Image Processing with ANTsR

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ANTS and ANTsR

- Advanced normalization tools (ANTS) [1] is state-of-the art software that can perform many neuroimaging-related functions.
  - Collection of routines in C, C++, and some R
- ANTsR: port of ANTS into R using Rcpp
- The two functions we focus on are:
  1. Image inhomogeneity correction (N3 [2] and N4 [3])
  2. Image registration

Installing ANTsR

ANTsR is currently (as of March 23, 2015) hosted on GitHub.
We will install ANTsR using the `devtools` package.
Overall, any updates to the install process will be located at https://github.com/stnava/ANTsR.

```
if (!require(devtools)){
        install.packages('devtools')
}
devtools::install_github("stnava/cmaker")
devtools::install_github("stnava/ITKR")
devtools::install_github("stnava/ANTsR")
```

Reading in Images using ANTsR

Reading in images using ANTsR requires 2 changes compared to `readNIfTI` from `oro.nifti`:

1. The extension of the filename (e.g. `.nii.gz`) must be specified
2. The dimension of the image (usually 3) must be supplied (could be 2, 3, or 4)

```
library(ANTsR)
aimg = antsImageRead("Output_3D_File.nii.gz",
         dimension = 3)
```

ANTsR images

The aimg object is an object of antsImage, which consists of:

- pixeltype - how is the image stored (integers versus fractional numbers (floats))
- dimension - how many dimensions does the image have
- pointer - where the data is stored

```
class(aimg)
[1] "antsImage"
attr(,"package")
[1] "ANTsR"
aimg
antsImage
  Pixel Type   : float
  Pixel Size   : 1
  Dimensions   : 512x512x22
  Voxel Spacing: 0.46875x0.46875x5
  Origin       : 0 0 0
  Direction    : 1 0 0 0 -1 0 0 0 1
```

ANTsR images: statistics

We can still do statistics from an `antsImage`:

```
mean(aimg)
[1] 102.4701
mean(aimg[aimg!=0])
[1] 179.4116
```

and get the image data from an `antsImage` using `as.array`:

```
class(as.array(aimg))
[1] "array"
```

But we discussed nifti objects before!?

Why discuss the `antsImage` class?

1. The class can be very fast at performing operations
2. Some ANTsR functions return object of `antsImage` class
3. Some ANTsR functions require an object of `antsImage` class as input

Partial Solution: Use extrantsr

The `extrantsr` (EXTRa ANTsR) package has helper functions to jump `ANTsR` and the `oro.nifti` classes:
Installing `extrantsr`:

```
devtools::install_github("muschellij2/extrantsr")
```

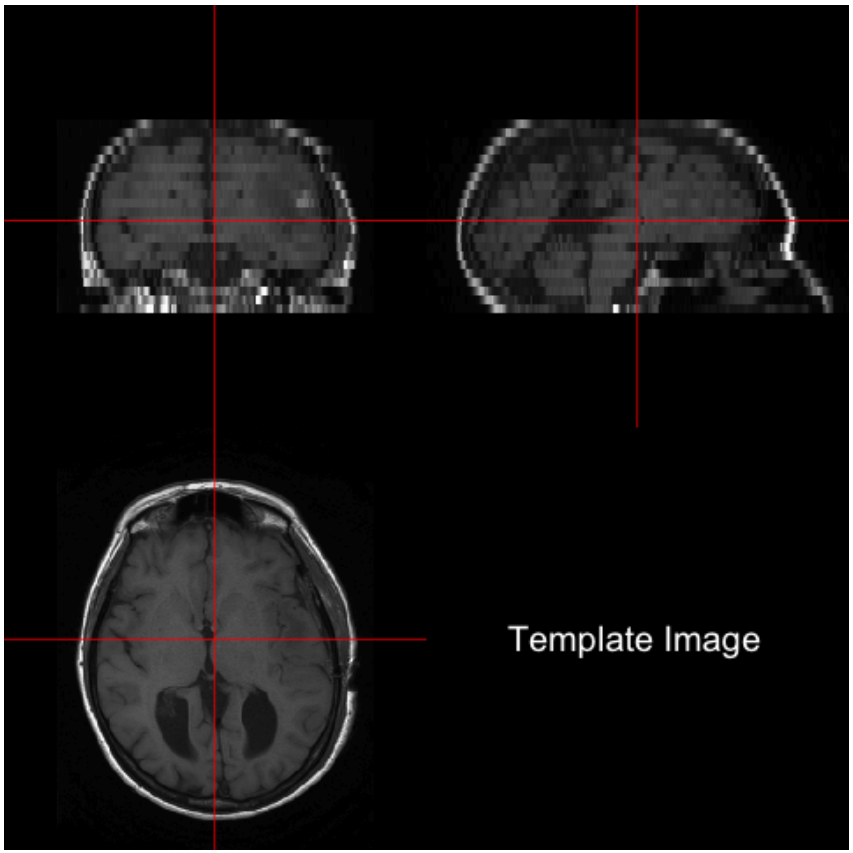
```
library(extrantsr)
class(nim <- ants2oro(aimg))
[1] "nifti"
attr(,"package")
[1] "oro.nifti"
```

