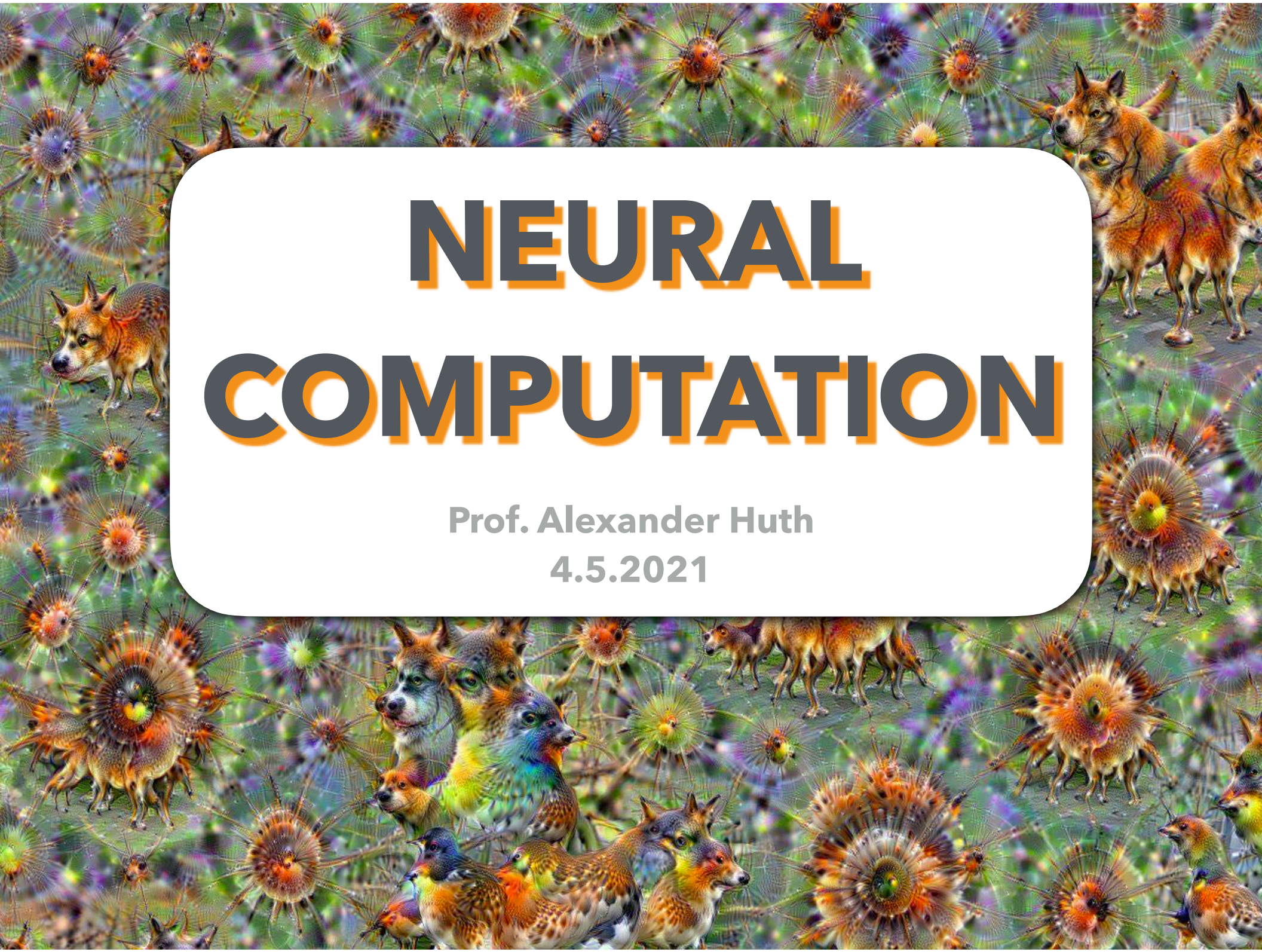


NEURAL COMPUTATION

Prof. Alexander Huth

4.5.2021

RECAP

* **System construction** to **system identification**
  * First, build a system that solves a task
  * Second, collect data from brain that is solving the same task
  * Third, use representations from the system you built to predict responses in the

RECAP

* In the context of vision
  * Use convolutional neural network (e.g. AlexNet, OverFeat) as **linearizing transform**
  * i.e. use **activations** from different layers of convolutional neural network as **features** of the input images for system identification

RECAP

* From fMRI paper (Eickenberg et al.)
  * Features/representations extracted from **different layers** of the artificial network are best for predicting **different areas** in visual cortex
  * The **hierarchy** matches: early layers in network are best for “early” visual cortex

TODAY

* Continuation of vision w/ another example (Yamins et al.)

