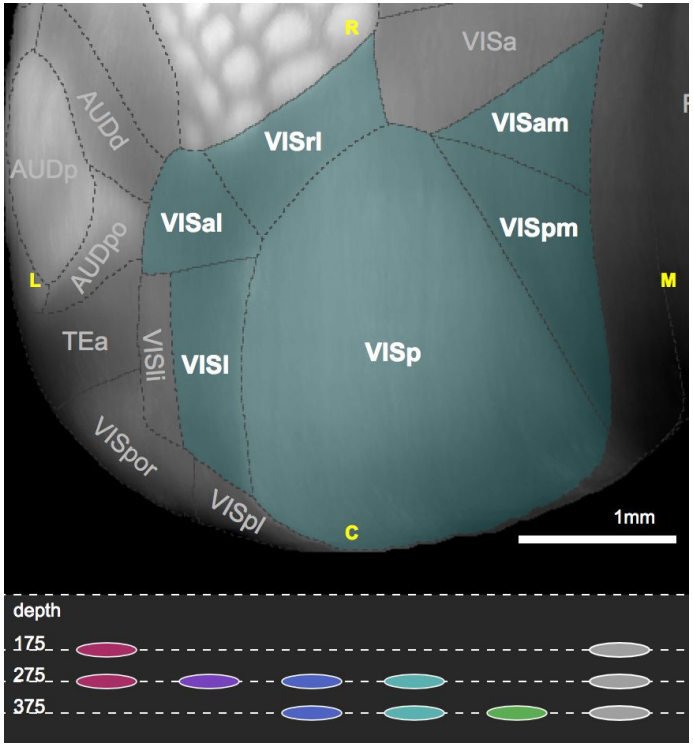
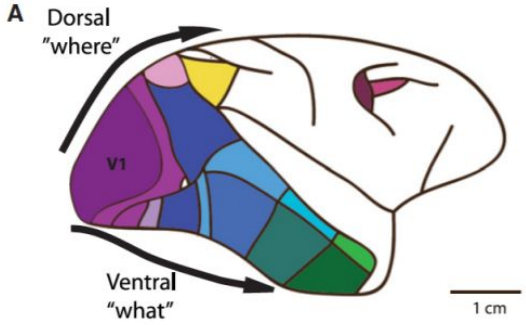
Area, Cre line, and layer-wise differences in visual cortex population responses

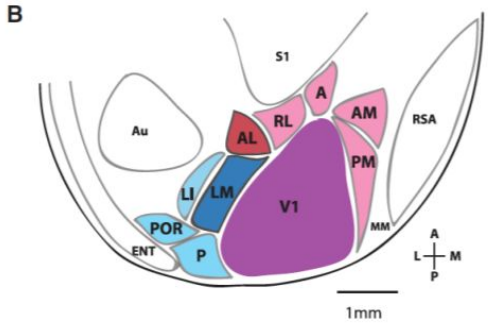
Or how I stopped worrying and learned to love the heatmap

Team NA:SA
Natalia Mesa, Ari Benjamin

How do population responses differ in the visual cortex?

