Interactionism
The Training Program

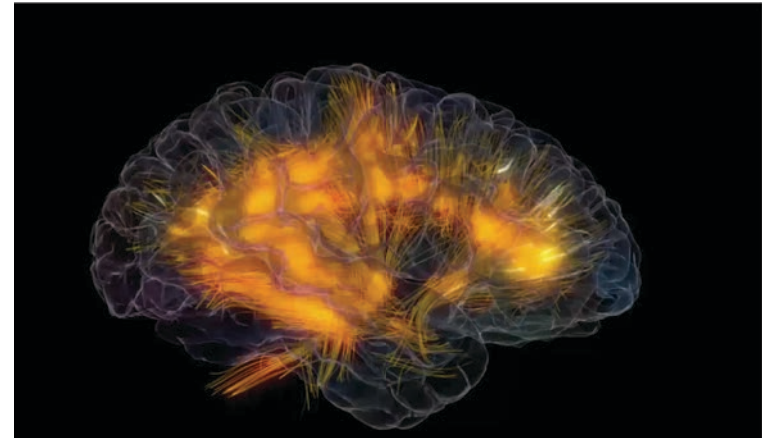**Interactionism**

Noun   A Movement in the early 21st Century that proved <u>the</u> key step in unlocking the Neural Mechanisms of Human Cognition.

See also <u>Interactionista</u>   A stylish revolutionary credited with changing the future of brain/mind science, first observed at Brown University.
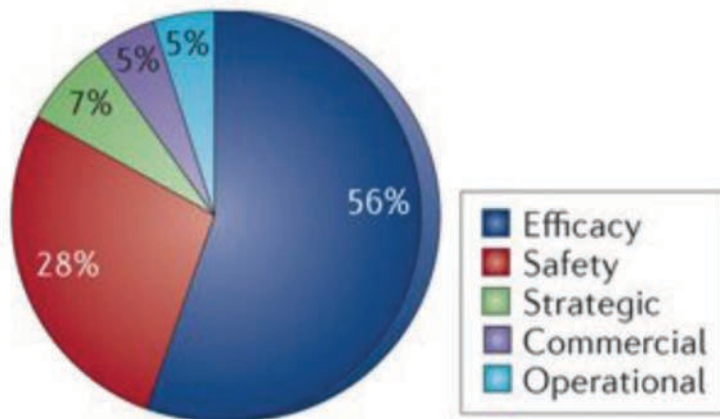
The Goal
Neural Mechanisms
of Human Cognition

The Opportunity Animal models are an essential source of detailed insight

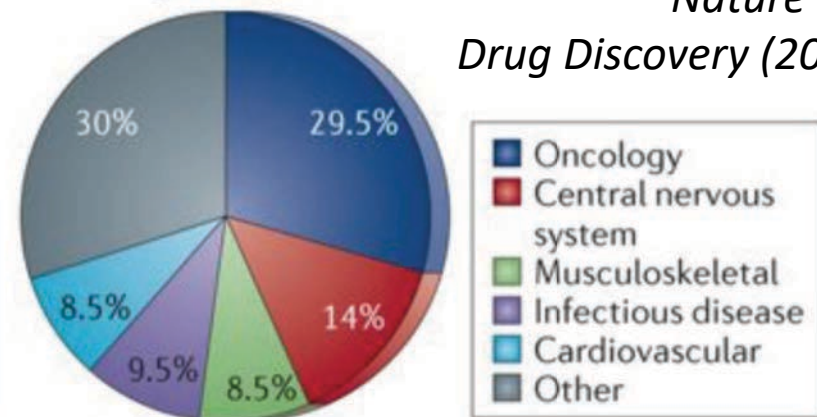**The Challenge** um...they are animals...

