Hacking the Brain🧠:
An Intro to Software Development for Neurotechnology

Description

Join us for an immersive workshop that delves into the fascinating world of neurotechnology, where the human brain and cutting-edge technology converge. Over the course of this workshop, you'll gain a comprehensive understanding of the principles behind neurotechnology, from the basics of brain-computer interfaces to data collection, processing, and machine learning for building your own neurotech projects. Whether you're a beginner with a curiosity for the brain or an experienced enthusiast in machine learning and neuroscience, this workshop offers something for everyone.

Learning Outcomes

After this workshop, you will be able to:

- Become aware of the sensing modalities that exist for both invasive and noninvasive neural interfaces
- Learn existing paradigms from neural interface literature and will understand how the theory influences data collection, processing, and classification
- Understand existing devices on the market for developers and will be familiarized with common APIs/SDKs used for neural interface software development

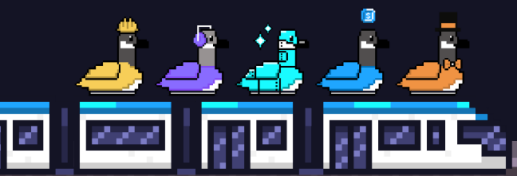
Prerequisite Knowledge

- Basic knowledge in Python

Pre-Workshop Checklist

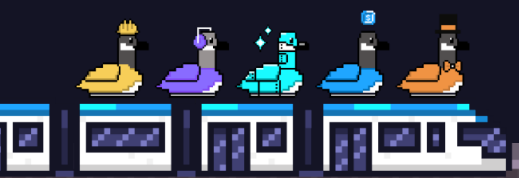
Before the workshop, please make sure you complete the following items:

- Ensure you have a Google account where you can access Google Collab files (recommended) or alternatively a local installation of Python and VSCode if you would like to follow along locally instead (not recommend)



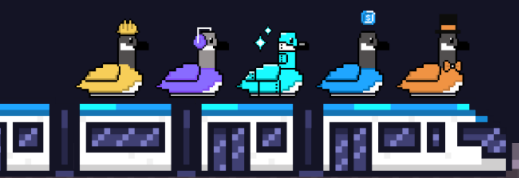
Technical Jargon and Definitions

- **BCI:** Brain-Computer Interface - also commonly known as neural interface or brain machine interface (BMI)
- **Neurotechnology:** The field that involves the application of technology to interact with or manipulate the nervous system, often for medical, research, or entertainment purposes.
- **EEG:** Electroencephalography - A noninvasive method for recording electrical activity in the brain using electrodes placed on the scalp.
- **EMG:** Electromyography - Technique to record muscle electrical activity using electrodes on the skin.
- **Neuron:** The basic functional unit of the nervous system, responsible for transmitting signals.
- **Neuroanatomy:** The study of the structure of the nervous system, including the brain and neurons.
- **ERPs:** Event-Related Potentials - Neural responses in the brain that are triggered by specific events or stimuli, often used to study cognitive processes.
- **Motor Imagery:** The mental visualization of movement that can be used to control external systems.
- **Motor Intent:** Using muscle activity to convey intention, often used to control devices or systems.
- **SSVEP:** Steady-State Visually Evoked Potentials - Brain response to flickering stimuli that remains constant.
- **CCA:** Canonical Correlation Analysis - A statistical technique to analyze relationships between two sets of variables.
- **CNN:** Convolutional Neural Networks - A type of deep learning model often used for image analysis.
- **FFT:** Fast Fourier Transform - A mathematical method to analyze and transform signals from the time domain to the frequency domain.
- **Neurosity Crown:** An advanced neurotech device that records real-time brain data.
- **SDK: Software Development Kit** - A collection of tools and libraries that helps developers build software for a specific platform.



Timeline (1 hour)

Time	Module	Description
10 min	Intro to Neurotechnology	• Discover the remarkable applications of neurotechnology in various fields, including healthcare, research, and even entertainment. • Explore the mechanics of brain-computer interfaces and how they facilitate communication between the brain and external devices. • Understand the different levels of invasiveness in neurotech, from noninvasive methods like EEG to more invasive techniques. • Get a primer on basic neuroanatomy, focusing on the fundamental building block of the nervous system: the neuron, as well as diving into the different regions of the brain and what regions apply to certain tasks, motor neurons in muscles will also be covered.
5 min	Common paradigms used in non-invasive neural interfaces	• Discuss Event Related Potentials and how user response to audio or visual environmental stimuli can be identified captured and used. • Discuss Motor Imagery as a method to control external systems through imagined movement • Discuss Motor intent as a method to control external systems through muscle activity
5 min	Data Collection and Filtering	• Learn how EEG (Electroencephalography) and EMG (Electromyography) data are collected, and understand the strategic placement of electrodes on the scalp and muscles. • Dive into the crucial process of obtaining clean and accurate brain signals, as well as the challenges posed by noise and interference. • Explore techniques for removing noise and smoothing the collected data, enhancing its quality and usability.
10 min	Data Processing and Machine Learning for	• Embark on a captivating case study of SSVEP (Steady-State Visually Evoked Potentials), a neural



	Interpreting EEG Data (Case study with Event Related Potentials)	response that occurs when viewing a flickering stimulus. • Explore key techniques like Canonical Correlation Analysis (CCA), Convolutional Neural Networks (CNN), and Fast Fourier Transform (FFT) as tools for interpreting and analyzing EEG data. • Visualize and interpret the results through insightful plots and visual representations.
10 min	Introducing the Neurosity Crown	• Experience a hands-on introduction to the Neurosity Crown, an advanced neurotechnology device that provides real-time brain data. • Learn how to set up the Neurosity Crown, including hardware setup and software installation. • For those without hardware, explore the Neurosity demo dataset to gain a practical understanding of the data collected by the Crown.
20 min	Hands on coding	• Gain practical experience in working with brain data through coding exercises and guided examples.

Workshop Lead Contact

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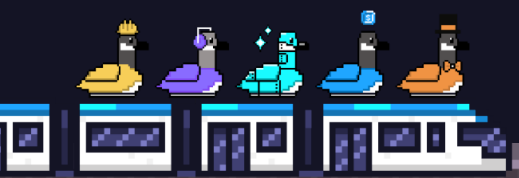

Additional Resources

Hack the North Resources

Hack the North 2023 Event Schedule

Check this out to stay up-to-date on activities, workshops, and other key happenings this weekend.

Workshop-Specific Resources

Google Drive with template code and solutions:
https://drive.google.com/drive/folders/1pi0z-9fivw3xjtXyhaST2RvOssWtQbv1?usp=drive_link

Github repo with template code, solutions, and extra resources:
https://github.com/WATOLINK/hackthenorth-neurotech-2023