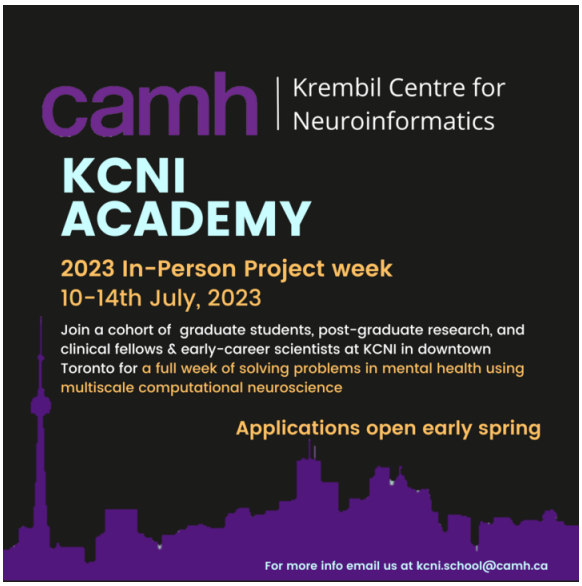
# KCNI Summer Academy 2023 Project Week




**When**: July 10-14, 2023

**Intended Audience**: Graduate Students, Post-Graduate Research and Clinical Fellows, as well as Early-Career Scientists with interest in learning more about Neuroinformatics

**Where: In-person** at the Krembil Centre for Neuroinformatics, 12th Floor, 250 College Street, Toronto, Canada

**Cost**: Minimal ($50), only 30 spots available

## Click here to apply!

**Application Deadline has been extended to June 9, 2023, 11:59PM EST!**

***Those selected to participate will be contacted in mid-June to register.***

### Overview

The Krembil Centre for Neuroinformatics is excited to offer a five-day intensive project-based learning week where trainees will learn hands-on techniques for integrating multi-scale neuroscience data. This course is designed to introduce participants to the concepts and methods behind psychiatric neuroinformatics - encompassing genetics, brain structure and function, and cognition.

In addition, participants will uncover the links between modalities of human genomics, neuronal electrophysiology, structural and functional neuroimaging, and observed behaviour that KCNI scientists are integrating through a series of virtual modules and a group-based project using real-world data types to study mental illness.

This unique learning opportunity will prepare participants to handle and analyze multiple data types in hopes that their own research may benefit from collaborative, multi-modal approaches. Critically, participants will also learn about best practices for data management and quality control in the context of integrative analysis.

## Registration now open Click here to apply!

**Application Deadline June 2, 2023**

***Those selected to participate will be contacted in mid-June to register.***

### Course Requirements and Prerequisites

Applications from senior undergraduate students, graduate students, post-graduate research and clinical fellows, and early-career scientists will be considered. Researchers from diverse backgrounds (e.g. medicine, computer science, biology, psychology, engineering etc.) are encouraged to apply. To ensure that all attendees can fully follow and benefit from the practical assignments, fundamental and demonstrable experience in R and Python is a minimum requirement.

