

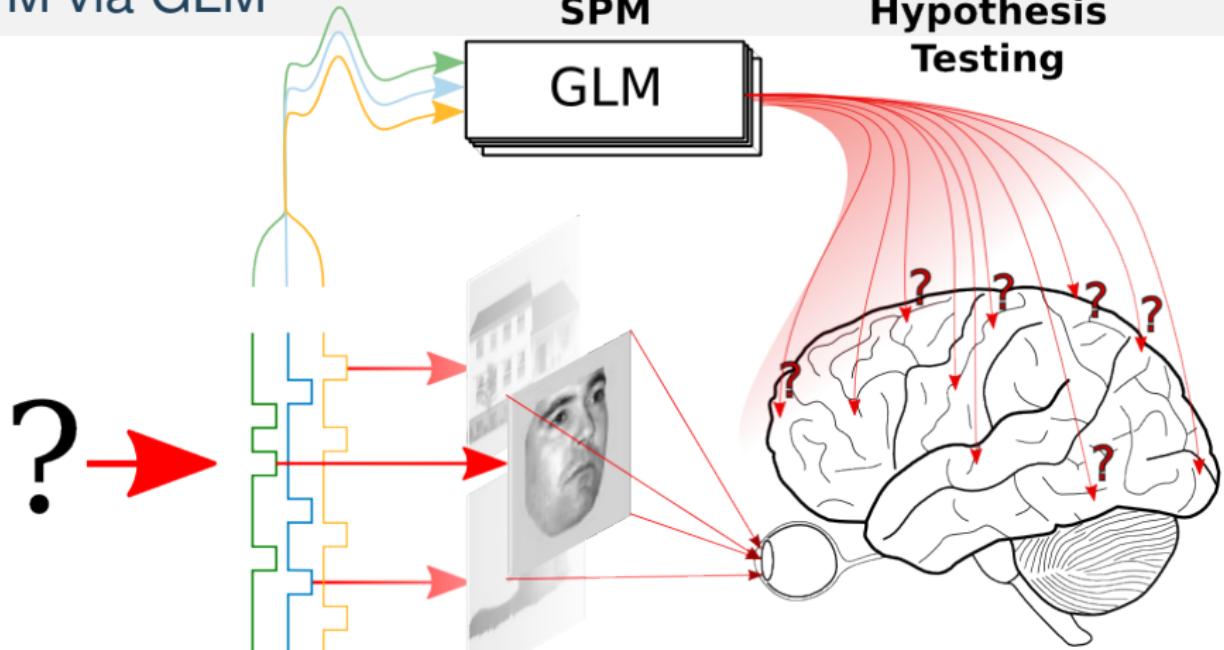
A very short introduction to multivariate pattern analysis (MVPA) for neuroscience

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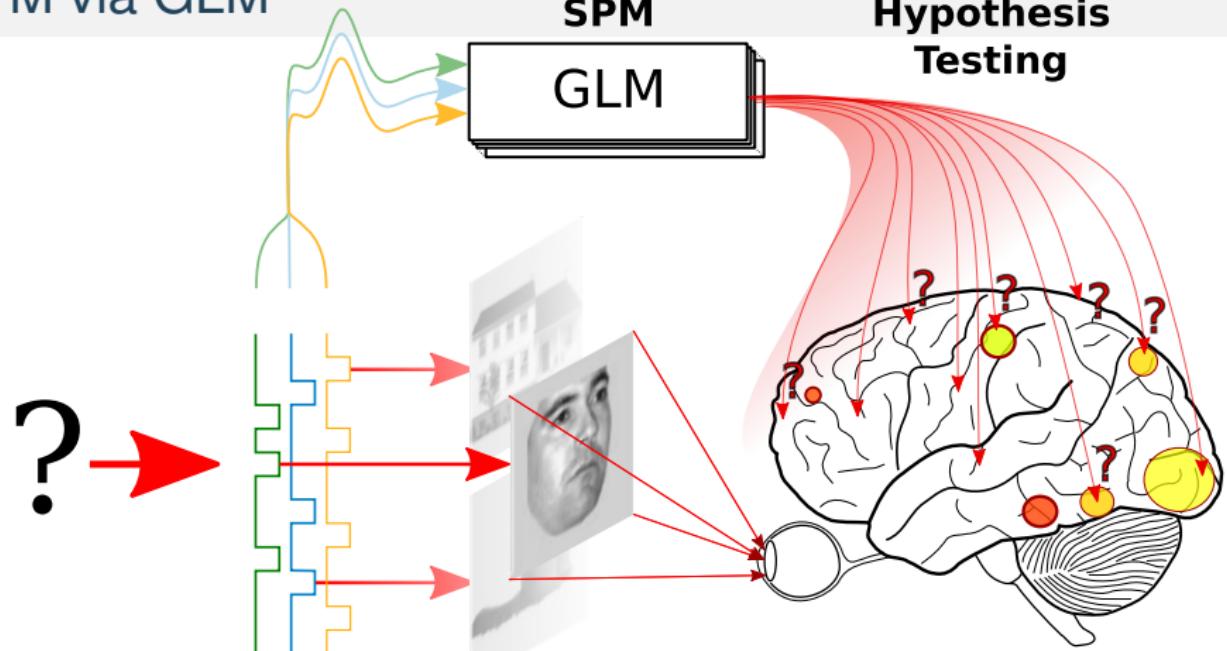
Delmenhorst 2014