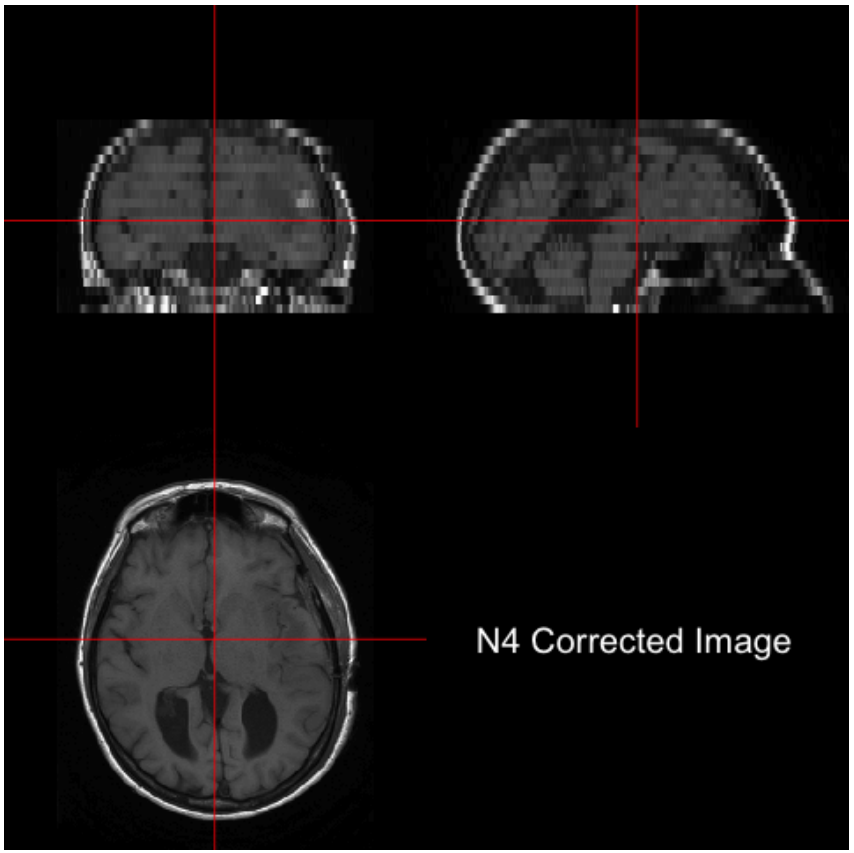
Wrapper functions in extrantsr: Bias Field Correction

`extrantsr::bias_correct` wraps `n3BiasFieldCorrection` [2] and `n4BiasFieldCorrection` [3] from `ANTsR` for bias field correction:

```
n3img = bias_correct(nim, correction = "N3",
        retimg=TRUE)
n4img = bias_correct(nim, correction = "N4",
        retimg=TRUE)
```

Wrapper functions in extrantsr: Bias Field Correction





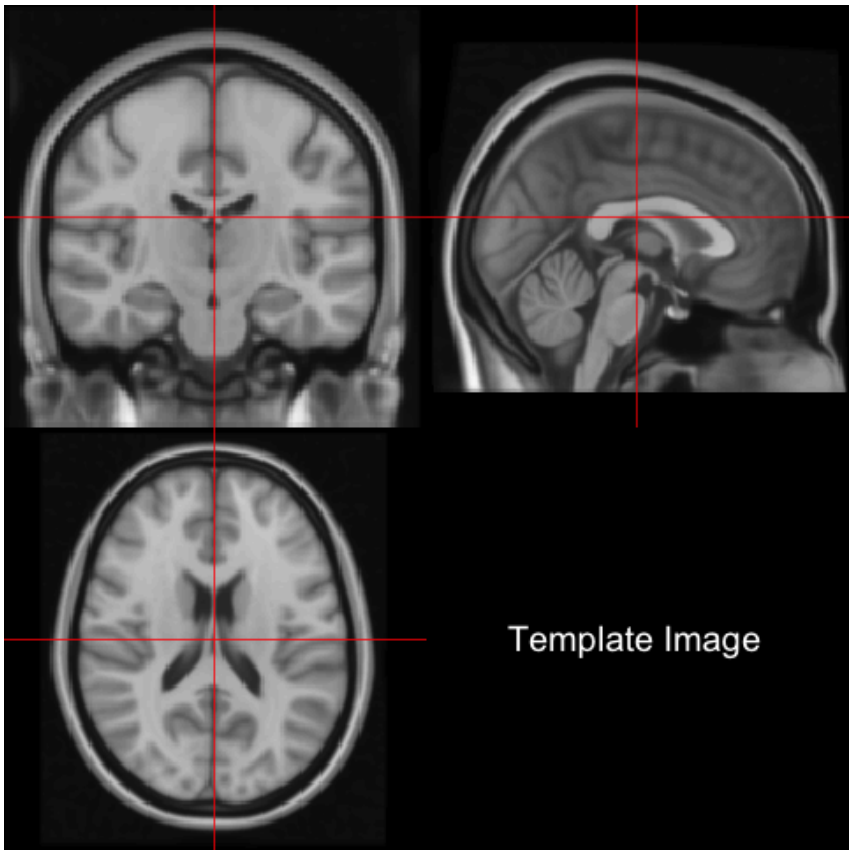
Wrapper functions in extrantsr: Image Registration

