PyMVPA and the larger scientific software ecosystem

Yaroslav Halchenko & Michael Hanke

University of Magdeburg, Germany
Dartmouth College, USA

Delmenhorst 2014
Python in Neuroimaging

Stimuli delivery & Data access

- PsychoPy, Opensesame, VisionEgg, Expyriment
- Nibabel (superseeded PyNIfTI, PyMGH, etc.), h5py, PyTables

H2 (Dartmouth; Magdeburg)
Python in Neuroimaging: PsychoPy

PsychoPy v1.60.00
For stimulus generation and experimental control in python.
PsychoPy depends on your feedback. If something doesn’t work then let me/us know at psychopy-users@googlegroups.com
© 2002-2009 Jonathan Peirce
http://www.psychopy.org

```
#!/usr/bin/env python
from psychopy import core, visual, event

# create a window to draw in
myWin = visual.Window((400,400,0), allowGUI=False)

# INITIALISE SOME STIMULI
gabor = visual.PatchStim(myWin, tex='sin', mask='gauss', texRes=256,
                        size=[1.0,1.0], sf=[4.0],
                        ori = 0)
message = visual.TextStim(myWin, pos=(0.0,-0.9), text='Hit Q to quit')

trialClock = core.Clock()
```

Output:
```
AL lib: Alc1.16: exit()
Device closing
AL lib: Alc1.16: alCloseDevice: destroying 1 Context(s)
```

Hit Q to quit
Python in Neuroimaging

Stimuli delivery & Data access

- PsychoPy, Opensesame, VisionEgg, Expyriment
- Nibabel (superseeded PyNIfTI, PyMGH, etc.), h5py, PyTables

Data analysis

- NumPy, SciPy, NetworkX
- MDP, scikit-learn, statsmodels, pandas, sympy
- IPython (notebooks), Sage
- OpenMEEG, Dipy, NiPy, Nitime, NiPype, BrainVisa

http://www.ipython.org/
http://nipy.org

NIPY features

- preprocessing: space-time realignment of fMRI data
- fMRI data analysis: GLM model (model specification, fit)
- inference:
  - parametric tests (false discovery rate, Gaussian Random Field theory)
  - non-parametric tests (voxel-level, cluster-level, mixed effects, various statistics)
- spatial models:
  - anatomic-functional parcellation,
  - structural models (brain functional landmarks)
Python in Neuroimaging: NiPype

Stimuli delivery & Data access

- PsychoPy, Opensesame, VisionEgg, Expyriment
- Nibabel (superseeded PyNIfTI, PyMGH, etc.), h5py, PyTables

Data analysis

- NumPy, SciPy, NetworkX
- MDP, scikit-learn, statsmodels, pandas, sympy
- IPython (notebooks), Sage

Neuroimaging in Python Pipelines and Interfaces

```
import nipype.interfaces.fsl as fsl
mybet = fsl.Bet()
mybet.inputs.infile = 'foo.nii'
mybet.inputs.outfile = 'bar.nii'
result = mybet.run()
```

```
import nipype.interfaces.spm as spm
from glob import glob
allepi = glob('epi*.nii')
allepi.sort()
realigner = spm.Realign()
realigner.inputs.infile = allepi
result = realigner.run()
```
Python in Neuroimaging

Data visualization

- **matplotlib**, **guiqwt**
- **Seaborn**, **ggplot**
- **Mayavi2**, **PySurfer**, **Anatomist**

http://www.connectomeviewer.org

http://matplotlib.sourceforge.net/gallery.html

Python in NeuroImaging

Find the community @ http://www.nipy.org

Stimuli Delivery

PsychoPy
http://www.psychopy.org

PsychoPy is an easy, precise, platform-independent package for stimulus presentation. Suitable for psychophysics, neuroimaging, and all areas of psychology.

