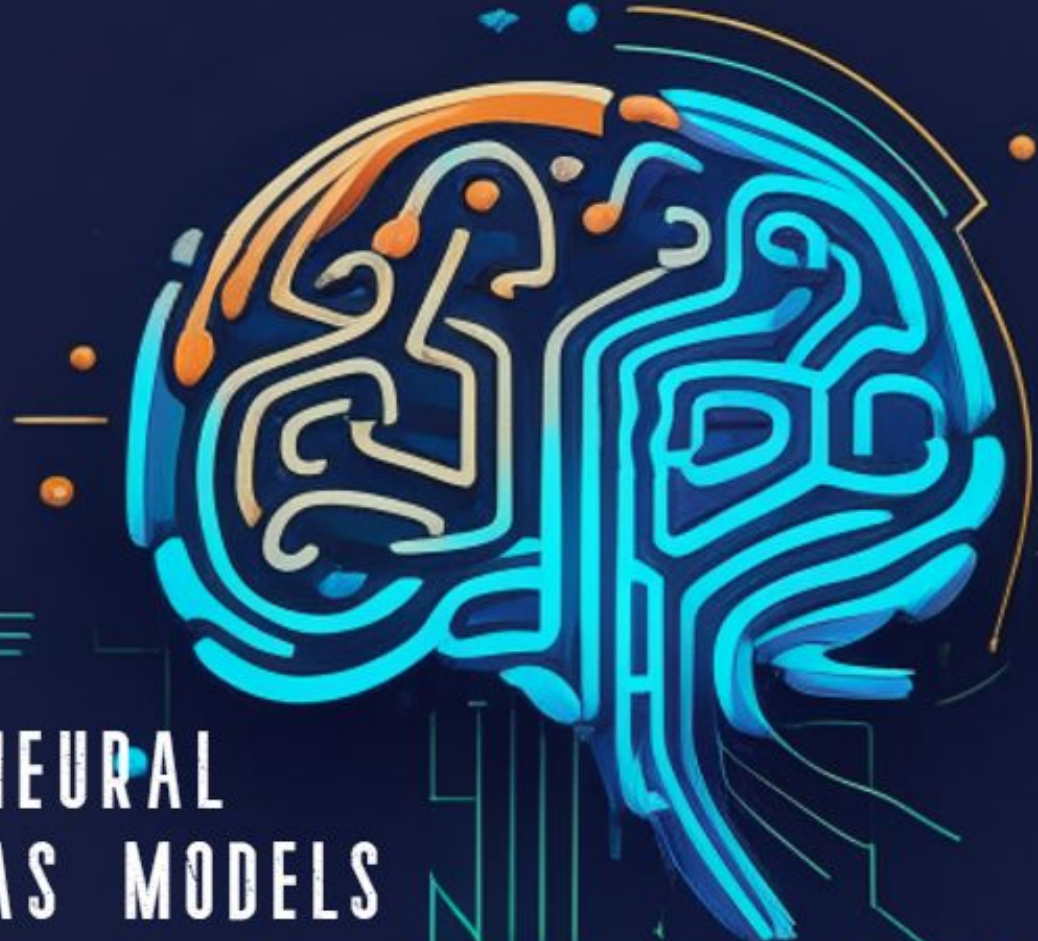


HBM
2023



NEUROAI:
ARTIFICIAL NEURAL
NETWORKS AS MODELS
OF THE BRAIN IN COGNITIVE NEUROSCIENCE

NeuroAI Educational Website

<https://neuroai-educational.github.io>



Welcome

The NeuroAI educational workshop is organized by Dr. Isil Poyraz Bilgin, Centre de recherche de l'Institut universitaire de gériatrie de Montréal (CRIUGM), Prof. Pierre Bellec, University of Montreal (UdeM), Dr. Elizabeth DuPre, Wu Tsai Neurosciences Institute, Stanford University, as part of the annual Organization for Human Brain Mapping (OHBM) 2023 conference.

The event is held as an in-person event, however the pre-recording of the sessions will be accessible via OHBM's online platform.

Majority of the speakers will present in-person but only one presenter due to their overlap with participating in another conference.

The educational session features both theoretical lectures as well as hands-on tutorials. The hands-on tutorials will be held via online Jupyter Notebook implementations to facilitate the attendees' interaction with the materials. The attendees will not be required to bring a laptop, but following the demonstration given by the lecturer will be enough to grasp the generic aspects of the tutorials.

