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Champalimaud Research Symposium 2021

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Submission ID

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Title

Using Recurrent Neural Networks to model the dynamic behaviour of the *C. Elegans* nervous system

Abstract

C. Elegans is a nematode whose rather small nervous system allowed for its almost complete description by experimental neuroscientists from different perspectives and scales. The dynamics of its relatively small connectome (around 300 neurons and 7000 connections) can provide insight into larger-scale brain structures and neuronal organizations. Yet, scaling the results obtained for *C. Elegans* for more complex systems will imply more computationally demanding, potentially intractable simulations of their dynamic behaviour. This increased complexity is a by-product of the detailed modelling of the internal structure, whereas often one is only interested in the peripheral, input-output behaviour.

We propose a methodology for generating models of the neuronal behaviour of such organisms using only peripheral information of the system. These models are completely data-driven and generated using Recurrent Neural Networks (RNNs), first proposed to model sequential data. We test three different architectures for the network unit: the simple RNN, the Long Short-Term Memory (LSTM) and the Gated Recurrent Unit (GRU). The RNNs are trained on datasets generated in the NEURON simulator from the high-fidelity *C. Elegans* model, representing the system's response to different stimuli.

The three architectures are compared in terms of their properties and ability to accurately reproduce the *C. Elegans* data without increased complexity of the resulting models. The LSTM and GRU units prove able to model the system's response with high accuracy (mean squared error of 10^{-4}) with only a 4-neuron recurrent layer. Future work will focus on the correct interpretation and optimization of the low-order models.

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Author Approval

☑ I confirm that this submission has been approved by all authors.

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Author Attendance

☑ I confirm that at least one author will register in full to attend and present at the Symposium.

Type of Presentation

◉ Yes.

○ No, I wish to present a poster.

How do you plan to participate?

◉ In-person.

○ Only virtually.

○ Don't know yet.

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