CONGRÈS JUNIOR PLURIDISCIPLINAIRE DE L'UNIVERSITÉ PARIS-SACLAY

université PARIS-SACLAY | GRADUATE SCHOOL Métiers de la Recherche et de l'Enseignement Supérieur

Make each visual stimulus count

Optimizing Stimulus Selection to enhance Understanding of the Inferior Temporal Cortex Organization using biologically constrained TDANN

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Contextualization: This work was carried out as a Supervised Project of the Master in Computational Neuroscience.

INTRODUCTION

What is TDANN?

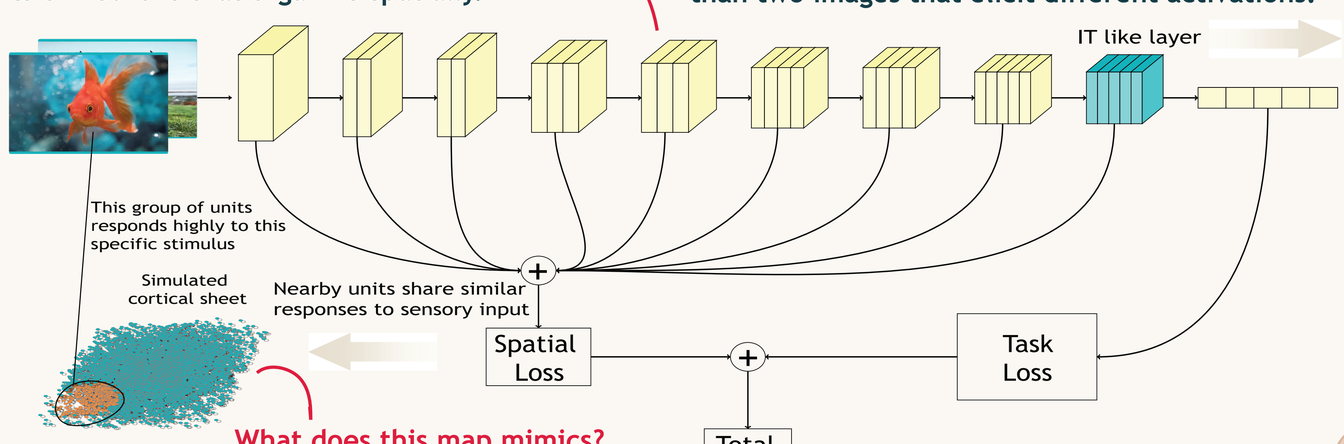
It is a Topographic Deep Artificial Neural Network. It has different layers with artificial units or neurons that organize spatially.

What is this map showing?

It shows a 2D projection of the activations for each image. If two images elicit similar activations they will be closer than two images that elicit different activations.

What is the IT cortex?

It is a region that helps us to recognize what we see, turning visual input into meaning



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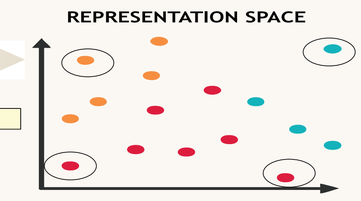
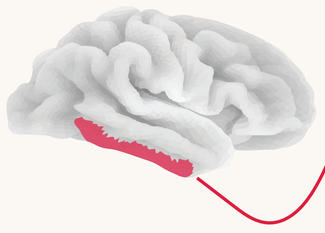
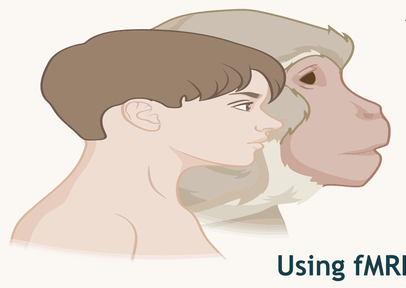
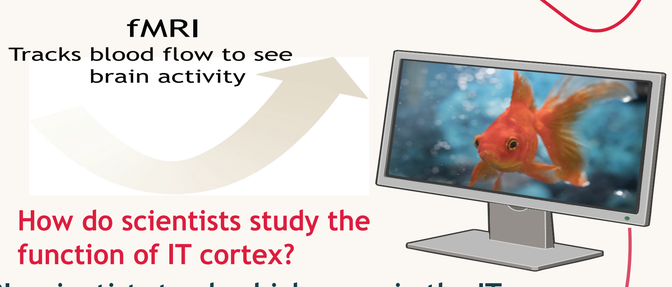








What does this map mimics?