- Huge variety of stimuli generated in real-time
- Cross-platform – run the same script on Linux, Win or OS X
- Flexible stimulus units (degrees, cm, or pixels)
- Coder interface for those that like to program
- Builder interface for those that don’t
- Input from keyboard, mouse, joystick or button boxes
- Multi-monitor support
- Automated monitor calibration (supported photometers)

OpenSesame
http://www.cogsci.nl/software/opensesame

OpenSesame is a graphical experiment builder for the social sciences.

- A comprehensive and intuitive graphical user interface
- WYSIWYG drawing tools for creating visual stimuli
- Cross-platform
- Python scripting for complex tasks
- A plug-in framework
- Compatibility (through plug-ins) with commonly used devices: e.g. Eyelink eye trackers, serial response boxes, Mantra object tracker
- Compatibility with popular Python libraries: PsychoPy, PyGame, PyOpenGL, etc.

Data I/O

NiBabel
http://nipy.org/nibabel

NiBabel provides read and write access to some common medical and neuroimaging file formats, including: ANALYZE (plain, SPM99, SPM2), GIfti, NIfTI1, MINC, as well as PAR/REC. NiBabel is the successor of PyNIfTI. The various image format classes give full or selective access to header (meta) information and access to the image data is made available via NumPy arrays.

Analysis

BrainVISA
http://brainvisa.info

BrainVISA is an open-source, modular and customizable software platform built to host heterogeneous tools dedicated to neuroimaging research. It aims at helping researchers in developing new neuroimaging tools, sharing data and distributing their software.

- Databasing capabilities
- Massive computation facilities using Soma-workflow
- Open environment, with many toolboxes
- Specialized toolboxes for T1 MRI processing, sulci ang gyrri morphometry, diffusion imaging and fibers tracking, surfacic and structural analysis, 3D histology...
- Links with other software like SPM, FSL, FreeSurfer, or CIVET

DiPy
http://nipy.org/dipy

Dipy is an international FOSS project for diffusion magnetic resonance imaging analysis. Dipy is multiplatform and will run under any standard operating system such as Windows, Linux, Mac OS X. Some of our state-of-the-art applications are:

- Reconstruction algorithms e.g. GQI, DTI
- Tractography generation algorithms e.g. EuDX
- Intelligent downsampling of tracks
- Ultra fast tractography clustering
- Resampling datasets with anisotropic voxels to isotropic
- Visualizing multiple brains simultaneously
- Finding track correspondence between different brains
- Warping tractographies into another (e.g. MNI) space
- Support of various file formats e.g. Trackvis or NIfTI

Deployment Resolution: NeuroDebian

Matlab -> Linux -> Debian

LIPSIA

AFNI

BrainVoyager

FreeSurfer

fMRIstat

PLS

MVPA Toolbox

Freed

LiPSIA

AFNI

PyNifti

NiPyPE

PyMVPA

CRAN

Python

NumPy

SciPy

Matplotlib

SVMLight

LIBSVM

Shogun

MDP

SciPy

Python2

Python3

R

RPy

'90

'92

'94

'96

'98

'00

'02

'04

'06

'08

H2 (Dartmouth; Magdeburg)

NeuroDebian

Delmenhorst 2014

6 / 10
## NeuroDebian from a researcher’s perspective

**Install simple editor**

```bash
apt-get install gedit
```

**Install complex MRI analysis package**

```bash
apt-get install fsl
```

**Install software collection for psycho-physics**

```bash
apt-get install science-psychophysics
```

**Keep the whole system up-to-date**

```bash
apt-get upgrade
```
NeuroDebian (http://neuro.debian.net) after X years and the contributions of many people:
Support: Where to Look for Help?

http://www.pymvpa.org/support.html

Mailing List

pkg-exppsy-pymvpa@lists.alioth.debian.org
http://lists.alioth.debian.org/mailman/listinfo/pkg-exppsy-pymvpa

IRC

#neurodebian on OTFC

Bug/Wishlist Tracking

http://github.com/PyMVPA/PyMVPA/issues
On Debian system, just use ’reportbug’.
Brain Download:

iz compites.