Basic MVPA strategies

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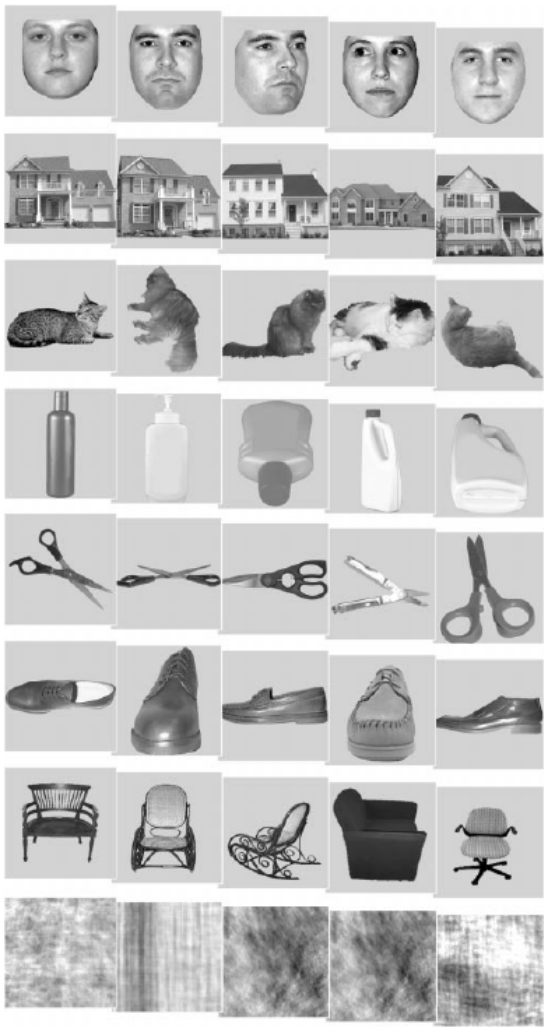
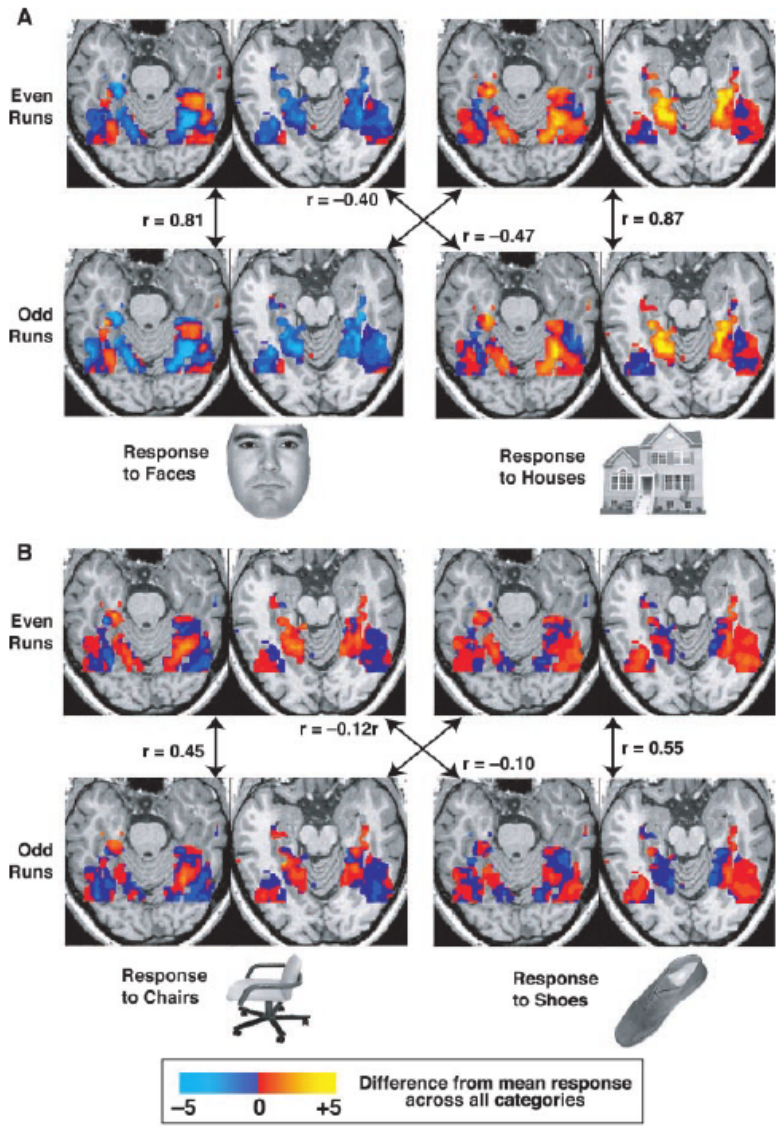
How it all began: VT ROI, Haxby *et al.* 2001





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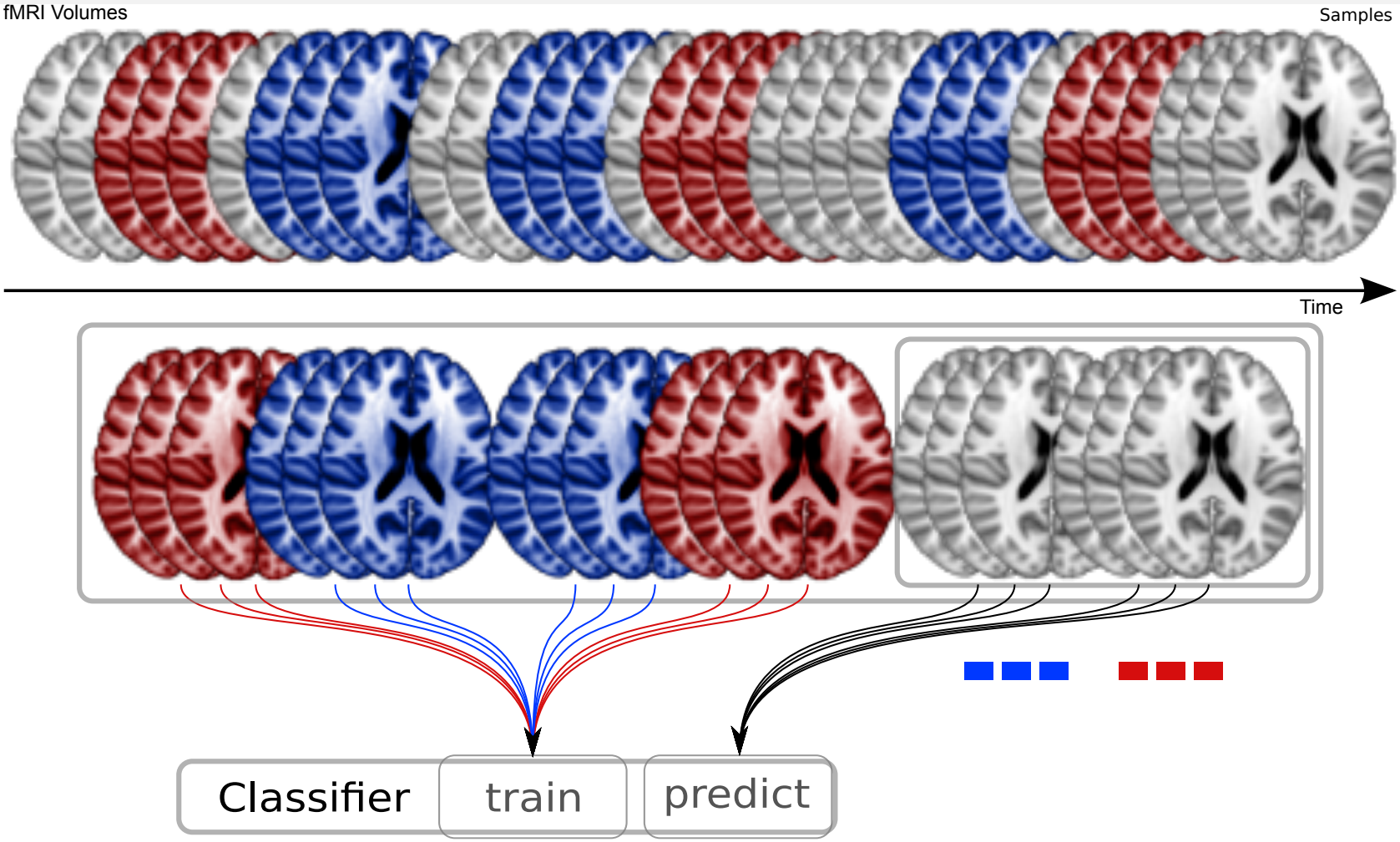
Cross-validation