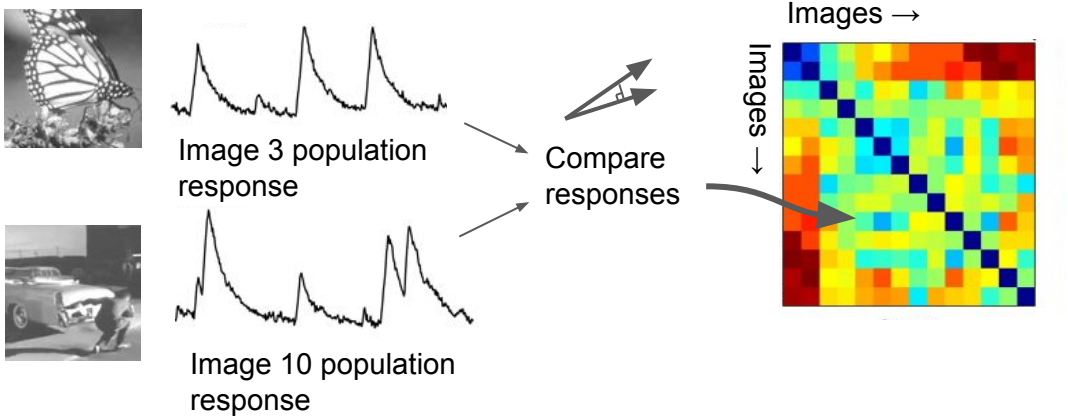






Representational Similarity Analysis

A tool for comparing population codes



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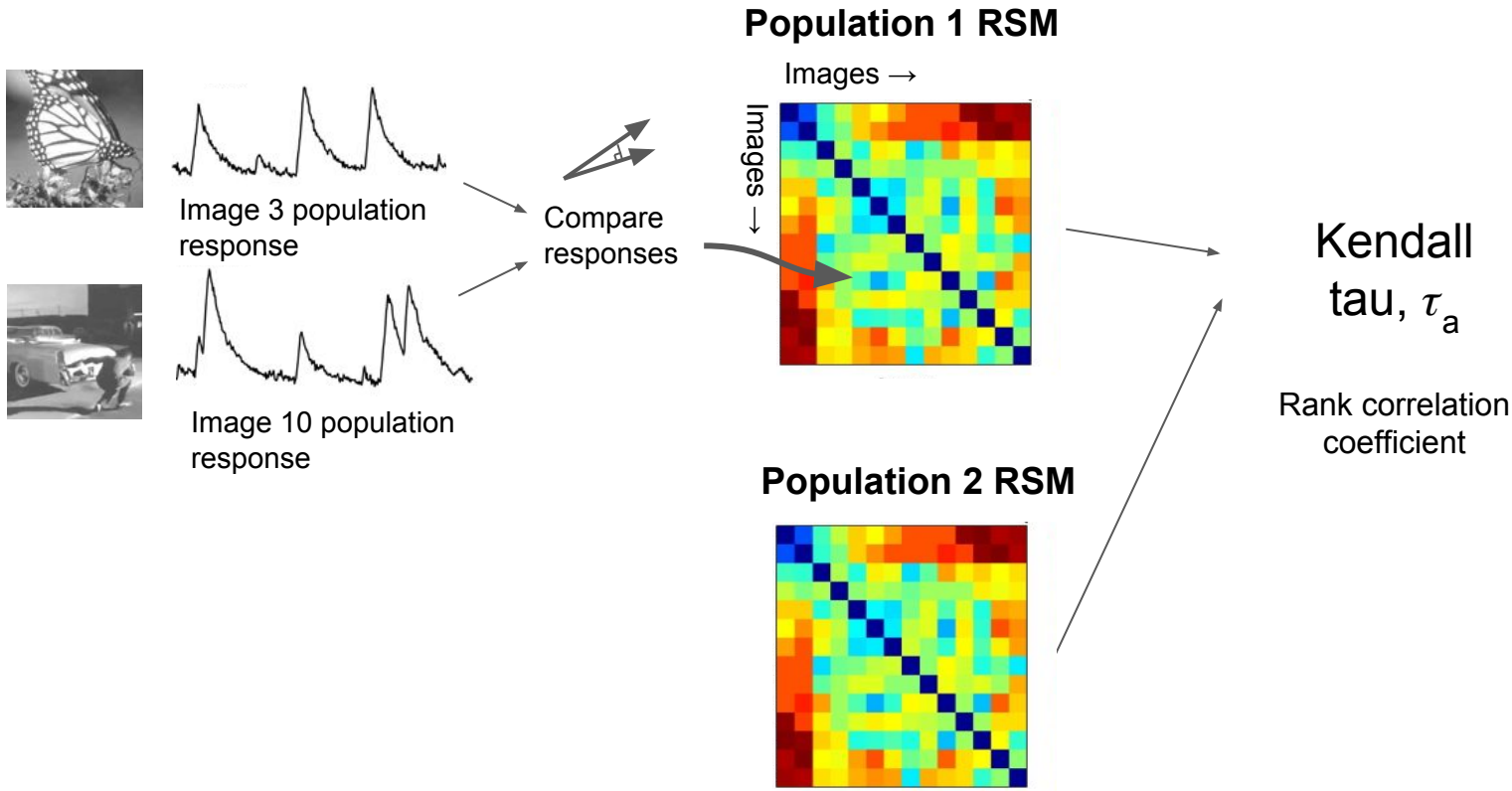

~~Representational~~ Similarity Analysis

Response

What defines two population responses as similar?

A popular metric is **correlation** (as implemented in the current SDK).

