Advanced fMRI Practical Nonparametric Inference, Power & Meta-Analysis

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Zurich SPM Course

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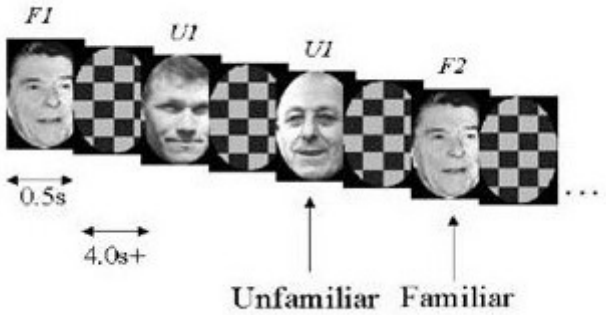
Advanced fMRI Practical

- Nonparametric Inference
- Power
- Meta-Analysis

Henson et al. Faces Data



- Famous-vs-Nonfamous faces
  - Chapter 30 of SPM manual
  - Main effect, Any Faces – Checkerboard
  - 12 subjects
    - 'cons_can' Canonical HRF only
    - 'cons_informed' Canonical + Temp Deriv + Disp Deriv
- Will compare SnPM to SPM
  - For 1-sample t-test (cons_can)

Using SnPM: Key options

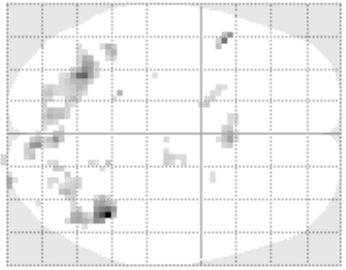
- Choose design
  - One-sample t? Two-sample t? Correlation?
- Cluster inference?
  - Yes: Commit to particular cluster-forming threshold now
    - "Yes, set cluster-forming threshold now (fast)"
  - Yes: Don't commit, collect *huge* SnPM_ST file
    - "Yes (slow, may create huge SnPM_ST.mat file)"
- Number of permutations
  - Defaults to 5000
  - 10,000 is 'gold standard'
  - Anyway, this is maximum; possible number might be smaller

Give it a try!

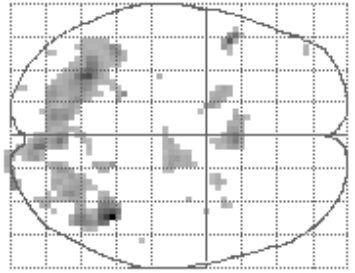
(see ‘handout’)

Voxel-Wise Results
Canonical HRF t test

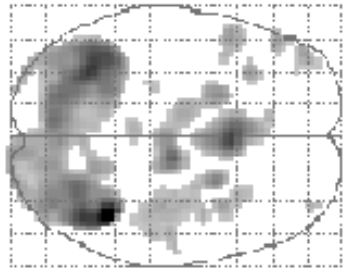
- SPM
  - u_{FWE} = 9.071, 371 voxels



- SnPM
  - u_{FWE} = 7.925, 917 voxels



- SnPM w/ Var Smoothing
  - (u_{FWE} not comparable) 3575 voxels w/ 6mm
  - 3483 voxels w/ 4mm



8mm var. sm.

Advanced fMRI Practical

- Nonparametric Inference
- Power
- Meta-Analysis

Estimating Signal Change

- Ideally we'd measure % BOLD signal change
- Units in SPM (or any model) depend on
  1. Data scaling
     - Want (arbitrary unit) fMRI data scaled to mean 100
     - SPM's spm_global underestimates global mean

Globals (1)

- Standard practice in fMRI
  - Scale brain mean to 100
  - Then 1 unit change approximately % change
- SPM, uses spm_global to find brain mean
  - Good estimate for tightly cropped PET data
  - Less good for fMRI