The Insufficient Answer Just gather enough animal data and we will someday understand the human brain

Despite hundreds of millions of dollars invested in translating animal research into human treatments, >50% clinical trials fail in Phase II, and >50% fail due to lack of human efficacy

a Causes of failure

Efficacy 56%
Safety 28%
Strategic 7%
Commercial 5%
Operational 5%

Failure by therapeutic area

Nature Rev Drug Discovery (2013)

Oncology 29.5%
Central nervous system 14%
Musculoskeletal 8.5%
Infectious disease 9.5%
Cardiovascular 8.5%
Other 30%

The Answer: Interactionism Close collaboration across species, traditional fields of study, and levels of analysis
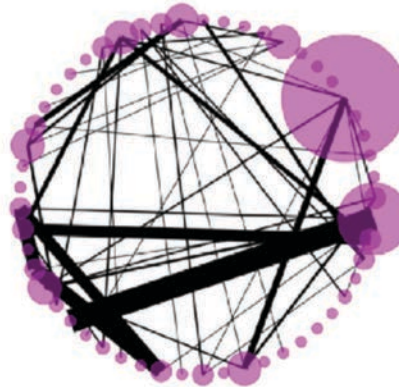

Comp 1   Comp 2   Carney

Brown Brain/Mind Science is already distinctively good at collaboration relative to peers. Each node = a Faculty, line thickness = # shared publications, disc size is the degree of each node

The Bridges Supporting Interactionism

<u>Identical methods across species</u> (e.g., monkey fMRI; EEG-LFP human-animal)

<u>Fluently Bilingual Interactionistas</u>, that understand human and animal work, and that speak the common tongue…

Computation: The Common Tongue of Interactionism

Theoretical frameworks and rigorous models are key to unifying across levels

Allows impossible experiments and understanding complex signals e.g., animal -derived models to explain human data
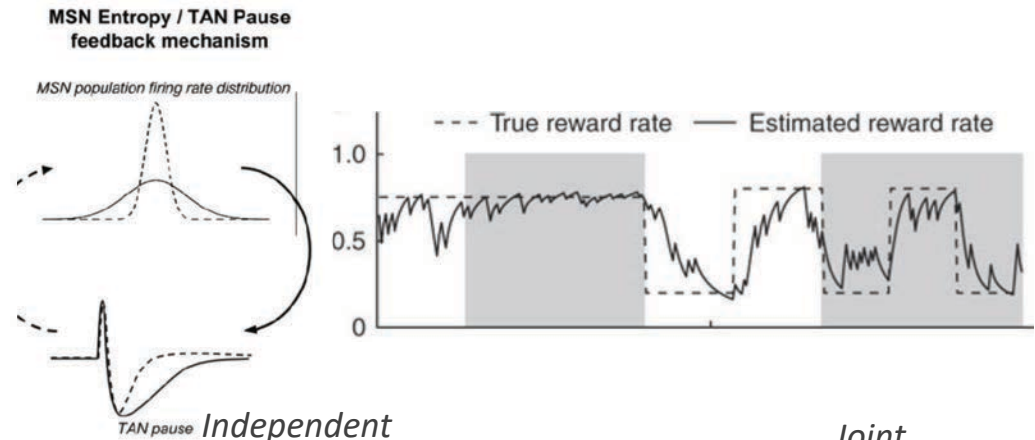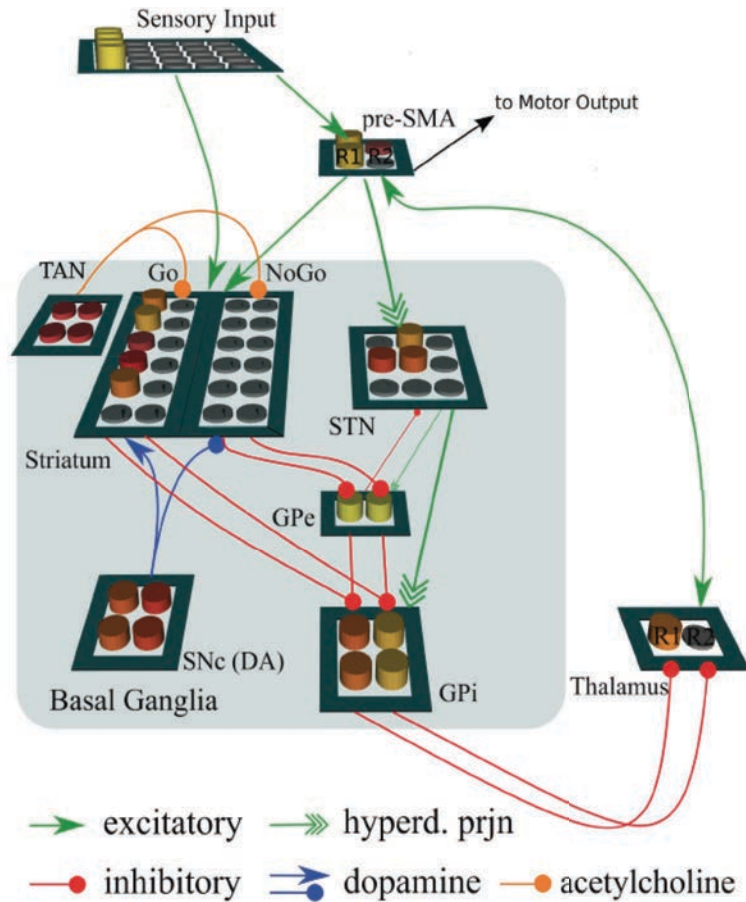
Example Interactionist students
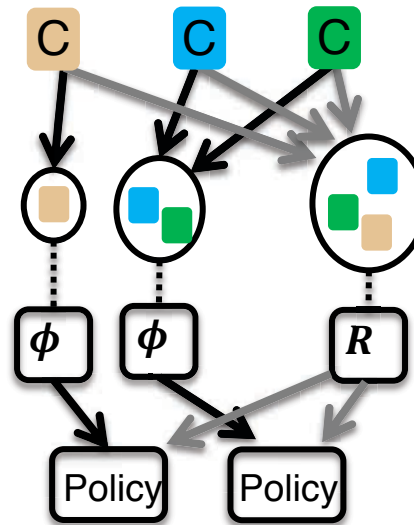
Nick Franklin, CLPS PhD 2017