### Delivery Method

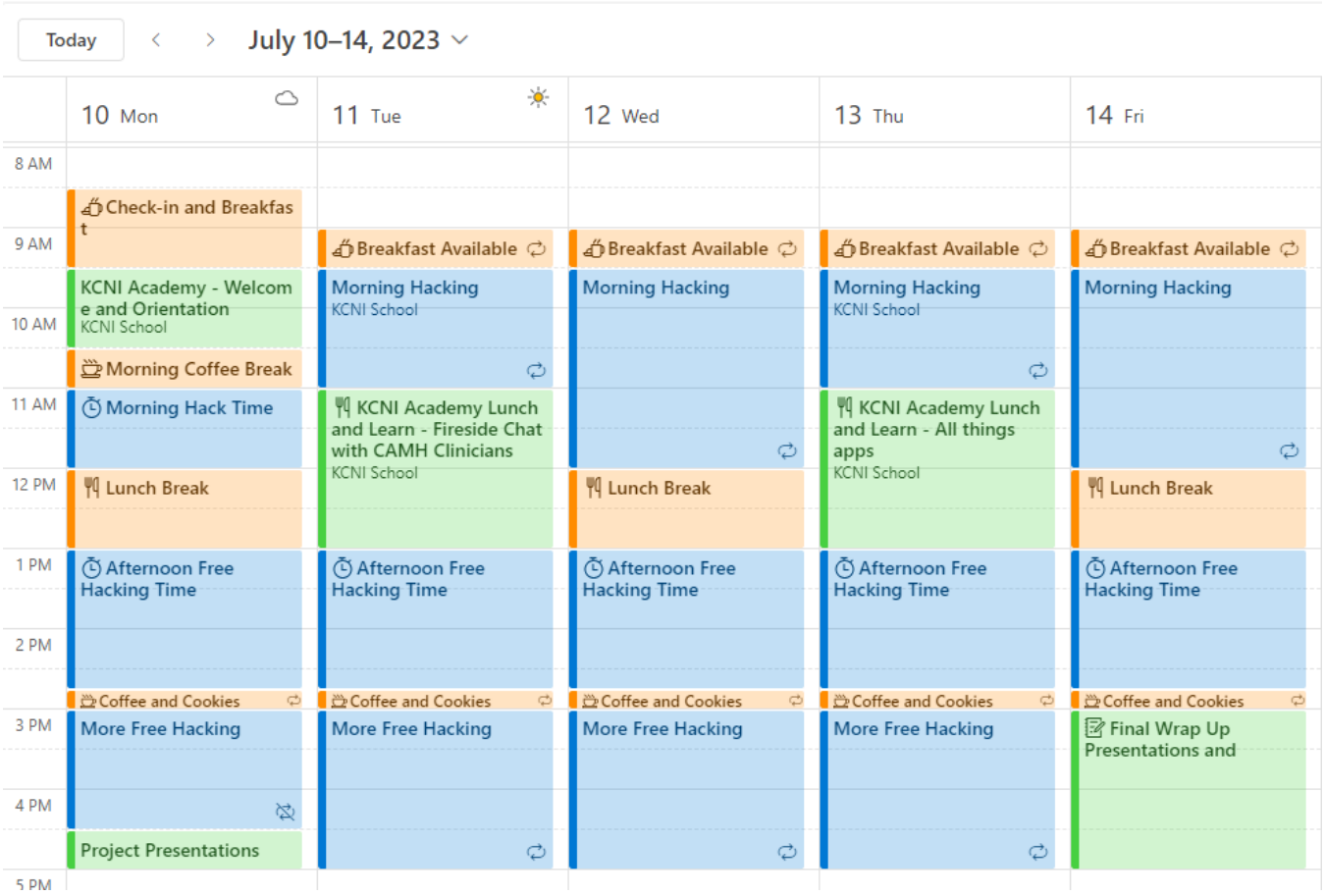
Students will be provided with a collection of virtual didactic teaching (lectures) and hands-on tutorial components to engage critical thinking and develop practical skills in crucial selected areas. Lessons will be led by members and affiliates of the KCNI team, including faculty at the University of Toronto's Department of Psychiatry. Successful applications to Project Week will be mentored (in-person or hybrid) by KCNI Scientists as they complete one-week intensive group projects matched to their interests. These projects will allow participants to build mastery in selected integrative research methods.

All project week participants will take part in each full day of training. Students will have the opportunity for project-specific discussions, collaboration, and guidance outside of structured time.

Students will present their group project to KCNI Scientists at the conclusion of Project Week. Project week will occur in person at CAMH KCNI and be supplemented by multiple networking, collaboration, and socializing opportunities.