Given two populations X and Y,

If $$Y = XM + \epsilon$$

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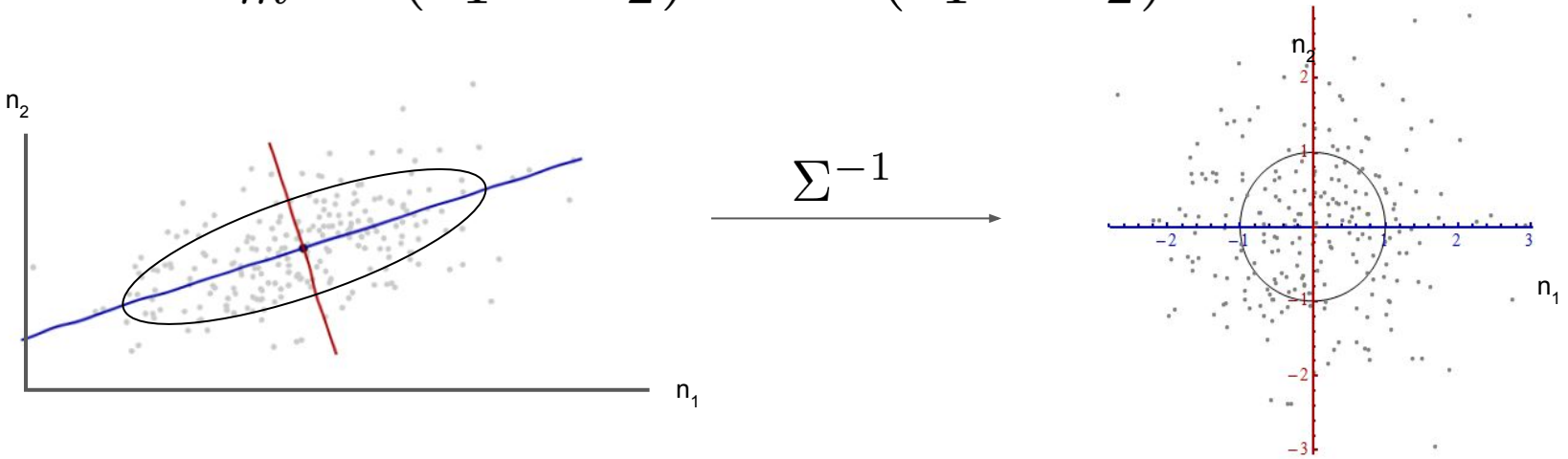
We'd like a measure that at least allows to test for linear relationships!

Mahalanobis distance is invariant to linear transforms

$$\mathrm{d}_m = (r_1 - r_2)^T \Sigma^{-1} (r_1 - r_2)$$



Comparing two Mahalanobis RSMs is equivalent to asking if X and Y are linearly related.

How we constructed our RSMs

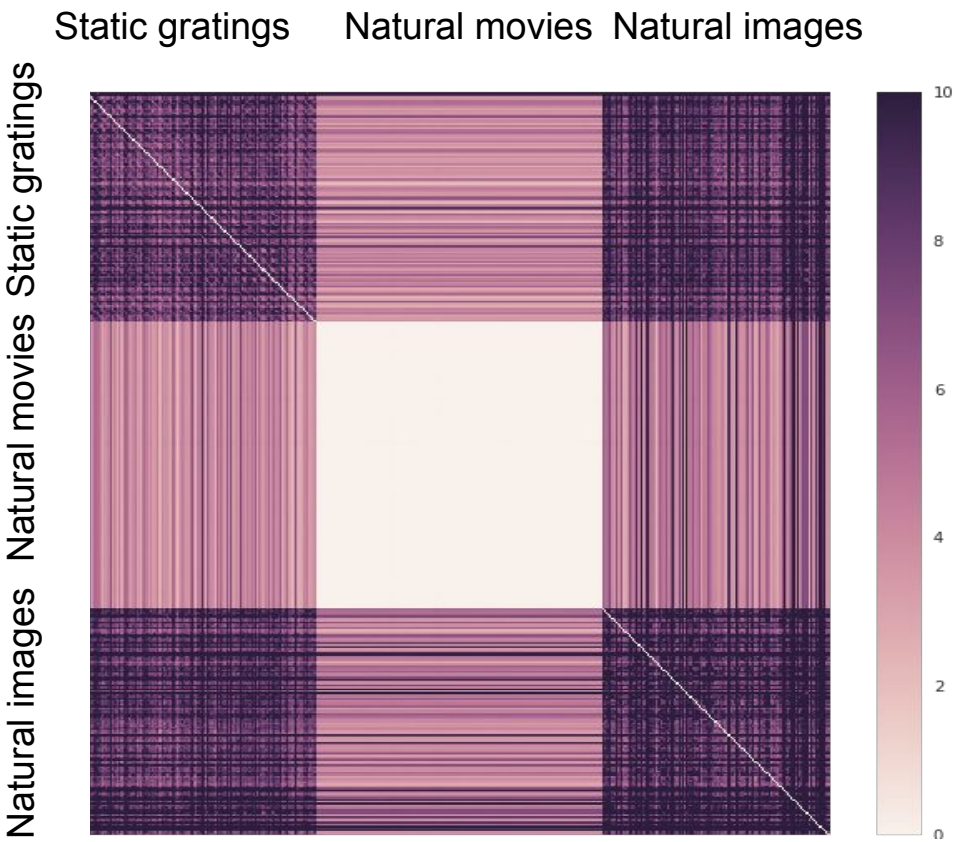
For Mahalanobis distance, need covariance matrix