SPM via GLM



Research Experiment Stimuli
Question Design

SPM via GLM



Research Question **Experiment Design** **Stimuli**

$$p(\text{brain activity} | \text{behavior})$$

That's not enough

Eric Kandel in *Principles of Neuroscience*



“The task of neural science is to explain behavior in terms of the activities of the brain.”

$$p(\text{brain activity}|\text{behavior}) \neq p(\text{behavior}|\text{brain activity})$$

Approach: Meta analysis and Bayes' theorem



neurosynth.org beta

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NeuroSynth is a platform for large-scale, automated synthesis of functional magnetic resonance imaging (fMRI) data extracted from published articles.

Our goal is to turn this:

The figure displays four separate fMRI study abstracts from the NeuroSynth database, each showing a title, authors, and a brief summary of the findings. The studies include:

- Learned Predictions of Error Likelihood in the Anterior Cingula** (John W. Brown)
- Language fMRI abnormalities associate gene mutation** (Hildegard G. Koppitz, Jennifer M. Pfeifer, Todd S. Brainerd, Leigh R. Nederhof, Michael A. Gernsbacher, Edward E. Smith)
- Temporal dynamics of brain activation during a working memory task** (Todd S. Brainerd, Leigh R. Nederhof, Michael A. Gernsbacher, Edward E. Smith)
- Auditory-Specific Neural Substrates of Emulating the Future** (Marilia S. Kiebel, Michael J. Anderson, C. Ervin Etie, Michael A. Gernsbacher, Edward E. Smith)

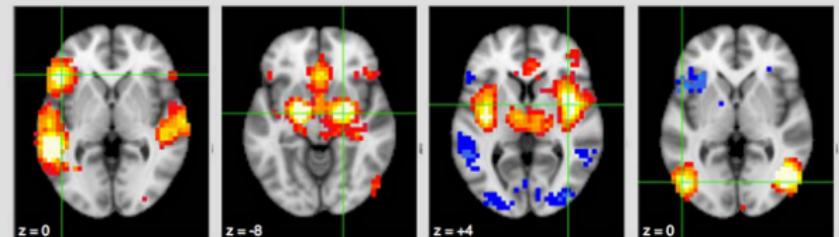
Database contents

2,047 terms

4,393 studies

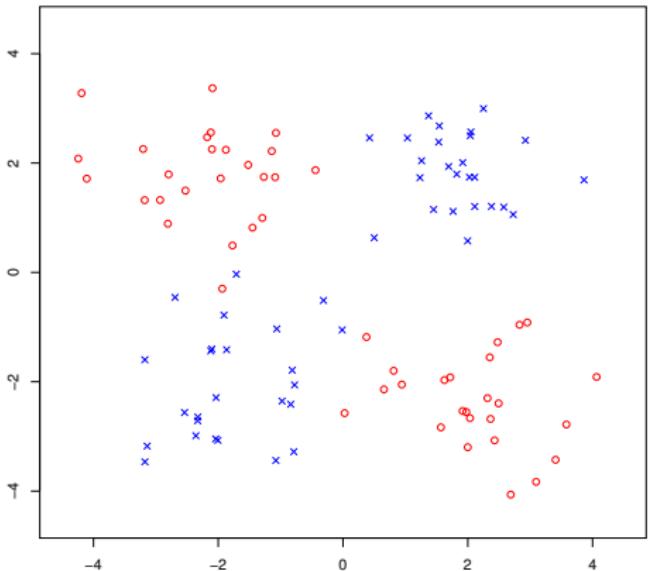
147,493 activations

Into this:

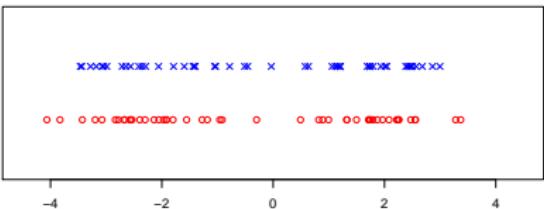
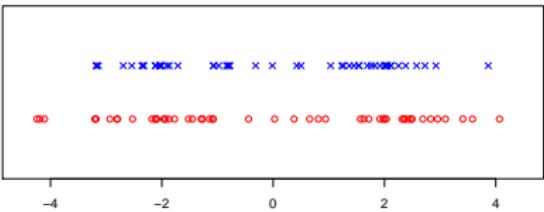
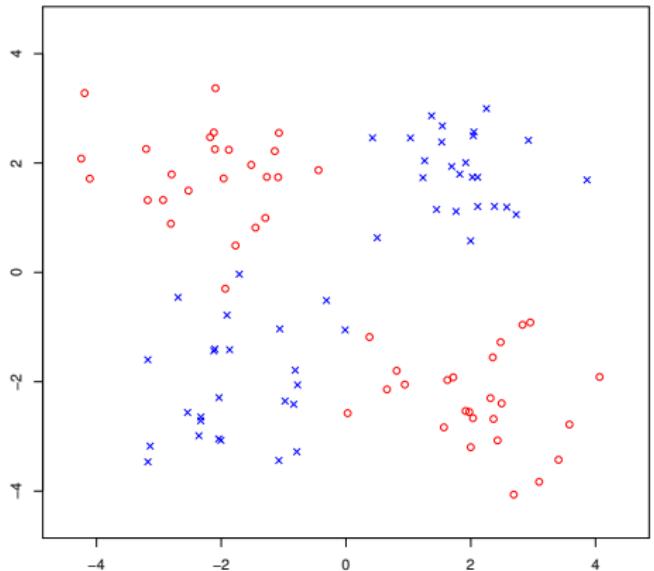


