projection analysis

mike freund

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intro

notation

- vertex v in $1, \ldots, V$
- TR t in $1, \ldots, T$
- $\mathbf{b}$: *training set* beta pattern vector of length V, condition indicated by subscript
- $\cdot'$: from *test* set
- $\mathbf{e}_t$: residual vector (of length V) at TR = t
- $\mathbf{W}$: regularized inverse covariance matrix of residuals ($V \times V$)

within-run version

First validate the method by examining the distribution about the discriminant *within each run*. This is perhaps the most 'liberal' test as it does not require the discriminant to be aligned across scanning runs.

Calculate the mean pattern $\mathbf{m}$:

$$\mathbf{m} = (\mathbf{b}_{(incon.)} + \mathbf{b}_{(congr.)})/2$$

Select a condition to represent the positive end of the discriminant. Center the corresponding beta vector at the mean pattern and scale by the square of the length. This gives the discriminant, $\mathbf{d}$.

$$\mathbf{d} = \frac{\mathbf{b}_{(incon.)} - \mathbf{m}}{||\mathbf{b}_{(incon.)} - \mathbf{m}||_2^2}$$

Prewhiten and project a residual onto the discriminant.

$$\hat{e}_t = \mathbf{dW}(\mathbf{e}_t - \mathbf{m})$$

unit: ratio of distance to hyperplane between test point and class centroid.

how to validate (positive / negative control analyses)

- At post-trial TRs in ROIs, do residuals move along discriminant as function of previous trial type?
- Does this effect dissapear in non-ROIs?
- Detrend BOLD timeseries with baseline model of regression. Project detrended timeseries from ROIs and non-ROIs onto discriminant. Regress projection onto events design matrix. Does this recover trial type info? I.e., $\beta_{(incon.)} > 0$ and $\beta_{(congr.)} < 0$? (This projected timeseries could be used as a trial-by-trial measure, depending on its fidelity.) Can also assess correlation of recovered β with $\mathbf{b}$.

cross-validated version

Next establish robustness to scanning run by cross-validating the discriminant *across runs*.

$$\hat{e}'_t = \mathbf{dW}(\mathbf{e}'_t - \mathbf{m}')$$

validation: repeat same validation analyses as above. Additionally:

- calculate cosine angle between discriminants across runs. Hopefully positive.
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