It mimics the coordinate system of the cortex. Think of it as a 2D plane where all the neurons are situated.

How do scientists study the function of IT cortex?

Using fMRI, scientists track which areas in the IT cortex light up in response to images like this one

?

Model validity

Are the activations of TDANN model units similar to the activations of monkey neurons?

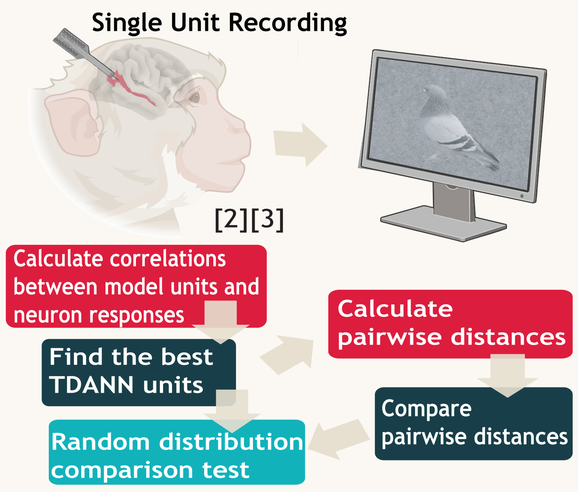
Are the TDANN model units capable of displaying category selectivity areas in its artificial cortical map?

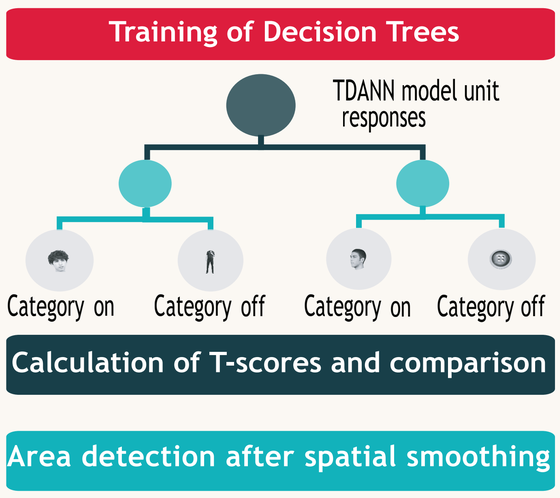
Selection of Stimuli

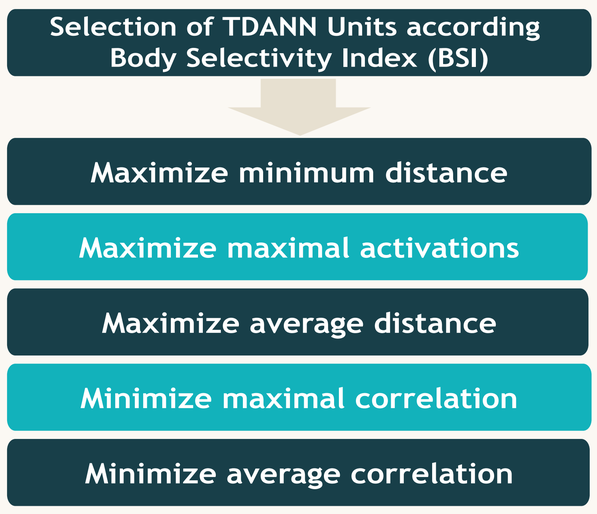
Which measures can assess the potential to drive diverse activations within a set of stimuli?

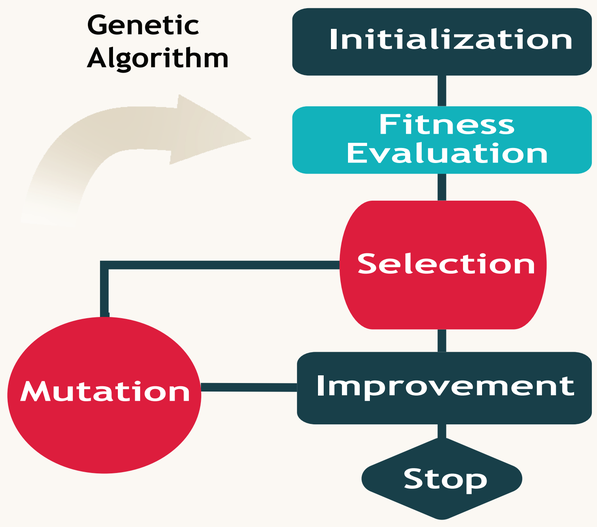
How do we select the stimuli?