Yarkoni et al., Nature Methods, 2011; <http://neurosynth.org>

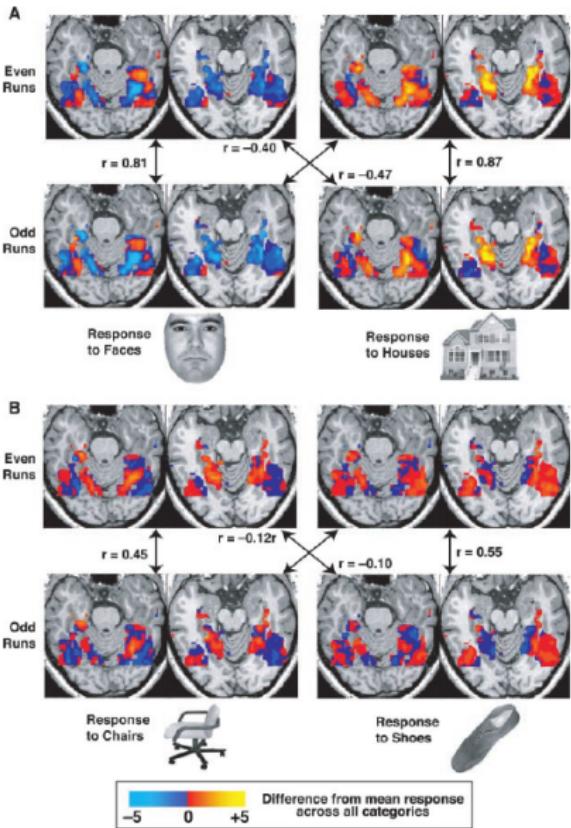
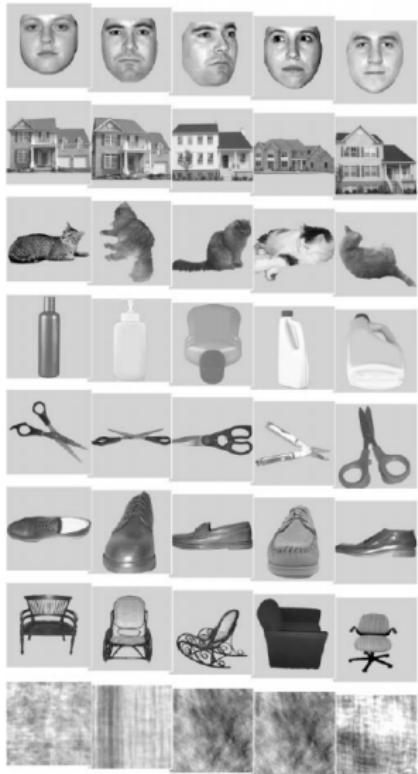
Why multivariate methods?



Why multivariate methods?