The educational session will be finalized by a panel discussion, where the speakers of each NeuroAI educational session will join in to share their opinions for questions either pre-made by the organization committee or asked by the audience.

There are thematic of the event:

1. **Technical construction of the brain models:** An introduction of fundamental concepts applicability of AI in the neuroscience research;
2. **Brain decoding and encoding:** Identifying cognitive states based on brain activity (**brain decoding**); and predicting brain activity based on the activity of an artificial neural network (**brain encoding**);
3. **Multimodal overview of NeuroAI:** Implementation of AI in various sensory modality processing including vision, auditory, language.
4. **Ethics and future of NeuroAI:** Ethical concerns and potential future directions in the field.

This event will be held as a full day educational session starting at 8 am EST until 5 pm EST. There will be a lunch break at 12-1 pm EST, and two coffee breaks each of 30 min durations, one in the morning and one in the afternoon.

There will be continuous access to water and coffee outside of the event room.

Land Acknowledgement

The HBM conference 2023 is located on unceded land that has long served as a site of meeting and exchange amongst Indigenous peoples, including the Kanien'kéha and Anishinabeg nations.

The City of Montreal is known as Tiohtià:ke in Kanien'kéha, and Mooniyang in Anishinaabemowin.

Our team acknowledge the historical oppression of lands, cultures and the original Peoples in what we now know as Canada, as well as the harms and mistakes of the past.

Please consider how we can each, in our own way, move forward in a spirit of reconciliation and collaboration.

This text is adapted from the [land acknowledgement](#) of the Canadian Open Neuroscience Platform. Picture by John Lian under CC-BY-SA.



