

fMRI Reproducibility in R

Brian B. Avants

PENN Image Computing & Science Laboratory
Dept. of Radiology, University of Pennsylvania
Philadelphia, PA, 19104 ¹

October 14, 2013

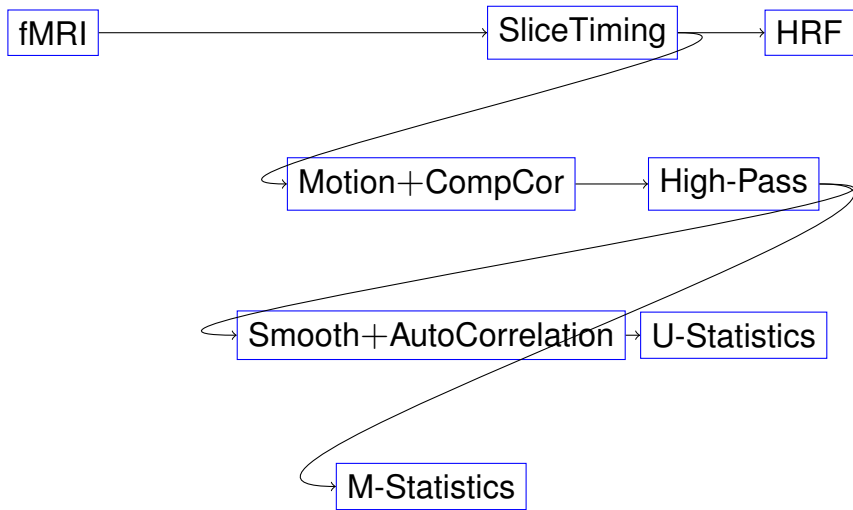
¹for KRNS project

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Block Diagram: *ANTsR* fMRI Processing



Reproducibility Datasets

Dataset 1 : [Gorgolewski](#) $n=10$

Dataset 2 : [Duncan](#) $n > 35$

```
run1 <- rnorm(100)
run2 <- rnorm(100)
cor.test(run1, run2)

##
## Pearson's product-moment correlation
##
## data:  run1 and run2
## t = 1.716, df = 98, p-value = 0.08923
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.02646  0.35534
## sample estimates:
##      cor
## 0.1708
```

R Processing

Use *R* to test processing strategies for fMRI

- ▶ Pre-processing [minimal connectome strategies](#)

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- ▶ Univariate: GLM with [CompCor](#) and [ANTs](#) motion correction.

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- ▶ Multivariate: fMRI application of [SCCAN](#)

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Use *R* to test processing strategies for fMRI

- ▶ Pre-processing [minimal connectome strategies](#)
- ▶ Univariate: GLM with [CompCor](#) and [ANTs](#) motion correction.
- ▶ Multivariate: fMRI application of [SCCAN](#)
- ▶ Multi/Univariate use same pre-processing and includes high-pass filtering.

Signal Reproducibility Measurements

Validation Mechanisms

- ▶ Use test-retest data as training-testing data

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Prediction

Significance of training features in testing run

Analysis Scripts

in RfMRI scripts directory

- ▶ `process.sh` — calls scripts for each subject (should write your own according to data organization)

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- ▶ `process_bold.R` — bold processing for one run ... outputs hrf, matrices and (thresholded) beta maps
- ▶ `ants_compare.sh` — do a quick registration and compute comparison metrics
- ▶ `activity_cross_validation.R` — apply training features to test data ... works for either univariate or multivariate data

Repeatability: Univariate

10 subjects

- ▶ Do β maps overlap? somewhat

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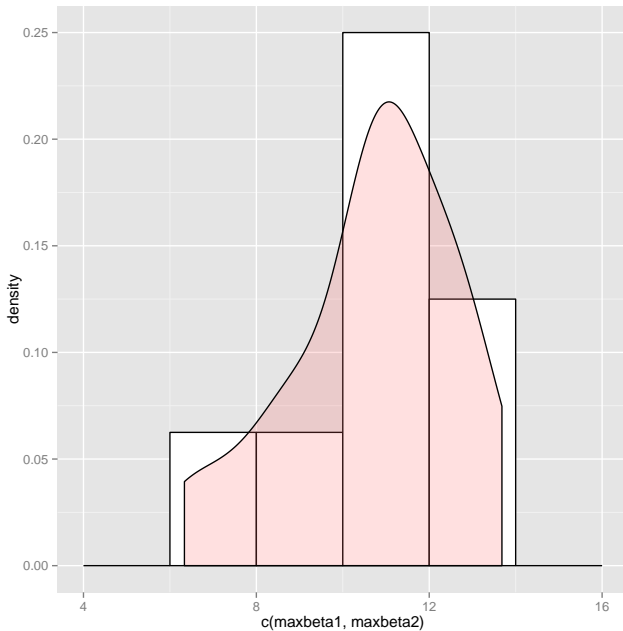
- ▶ Do β maps overlap? somewhat
- ▶ Do β maps correlate? Yes Over 0.83