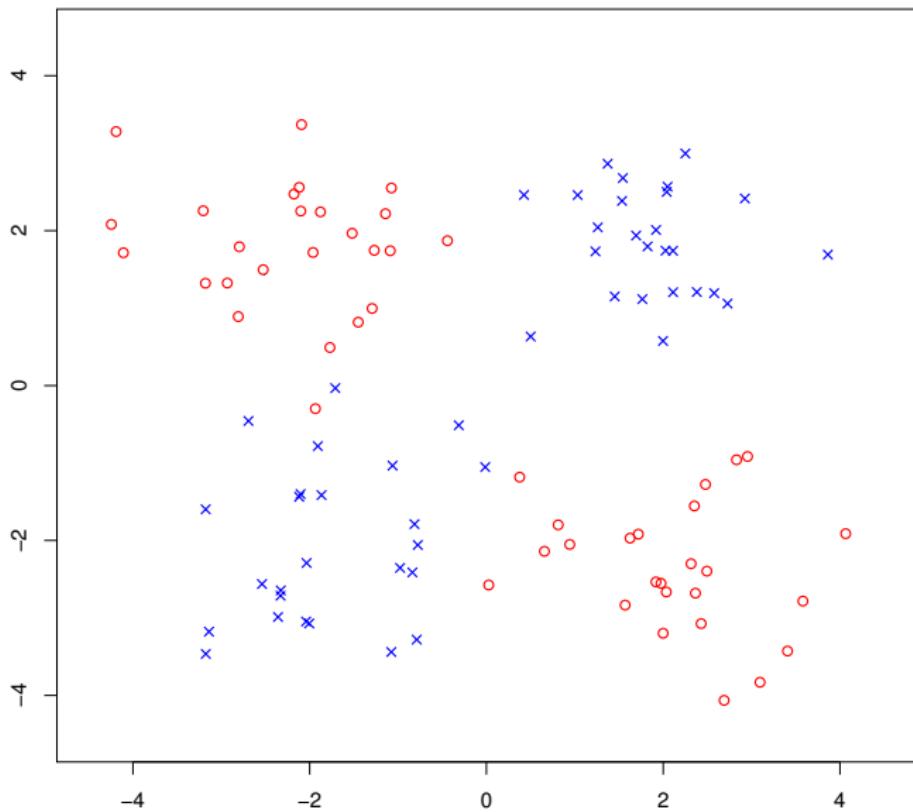


Pioneering work: visual objects

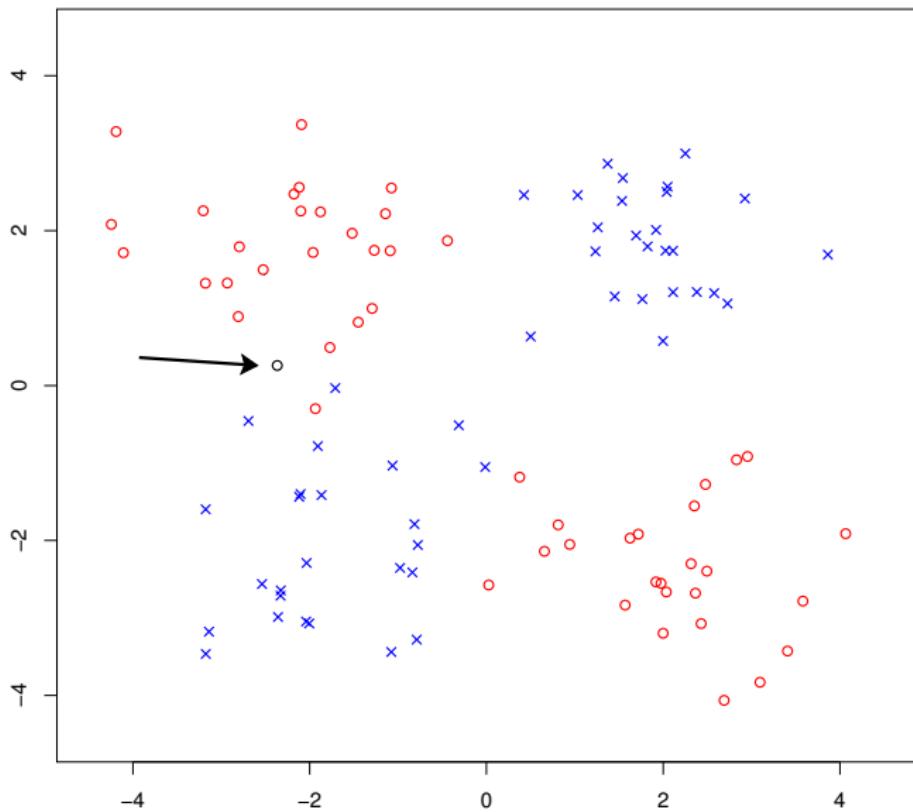


Haxby et al., Science, 2001

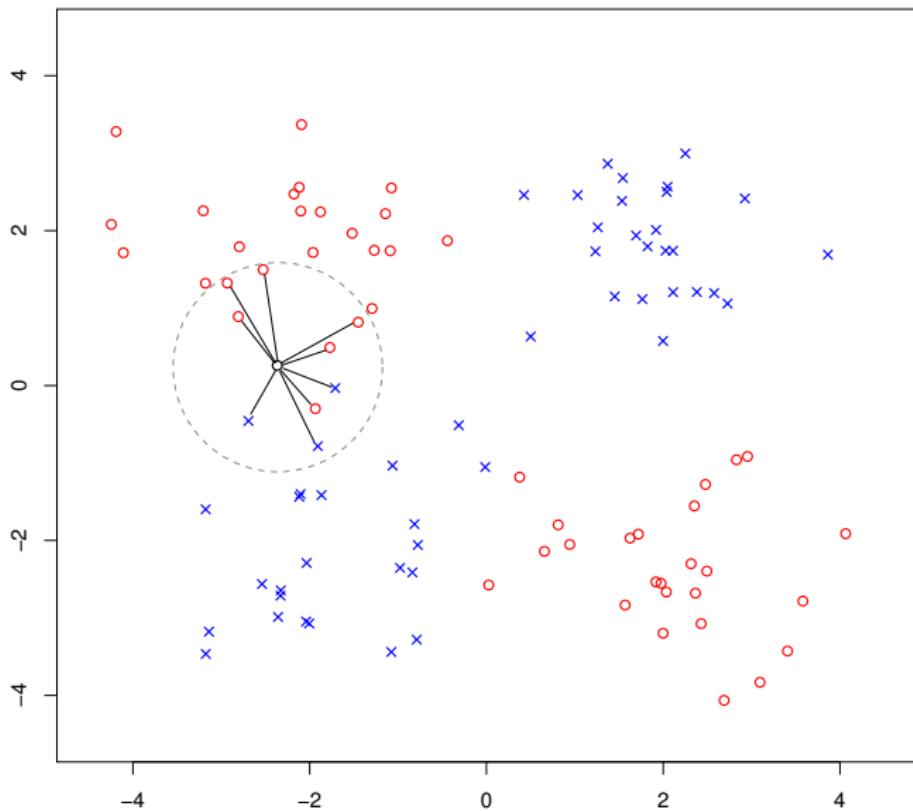