* Discussion of “task” / “computational goal”

CONSTRUCTION TO IDENTIFICATION

* Key questions about Eickenberg et al. scheme
  * Does this work at all? ***YES***
    * If so, is this trivial? ***HMM…***
  * Do activations from different layers predict different parts of the brain? ***YES***
    * Does this correspond to known computational hierarchies? ***YES***
    * If so, is *this* trivial? ***HMM…***

NEURAL EXAMPLE

* Yamins, Hong, Cadieu, Solomon, Seibert, & DiCarlo (2014) Performance-optimized hierarchical models predict neural responses in higher visual cortex. *PNAS*

NEURAL EXAMPLE

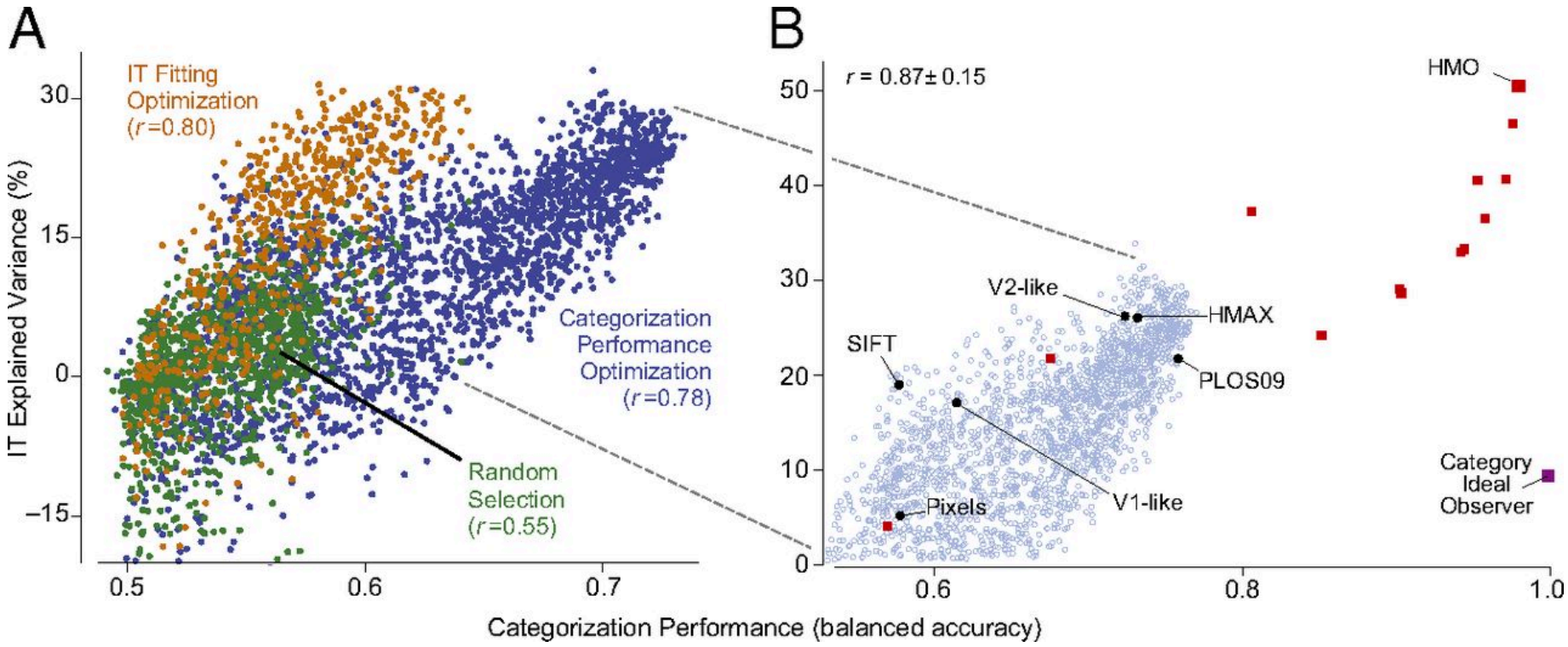
* Neural recordings from areas V4 and IT (inferotemporal cortex) in macaques while they view naturalistic images

* Hierarchical modular optimization (HMO) models (CNN, ~equivalent to AlexNet) used to extract features

NEURAL EXAMPLE

* **Question 1:** Are model performance at object recognition & model performance at predicting brain data correlated?

