

Team Name: Q-Connectome**Team Participants:****Name: Natalie Hawkins**

Role: Team Lead, Neuroscience Data Analyst, Software Integrator

Email: nrhawkins@gmail.com

Job Title and Organization: Research Software Engineer and Analyst, Former University of Washington

Name: Vysakh S

Role: Quantum Algorithm Design Lead, Technical Writer

Email: svysakh1109@gmail.com

Job Title and Organization: Master's Student in Photonics, CUSAT, India

Team Qualifications for tackling the Challenge:

Vysakh has hands-on experience developing and simulating quantum algorithms using Qiskit and PennyLane. His academic background in photonics and prior research in Raman spectroscopy and quantum optics provides a solid foundation for tackling the computational and data challenges posed by large-scale neural recordings. He has also completed advanced coursework and research internships in quantum computing, enabling the implementation of hybrid models on NISQ-compatible platforms.

Natalie has worked in bio and computer science research, with degrees in math (UChi), biostatistics and computer science (UW-Sea). She is educated in quantum computing via online courses, conferences, IBM Qiskit Challenges, and self-study. She is a Qiskit Advocate, and active in the Seattle QC community.

Brief Description of steps to solve this challenge:**(a) High-Level Overview**

We propose a hybrid quantum-classical framework to analyze calcium imaging data from neural circuits. The goal is to identify higher-order correlations and network structure using the Quantum Approximate Optimization Algorithm (QAOA) and Quantum Neural Networks (QNNs). Spike segments will be analyzed for dynamic clustering and classification tasks that reveal circuit-level communication patterns.

(b) Technical Approach

The calcium imaging data will be processed to extract spike train features and functional connectivity. A correlation graph of neural activity will be constructed and analyzed using QAOA to uncover functional modules. For classification of spike segments, we will develop a VQC-based Quantum Neural Network trained on statistical features of calcium signal windows. Both algorithms are well suited for NISQ devices, as they employ variational circuits with shallow depth and are optimized using classical backends. We will run small-scale versions of the circuits on the QBraid compatible hardware.

(c) Projected Industry Impact

The goal of adding quantum computing to classical neuroscience pipelines is to detect weak or collective signals currently undetected and to provide more accurate detection of spikes. This could provide near-term benefits in neurological disease diagnosis, brain-computer interfaces, and development of neuro inspired computing architectures.