations in both directions. See details.                                                                                                                                      |
| target    | When transforming image data, this specifies the target space (defaults to reference when imagedata=TRUE). See Details.                                                                                     |
| Verbose   | Whether to show a message with the sequence of template brains                                                                                                                                              |
| ...       | extra arguments to pass to <a href="#">xform</a> and then on to <a href="#">xformpoints</a> or <a href="#">xformimage</a> which will eventually hand off to <a href="#">cmtk.reformatx</a> when using CMTK. |

## Details

NB the sample, reference and via brains can either be `templatebrain` objects or a character string containing the short name of the template e.g. "IS2".

`xform_brain` uses the helper function `shortest_bridging_seq` to find the shortest path between different template brains based on the set of bridging registrations that the `natverse` has been informed about (see `bridging_graph`). You can specify a `via` argument to ensure that the registrations passes through one or more intermediate templates. Note that when multiple brains are passed to `via` they should be in order from sample to reference. If you are passing multiple `templatebrain` objects, they must be wrapped in a list.

When transforming image data (`imagedata=TRUE`), the `target` argument should normally be specified. This defines the absolute/voxel dimensions of the target space. This can be calculated from a `templatebrain` object, so by default it will be set to the value of the reference argument. Alternatively an image file on disk can be specified; this is essential if the reference argument does not specify a `templatebrain` object but instead just names a template space (i.e. is a string).

The significance of the `imagedata` and `checkboth` arguments is that CMTK registrations are not directly invertible although they can be numerically inverted in most cases (unless there are regions where folding occurred). For image data, numerical inversion is *much* slower.

You can control whether you want to allow inverse registrations manually by setting `checkboth` explicitly. Otherwise when `checkboth=NULL` the default is to act as if `checkboth=TRUE` but issue a warning if an inversion must be used.

## Value

A transformed version of `x`

## See Also

`mirror_brain`, `shortest_bridging_seq`, `bridging_graph`, `regtemplate`, `xform`, `xformpoints`, `xformimage`, `cmtk.reformatx` (for transforming image data with CMTK).

## Examples

```
## depends on nat.flybrains package and system CMTK installation
## Not run:
## reformat neurons
##
library(nat.flybrains)
# Plot Kenyon cells in their original FCWB template brain
nopen3d()
plot3d(kcs20)
plot3d(FCWB)
# Convert to JFRC2 template brain
kcs20.jfrc2=xform_brain(kcs20, sample = FCWB, reference=JFRC2)
# now plot in the new JFRC2 space
nopen3d()
plot3d(kcs20.jfrc2)
plot3d(JFRC2)
# compare with the untransformed neurons
plot3d(kcs20)
```

```
# plot with neuropil sub regions for the left mushroom body
clear3d()
plot3d(kcs20.jfrc2)
# nb "MB.*_L" is a regular expression
plot3d(JFRC2NP.surf, "MB.*_L", alpha=0.3)
# compare with originals - bridging registration is no perfect in peduncle
nopen3d()
plot3d(kcs20)
plot3d(FCWBNP.surf, "MB.*_L", alpha=0.3)

# insist on using a specific intermediate template brain
# this would nor be an improvement in this case
kcs20.jfrc2viais2=xform_brain(kcs20, sample = FCWB, via=IS2, reference=JFRC2)

## reformat image examples
# see ?cmtk.reformatx for details of any additional arguments
# note that for image data a target space defining the dimensions of the
# output image must be specified - this happens by default using the
# reference templatebrain object
xform_brain('in.nrrd', sample=FCWB, ref=JFRC2, output='out.nrrd')
# or you can specify an image file explicitly as target
xform_brain('in.nrrd', sample=FCWB, ref=JFRC2, output='out.nrrd',
            target='JFRC2.nrrd')

# use partial volume interpolation for label field
xform_brain('labels.nrrd', sample=FCWB, ref=JFRC2, output='out.nrrd',
            interpolation='pv')

# use binary mask to restrict (and speed up) reformatting
xform_brain('in.nrrd', sample=FCWB, ref=JFRC2, output='out.nrrd', mask='neuropil.nrrd')

## End(Not run)
```

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