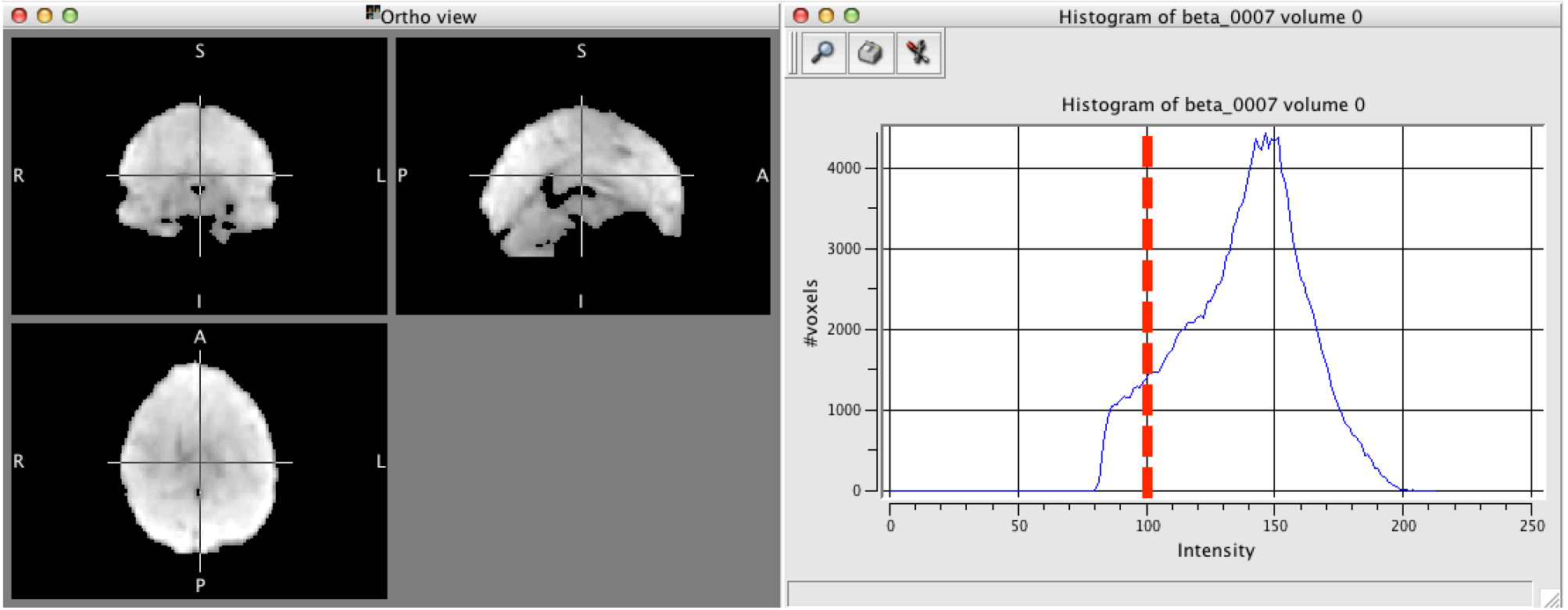
```
function GX = spm_global(V)
% Compute the global mean for a volume image - a compiled routine
% FORMAT GX = spm_global(V)
% V   - image handle structure
% GX  - global mean
%_______________________________________________________________________
%
% spm_global returns the mean counts integrated over all the slices from
% the volume.
%
% The mean is estimated after discounting voxels outside the object using
% a criteria of greater than > (global mean)/8.
%_______________________________________________________________________
% Copyright (C) 1996-2012 Wellcome Trust Centre for Neuroimaging

% Anonymous
% $Id: spm_global.m 4921 2012-09-13 11:16:21Z guillaume $
```

% Anonymous
% $Id: spm_glob

Globals (2)

- Quick check in SPM
  - View last beta_XXX - usually the constant/intercept – check it!



  - Modal brain intensity 150 ≫ 100 !
  - Use (e.g.) MarsBar to get % BOLD change

Estimating Signal Change

- Ideally we'd measure % BOLD signal change
- Units in SPM (or any model) depend on
  1. Data scaling
     - Want (arbitrary unit) fMRI data scaled to mean 100
     - SPM's spm_global underestimates global mean
  2. Design matrix scaling
     - Predictor should have [0,1] range?
     - **SPM** Long blocks: **yes**; Short blocks: **no**; Events: **no**.
  3. Contrast scaling
     - Sum of positive contrast values equal 1.0?
     - Sum of negative contrast values equal -1.0?