$$\sum^{-1}$$

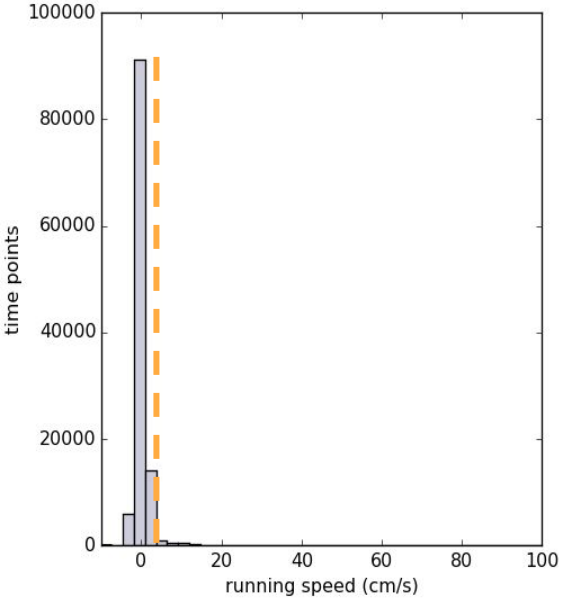
Constructed with all stimuli all trials in session B

- Static gratings
- Natural movie 1
- Natural images

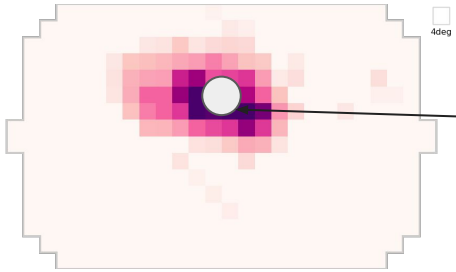
Used mean sweep responses in session B to construct RSM



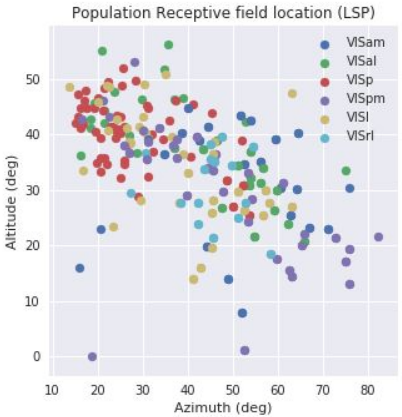
Accounting for running speed, receptive field size