- Entered Brown with no computational training
- Joined Frank lab in 2012
- Became expert in systems level neural networks of basal ganglia, then: several Applied Math and Computer Science courses, reading groups

- Became well versed in multiple levels of computation:
    - Model-based reinforcement learning, POMDPs
    - Bayesian formulations
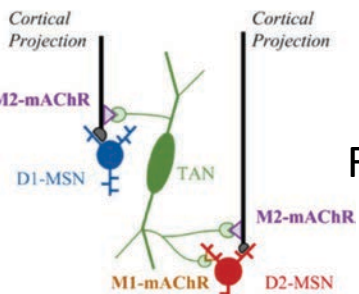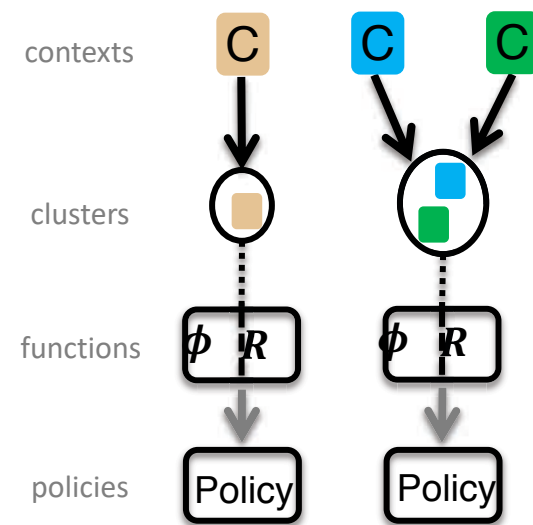   - Information theory
    - Machine learning