Organizers



Isil Poyraz Bilgin



Pierre Bellec



Elizabeth DuPre

Volunteers

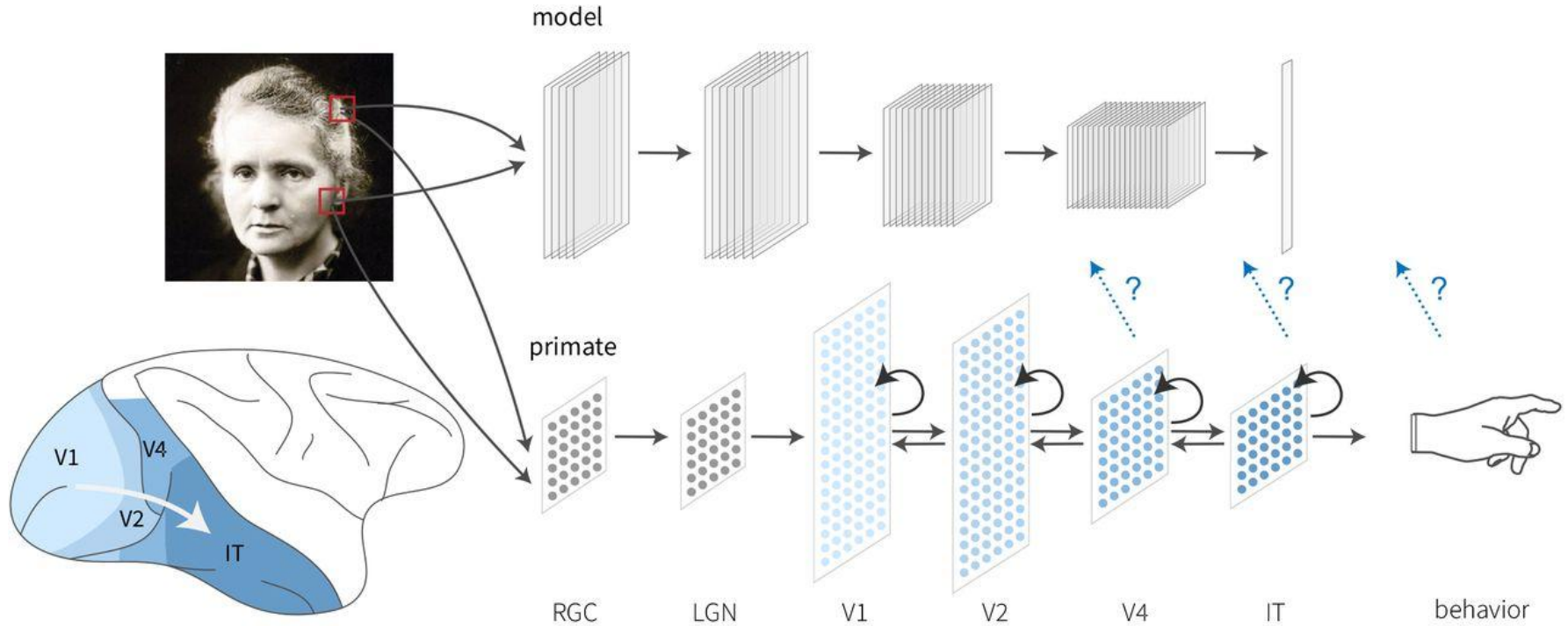


Pravish Sainath



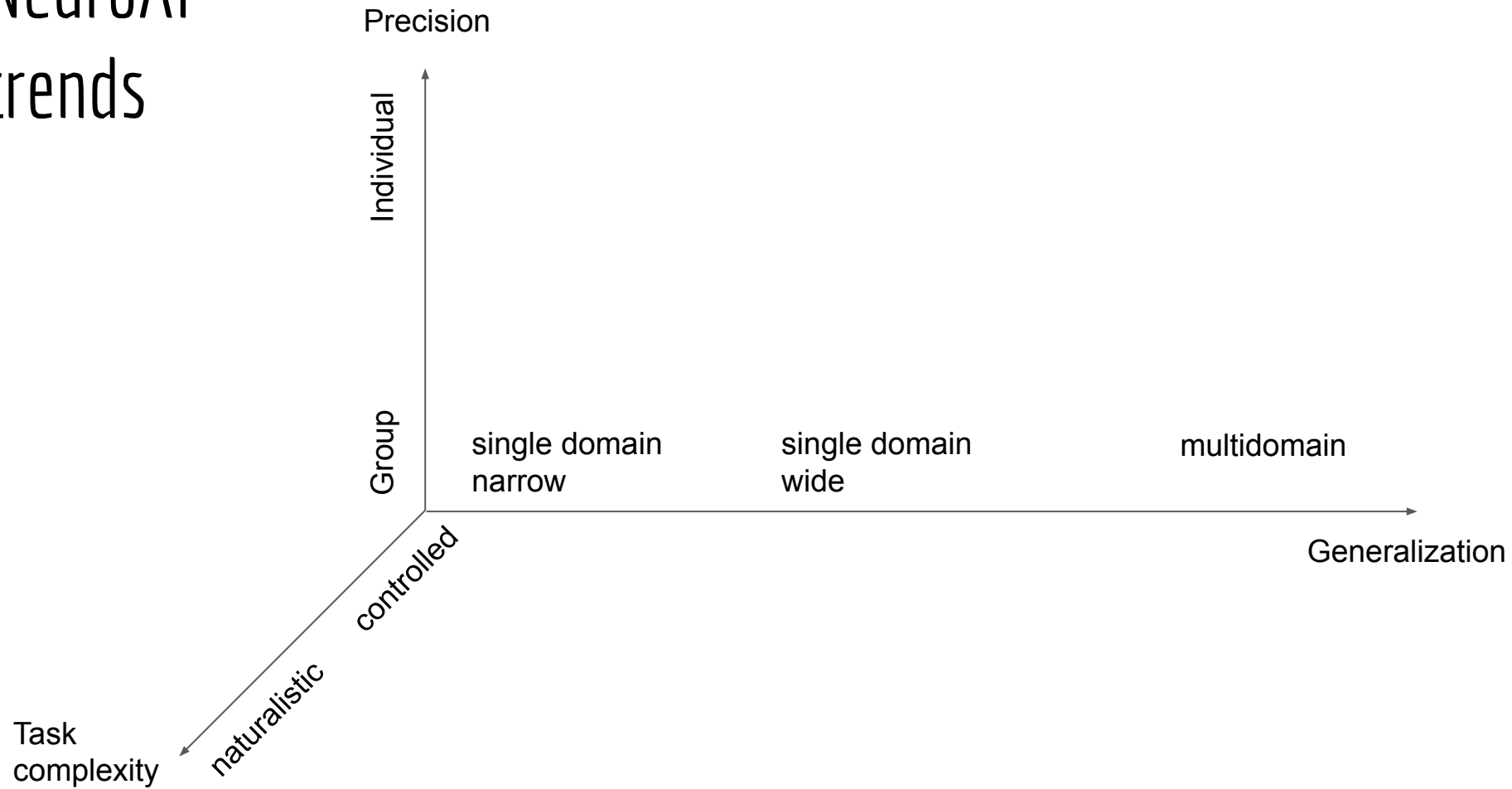
Yann Harel

NeuroAI models

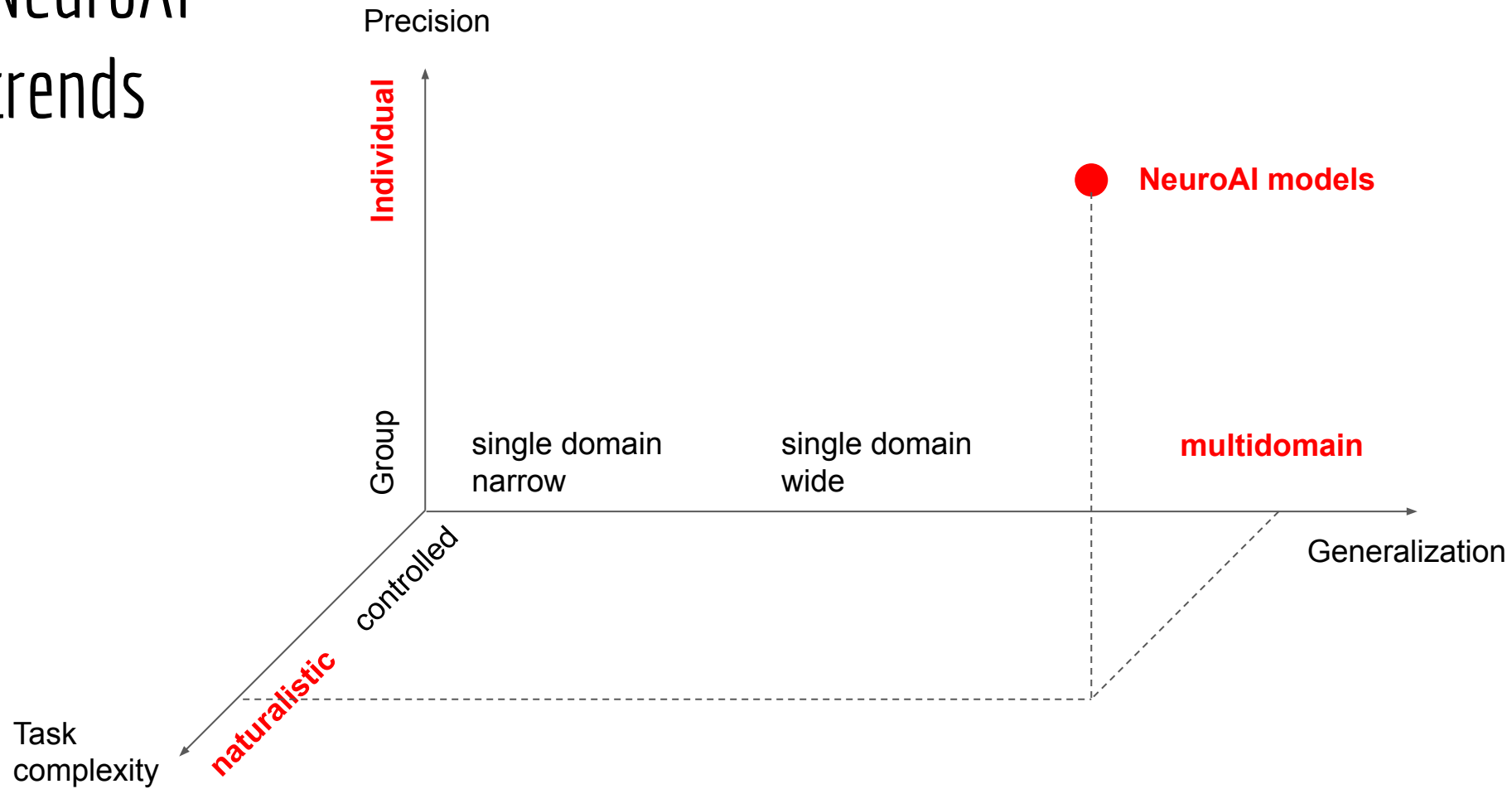


One way to test the consistency of representations in artificial neural networks (ANNs) and the brain is to **encode** brain activity based on ANN presented with identical stimuli or **decode** network features from brain activity.