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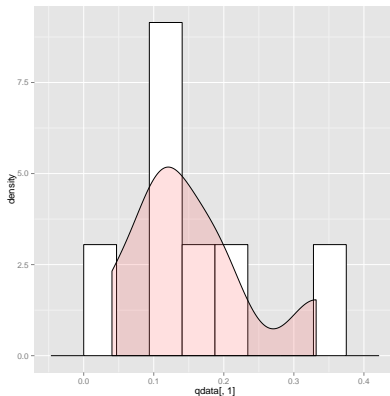
- ▶ Do β maps overlap? somewhat
- ▶ Do β maps correlate? Yes Over 0.83
- ▶ Are significant training features there in test data?
Yes in 6 of 7.

Max β Distribution

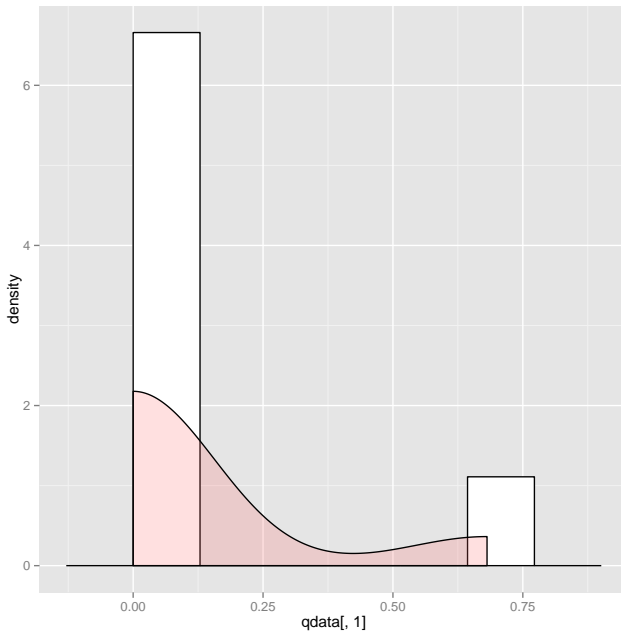


Univariate Overlap Distribution

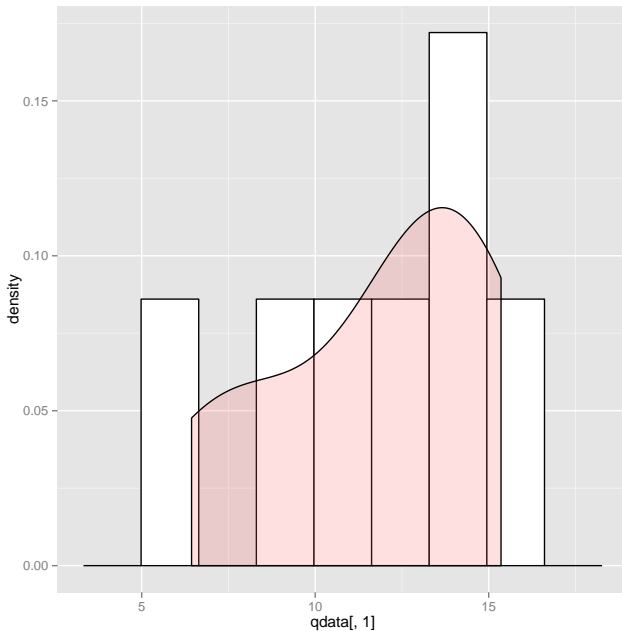
```
## [1] "7 subjects"
```



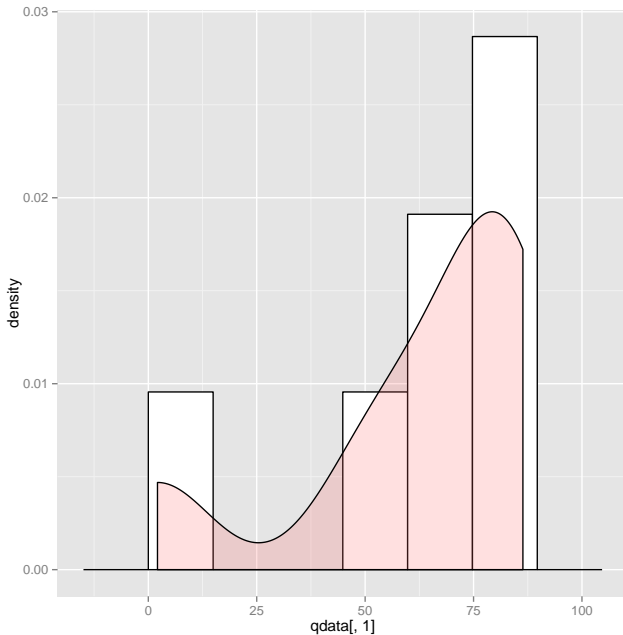
Multivariate Overlap Distribution



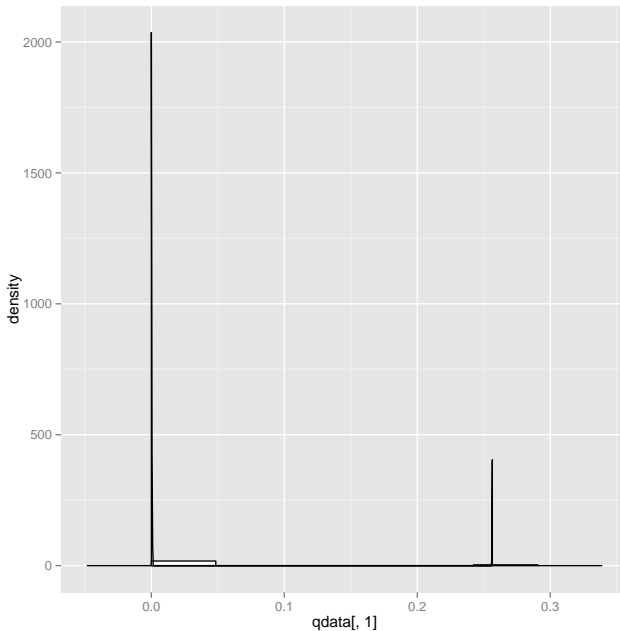
Univariate MDS Distribution



Multivariate MDS Distribution



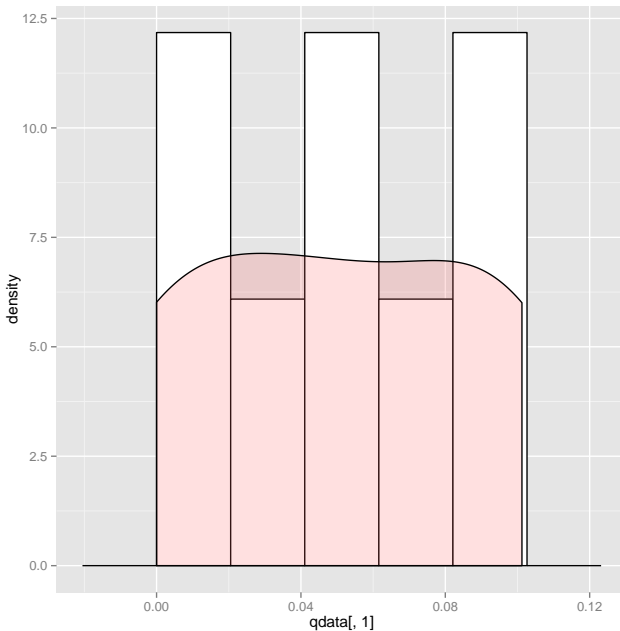
Univariate Significance in Test Data



Univariate Significance in Test Data: Raw Data

```
## ProjectionPVal VoxMinPval nvox
## 1 0.0005745 4.315e-12 149
## ProjectionPVal VoxMinPval nvox
## 1 0.2565 1.226e-09 178
## ProjectionPVal VoxMinPval nvox
## 1 2.7e-10 0 161
## ProjectionPVal VoxMinPval nvox
## 1 1.422e-09 0 166
## ProjectionPVal VoxMinPval nvox
## 1 0 0 243
## ProjectionPVal VoxMinPval nvox
## 1 0 0 218
## ProjectionPVal VoxMinPval nvox
## 1 0 4.485e-14 207
```

Multivariate Significance in Test Data



Multivariate Significance in Test Data: Raw Data