NEURAL EXAMPLE



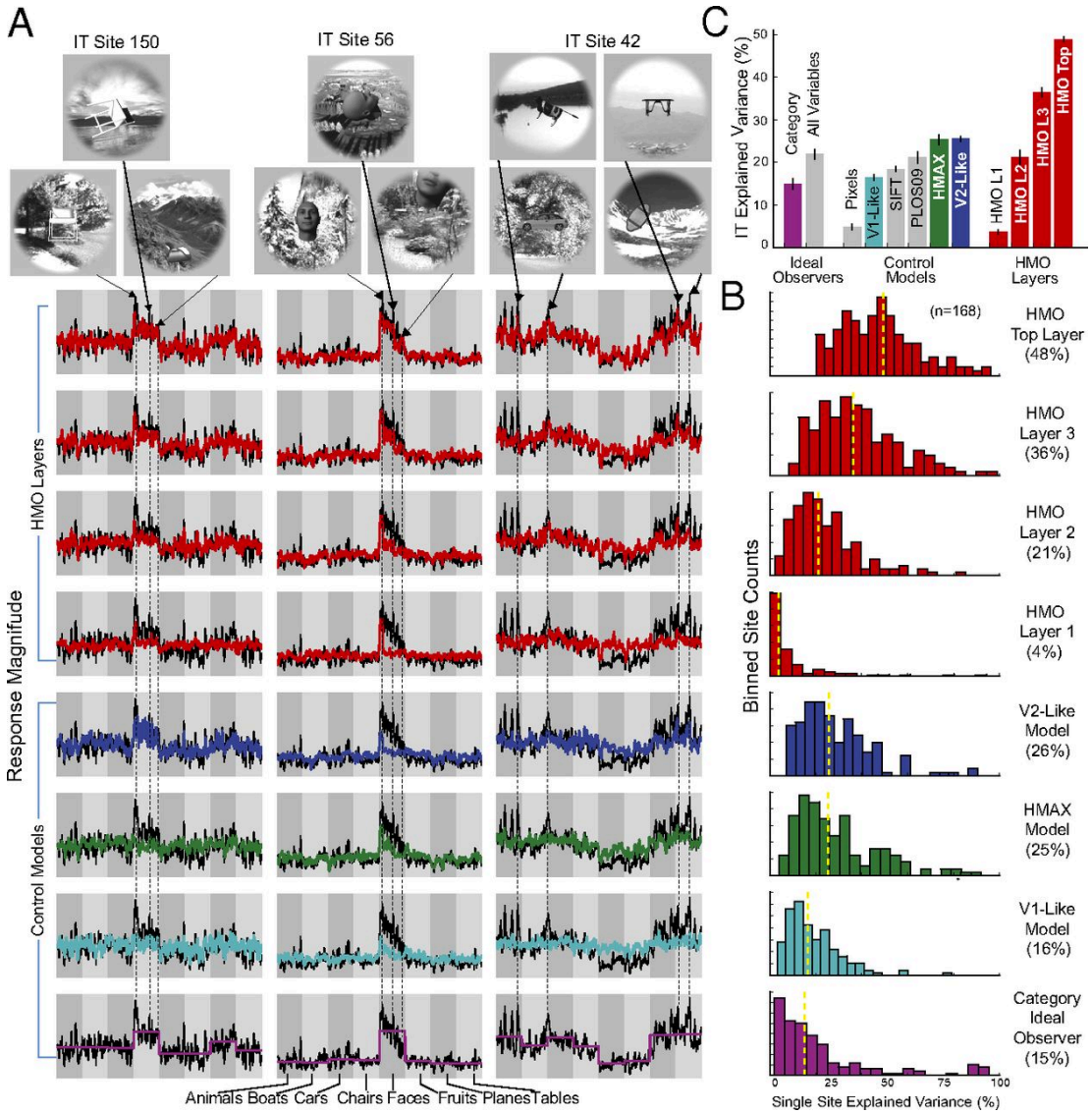
* **Answer 1:** Yes, broadly!