k-Nearest Neighbours



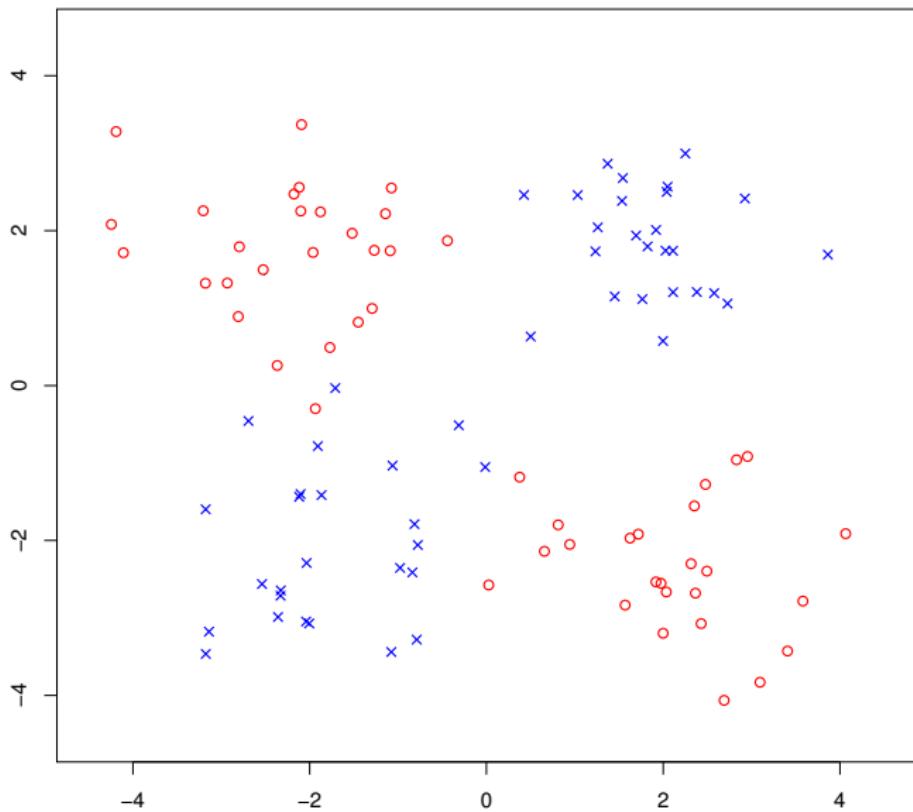
k-Nearest Neighbours



k-Nearest Neighbours

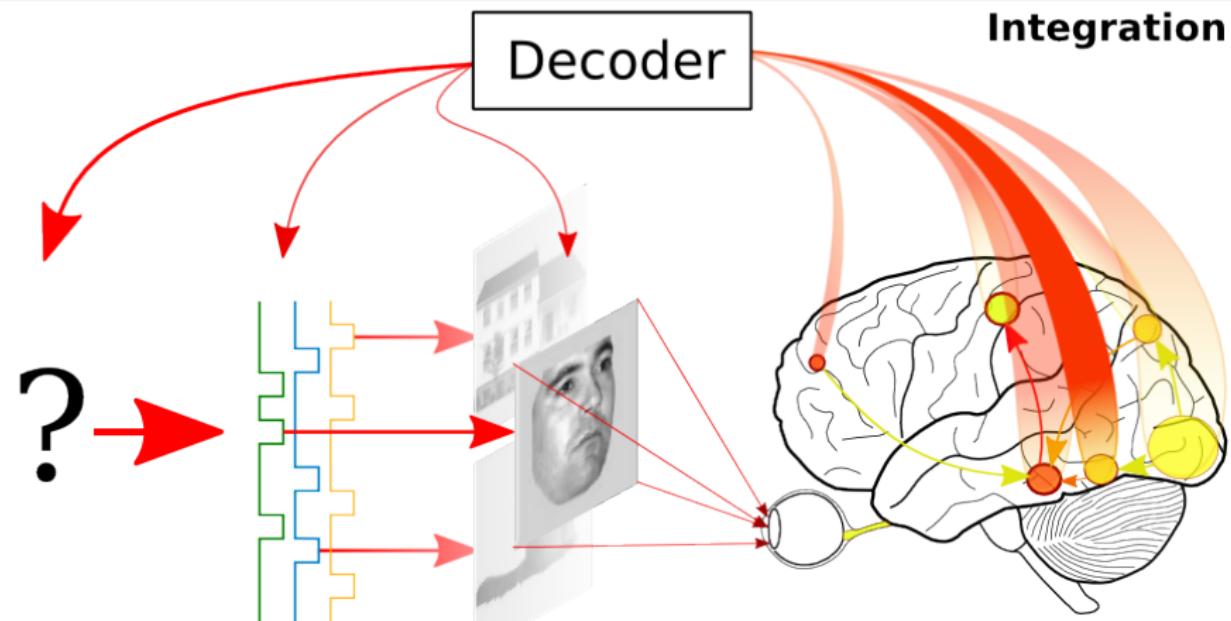


k-Nearest Neighbours



MVPA approach: Reverse the flow!