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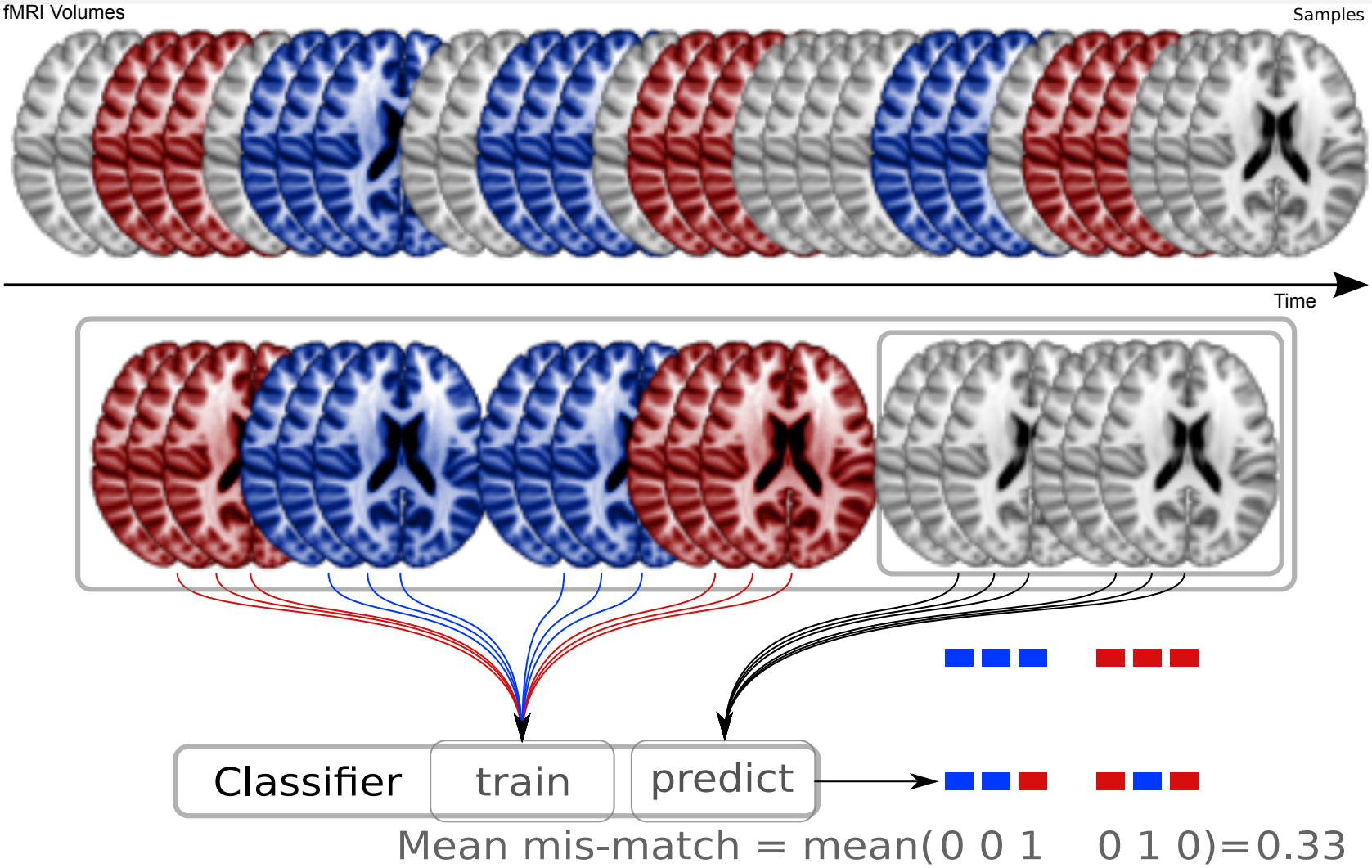
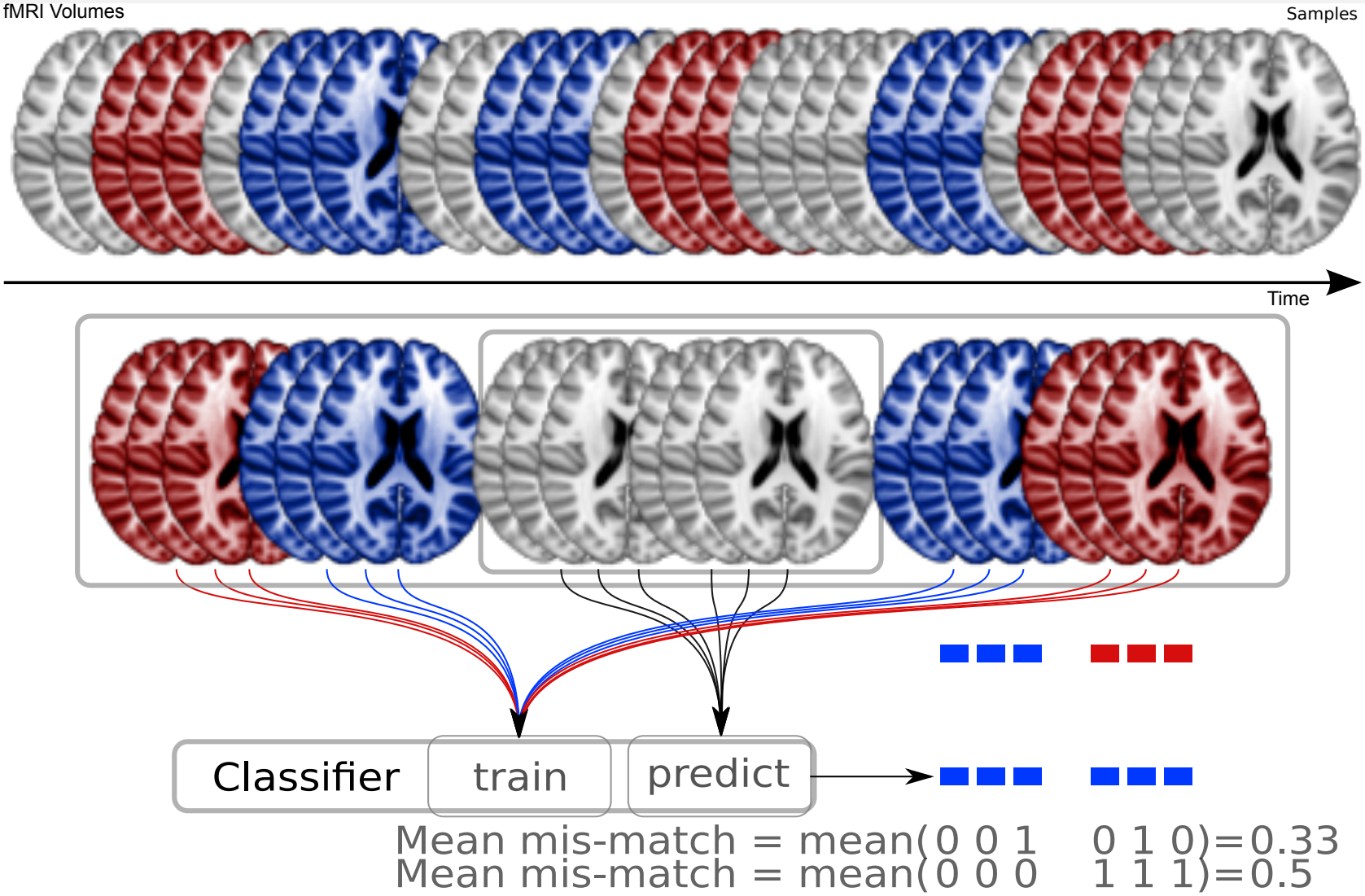


N-fold Cross-validation



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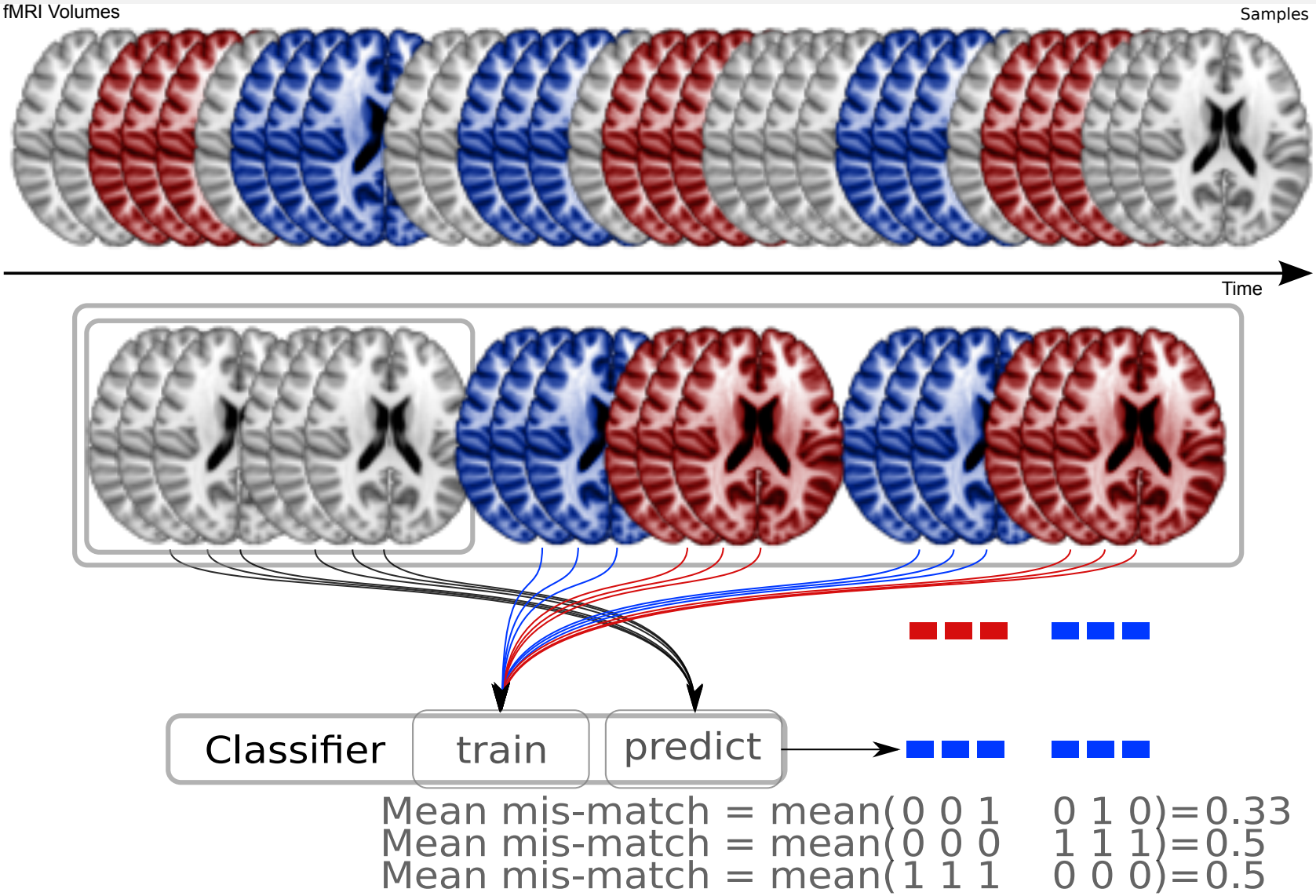