NEURAL EXAMPLE

* **Question 2:** Are different layers of the model good at predicting different regions in cortex?

NEURAL EXAMPLE

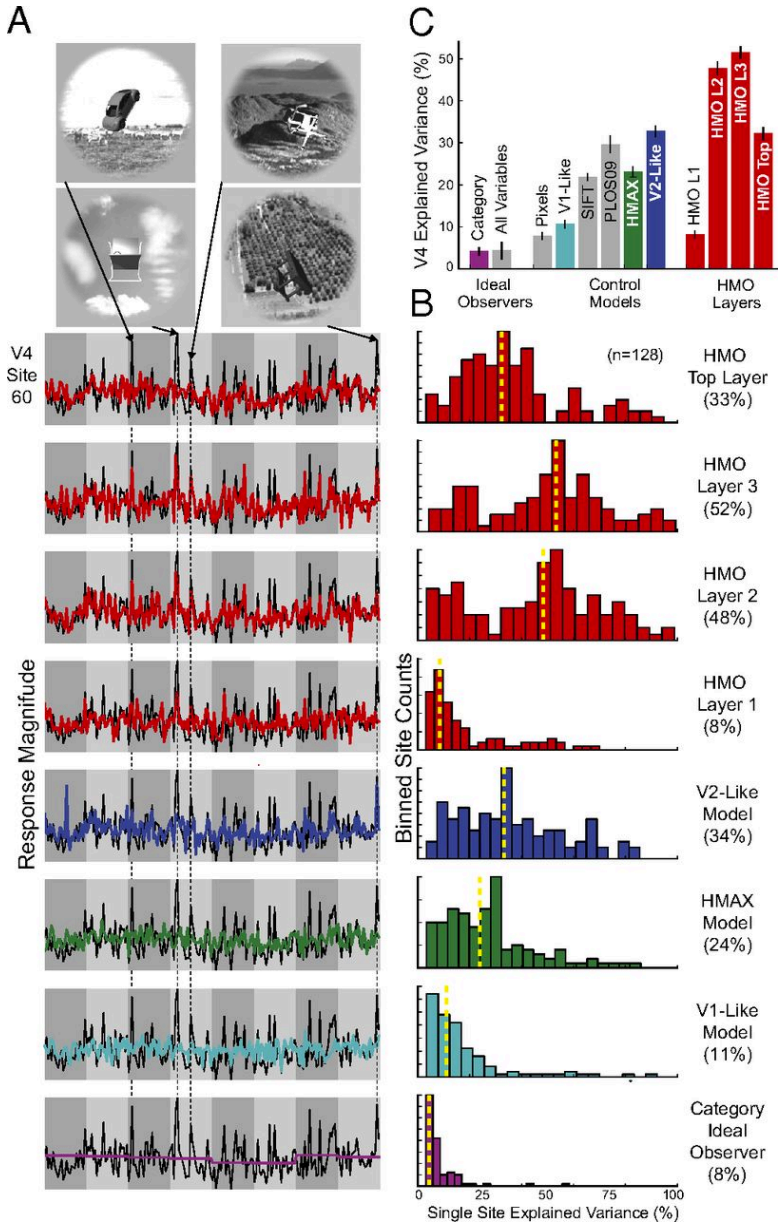
* IT neural responses are best explained by the “Top Layer” of the model



NEURAL EXAMPLE

* V4 neural responses are best explained by Layer 3 of the model!

