 DOI: 10.3217/978-3-85125-962-9-200

A dynamic spiking data simulator for iBCI development

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Introduction: Development of intracortical brain-computer interface (iBCI) systems is difficult because the behaviour of the system depends on its interaction with the iBCI user. Thus, new iBCIs undergo costly continuing development post-implantation. We created Spiking Data Simulator (SDS) – a tool that generates realistic intracortical brain signals that respond to changing task demands – to facilitate robust iBCI system development early in the product lifecycle.

Material, Methods and Results: SDS (Fig. 1) is a Python package with independent modules that interact with each other and with clinical BCI systems (e.g., Blackrock Neurotech's Neuroport system). The SDS Simulator module consumes behavioral state and produces neural activations via a generative model; SDS includes pre-trained models (e.g. a tuning curve model [1]) trained on publicly available data [2] and instructions to train and substitute a custom model. The SDS Signal Output module consumes simulated neural activations and produces realistic raw brain signals including field potentials and multi-unit spiking. The SDS Examples module provides tools to help the iBCI developer complete the loop.

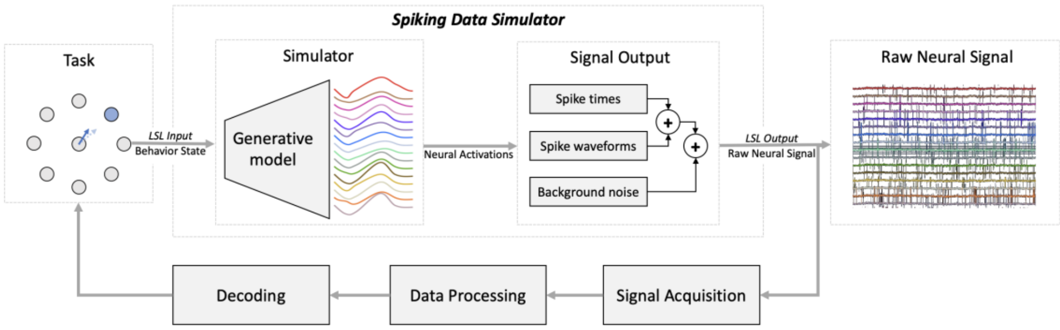

Figure 1. *Spiking Data Simulator system diagram.*

SDS ran at about 30% CPU utilization on an i3-12100f while generating 190 unique channels of data with 30 kHz sampling rate. The duration between reception of application state update and publishing the associated raw signal change was 1.23 +- 0.37 msec. Generated signals' statistics were reproducible when receiving the same state timeseries, and were similar to recorded brain signals.

Discussion: SDS generates realistic and dynamic brain signals that modulate in response to ongoing task demands. SDS is designed to be modular and easily extended; future extensions may add latent-space perturbations, non-stationarities, and support for additional neurophysiology platforms.

Significance: The SDS can serve as a surrogate participant to facilitate end-to-end iBCI development and testing prior to deployment, with potential to decrease costs, and improve system acceptance and success.

Acknowledgements: We thank Blackrock Neurotech for the support integrating SDS with their platform.

References

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