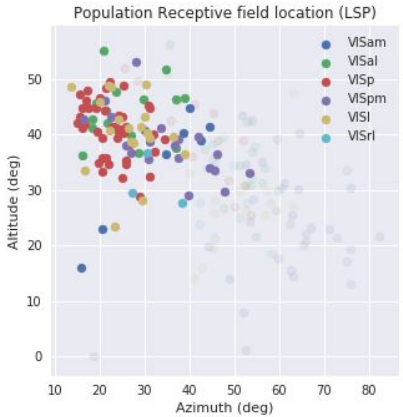


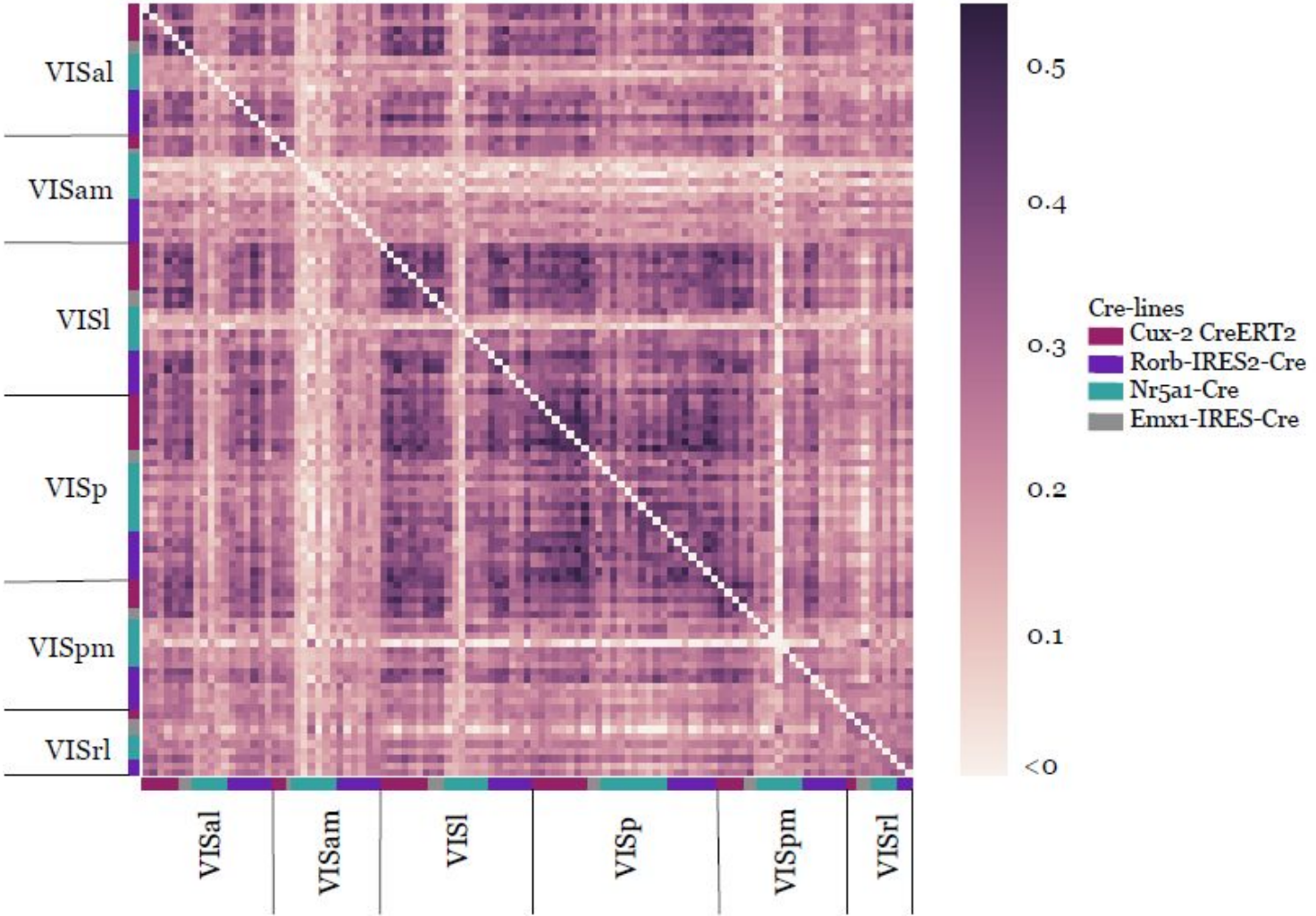
Population receptive field



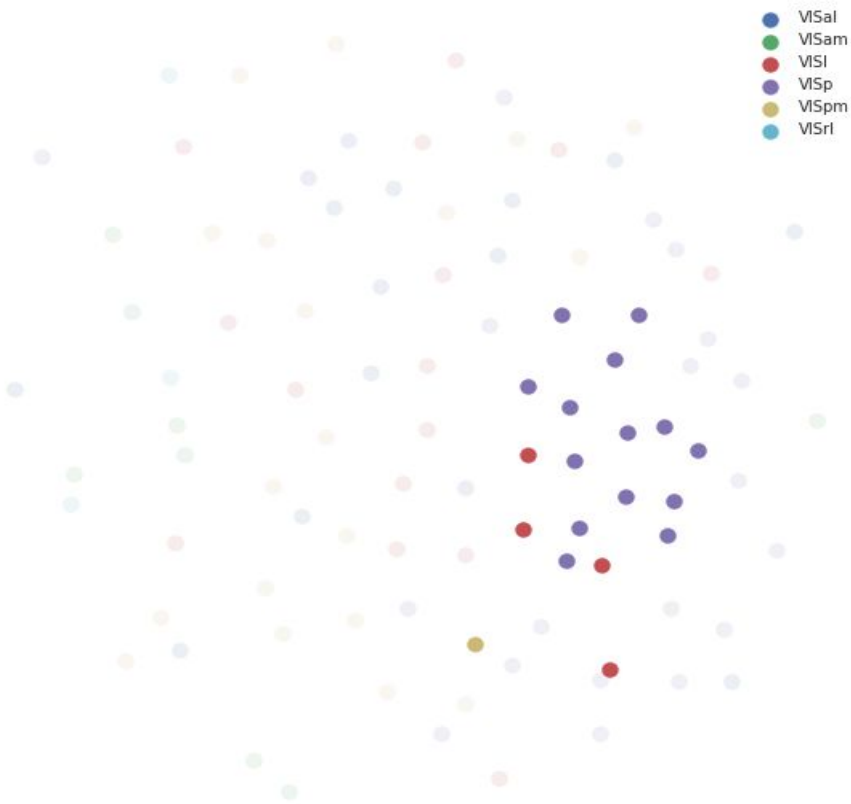
Center of mass






VISal
VISam
VISl
VISp
VISpm
VISrl
0.5
0.4
0.3
0.2
0.1
<0
Cre-lines
Cux-2 CreERT2
Rorb-IRES2-Cre
Nr5a1-Cre
Emx1-IRES-Cre

Evidence for a hierarchy of linear dissimilarity?

