SOS LASSO: A NEW METHOD FOR FINDING DISTRIBUTED REPRESENTATIONS IN FMRI DATA

Christopher Cox, Nikhil Rao, Robert Nowak, Timothy Rogers  University of Wisconsin, Madison

Introduction

- PDP models have motivated many influential hypotheses.
- Distributed representations are at the heart, responsible the learning, responding, generalizing, and predicting that the models are capable of.
- However, there is limited neural evidence for distributed representations, e.g. from fMRI.
- There may be a disconnect between methods of analysis and representational assumptions of PDP that systematically overlook distributed patterns in the brain.
- SOS LASSO is an optimization technique that is sensitive to distributed representations, similarly located in samples of subjects.

Data Generation & Method

Data were generated by training an auto-encoder neural network.

- Two areas specified to be A and B selective.
- One area placed between systematic input and output units.
- Categorization is possible based on either region, but the information is represented very differently.

Methods vary in their representational assumptions, and will label different patterns of data as “important”. We explore this by applying a range of methods to these data, to obviate the consequences of these assumptions.

Univariate

Seeks consistent, localized activation.

Univariate Contrast

Locomized

Dispersed

Ridge Regression

Seeks consistent, localized information.

Multivariate Searchlight

Locomized

Dispersed

Ridge Regression

SOS LASSO

Seeks best solution using fewest voxels and fewest groups, in individuals and in the sample.

Ridge Regression

(low threshold)

Ridge Regression

(high threshold) LASSO

0 2 4 6 8 10 12

Significant for n subjects

0 1

Proportion positive

Classifier Accuracy

mean=0.65

se=0.008

n=108

Dispersed

mean=0.65

se=0.008

n=108

Abstract: 

SOS LASSO is a method for finding distributed representations in FMRI data. It is an optimization technique that is sensitive to distributed patterns in the brain, similar to those found in samples of subjects. The method involves applying a range of techniques to these data, to obviate the consequences of these assumptions.

Summary (assumptions)

Assumption  U  SL  L  R  SOS

Local representations within an individual  ✓  ✓  ✓  ✓  ✓

Local representations between individuals  ✓  ✓  ✓  ✓  ✓

Consistent representation between individuals  ✓

Independence  ✓

Representation is sparse  ✓  ✓  ✓  ✓

SOS LASSO assumes “locality” in a very different way than the univariate and searchlight methods. Similarity is defined a priori.

Regularized (logistic) regression involves adding a penalty that is a function of the solution β. The nature of this penalty encourages different β to be found. The severity of this penalty is scaled by λ; ordinary regression when λ = 0.