Iterative LASSO: An even-handed approach to whole brain MVPA

Christopher Cox, Qihong Lu, Timothy Rogers

University of Wisconsin–Madison

Introduction

- A large body of the most historically relevant work in cognitive neuroscience has emphasized **functional localization**.
- However, the focus on *reliability*, *specificity*, and *locality* of neural activity may reveal only a fraction of the full neural representation of these concepts and processes (ref), overlooking what is **distributed and idiosyncratic**.
- We consider whether **Face**, **Place**, and **Object** recognition are processes whose neural bases are specific, reliable, and localized systems, or if they have important aspects that are distributed and idiosyncratic.

Iterative Lasso

Lasso (ref) is an example of regularized regression:

$$\arg\min_{\beta} \sum_{i=1}^{n} (\bar{y}_i - X_i\beta)^2 + \lambda h(\beta)$$

It is standard regression with an additional penalty:

$$h(\beta) = \sum |\beta_j|$$

Seeks best solution using *fewest* voxels. But that means many informative voxels may not be included in the solution. That is, **Lasso has a low hit-rate**.

If Lasso is run **iteratively**, each time excluding voxels that have already been discovered, more of the activity contributing to neural state can be recovered.

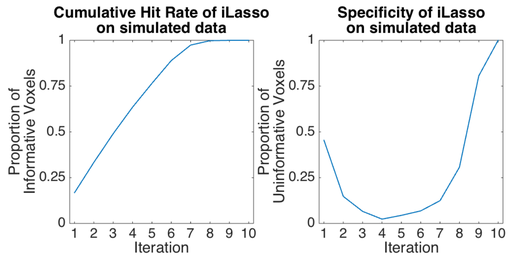

Figure 1: Specificity of Iterative Lasso

Lasso for fMRI analysis

Lasso achieves a sparse solution by selecting voxels that each provide *unique* information. Is several voxels are very informative but are correlated, Lasso will select one and ignore the others. By running Lasso iteratively, these correlated voxels can be identified.

Data

- fMRI data from 10 Ps.
- Ps viewed each of 30 celebritiy **Faces**, 30 famous **Places**, and 30 common **Objects** in random order.
- On each trial, the picture stayed on the screen for 5s.
- After it disappeared, Ps rated how much they liked the celebrity, how much they would like to visit the location, or how often they encountered the object in everyday life.

Procedure

for all Subjects **do**
  for TR in 0–4 **do**
  end for
end for

Performance

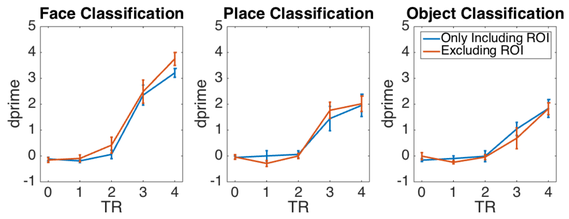

Figure 2: Classification performance, contrasting whether iLasso is trained on voxels only within, or only beyond, the prescribed ROIs. TR 0 is stimulus onset.

Data and ROIs

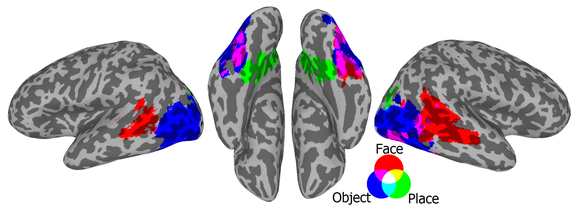

Figure 3: ROIs defined by Julian, J.B., Fedorenko, E., Webster, J., & Kanwisher, N. (2012)

Whole-brain Solutions

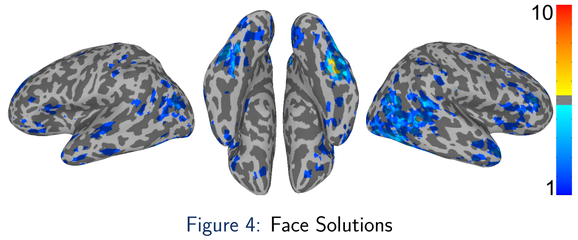

Figure 4: Face Solutions

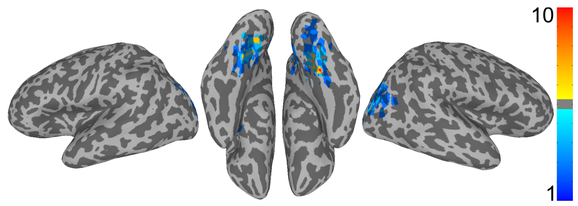

Figure 5: Place Solutions

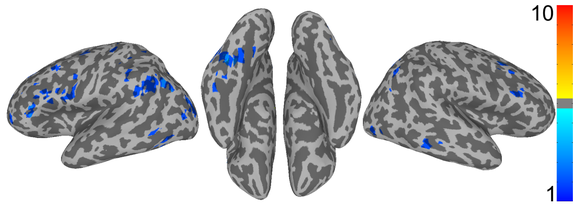

Figure 6: Object Solutions

Aggregate

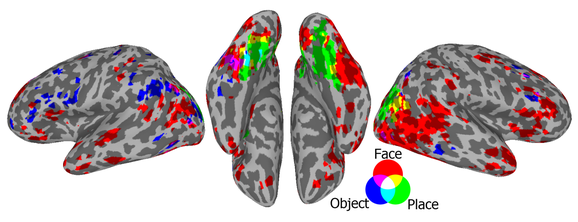

Figure 7: Combined Solution Map

Alert Block Colours

You can similarly modify the colours for alert blocks (but try not to overdo it):

```
\setbeamercolor{block title}
{fg=black,bg=norange}
\setbeamercolor{block body}
{fg=black,bg=white}
```