

Title: Topology of the brain's spatial code

Description of the project:

The goal of the internship is for the student to learn general principles about learning and memory in neuroscience and how this connects to data analysis tools from topology. Candidates will be exposed to our lab's experimental framework where hippocampal spatial neuronal activity representation can be observed, measured, and manipulated in order to understand how this representation of learning is encoded in the brain's activity. The scientific outcome of the research plan is to find a computational algorithm based on topology principles that allow us to estimate dimensionality of a memory in the brain.

Student's Goals:

Aim 1) Familiarize with the process of learning in the brain

Aim 2) Learn the current tools to estimate the dimensionality of a neuronal code (i.e. UMAP, ISOMAP, Probabilistic-PCAs)

Aim 3) Implementing a new algorithm to describe dimensionality of a neuronal representation

Methodology:

For **Aim 1):** Python, and high dimensional data analysis. Geometric topology.

For **Aim 2):** learn and implement the algorithms of UMAP, ISOMAP, Probabilistic-PCAs

For **Aim 3):** Implement a novel code to determine neuronal activity dimensionality in an unsupervised manner.

Expected results:

We expect to build upon writing the algorithm to be used for our lab and for future publications. We expect students to provide a significant contribution to the project, present their results in public lab-meetings and to get familiarized with the relevant literature.