Linking levels of computation

Sensory Input

to Motor Output

pre-SMA

R1 R2

MSN Entropy / TAN Pause feedback mechanism

MSN population firing rate distribution

TAN

Go NoGo

Striatum

STN

GPe

SNc (DA)

Basal Ganglia

GPi

Thalamus

R1 R2

TAN pause

True reward rate — Estimated reward rate

1.0

0.5

0

→ excitatory ⟶ hyperd. prjn
●— inhibitory ⇉ dopamine ●— acetylcholine

Cortical Projection

Cortical Projection

M2-mAChR

D1-MSN   TAN

M2-mAChR

M1-mAChR   D2-MSN

Franklin & Frank 2015, *eLife*

Independent Clustering

Joint Clustering

C C C contexts C C C

clusters

ϕ ϕ R functions ϕ R ϕ R

Policy Policy policies Policy Policy

Franklin & Frank, 2018 *PLOS Computational Biology*

Hyeyoung Shin, Neuro

- First 2 years: Moore lab.

- Mouse ephys. Gamma and beta oscillations in perceptual attention

- 3rd year: Jones lab, biophysical computational model explaining how dynamics arise in circuits, novel predictions

- 2017 *eLife* paper on model, human and mouse

- New electrophysiology paper (Shih & Moore, *Neuron*) on gamma oscillations and interneurons

H onorific
EX tra-paradigmatic
B runonian
I nteractionist
N euroscience
S ociety
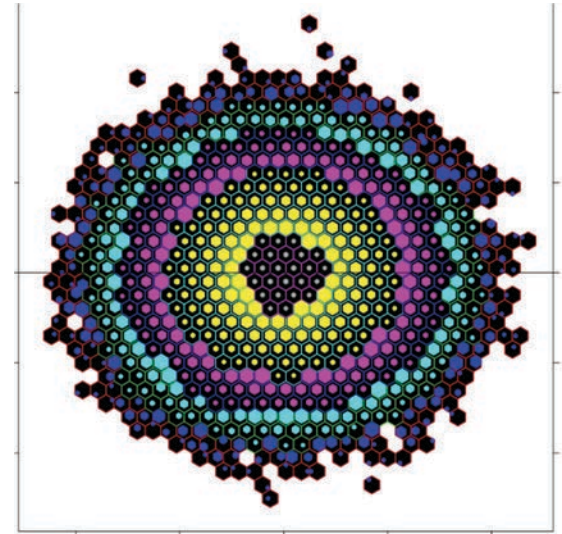
Why would I do this?

- Interest in interdisciplinary training/research

- Enrich interdisciplinary training/research

- Obstacles to interdisciplinary training

Why would I do this?

- Interest in interdisciplinary training/research

- Enrich interdisciplinary training/research

- Obstacles to interdisciplinary training

    - Knowledge barriers
    - Cultural barriers
    - <sigh> Financial barriers

Program Structure

Cross Training

A project (2-years) in a domain other than the one you did in your first 2 years.

- Test a computational model or approach in real data.

- Develop a computational account or new analysis of your own data.