Information
Integration

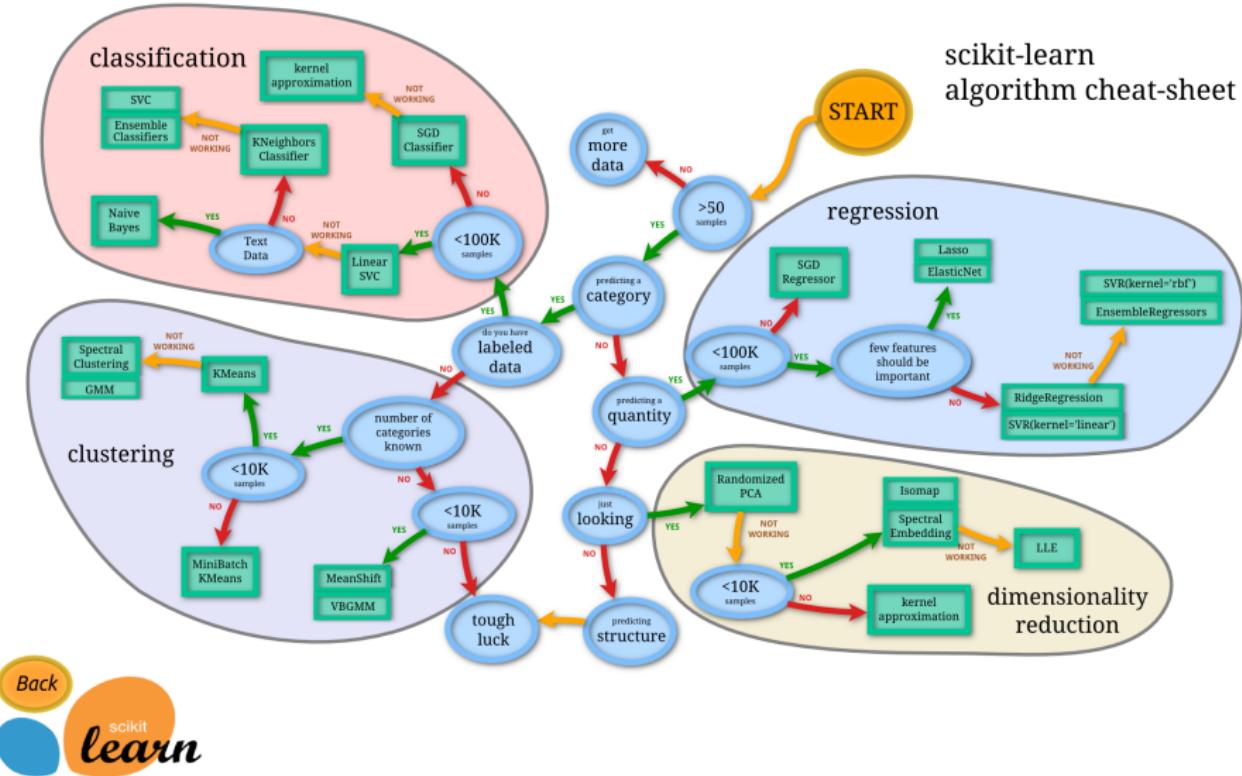


Research Question Experiment Design Stimuli

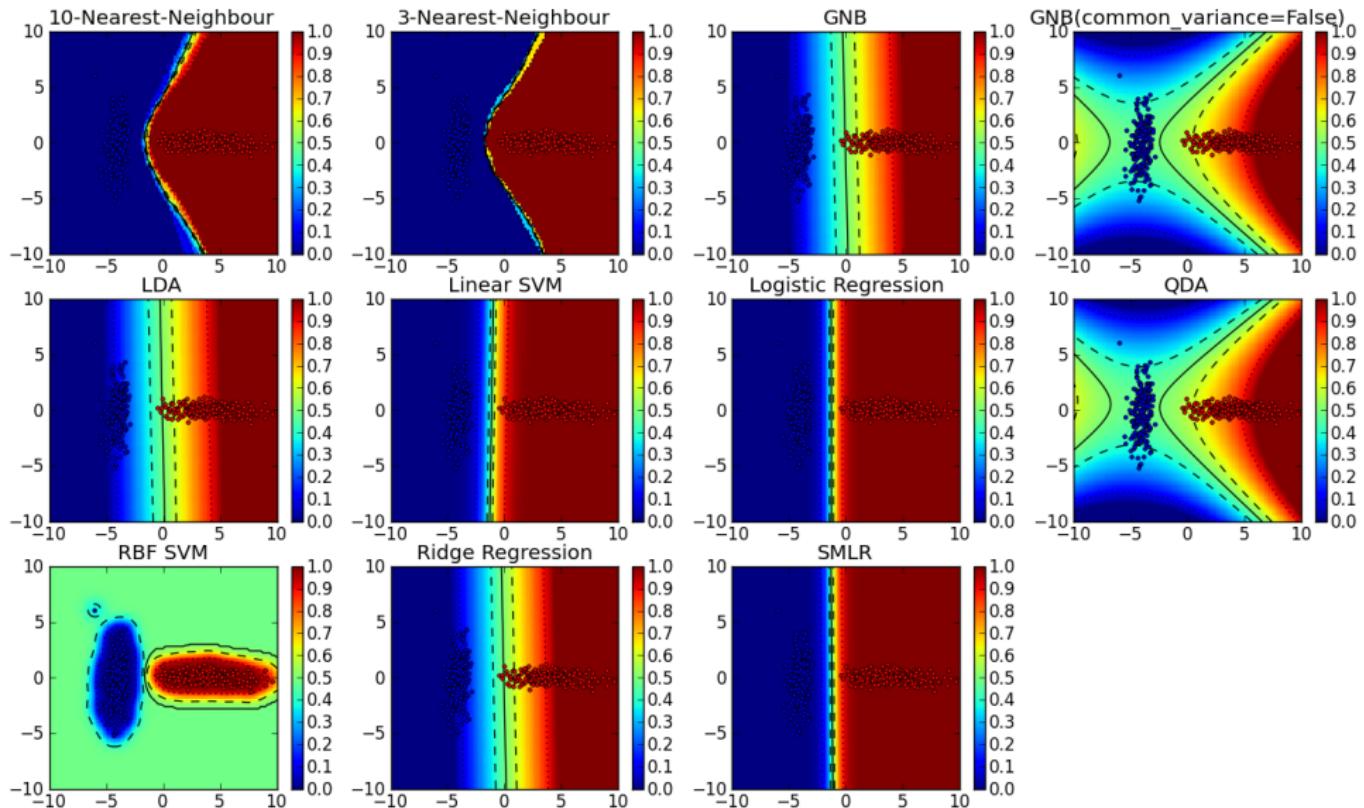