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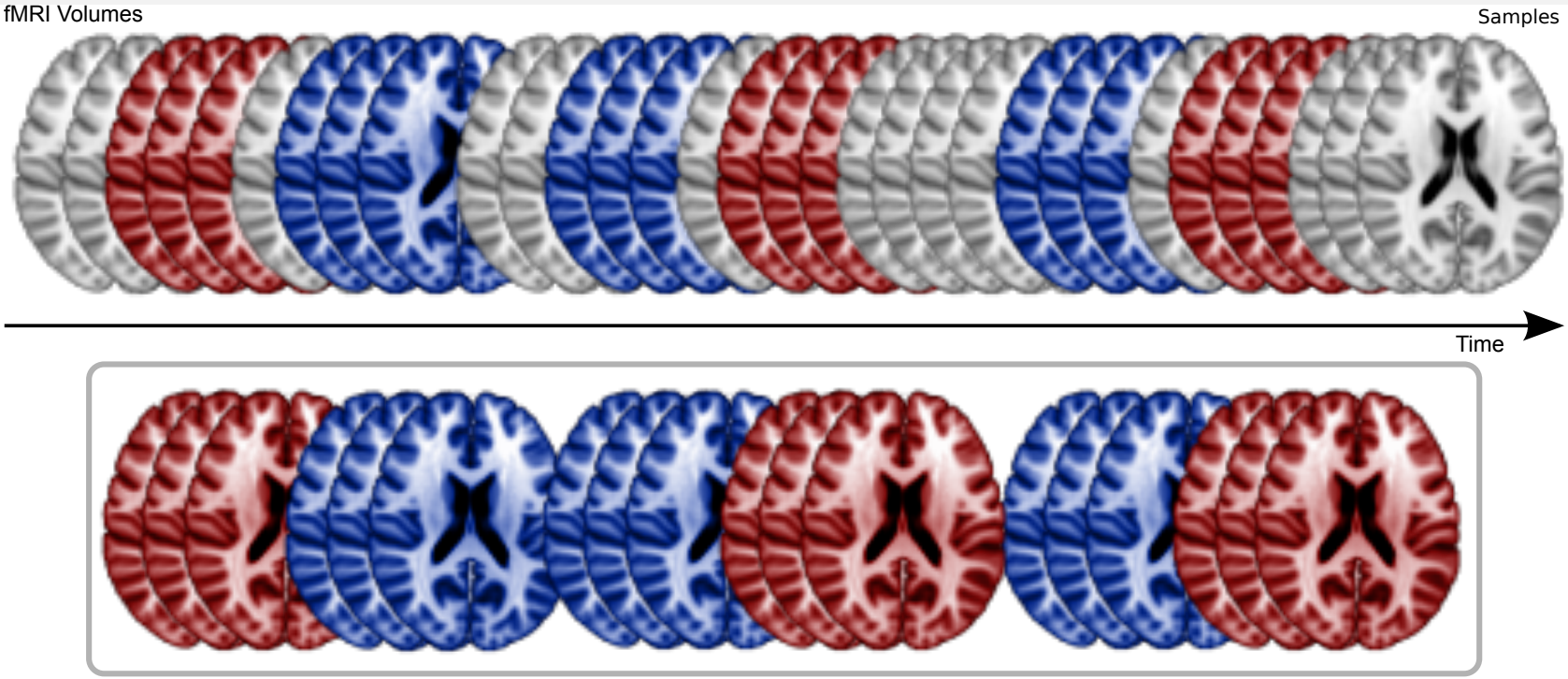
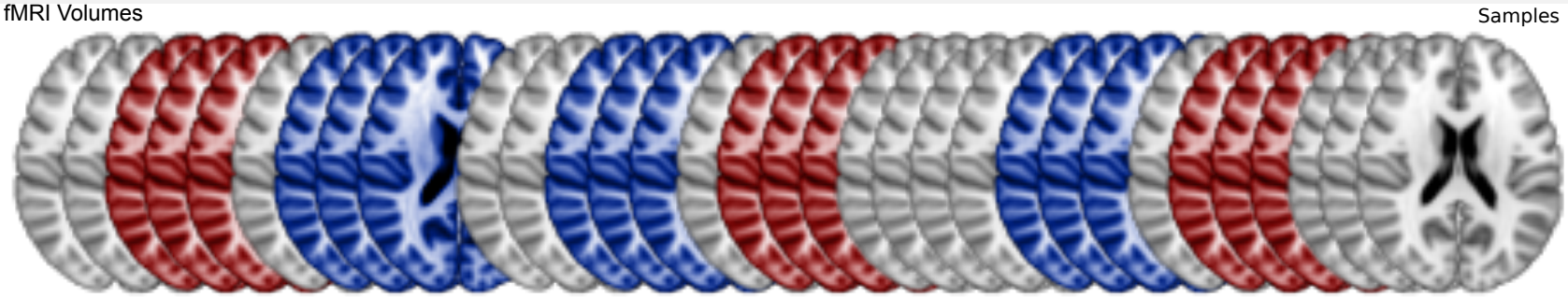


Classifier | train | predict

Total mean mis-match = mean(0.33 0.5 0.5) = 0.44

N-fold Cross-validation



--------.	3kHz	7kHz	12kHz	20kHz	30kHz	song1	song2	song3	song4	song5							
predict.\targets	38	39	40	41	42	43	44	45	46	47							
`------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	P'	N'	FP	FN	PPV	NPV	TPR
3kHz / 38	84	42	27	4	4	2	1	0	15	19	198	1351	114	90	0.42	0.93	0.48
7kHz / 39	43	94	16	0	1	1	1	2	1	24	183	1331	89	80	0.51	0.94	0.54
12kHz / 40	21	16	103	5	2	2	0	0	6	13	168	1312	65	70	0.61	0.95	0.6
20kHz / 41	1	2	13	158	1	0	0	1	3	1	180	1202	22	15	0.88	0.99	0.91
30kHz / 42	3	0	2	3	162	0	0	0	0	0	170	1194	8	11	0.95	0.99	0.94
song1 / 43	3	1	1	0	1	160	0	0	2	5	173	1199	13	14	0.92	0.99	0.92
song2 / 44	1	1	0	0	0	0	171	0	0	0	173	1176	2	2	0.99	1	0.99
song3 / 45	1	1	1	0	0	0	0	170	2	0	175	1179	5	4	0.97	1	0.98
song4 / 46	7	3	3	2	2	2	0	0	139	7	165	1240	26	34	0.84	0.97	0.8
song5 / 47	10	14	7	1	0	7	0	1	5	104	149	1310	45	69	0.7	0.95	0.6
Per target:	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----							
P	174	174	173	173	173	174	173	174	173	173							
N	1560	1560	1561	1561	1561	1560	1561	1560	1561	1561							
TP	84	94	103	158	162	160	171	170	139	104							
TN	1261	1251	1242	1187	1183	1185	1174	1175	1206	1241							
Summary \ Means:	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	173	1249	38	39	0.78	0.97	0.78
ACC	0.78																
ACC%	77.57																
# of sets	8																