`[ 1  1  -1  -1 ]` vs. `[ 0.5  0.5 -0.5 -0.5 ]`

Estimating Signal Change

- Solution 1:
  - Admit that we are using arbitrary units
  - Only compute (unitless) effect sizes $d = \Delta/\sigma$
- Solution 2:
  - Use MarsBar or another tool to get the % change

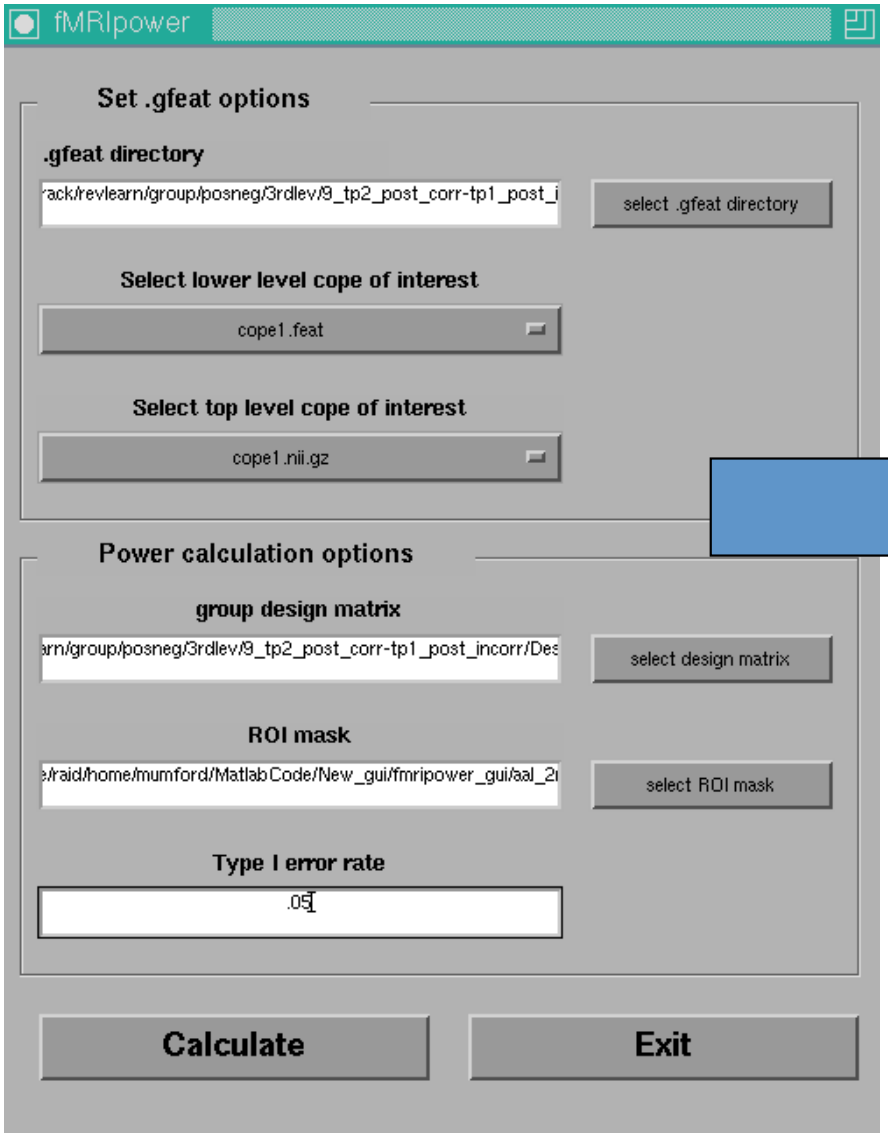
Resources

