
Discovery of semantic selectivity and functional specialization in the human brain

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Abstract:

Due to their remarkable ability to learn useful representations, neural networks that are pre-trained on large online datasets have recently become a tool of choice for neuroscientists. In contrast, by leveraging large-scale neuroimaging experiments, we show that we can take randomly initialized neural networks and train them to directly predict fMRI recordings, enabling the construction of functional brain models that can be manipulated, interpreted, and repurposed for other tasks. We present a bottom-up approach that uses data collected across multiple subjects viewing a large corpus of natural images, and we use it to uncover robust patterns of semantic selectivity in high-level visual cortex. We also use the predictions of our models to guide the generation of novel, out-of-distribution images that can drive the activity of brain regions of interest, and we validate the brain responses to these images with further fMRI experiments. Furthermore, we demonstrate that our brain-informed models can improve performance on different AI tasks, suggesting that the representations learned for predicting different brain areas have specific functionality. This approach builds towards integrated models of the brain and the world, which the potential of leading to new types of brain-computer interfaces.

Reading list:

- [Luo A, Henderson M, Wehbe L*, Tarr M*. Brain Diffusion for Visual Exploration: Cortical Discovery using Large Scale Generative Model. Neurips 2023, oral presentation.](#)
 - [Link: https://proceedings.neurips.cc/paper_files/paper/2023/hash/ef0c0a23a1a8219c4fc381614664df3e-Abstract-Conference.html](#)
- [Khosla M, Wehbe L. High-level visual areas act like domain-general filters with strong selectivity and functional specialization. in review.](#)
 - [Link: https://www.cs.cmu.edu/~lwehbe/files/domain_general_filters.pdf](#)