##	ProjectionPVal	VoxMinPval	nvox
## 1	0.09851	5.781e-07	71
##	ProjectionPVal	VoxMinPval	nvox
## 1	0.05158	6.08e-07	88
##	ProjectionPVal	VoxMinPval	nvox
## 1	0.08178	1.011e-13	322
##	ProjectionPVal	VoxMinPval	nvox
## 1	3.832e-12	2.22e-16	360
##	ProjectionPVal	VoxMinPval	nvox
## 1	0	0	238
##	ProjectionPVal	VoxMinPval	nvox
## 1	0.02174	2.777e-08	218
##	ProjectionPVal	VoxMinPval	nvox
## 1	0.04684	1.998e-07	220
##	ProjectionPVal	VoxMinPval	nvox
## 1	0.1012	4.803e-07	195

Repeatability: Multivariate

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- ▶ Do β maps correlate? Yes Over 0.94
- ▶ Are significant training features there in test data? Yes in 5 of 5 if we select bigger components. No if sparseness is too high.

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- ▶ Multivariate features hold up better in test data with "large" features
- ▶ Spatial smoothing separate in univariate
- ▶ Sparseness has different meaning

Discussion + Future Work

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- ▶ How do smoothing and specificity interact?
- ▶ Autocorrelation correction may be useful
- ▶ Test decoding of 3 simple tasks with both univariate and multivariate feature selection