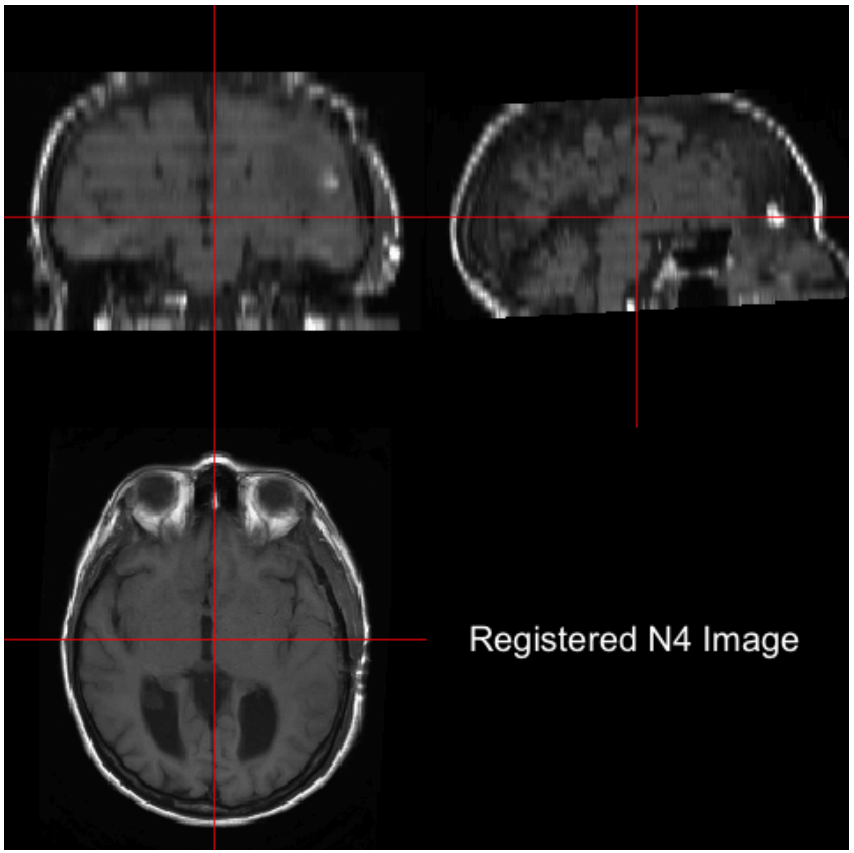
- `ANTsR` worker function: `antsRegistration`
- `extrantsr` worker function: `ants_regwrite`

`ants_regwrite` takes in a filename and a template filename, other files (in the same space as filename) to transform to template:

```
registered_n4 = ants_regwrite(filename=n4img,
        template.file = "MNI152_T1_1mm.nii.gz",
        remove.warp = TRUE,
        typeofTransform = "Rigid")
```

Wrapper functions in extrantsr: Image Registration





References I


Brian B Avants et al. "A reproducible evaluation of ANTs similarity metric performance in brain image registration". In: *Neuroimage* 54.3 (2011), pp. 2033–2044.


John G Sled, Alex P Zijdenbos, and Alan C Evans. "A nonparametric method for automatic correction of intensity nonuniformity in MRI data". In: *Medical Imaging, IEEE Transactions on* 17.1 (1998), pp. 87–97.


Nicholas J Tustison et al. "N4ITK: improved N3 bias correction". In: *Medical Imaging, IEEE Transactions on* 29.6 (2010), pp. 1310–1320.