## The 2023 Project Week Schedule

The schedule can also been accessed via these links: HTML, ICS




# This year's projects

This years students will be split into groups who will each focus on one of the projects given below, will guidance from KCNI trainees and staff

## Project 1 - Single Cell Transcriptomics

*Integrative analysis of human single-nucleus gene expression datasets: How are neocortical cell types defined by gene expression and how do cells' gene expression patterns change in Alzheimer's disease?*

**Main idea:** perform integrative analysis human neocortical cell types according to transcriptomics.

**Key questions / objectives:**

- What genes / features distinguish cell types in the human neocortex?
- How many neocortical cell types can we reliably define on the basis of gene expression?
- How are cell types different between people? like because of differences in sex or Alzheimer's disease status?

What (dataset) resources are available to help answer this question? Allen Institute for Brain Sciences Cell Types database https://celltypes.brain-map.org/

Programming Languages: R/Studio, (Seurat)

**Link to GitHub:** https://github.com/sonnyc247/KCNISS_2022_Week2

**Lead Scientist/Lab**: *Shreejoy Tripathy*

***Teaching Assistants:*** *Mel Davie & Derek Howard*

## Project 3: Transdisciplinary Mental Health Modeling with Machine Learning

*From domain-specific data to transdisciplinary models: an exercise in whole-person modeling from feature engineering to model explanations.*

**What's this project about?**

Building a transdisciplinary machine learning model to predict risk for mental illness in a large simulated human population dataset. This will involve exposure to genetic, neuroimaging, and sociodemographic data types and their integration.

**Key Questions/Objectives**

- **Objective 1:** How to approach a multi-disciplinary analysis
  - Steps to approaching a new dataset: how to handle data formats, variable types, missing data, transformations?
- **Objective 2:** Feature engineering from different data modalities
  - How do we go from raw data (i.e. genotype, brain scans) to individual level features?
- **Objective 3:** develop a transdisciplinary machine learning model
  - How do we combine multiple data types into one predictive model?
  - Can we analyze feature importance to understand relative contributions from different domains?

**Programming Languages**

- Bash, Python, R

**Link to code:** Overview (deepnote.com)

**Lead Scientist:** Daniel Felsky

**Teaching Assistants:**

- Earvin Tio
- Rajith Wickramatunga
- Mohamed Abdelhack
- Emily Wiljer

## Project 4 - Whole-brain modelling of noninvasive neurostimulation therapeutics and neuroimaging connectomics

**What's this project about?**

Main idea: use neuroimaging-based computational models of TMS brain stimulation to investigate the micro-physiological and macro-network effects of TMS therapies used in psychiatry and neurology

**Key questions:**

**Lead Scientist: John Griffiths**

**Teaching Assistants**

- Davide Momi
- Shreyas Harita
- Zheng Wang
- Sorenza Bastiaens
- Taha Morshedzadeh
- Kevin Kadak

- What do the electromagnetic stimulation patterns look like in 3D volume space and 2D surface space for different TMS target regions and targeting methodologies (eg 10-20 coords vs beam-F3 vs neuronavigated)?
- What do the associated whole-brain network stimulation patterns look like, as calculated using anatomical and/or functional connectivity information from MRI scans?
- What is the spatiotemporal pattern of stimulated activity propagation across the brain as measured with source-localized EEG?
- How do we use connectome-based neural mass modelling to unpack the structure of this activity propagation?
- How do neurophysiological properties such as excitability and level of inhibition affect this propagation, and differ across individuals and following clinical interventions?
- How can we incorporate theories and models of neural plasticity into the picture here?

**Programming Languages:** Python, PyTorch

**Link to GitHub:**

The project will be based on the code and associated (open-access) scientific papers available at these two github repositories

https://github.com/GriffithsLab/PyTepFit

https://github.com/GriffithsLab/HaritaEtAl2022_tms-efield-fc

**Reference reading:**
Momi et al. ELife 2023
Harita et al. Front Psych 2022
Griffiths et al. 2022
Griffiths et al. 2020