Neural Processing and Encoding

$$p(\text{behavior}|\text{brain activity})$$

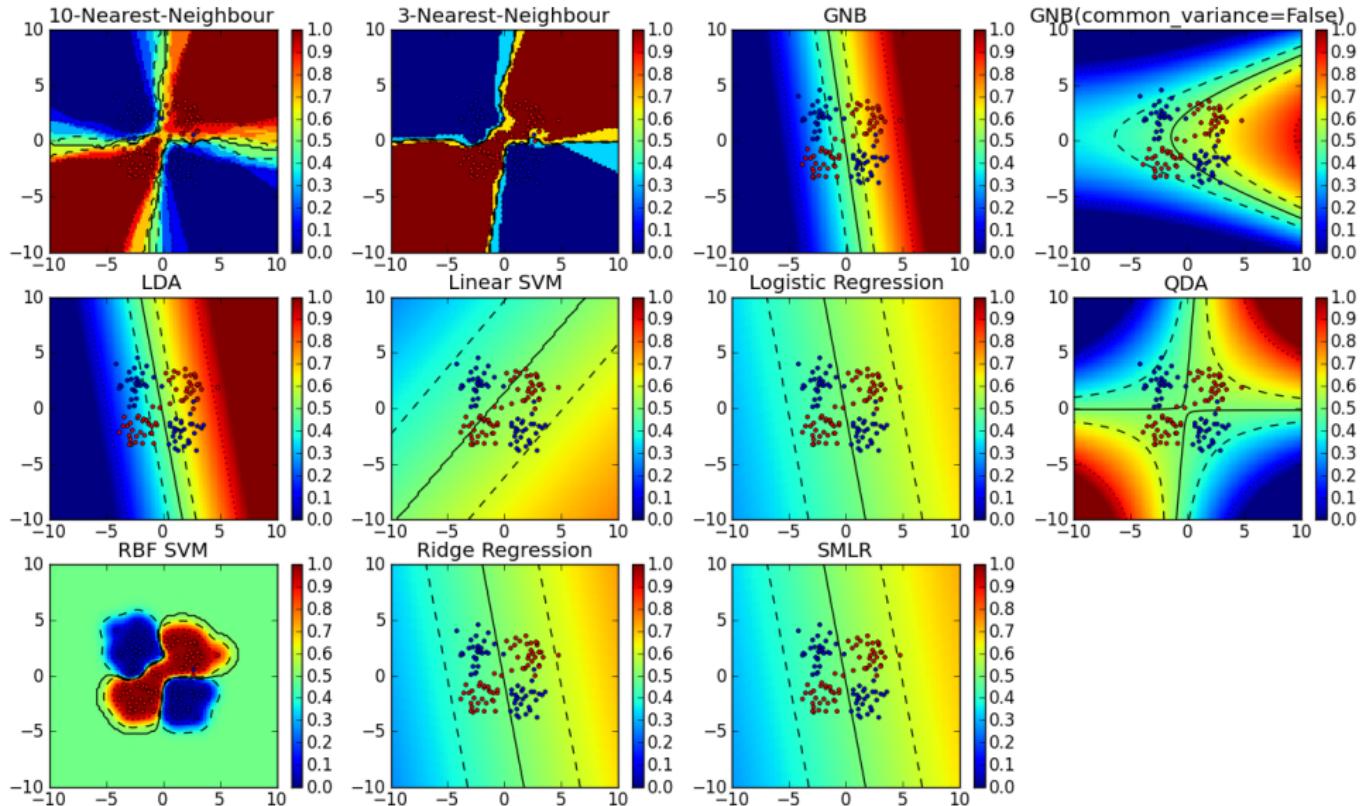
Which classifier?