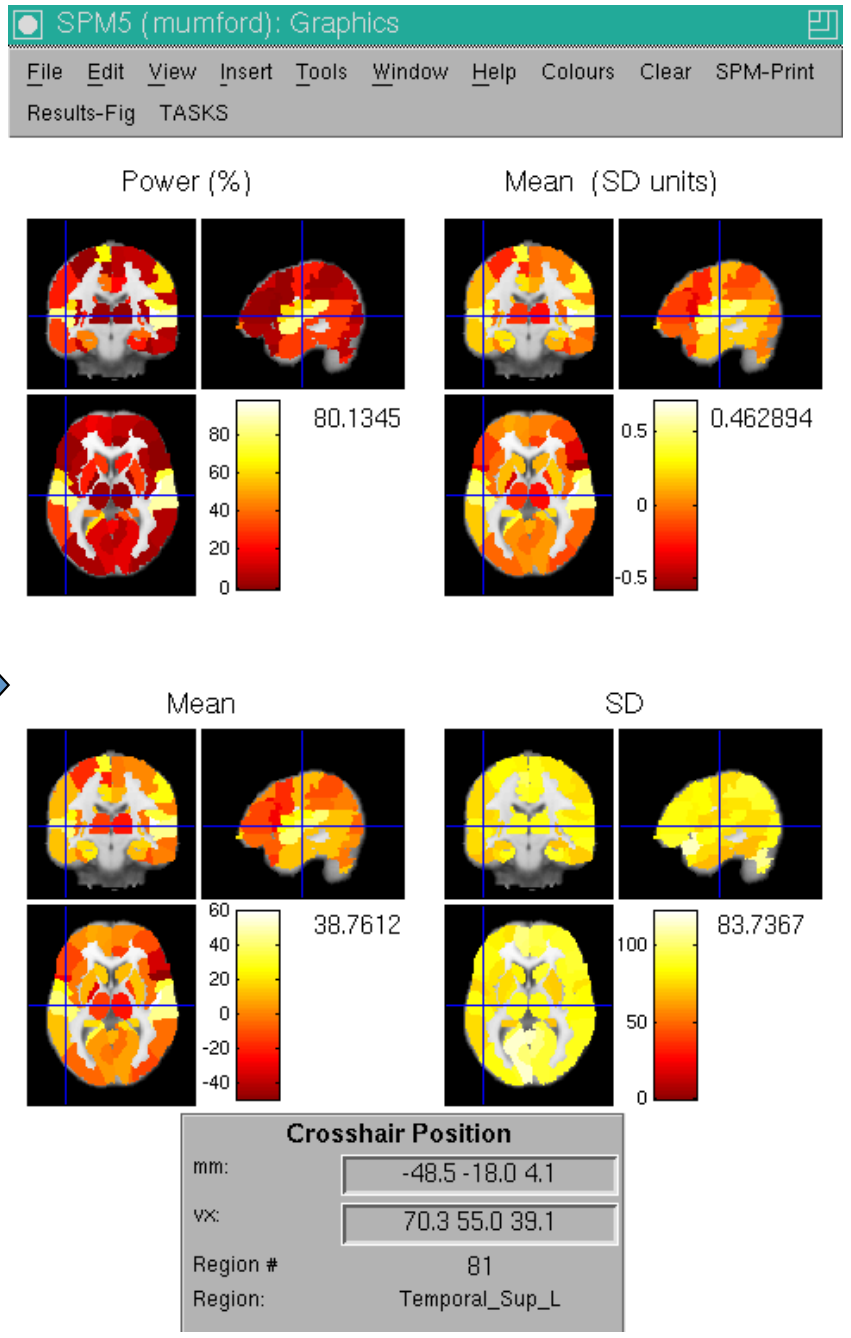
What are the units of a plot in SPM? blog post by me (T. Nichols)
How is the percent signal change calculated? from the MarsBar FAQ.
Percent Signal Change for fMRI calculations by Paul Mazaika.
Percent Signal Change FAQ from the MIT Mindhive on brain research.