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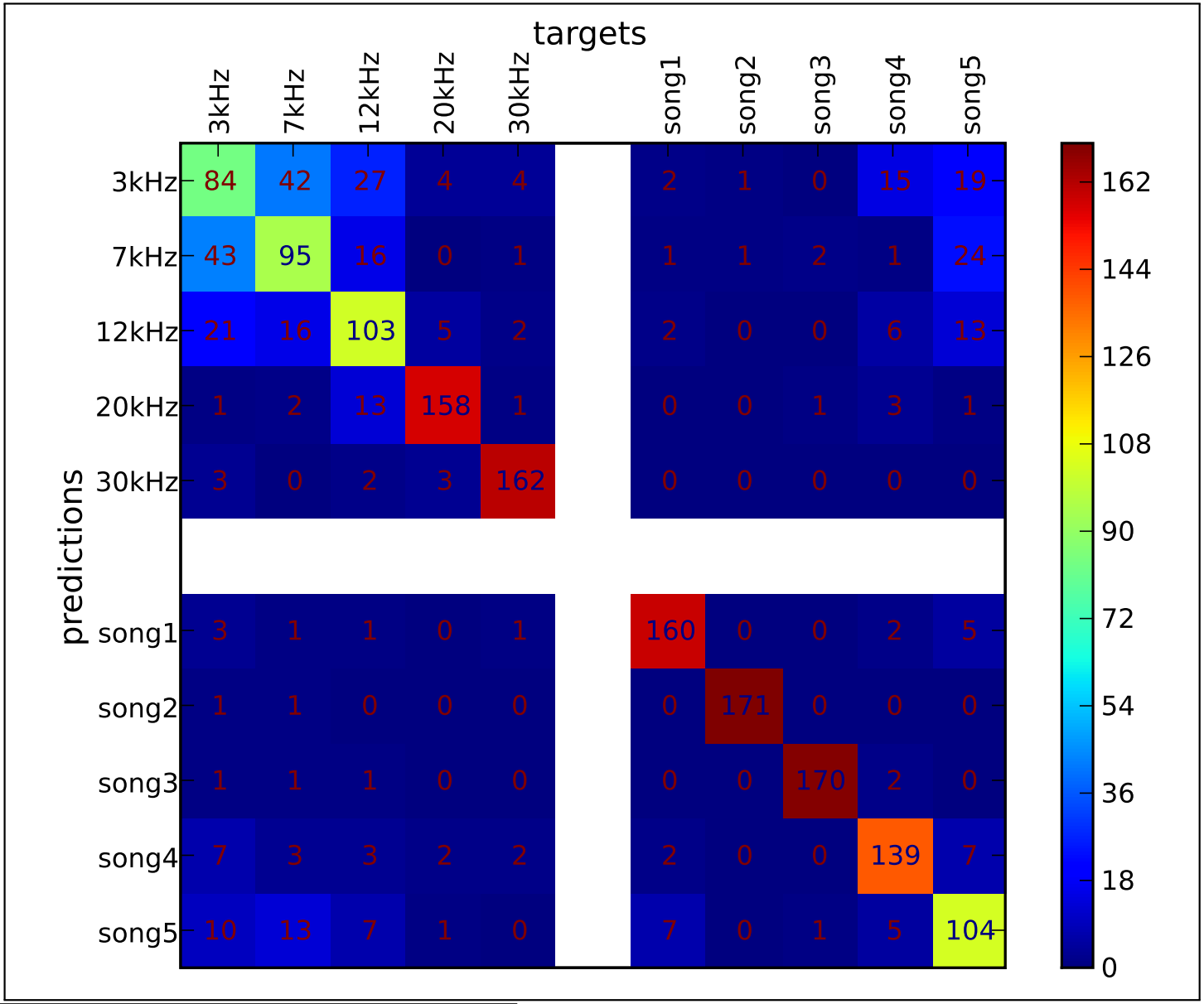
N-fold Cross-validation



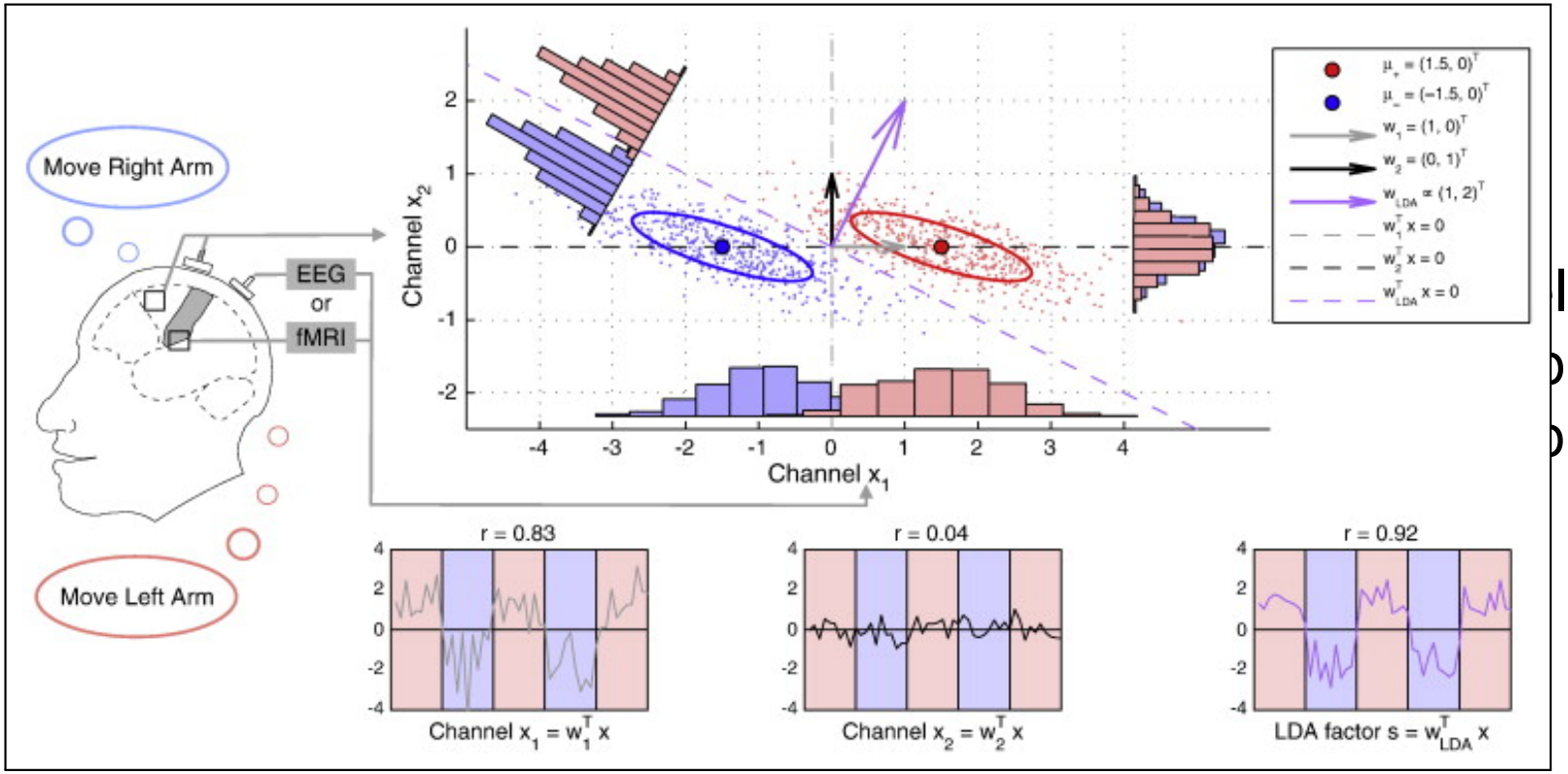
Hanke et al., Frontiers in Neuroinformatics, 2009

Classification analysis

Pros

- fancy: “brain reading”
- easy to grasp
- multivariate (uses information from multiple voxels)
- subject to significance estimation (via permutation)
- base for additional strategies (*e.g.*, voxel, ROI, or components *sensitivity*)

Classification analysis



ls)
on)
or

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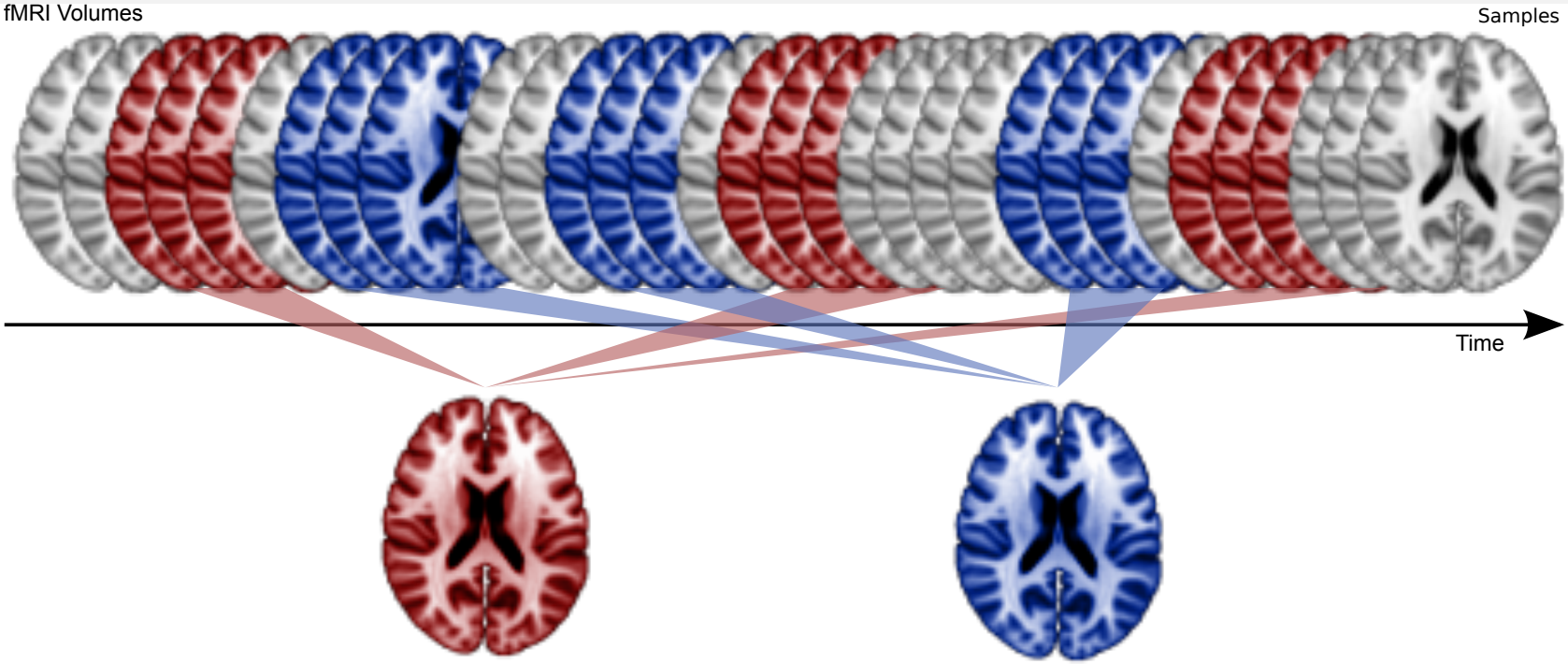
Cons