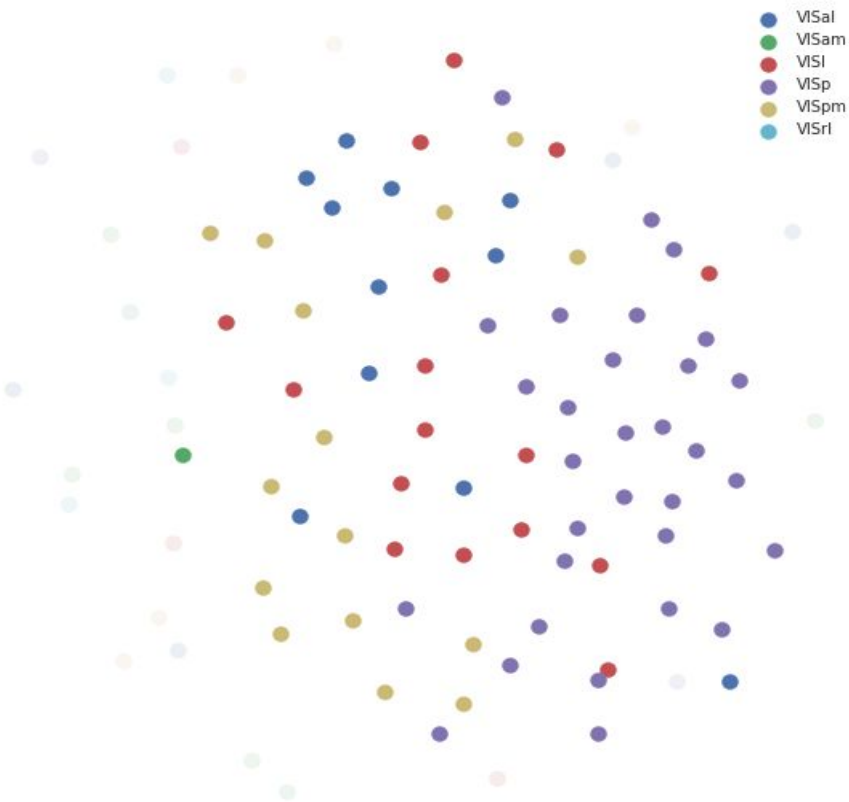


DBSCAN
ε = 0.5

Evidence for a hierarchy of linear dissimilarity?

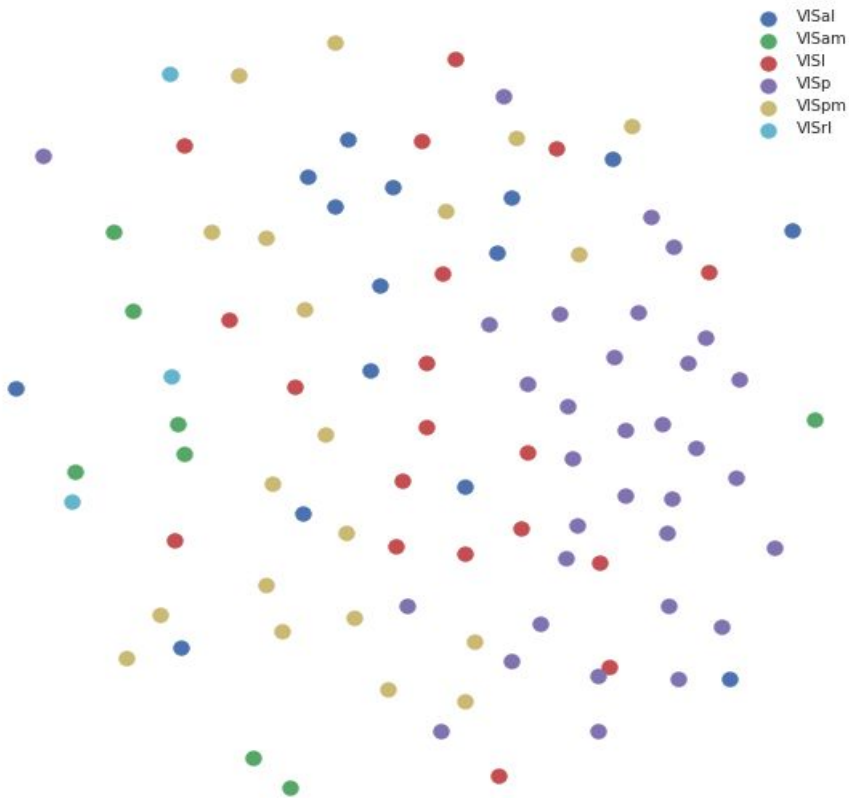
DBSCAN
ε = 0.6

Evidence for a hierarchy of linear dissimilarity?