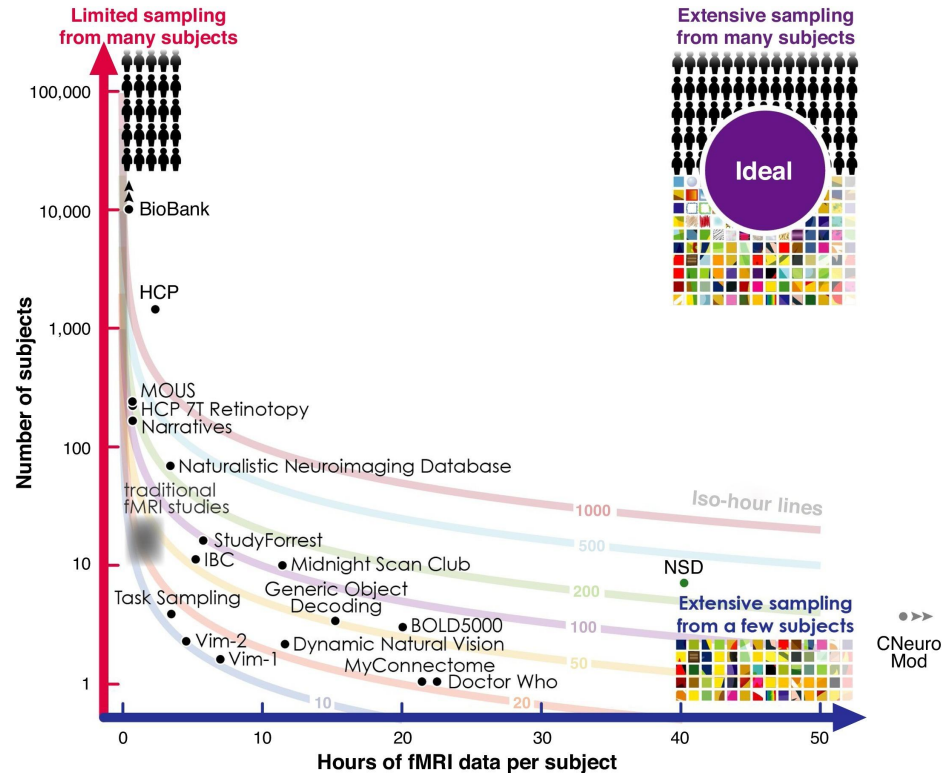
NeuroAI trends



NeuroAI trends



Towards individual precision in brain models



Towards individual precision in brain models

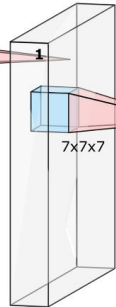


video stimulus space

linear layer

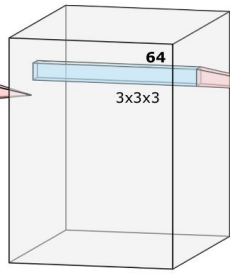


112 x 112 x 48



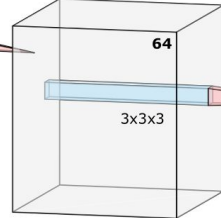
112 x 112 x 48

(...)
V1

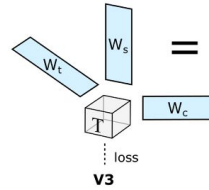


56 x 56 x 24

(...)
V2

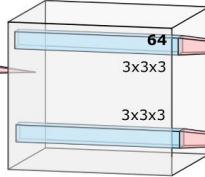


28 x 28 x 12

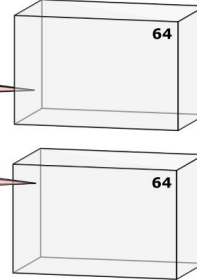


loss

V3



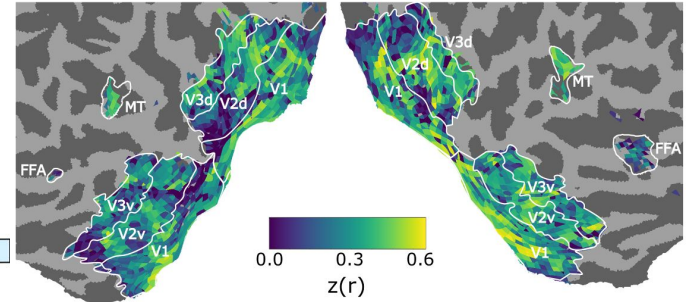
14 x 14 x 6



7 x 7 x 3

MT ... (...)