- there is no *best* classifier
- spatially non-specific (depends on choice of ROI)
- *curse of dimensionality*

Searchlight Concept: Information-based mapping



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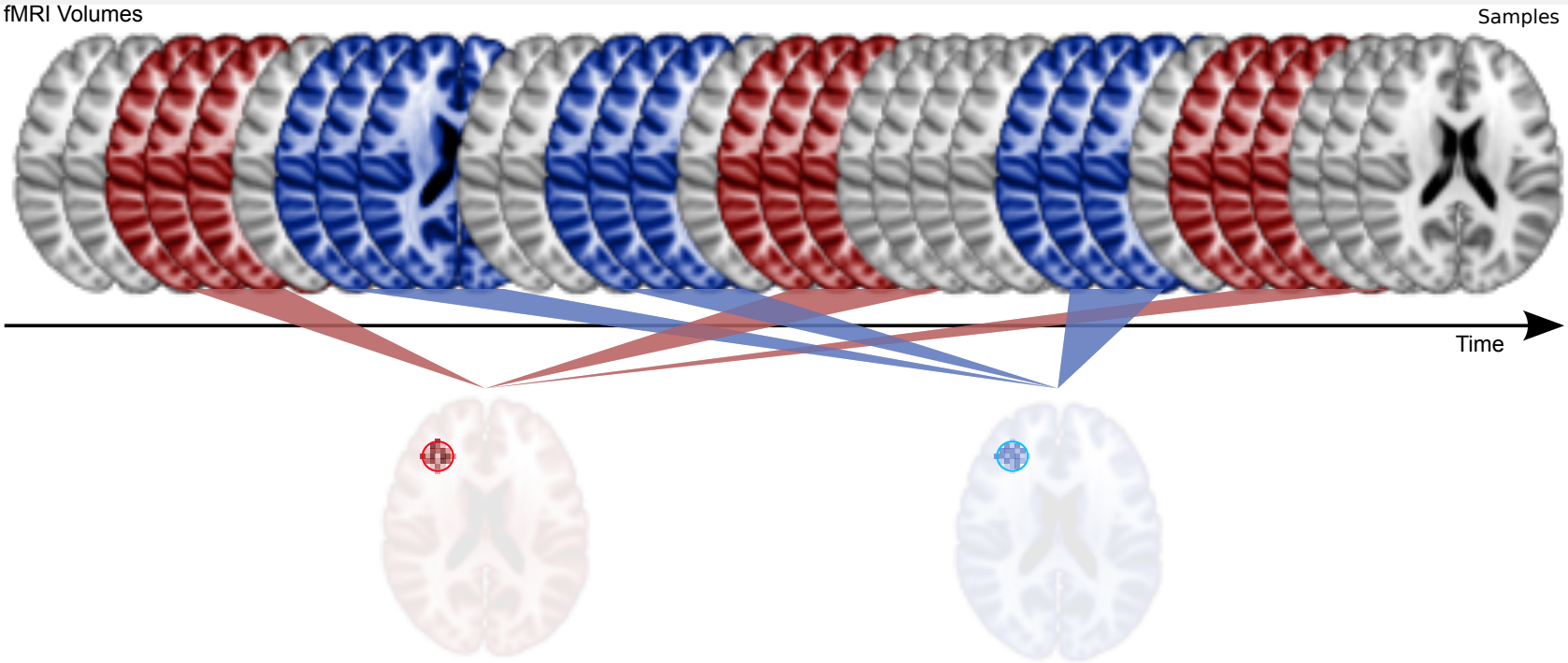

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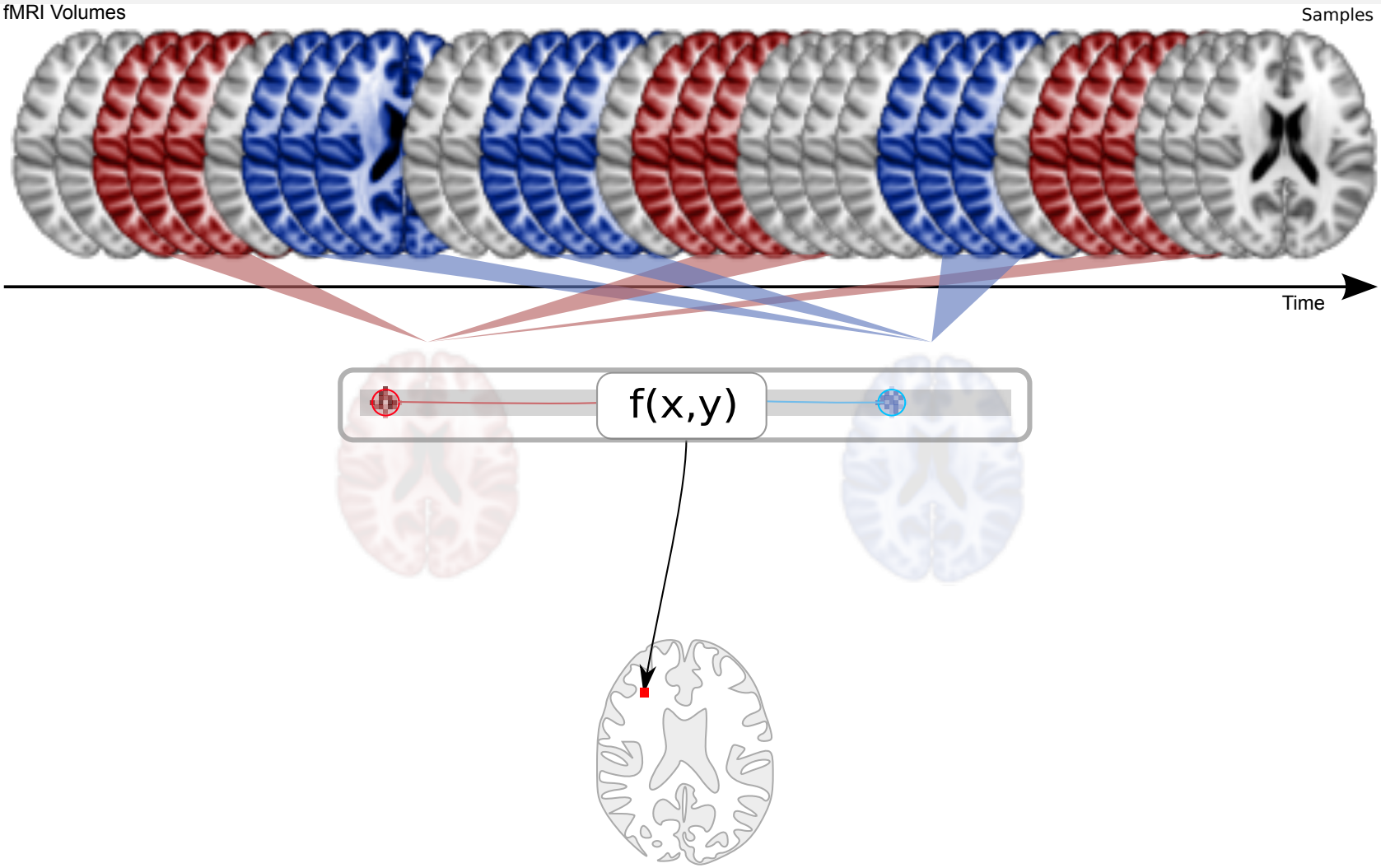

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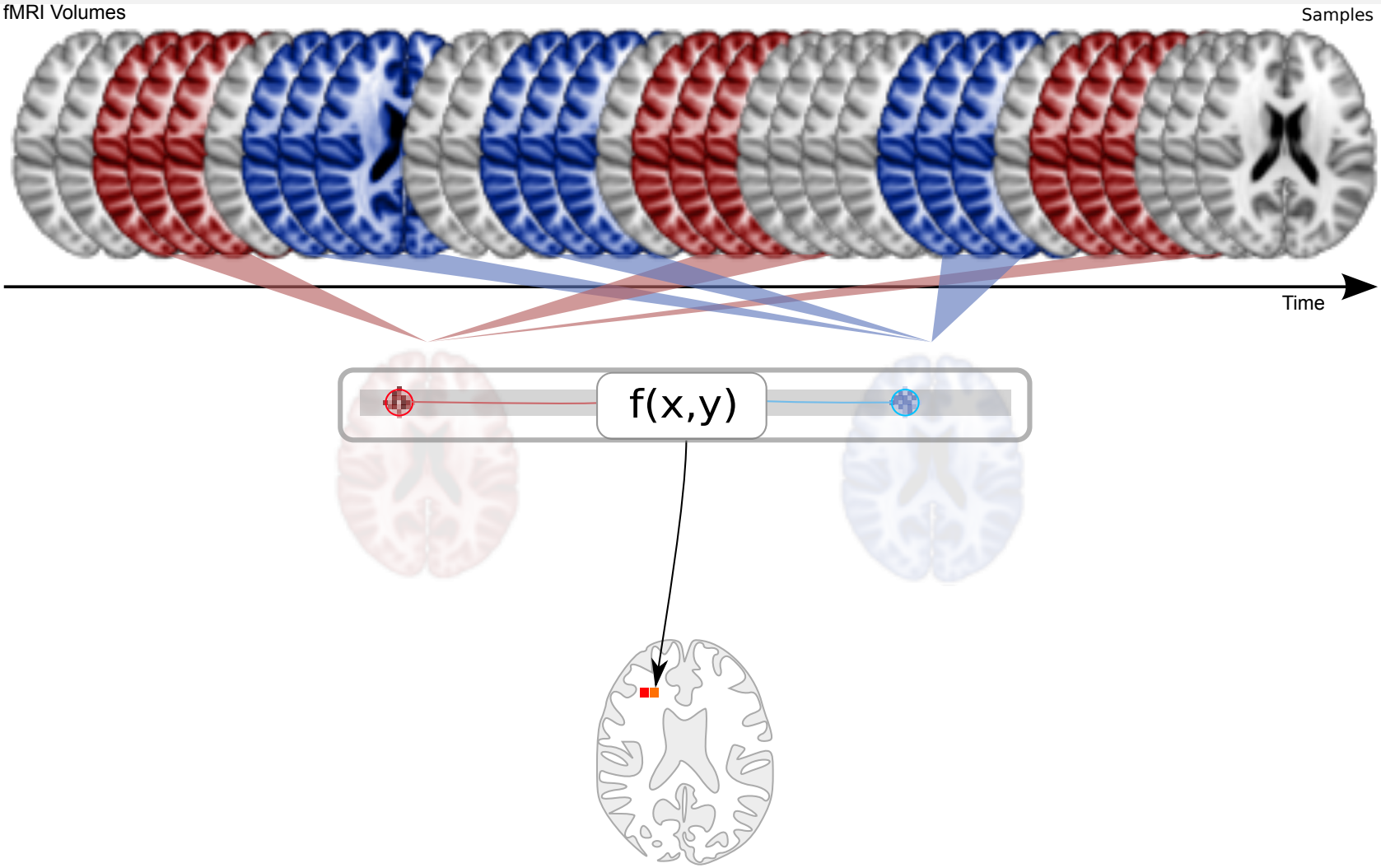

