NIPY: Neuroimaging in Python

http://neuroimaging.scipy.org

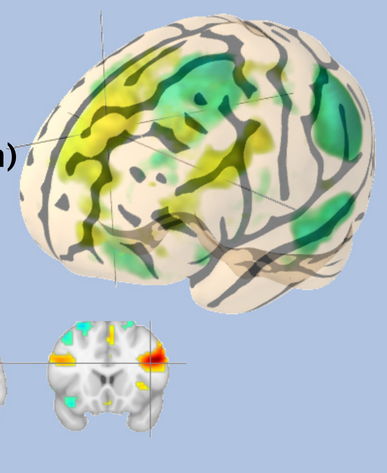
Matthew Brett (1), Christopher Burns (1), K. Jarrod Millman (1), Fernando Perez (1), Alexis Roche (3), Jonathan Taylor (2), Bertrand Thirion (4), Mark D'Esposito (1)

1. Helen Wills Neuroscience Institute, University of California, Berkeley, U.S.A 2. Dept. of Statistics, Stanford University, U.S.A.
3. Neurospin, Commissariat à l'Energie Atomique, Gif-sur-Yvette, France. 4. Parietal team, INRIA, Saclay, France.

Why Python?

- High-level, interactive, easy-to-use, versatile, freely available
- Easy computation-efficient extension with cython/c
- Well suited to design relatively complex neuroimaging objects
- Easy parallel computing
- Presence of well-developed and tested scientific libraries:
  numpy (numeric python): array functions
  scipy (scientific python): various utilities
  matplotlib & mayavi : visualization

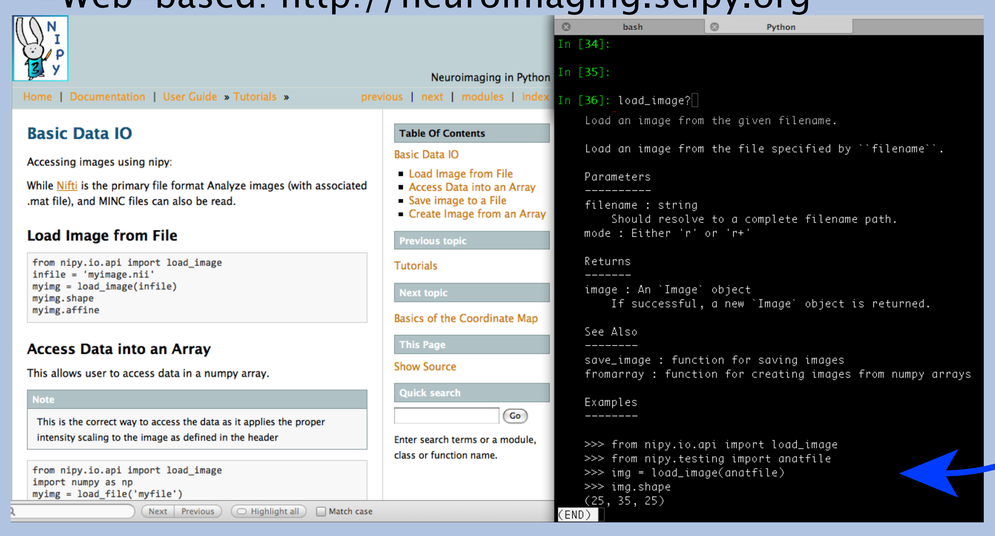
Scientific Python is a high level platform to support long-term sustainable development in neuroimaging



Resting State ICA (2D/3D Visualization)
G.Varoquaux
(Poster 536 F-PM)

Documentation

-PDF, HTML included in distribution
-Interactive Session help and examples
-Web-based: http://neuroimaging.scipy.org



Automated Test Framework

Ensures robust and reproducible software
Bugs found early in development cycle
Tests documentation and code

```
def test_file_roundtrip():
    img = load_image(datapjoin('avg152T1.nii.gz'))
    fd, name = mkstemp(suffix='.nii.gz')
    tmpfile = open(name)
    save_image(img, tmpfile.name)
    img2 = load_image(tmpfile.name)
    data = np.asarray(img)
    data2 = np.asarray(img2)
    tmpfile.close()
    os.unlink(name)
    # verify data
    yield assert_true, np.allclose(data2, data)
    yield assert_true, np.allclose(data2.mean(), data.mean())
    yield assert_true, np.allclose(data2.min(), data.min())
    yield assert_true, np.allclose(data2.max(), data.max())
    # verify shape and ndims
    yield assert_equal, img2.shape, img.shape
    yield assert_equal, img2.ndim, img.ndim
    # verify affine
    yield assert_true, np.allclose(img2.affine, img.affine)
```