FFA ... (...)



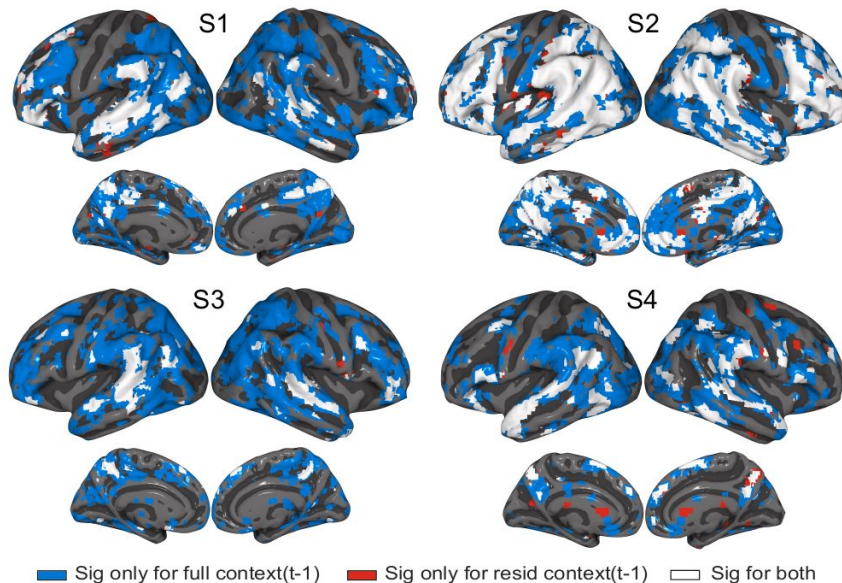
0.0 0.3 0.6
z(r)

End-to-end training of a model of the ventral visual stream, using 40 hours of fMRI data collected on a single participant watching the Dr Who TV series. Figures under CC-BY from Seeliger at al., PLOS Computational Biology 2021. Doctor Who logo by Mathis Biauout (Public Domain).