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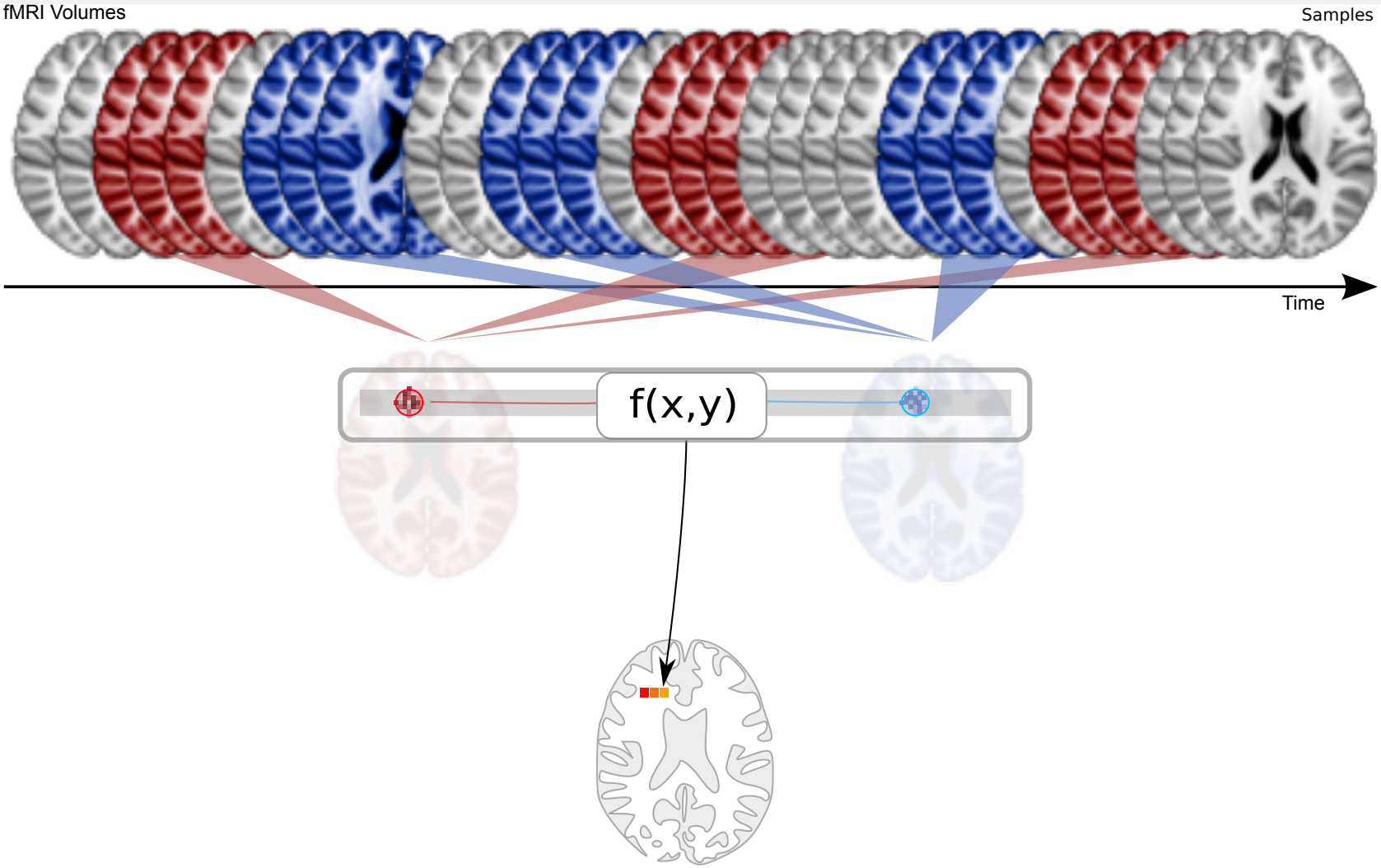

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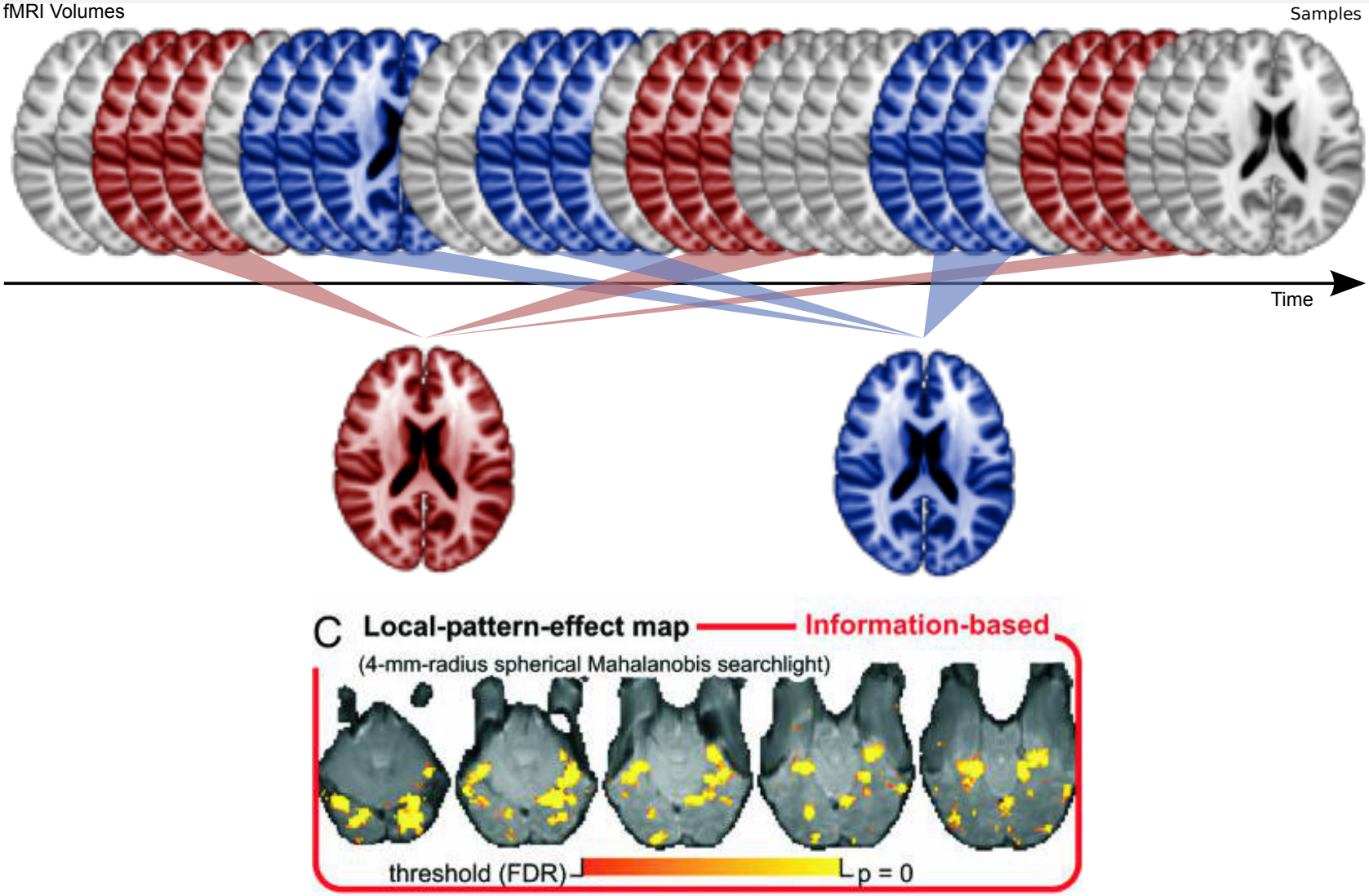

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Searchlight Concept: Information-based mapping