- Test, in humans, hypotheses developed in animal models

- Test, in an animal model, hypotheses from human experiments
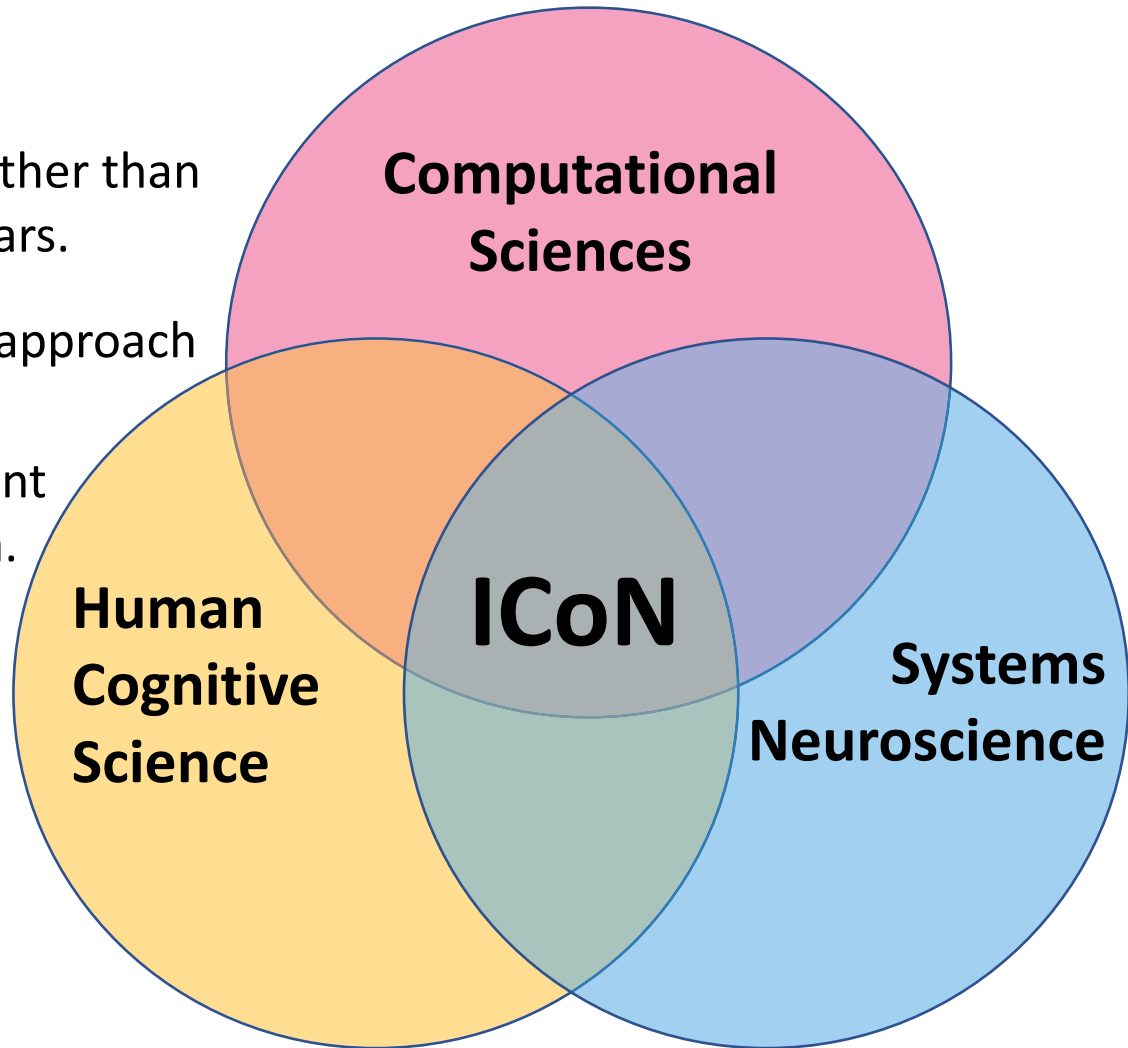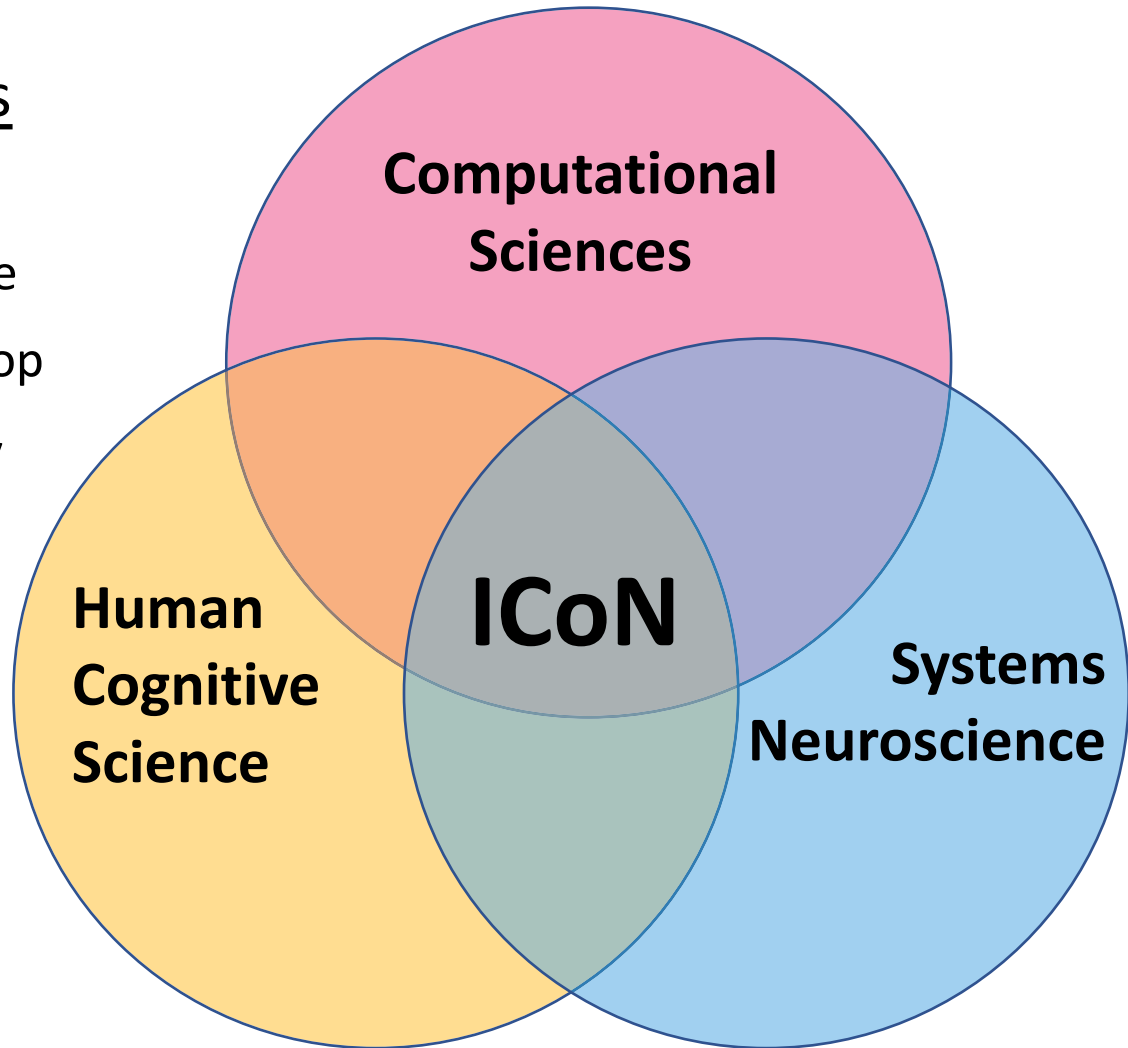
- **<YOUR IDEA HERE>**