Towards complex, naturalistic tasks



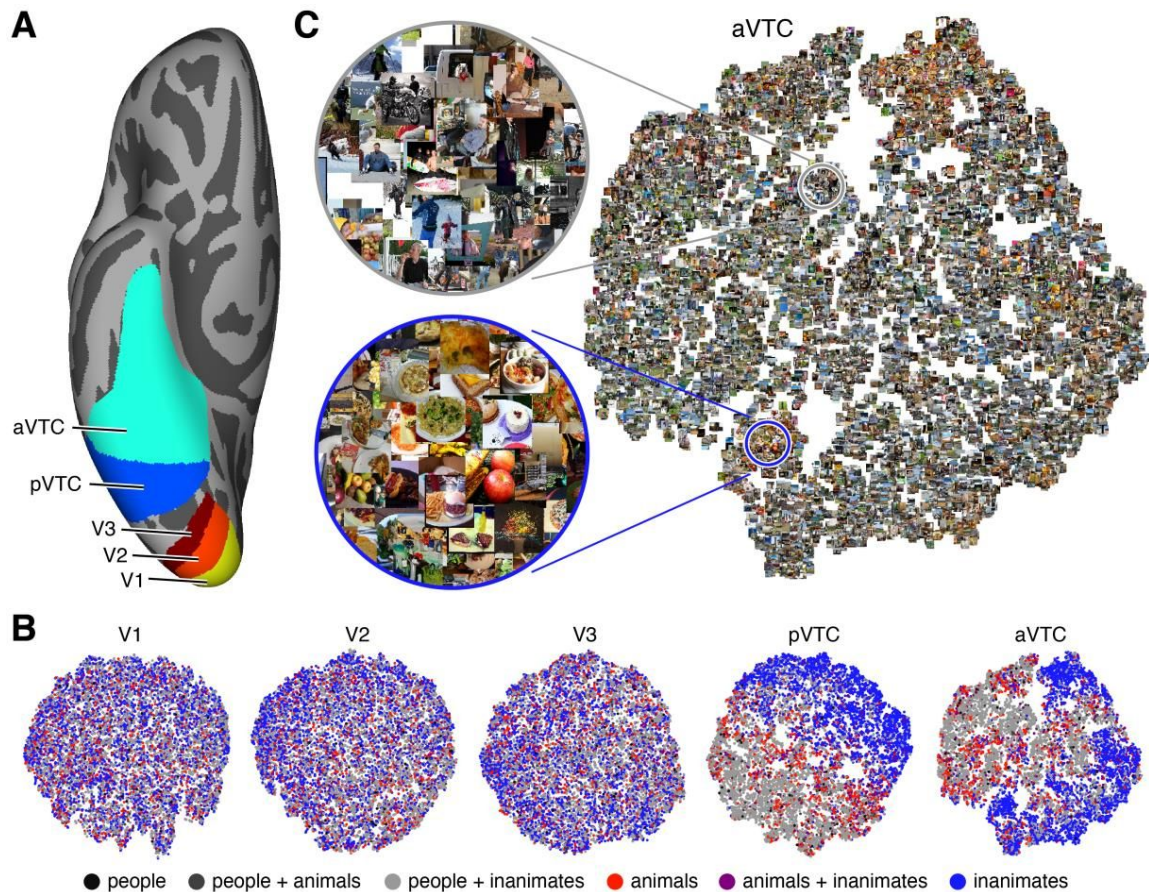
Voxels significantly predicted by full vs. residual context for 4 participants



Brain encoding with a large language model using fMRI on human subjects while reading chapter 9 of *Harry Potter and the sorcerer's stone* separate the contribution from semantic and supra-word representations. Figure under CC-BY-NC-ND from Toneva, Mitchell and Wehbe Biorxiv 2022 (now published in Nature Computational Science). Picture of the Howgarts train by Phil Scott (CC-BY-SA).

Towards wide generalization

Low-dimensional embedding of 10000 different complex images used as stimuli as NSD. Color coding represent high-level annotation of categories and corresponding brain representations in the NSD dataset. Figure under CC-BY from Allen et al., Biorxiv 2021 (now published in Nature Neuroscience).