Assumptions replicable spatio-temporal response model

Goals benefit from high spatial resolution through

- multivariate measure
- eliminating need for smoothing

Input predictor amplitudes, 1 sample per category

Measure Mahalanobis distance

$$\Delta = (a_2 - a_1)\hat{\Sigma}^{-1}(a_2 - a_1)^T$$

Statistic p-value (FDR correction) against results on 1000 random design sequences

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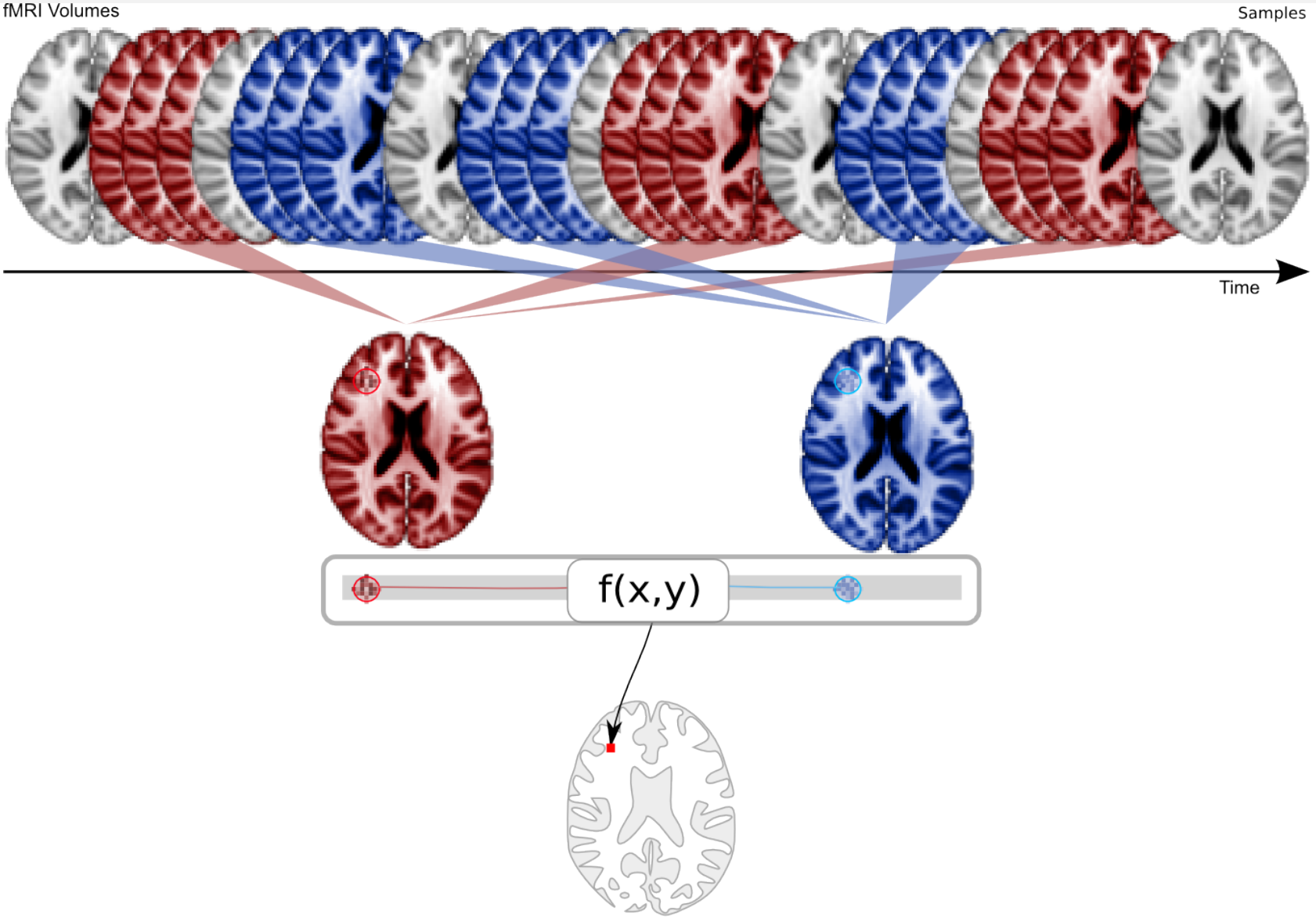
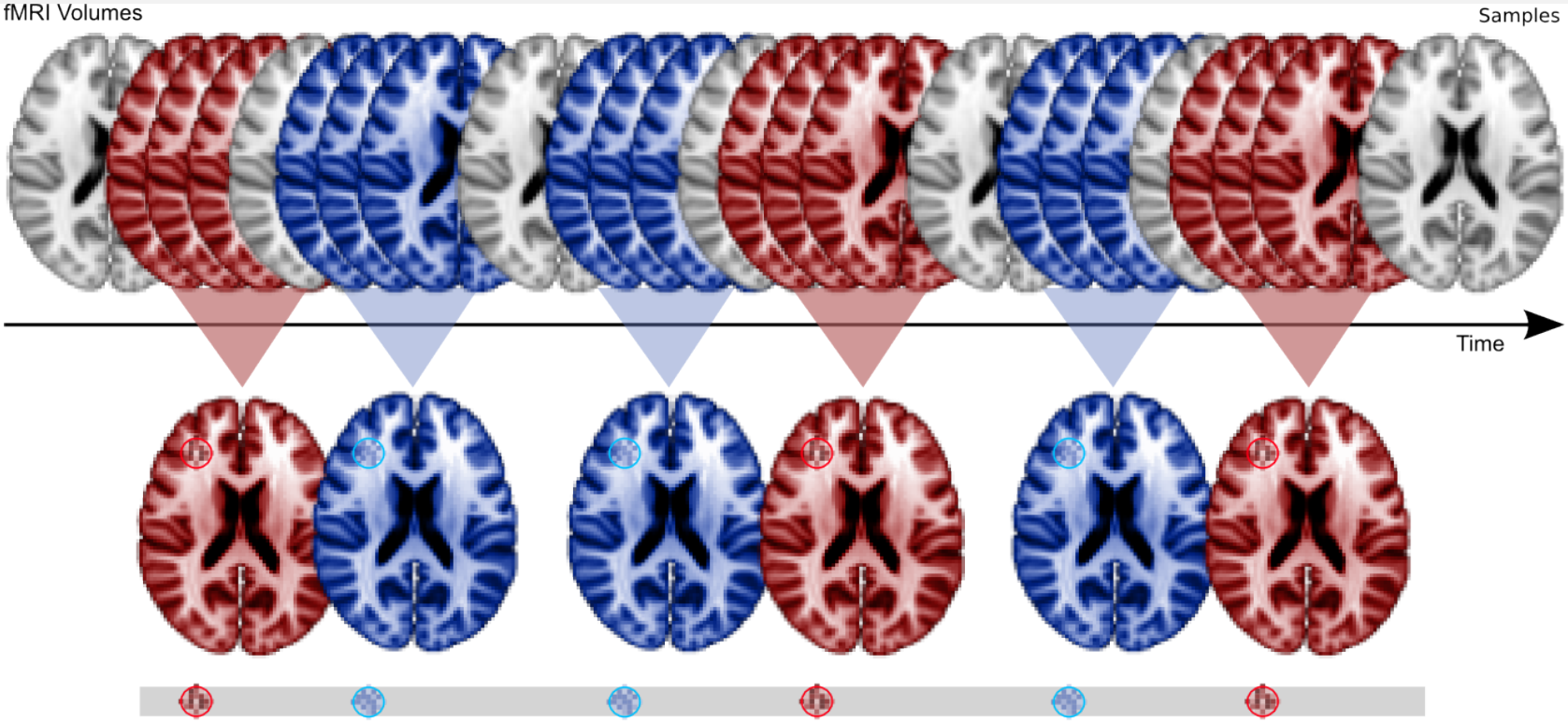