fMRIpower tool

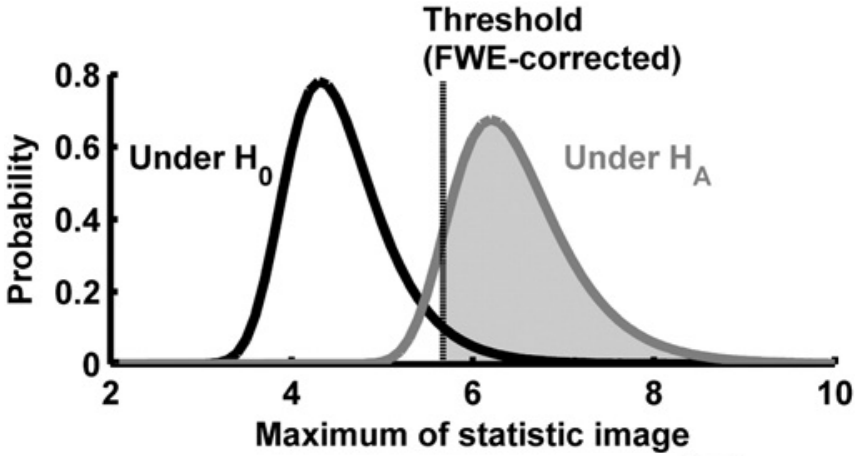
http://fmripower.org

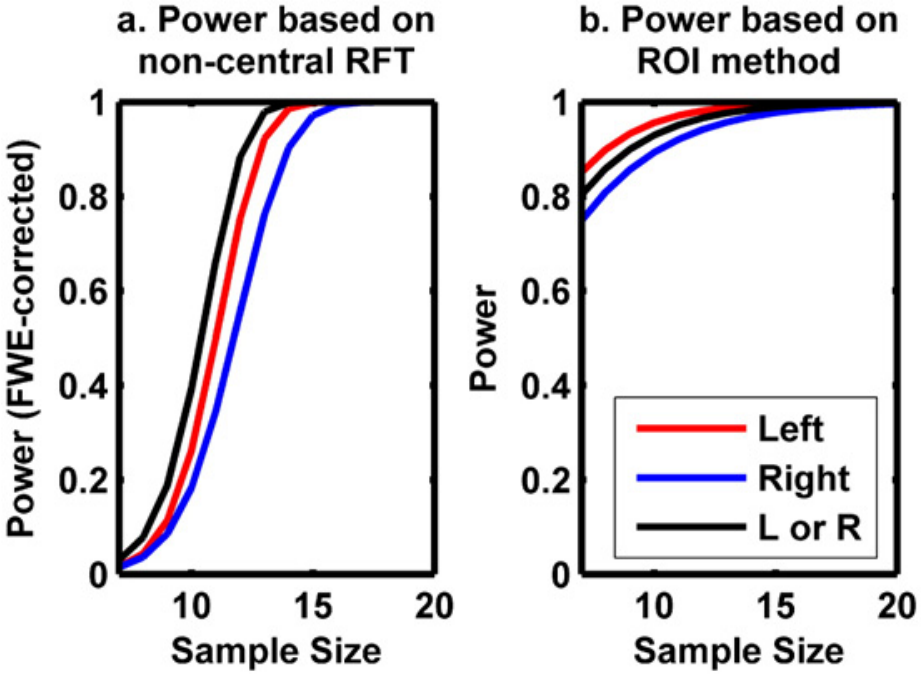
for both SPM & FSL





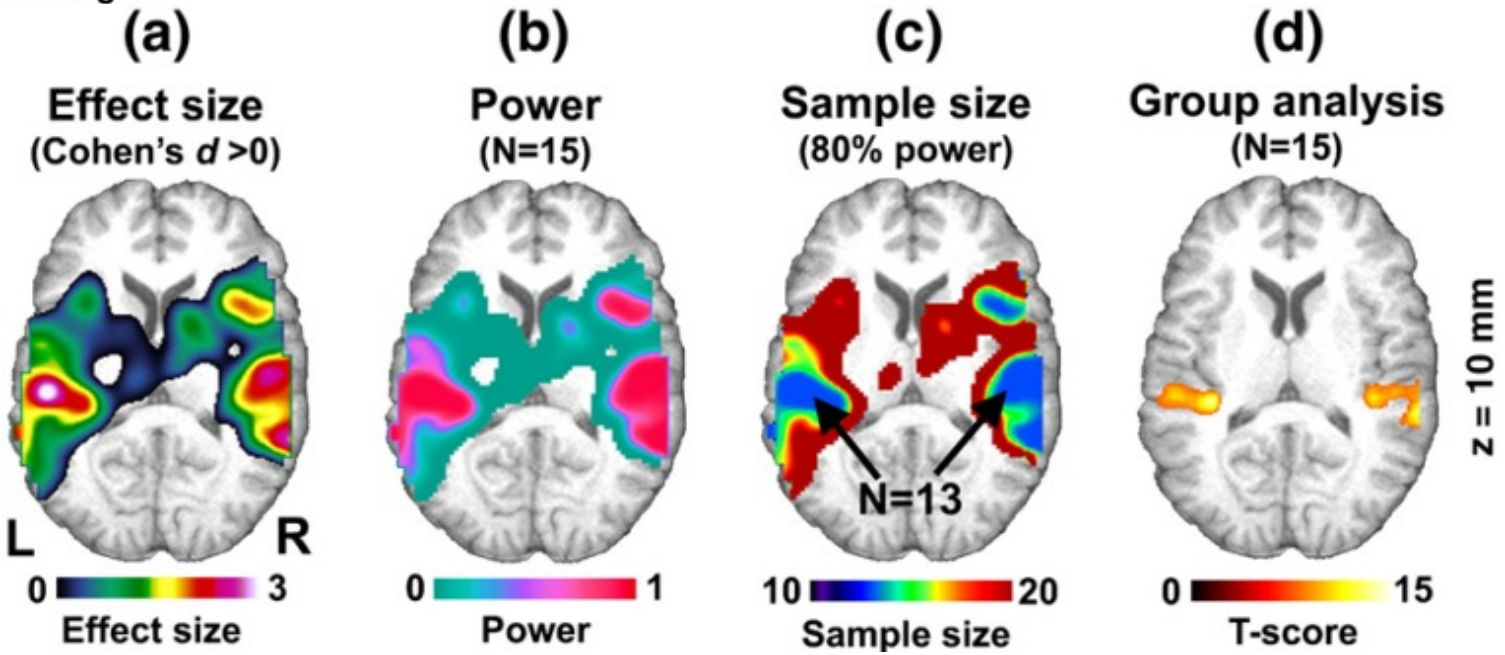
Voxel-wise Power Analyses (with RFT)