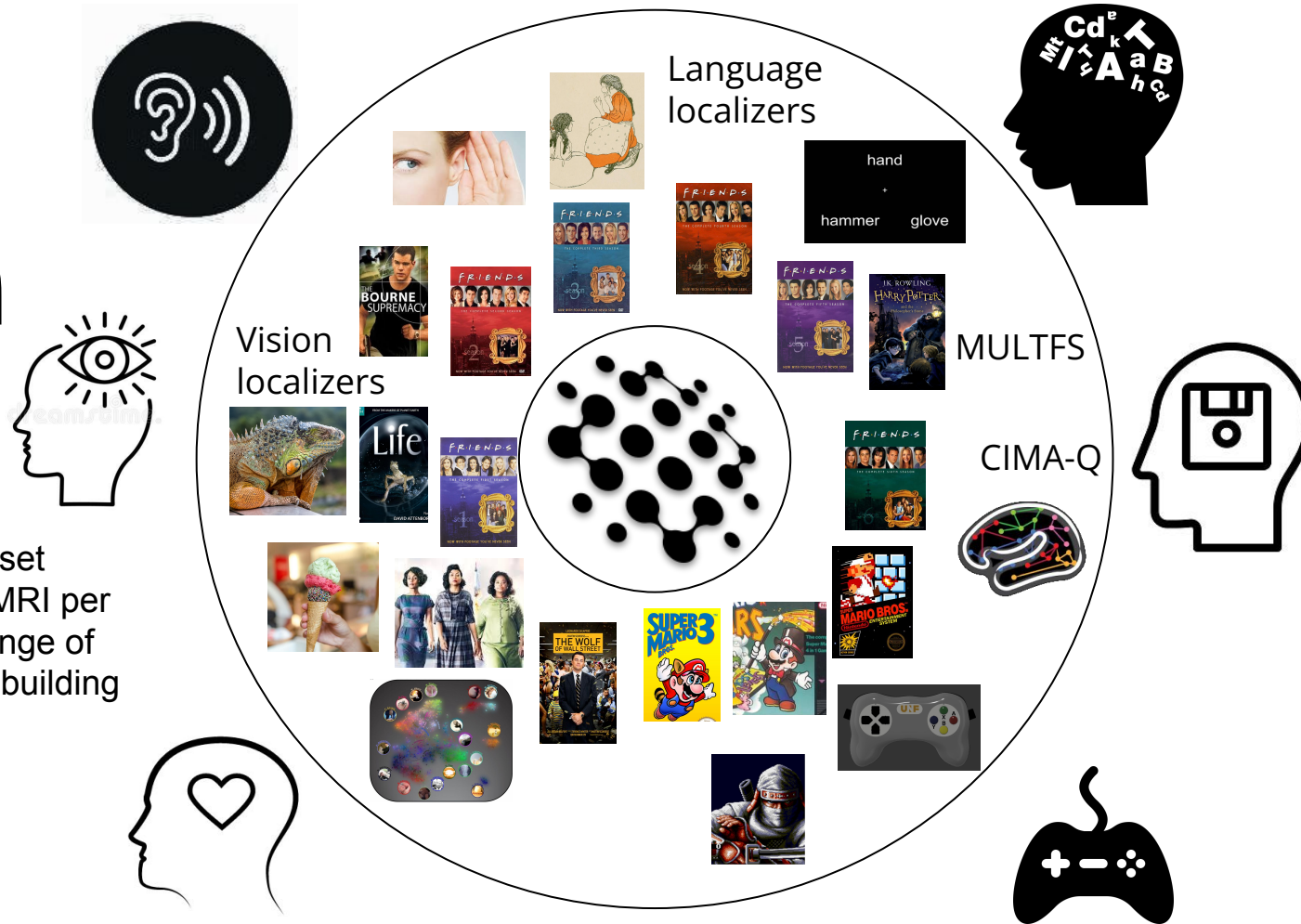


Towards multimodal generalization

The Courtois Neuromod dataset includes up to 200 hours of fMRI per subject (N=6) with a broad range of tasks with the explicit goal of building multimodal brain models.

<https://cneuromod.ca>

Boyle et al., poster 2455



Course objectives

1. Technical construction of the brain models
2. Brain decoding and encoding
3. Multimodal overview of NeuroAI applications
4. Ethics and future of NeuroAI

Speakers



Thomas Naselaris



Yu Zhang



Shahab Bakhtiari



Elizabeth DuPre



Mariya Toneva



Leila Wehbe



Isil Poyraz Bilgin

Code of Conduct

- We are excited to host this event in a safe and welcoming environment for all as part of OHBM 2023.
- All OHBM 2023 events, virtual and in-person, aim to be inclusive for all, regardless of race, age, health status, ethnicity, ability, religion, political affiliation, gender identity, and sexual orientation. This educational session, follows the OHBM Code of Conduct
- If someone makes you or anyone else feel unsafe or unwelcome, please report it as soon as possible to the OHBM Executive Director Beth Slater (bslater@humanbrainmapping.org). Harassment reduces the value of our community for everyone.

Program & Breaks

- This event will be hosted as a full day session (8 am - 5 pm EST) with 2 coffee breaks of 30 min and a lunch break of 1 hour.
 - Coffee break - 09: 55 - 10:25 EST
 - Lunch - 12 pm EST until 13:10 pm
 - Coffee break - 14:45 EST - 15:15 EST
- We have 3 lectures of 45 min and 3 hands-on workshops of 30 min where you will be able to ask your questions during the last 15 minutes of the each session.
- We will also have a talk on neuroAI ethics which will be followed by a panel session where each of our speakers will join and you will have a chance to raise your burning questions.

Hands-on tutorials

- We have 3 hands on tutorials throughout the session, 2 in the morning and 1 in the afternoon.
- To follow the hands on sessions you will not need anything to download but only internet access (OHBM 2023 with no password)
- Please open the online jupyter notebook to execute the commands together with the presenter.

Raising Questions

- The attendees will be able to have an access to microphones at the room or use system available through the OHBM Annual Meeting app.
- You should have been send the details about how to download the app will be provided in the “Know Before You Go” email OHBM sent you this week.