Access to Other Scientific Tools

pymvpa : multivariate analysis tools in python

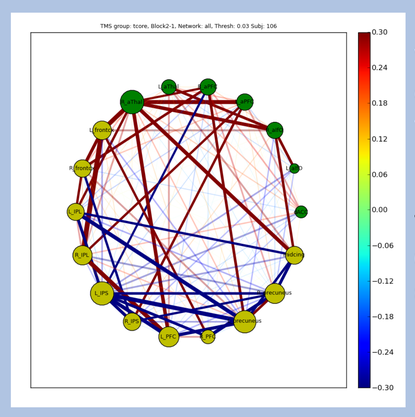
mlpy: machine learning toolbox

pygifti: python binding of gifti library

pyNN and many other Neural Network packages

sympy: symbolic mathmatics

brainvisa: interface to many anatomical/diffusion and visualization functions

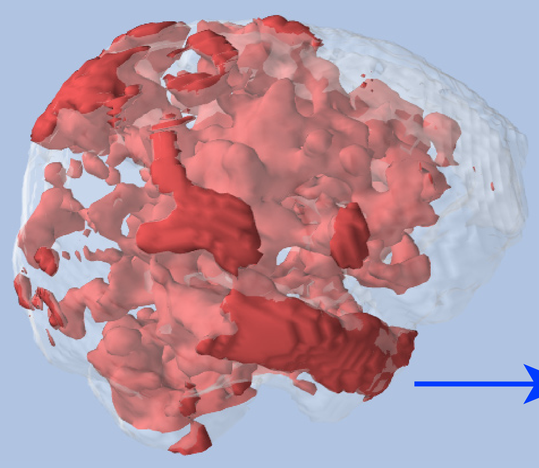


Visualizing changes in coherence of resting state functional connectivity networks after 10 minutes of repetitive TMS (1 Hz). Thanks to E. Nomura, C. Gratton and M. D'Esposito (Poster 282 M-PM)

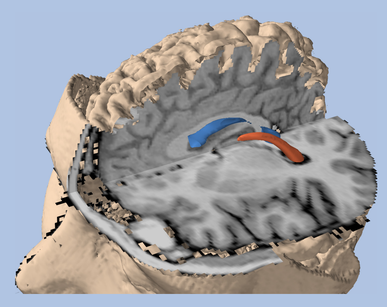
Whats in Nipy Now?:

- GLM Model (Model specification/fit)
- Parametric tests: (false discovery rate, Gaussian Random theory)
- Non-parametric Tests: (voxel-level, cluster-level, mixed effects)
- Spatial Models:
  ~region-of-interest based analysis
  ~anatomo-functional parcellations
  ~structural models (brain functional landmarks)

Visualize Statistical Results



```
def view_thresholdedT(design, contrast, threshold, inequality=np.greater):
    """A mayavi isosurface view of thresholded t-statistics

    Parameters
    ----------
    design: {'block', 'event'}
        Experimental design to view.
    contrast: {'speaker_0', 'speaker_1', 'sentence_0', 'sentence_1'}
        Which contrast of interest to view.
    threshold: float
        Value to threshold the t-map.
    inequality: {np.greater, np.less}
        Measure of inequality to compare t-map against `threshold`.
    """

    maska = np.asarray(MASK)
    tmap = np.array(load_image_fiac('group', design, contrast, 't.nii'))
    test = inequality(tmap, threshold)
    tval = np.zeros(tmap.shape)
    tval[test] = tmap[test]

    avganata = np.array(AVGANAT)
    avganat_iso = ML.contour3d(avganata * maska, opacity=0.3, contours=[3600],
                               color=(0.8,0.8,0.8))

    avganat_iso.actor.property.backface_culling = True
    avganat_iso.actor.property.ambient = 0.3

    tval_iso = ML.contour3d(tval * MASK, color=(0.8,0.3,0.3),
                            contours=[threshold])
    return avganat_iso, tval_iso
```



Whats Currently Being Developed

- spatial normalization
- handling regressors/contrasts in symbolic python formalism
- connectivity models: inference of brain connectiviy/ ICA
- Data Quality checking Methods
- Timeseries/Coherence Models
- Probablistic Spatial Models
- Haemodynamic Response Estimation
- Interfaces to other existing packages for cross validation
- Pipeline architecture/ parallelization