PowerMap tool

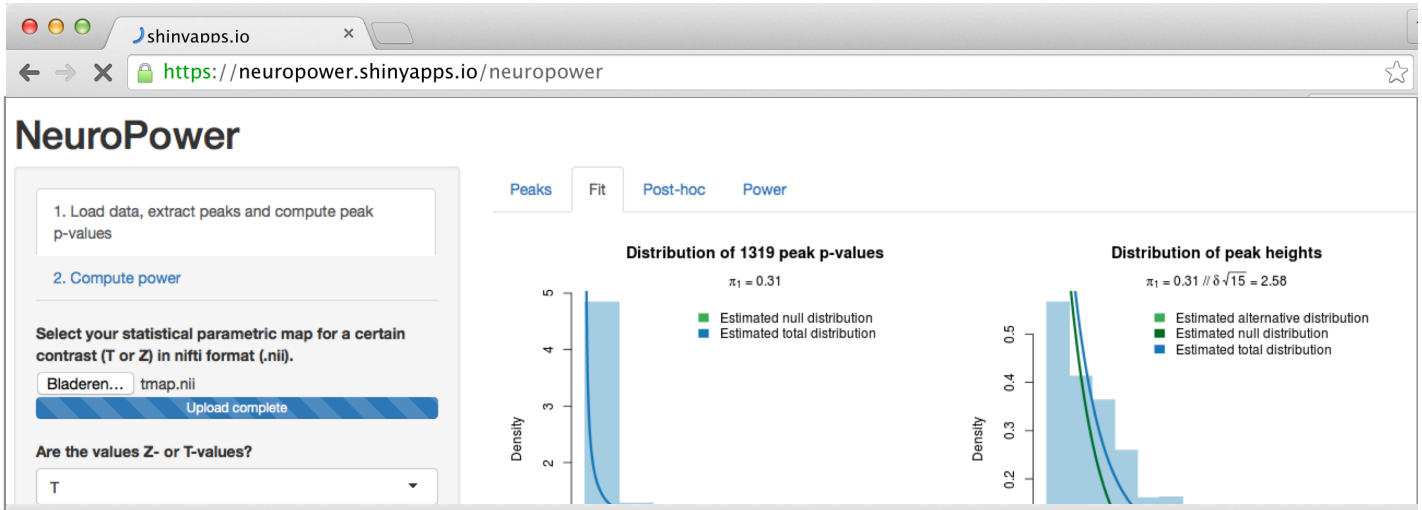
http://sourceforge.net/projects/powermap