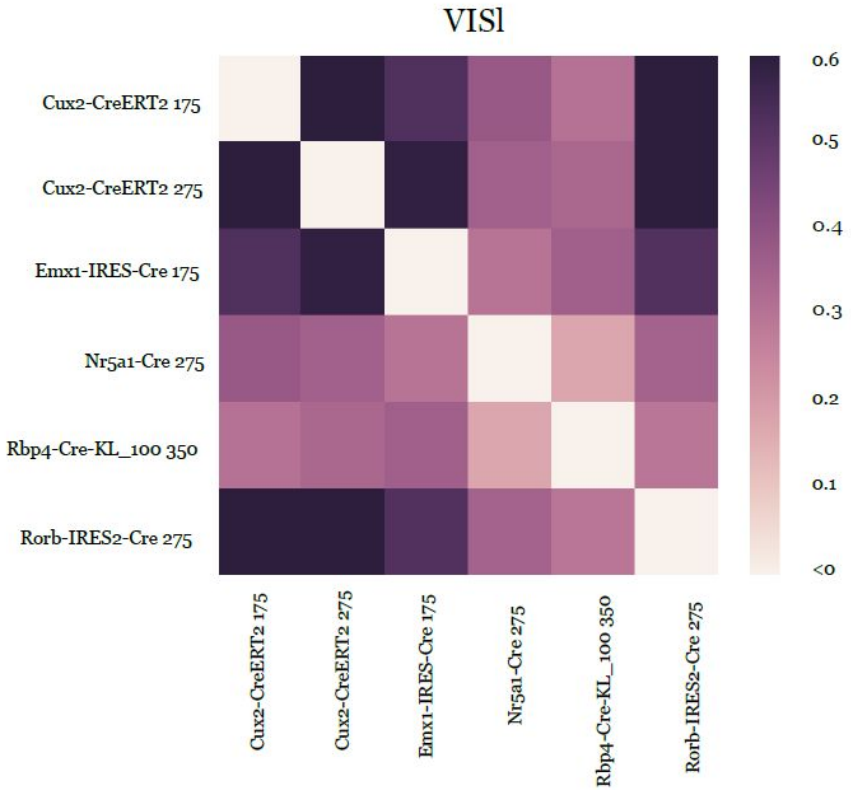
DBSCAN
ε = 0.7

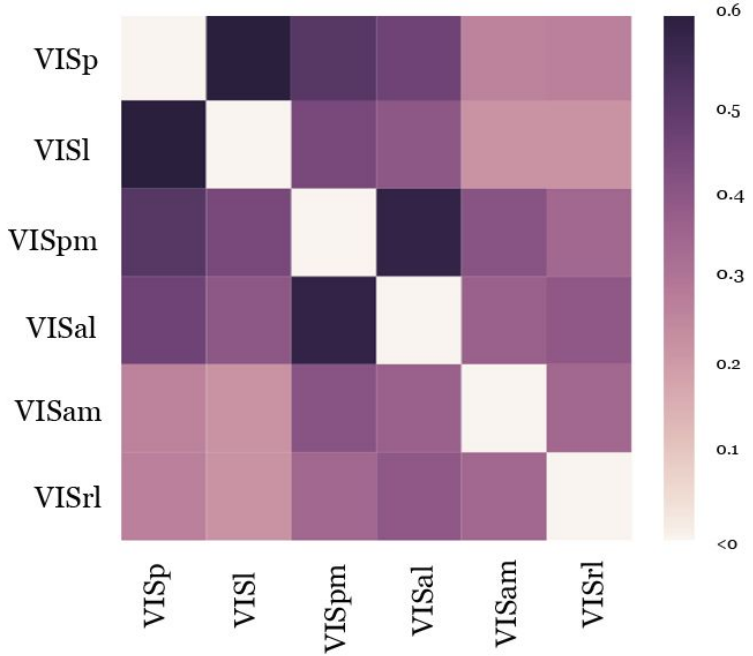
Evidence for a hierarchy of linear dissimilarity?