Searchlight Concept: Classification generalization



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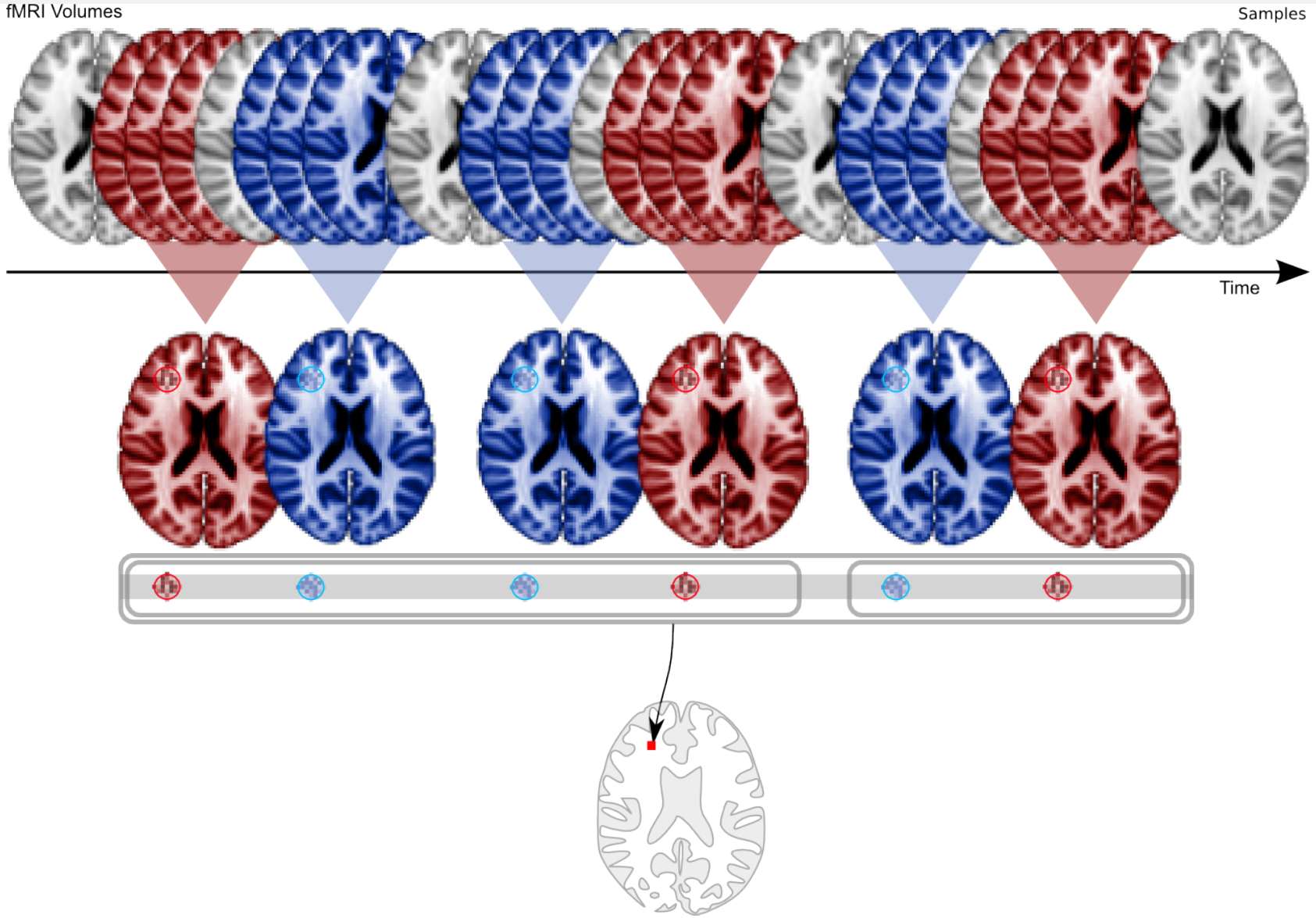

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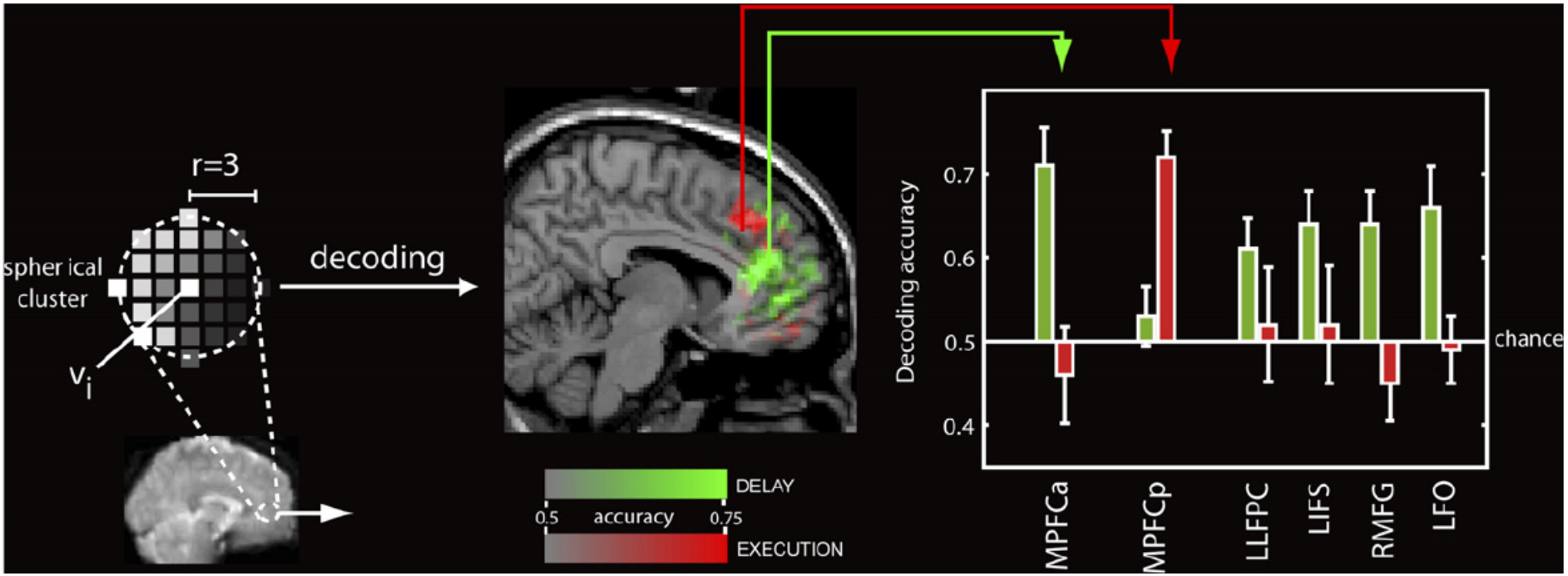

- Classify hidden intentions
- Smoothed with a Gaussian kernel of 6 mm FWHM
- Classifier input: GLM-parameter estimates per each of 8 runs
- Sphere radius approx 7.5 mm

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Classification Searchlight

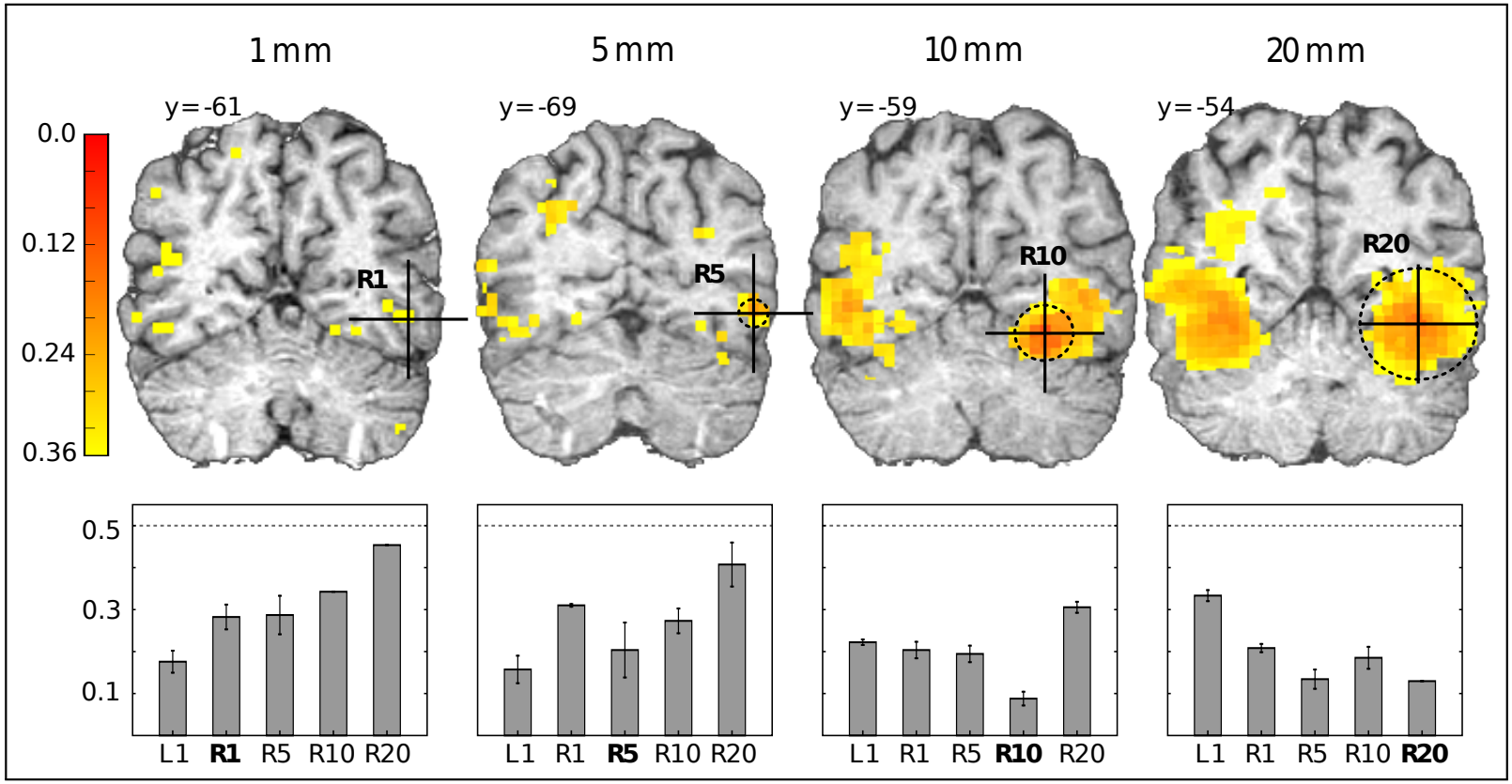
Pros

- easier to grasp
- investigates local patterns
- does (fancy) “brain reading”
- is not limited to classification (RSA, consistency, *etc.*)

Cons

- compromised spatial specificity (Etzel et al., 2013)
- difficult to do permutation-based significance testing (but see Pereira and Botvinick, 2011; Stelzer et al., 2013)

Classification Searchlight: Spatial specificity



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References

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Pereira, F. and Botvinick, M. (2011). Information mapping with pattern classifiers: A comparative study. *NeuroImage*, 56(2):476 – 496. Multivariate Decoding and Brain Reading.

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