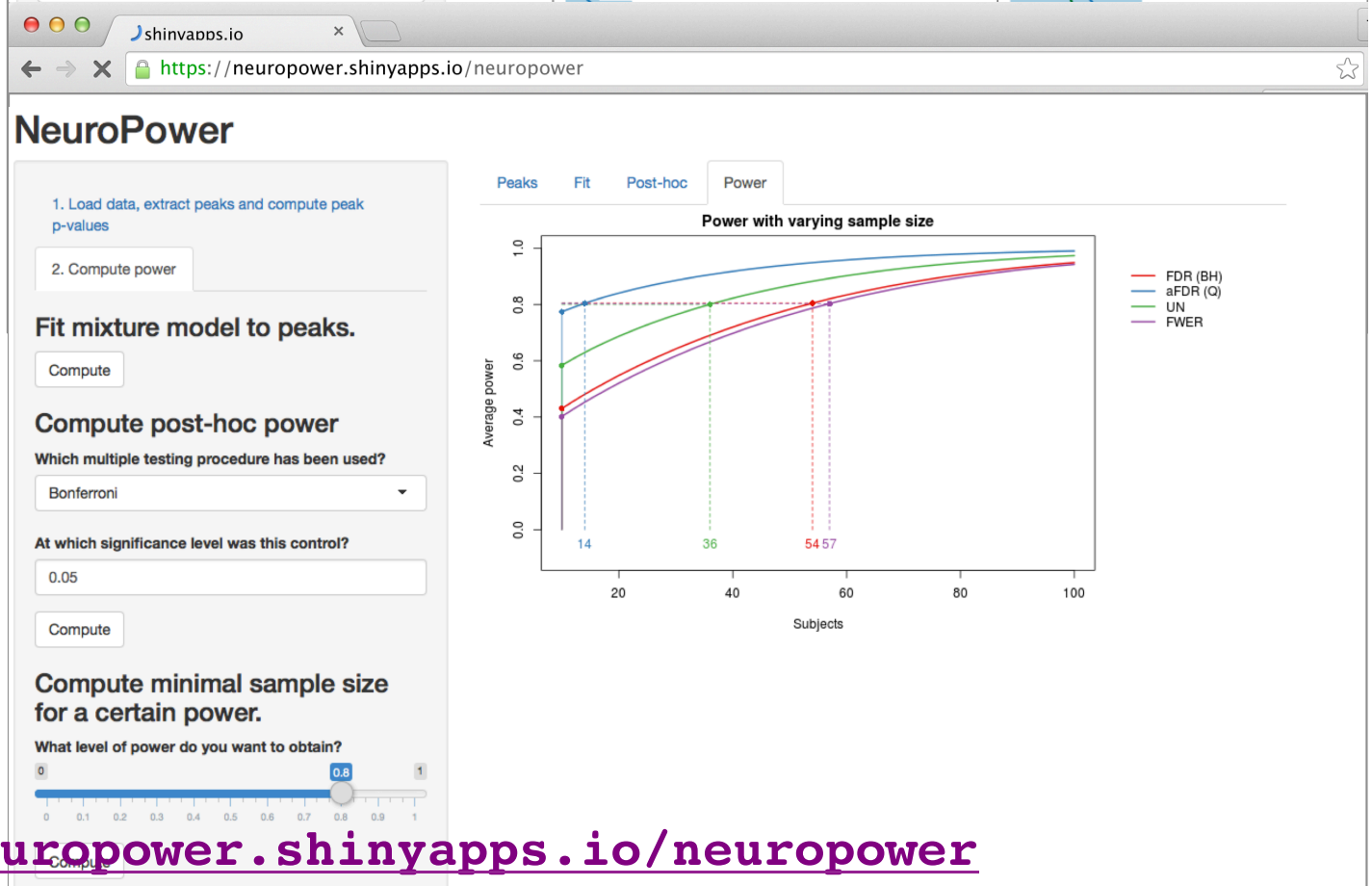


S Hayasaka, AM Peiffer, CE Hugenschmidt, PJ Laurienti. Power and sample size calculation for neuroimaging studies by non-central random field theory. NeuroImage 37 (2007) 721–730

NeuroPower

- Effect prevalance and effect size estimated from peaks *only*
- Then computes power for given number of subjects, peak threshold





http://neuropower.shinyapps.io/neuropower

SWITCH TO META-ANALYSIS LECTURE SLIDES