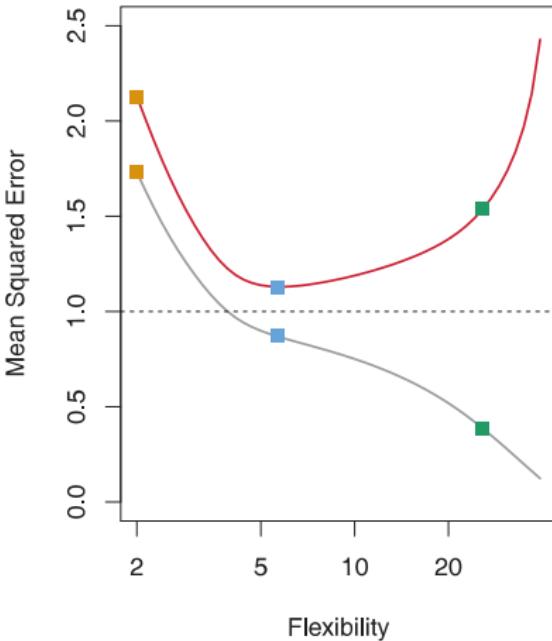
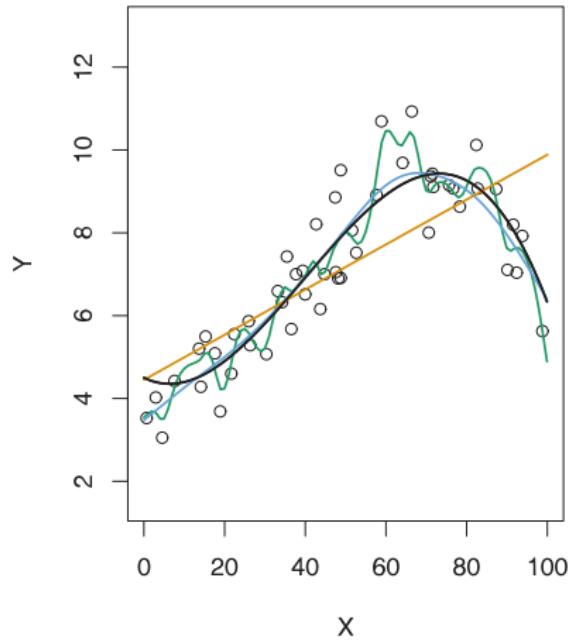
Decision models – linear problem



Decision models – non-linear problem



Model appropriateness



James, G., Witten, D., Hastie, T., and Tibshirani, R. (2013). *An Introduction to Statistical Learning: with Applications in R*. Springer Texts in Statistics. Springer. (free PDF copy)

Data representation – classification

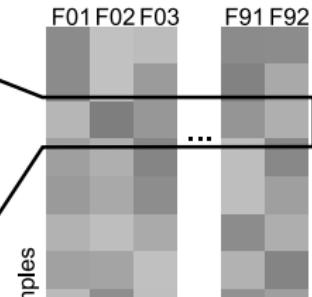
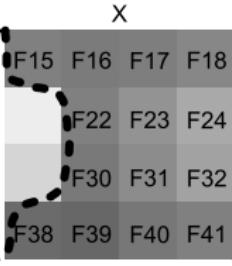
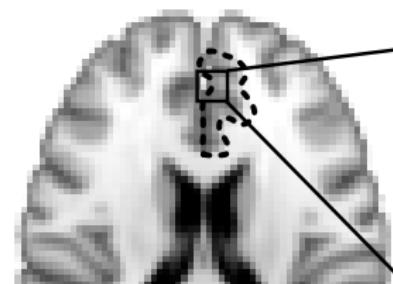
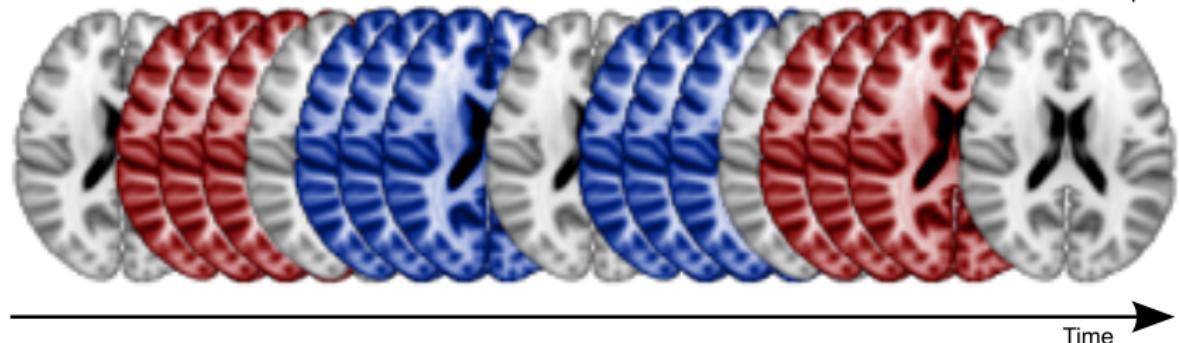
Experimental Runs



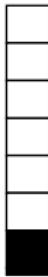
Experimental Conditions



fMRI Volumes



Samples



Enough said... (for now)

Let's see how we can do this...

References

James, G., Witten, D., Hastie, T., and Tibshirani, R. (2013). *An Introduction to Statistical Learning: with Applications in R*. Springer Texts in Statistics. Springer. (free PDF copy).