DBSCAN
ε = 0.9

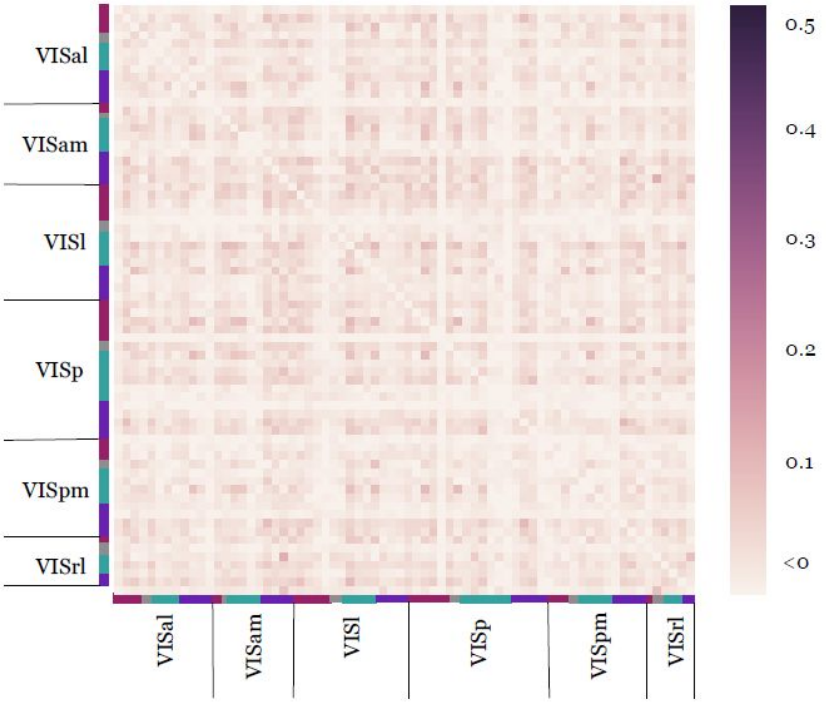
Population responses vary with Cre line



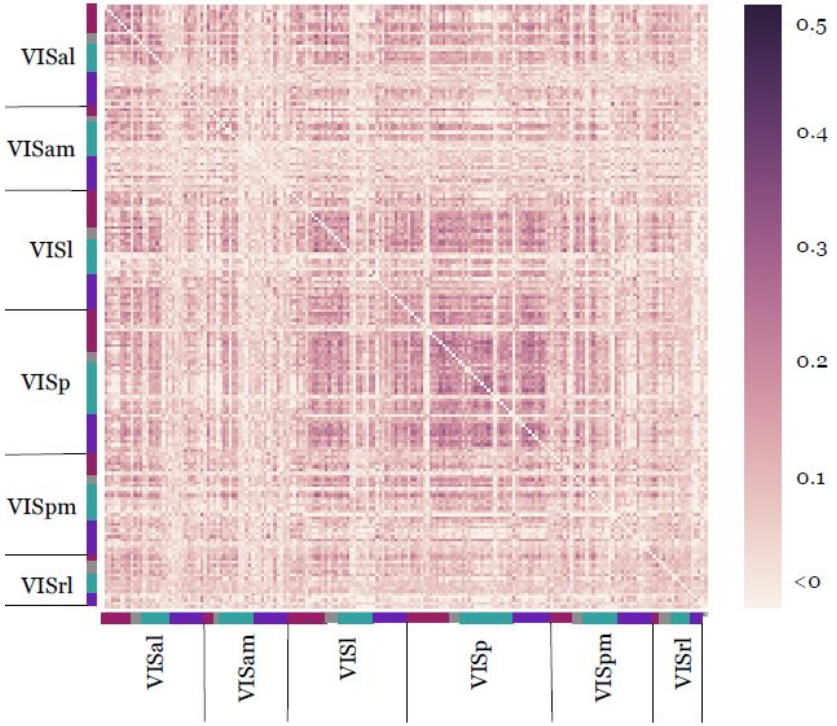


Alternative response distance metrics

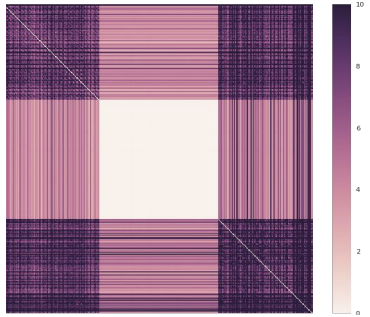
Correlation



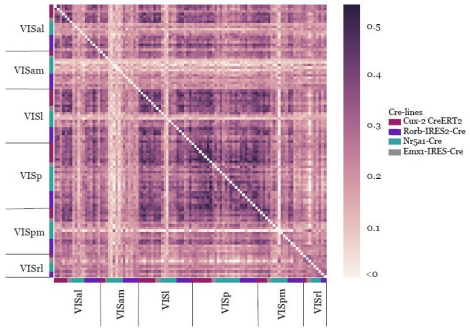
Spectral embedding distance



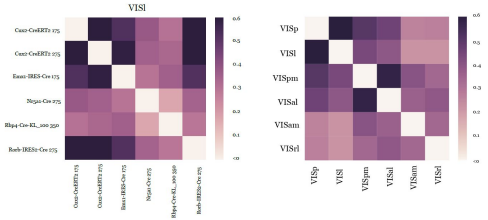
Conclusions



Implemented a new RSM metric



Compared across areas and Cre lines



Found Cre-specific differences and a hierarchy of linear similarity

Next steps

Are these results affected by:

- Stimuli type (movies vs. gratings, ...)?
- Noise correlations?

Are there trends in the spectral embedding matrix?

Can we modify this pipeline to test for significance?

Are these results comparable to those we would obtain with pure linear prediction? A GLM?

Are Cre-line differences consistent across areas?