* **Answer 2:** YES



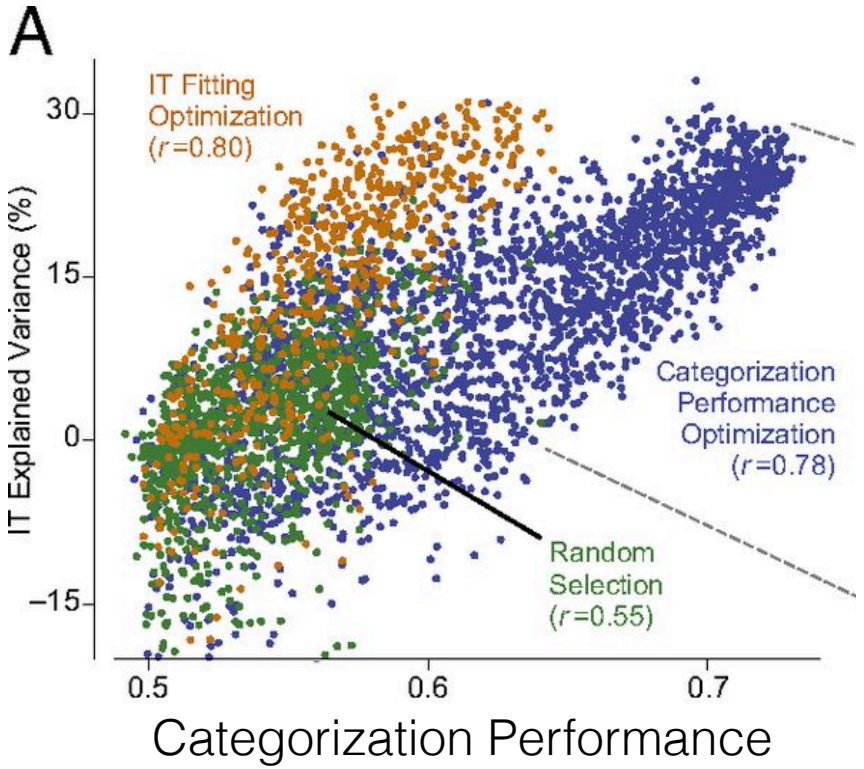
CONSTRUCTION TO IDENTIFICATION

* Key questions about this scheme overall:
  * Does this work at all? ***YES***
    * If so, is this trivial? ***HMM…***
  * Do activations from different layers predict different parts of the brain? ***YES***
    * Does this correspond to known computational hierarchies? ***YES***
    * If so, is *this* trivial? ***HMM…***

HOW MUCH DOES TASK MATTER?

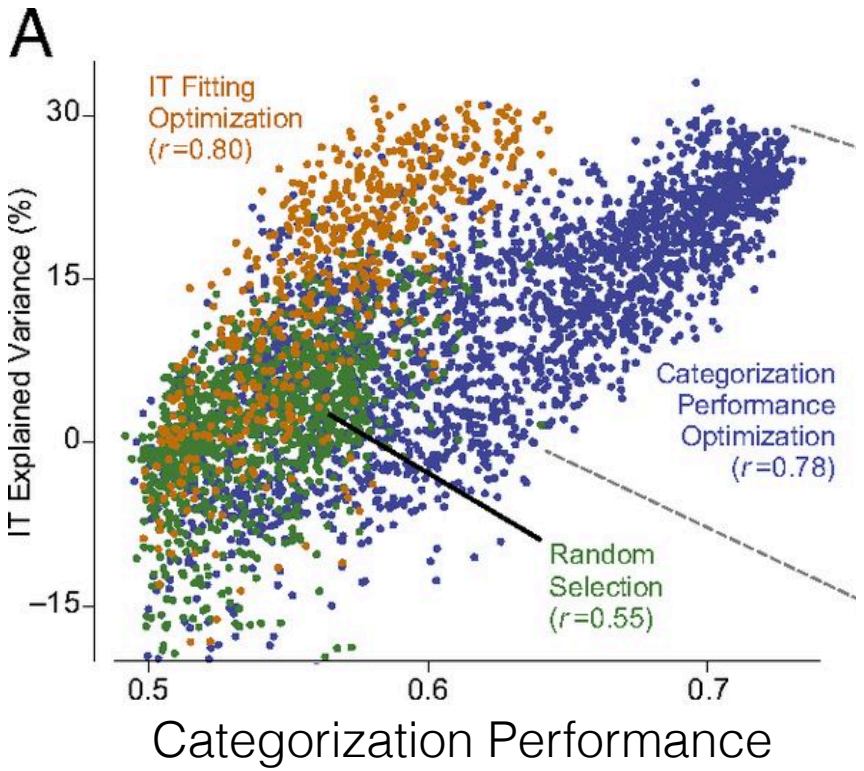
* Yamins et al. show that **untrained** neural networks do **reasonably well** at predicting brain data (& doing image categorization)

* i.e. building a supervised model on top of a **library of random non-linear features** works pretty well



HOW MUCH DOES TASK MATTER?

* ***Why?*** Let's take 5 minutes to discuss in small groups, then share thoughts w/ the rest of the class!



NEXT TIME

* Language & recurrent neural networks