METHODS

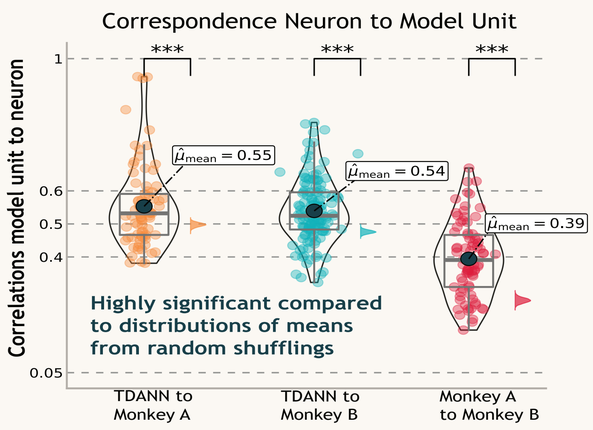


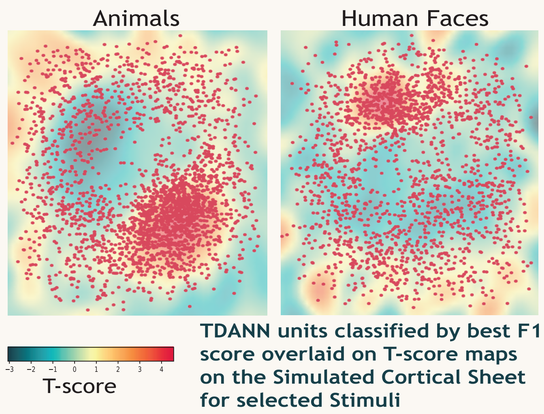




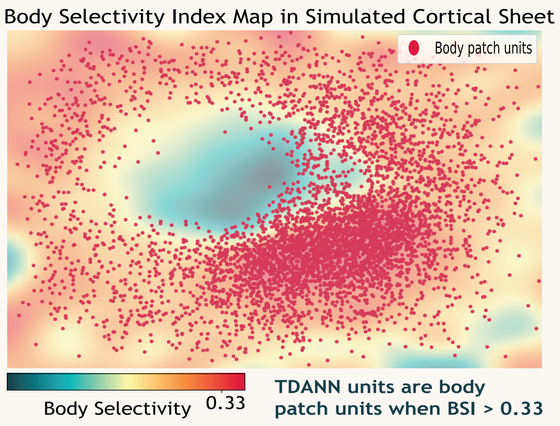


RESULTS

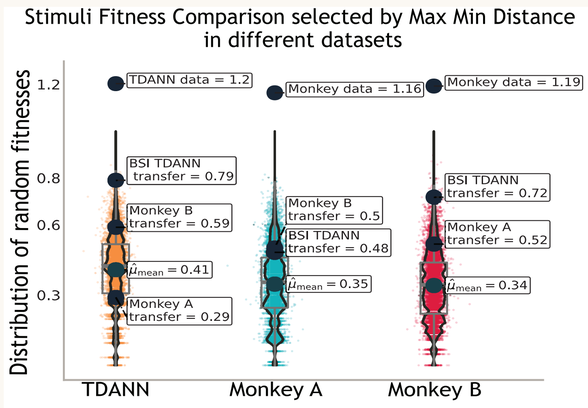


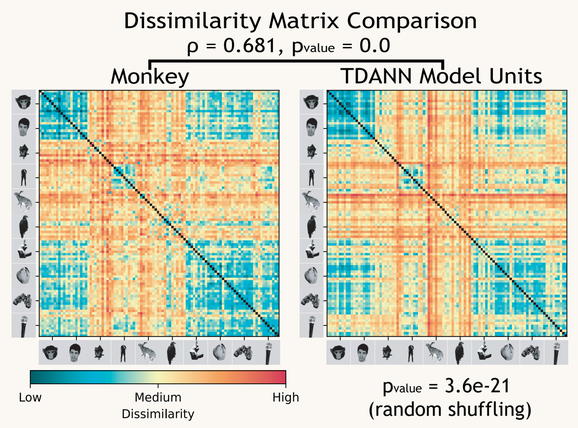


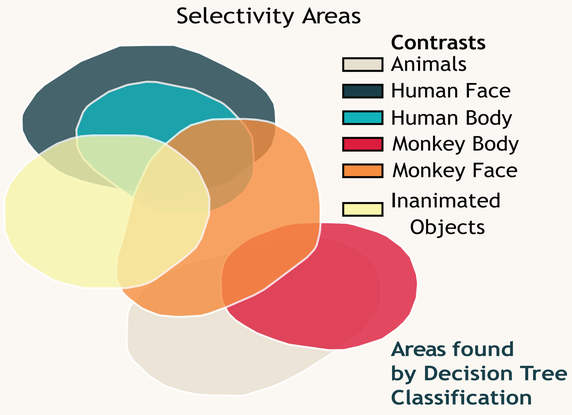
TDANN units classified by best F1 score overlaid on T-score maps on the Simulated Cortical Sheet for selected Stimuli

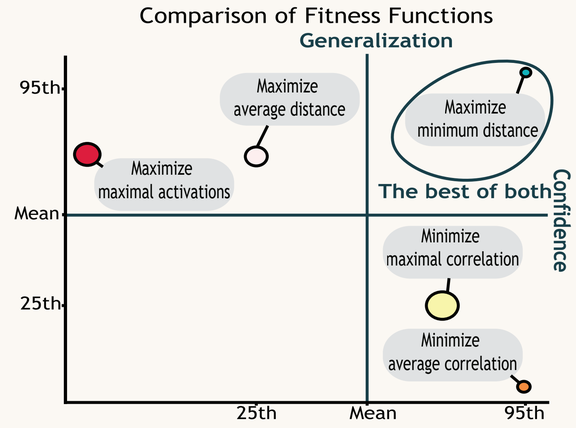


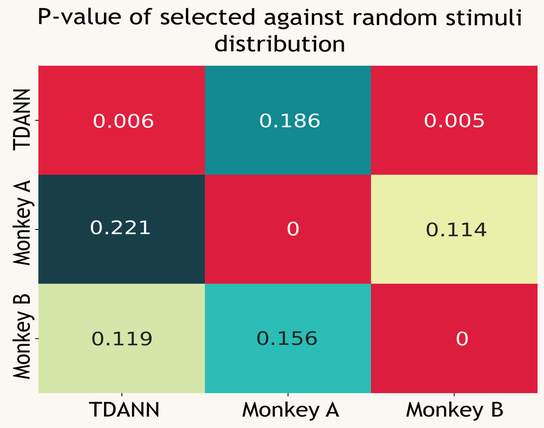
TDANN units are body patch units when BSI > 0.33











Discussion

- Selected TDANN units show similar activations to monkey neurons for the same stimuli. TDANN units are able to represent category-selective areas like high-level visual regions.
- Decision trees identify units most effective for predicting categories, which align with T-score based units, indicating selectivity over simple discrimination.
- TDANN exhibits similar category-selective areas as those seen in the brain. However, human and monkey body and face stimuli activate distinct, non overlapping TDANN body and face areas, respectively. This finding contrasts with previous observations in the monkey inferior temporal (IT) cortex, indicating a need for further refinement of the TDANN model.
- "Maximize minimum distance" is the most reliable measure for diversity, offering better generalization and the lowest standard deviation.
- TDANN successfully supports our developed genetic algorithm selecting diverse stimuli that lead to varied activation patterns in monkeys. TDANN may generalize better than monkey neurons, but this requires further validation.

References

[1] Margalit, E., Lee, H., Finzi, D., DiCarlo, J. J., Grill-Spector, K., \ Yamins, D. L. K. (2024). A unifying framework for functional organization in early and higher ventral visual cortex. **Neuron**

[2] Popivanov, I. D., Jastorff, J., Vanduffel, W., \ Vogels, R. (2014). Heterogeneous single-unit selectivity in an fMRI-defined body-selective patch. **Journal of Neuroscience**

[3] Popivanov, I. D., Jastorff, J., Vanduffel, W., & Vogels, R. (2012). Stimulus representations in body-selective regions of the macaque cortex assessed with event-related fMRI. **Neuroimage**

Link

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