

Introduction

The rapid progress of research in the neuroscience and neuroimaging fields has been accompanied by the development of many excellent analysis software tools. These are implemented in a variety of computer languages and programming environments, such as Matlab, IDL, Python, C/C++ and others. This variety has been developed over time through a combination of user preferences and the strengths/weaknesses of the computing environments. Here, we present a selection of tools dedicated to Medical Imaging written in the R Statistical Language.

Why another language? Why R?

- R is a free software environment for statistical computing and graphics.
- R compiles and runs on almost every UNIX platform, Windows, and Mac OS.
- R provides a wide variety of statistical (linear/nonlinear regression, classical statistical tests, time-series analysis, classification, clustering, etc...) and graphical techniques.
- R is highly extensible (over 3000 separate packages contributed by R users).
- Several mailing lists to provide updates and access to literally thousands of R users.
- Complete set of open-access manuals about the R language.

Special volume of *Journal of Statistical Software* (jstatsoft.org)

- Special issue "Magnetic Resonance Imaging in R" of JSS scheduled for August 2011.
- Featuring contributed papers on software packages and statistical methods covering
 - I/O Medical Imaging Data
 - Diffusion weighted MRI
 - Dynamic contrast enhanced MRI
 - Functional MRI, Functional integration
 - Structural MRI

I/O and Preprocessing

- The **oro.nifti** and **oro.dicom** packages provide access to medical imaging files in ANALYZE, NIFTI, DICOM, and AFNI files.
- **Rniftilib**: interface to the "official" *niftilib*.
- The **RNiftyReg** provides an interface to the NiftyReg image registration tools.

Diffusion Weighted MRI

- Package **diti** for Diffusion Tensor Imaging, structural adaptive smoothing, HARDI modeling (see Poster #611-WTh, #616-WTh)
- **TractoR** project for Tractography with R

Dynamic contrast enhanced MRI

- The **dcmrIS4** package contains a collection of functions to perform quantitative analysis from a DCE-MRI
- **DATforDCEMRI** deconvolution analysis

Functional MRI

- **AnalyzefMRI** for ICA with fMRI data
- **fmri** for structural adaptive smoothing in GLM approach (see Poster #651-MT)
- Activated region fitting with **arf3DS4**
- Bayesian Multilevel Model with **cudaBayesreg**

R: A language for statistical computing and graphics

- Open source, freely available
- Access to all kinds of statistical tools (linear/nonlinear regression, classical statistical tests, time-series analysis, classification, clustering, etc...)
- Extension by packages with new functionality
- Download at <http://cran.r-project.org>



R: A Language and Environment for Statistical Computing

R: The concept of packages

- Packages: Reliable, convenient, and documented access to a huge variety of techniques. Easy to install.
- Integrate code from low-level languages (C/C++, FORTRAN)
- A recent website (<http://cran.tastic.org>) provides the facilities to search for, review and tag CRAN packages.

Connectivity

- **brainwaver** package
- **FIAR** functional integration

Structural Imaging

- **dpmixsim** implements a Dirichlet Process Mixture (DPM) model for clustering and image segmentation
- Package **mrirc** provides tools for MRI tissue classification

General Imaging

- **adimpro** is a package for 2D digital (color and B/W) images
- **EBImage** is an R package which provides general purpose functionality

EEG

- The **EEG** package
- **PTAK** is an R package that uses a multiway method to decompose a tensor

Conclusions

- R provides an excellent environment for all levels of analysis with neuroimaging data, from basic image processing to advanced statistical techniques.
- Packages from Medical Imaging task view can assist user-guided data analysis for fMRI, DCE-MRI, and DTI data as well as automated bulk analysis of imaging data.
- The user is free to create additional data structures or analysis routines using the programming environment in R—making it easily customized.
- It may be run in either interactive or batch-processing modes in order to scale with the application,
- R may be combined with other computing environments (e.g., Matlab or NIPY) to allow even greater flexibility.

Links and literature

- **Medical Imaging task view** at <http://cran.r-project.org/web/views/MedicalImaging.html> (with download links to all packages)
- Access to R via the **Comprehensive R Archive Network (CRAN)** at <http://cran.r-project.org/>
- Tabelow, K., Clayden, J.D., Lafaye de Micheaux, P., Polzehl, J., Schmid, V.J., Whitcher, B. (2011), 'Image analysis and statistical inference in neuroimaging with R', *NeuroImage*, **55**(4), pp. 1686–1693.