Neuronal Cell Classification System and Methods

Tech ID: 34017 / UC Case 2025-944-0

BACKGROUND

Advances in biological research have been greatly influenced by the development of organoids, a specialized form of 3D cell culture. Created from pluripotent stem cells, organoids are effective in vitro models in replicating the structure and progression of brain development, providing an exceptional tool for studying the complexities of biology. Among these, cortical organoids, comprising in part of neurons, have been instrumental in providing early insights into brain formation, function, and pathology. Functional characteristics of cortical organoids, such as cellular morphology and electrophysiology, provide physiological insight into cellular states and are crucial for understanding the roles of cell types within their specific niches. And while progress has been made studying engineered neuronal systems, decoding the functional properties of neuronal networks and their role in producing behaviors depends in part on recognizing neuronal cell types, their general locations within the brain, and how they connect.

TECHNOLOGY DESCRIPTION

To help address challenges in translational research, a team at UC Santa Cruz (UCSC) has developed a deep learning framework named "High-dimensional Interpretation for Physiological Patterns in Intercellular Extracellular recordings" or HIPPIE. UCSC's HIPPIE pipeline, including algorithmic works for detecting brain regions and cell types from extracellular neural recordings, represents a new evolving tool for neurotech research. HIPPIE combines self-supervised pretraining on unlabeled datasets with supervised fine-tuning to classify neurons from extracellular recordings. Leveraging conditional convolutional joint autoencoders, HIPPIE learns technology-adjusted representations of waveforms and spiking dynamics. This was validated on *in vivo* mouse recordings and brain slices, HIPPIE significantly outperforms unsupervised methods in cell-type discrimination and aligns with anatomically defined classes. Its latent space organizes neurons along interpretable electrophysiological gradients, while enabling batch-corrected alignment of recordings across experiments. The HIPPIE tool could enhance brain-computer interfaces by identifying the brain region and cell types generating the signal, providing a better interpretation of user intent. Moreover, HIPPIE could provide estimates of probe location during experiments, significantly increasing the success rate of reaching target regions.

APPLICATIONS

- diagnostics – neuro
- therapeutics – neuro
- research tools – neuro

FEATURES/BENEFITS

- Significantly outperforms unsupervised methods in cell-type discrimination while aligning with anatomically defined classes
- Latent space organizes neurons along interpretable electrophysiological gradients
- Enables batch-corrected alignment of recordings across experiments
- Achieves consistent gains in both inductive and transductive learning scenarios; shows adaptability to real-world experimental constraints
- Generalizes across distinct experimental preparations while maintaining high anatomical resolution

INTELLECTUAL PROPERTY INFORMATION

Patent Pending

RELATED MATERIALS

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OTHER INFORMATION

KEYWORDS

neuroscience, neurodevelopment, organoid, cortex organoid, brain organoid, cortical organoid, electrophysiology, neural, neuron, neuronal, neuronal classification, multielectrode arrays, MEA, MEAs

CATEGORIZED AS

- **Computer**
  - Software
- **Medical**
  - Disease: Central Nervous System
  - Research Tools
  - Screening
  - Stem Cell
- **Research Tools**
  - Other
  - Screening Assays
- **Sensors & Instrumentation**
  - Scientific/Research
- **Engineering**
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