Computational Sciences

Human Cognitive Science

ICoN

Systems Neuroscience

*CLPS * Neuroscience * Computer Science * Engineering * Applied Math*
** Public Health * Psychiatry and Human Behavior*

Program Structure

Broader Program Activities

Computation @ Neuropracticum

Grand Brown Decoding Challenge

Summer Computational Workshop

Brown neuroHacks Research Day
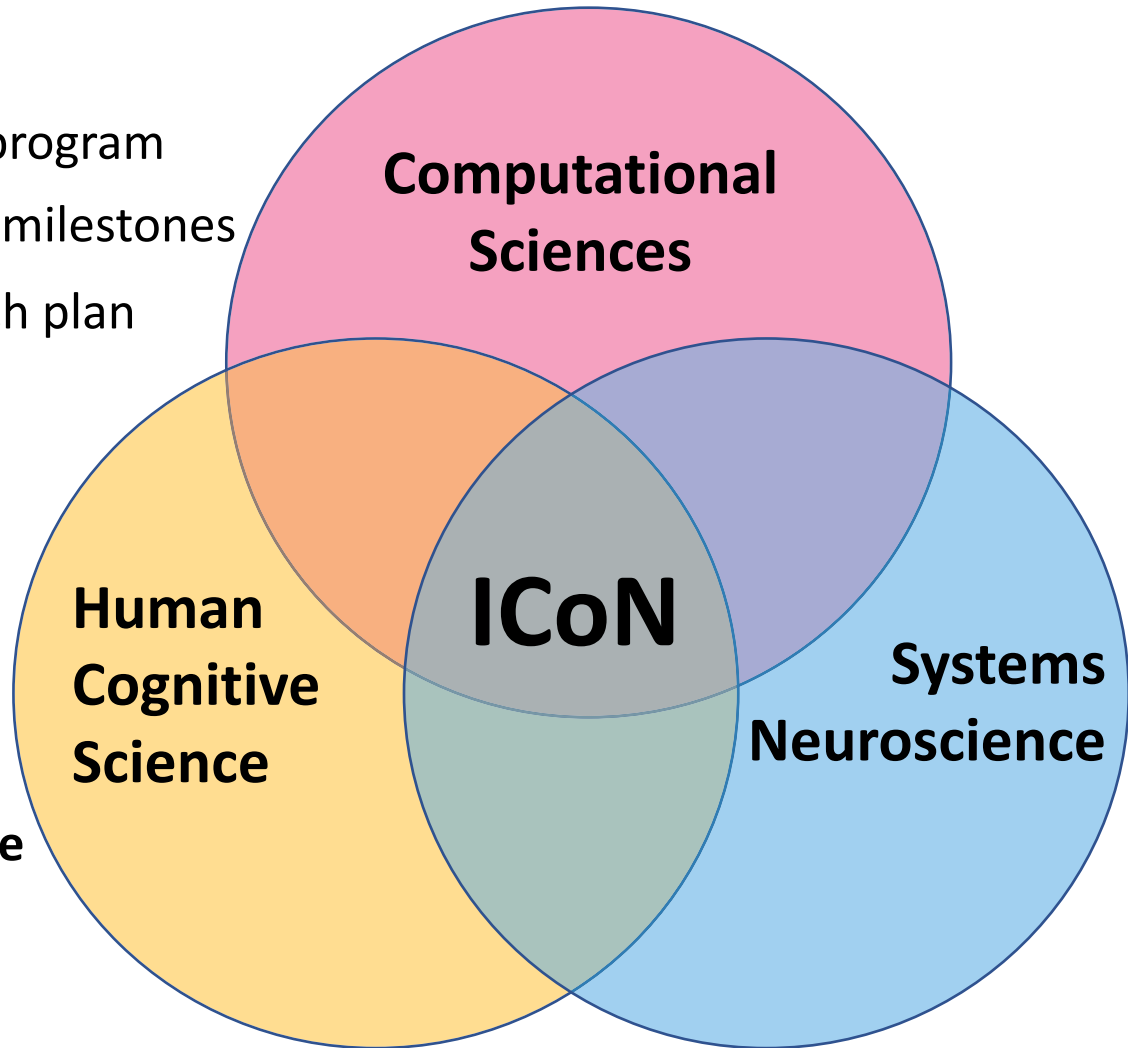
Interdisciplinary graduate seminars

*CLPS * Neuroscience * Computer Science * Engineering * Applied Math * Public Health * Psychiatry and Human Behavior*

How do I apply?

By Friday, May 24

- Entering 3rd or 4th year in your program

- Have completed early program milestones

- Paragraph summarizing research plan

- Email from advisor

- Email from co-advisor
(if applicable)

- Current CV

- Email materials to:
  ines_tomas_pereira@brown.edu

- **International students welcome**

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