

Xolotl: A Fast and Comprehensible Neuronal Simulator

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2 ABSTRACT

xolotl is an open-source neuronal simulator written in C++ with MATLAB wrappers. Complex 3 models and networks can be designed efficiently using an intuitive language tightly coupled 4 to the object-based architecture of the underlying C++ code. Models are specified by adding conductances to compartment objects. The structure is modular, serialized, and searchable, 6 permitting high-level programmatic control over nearly all features of the models. C++ templates 7 are provided for developing new conductances, compartments, and integration schemata. xolotl readily implements parallel-processing on multicore processors and high-performance 9 computing clusters. It also includes a customizable graphical user interface ('puppeteer') for rapid 10 prototyping and hand-tuning conductances in real-time. In addition, xolotl comes packaged with 11 a powerful optimization toolbox (procrustes) for optimizing any model parameters accessible 12 in the xolotl tree. The modular structure and accessibility to all parameters, variables, and dynamics of the model network in MATLAB facilitate interoperability with other specifications (viz. NeuroML, SBML), simulators (viz NEURON, Brian, NEST), and web-based applications (viz. 15 16 Geppetto). xolotl is freely available at https://github.com/sg-s/xolotl. This tool provides rapid implementation and fast simulation of neuronal models while permitting full control over every aspect of the network and integration.

19 Keywords: simulator, MATLAB, C++, xolotl, conductance-based, computational, keyword, keyword

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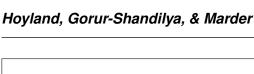
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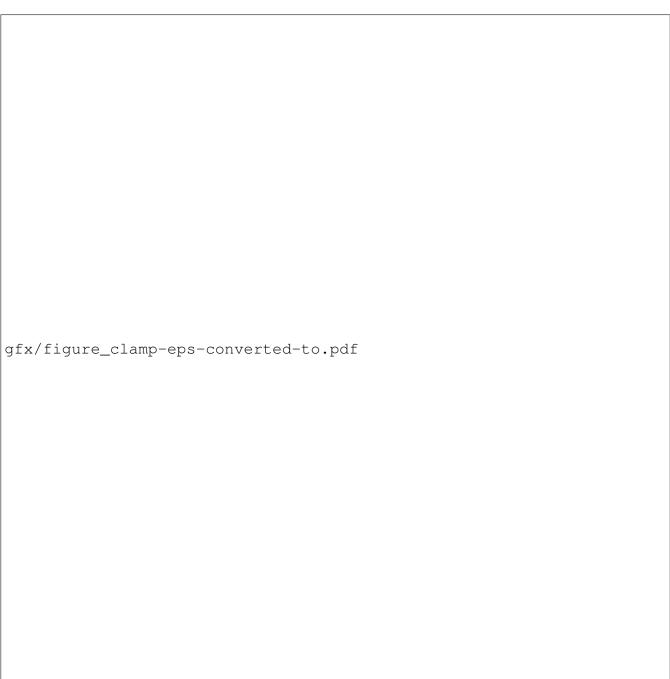
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Figure 1. xolotl readily implements voltage clamp. (A) Cartoon of a cell with potassium conductance with experimentally-fixed voltage. (B) Structure of xolotl object in A. (C) Code snippet depicting integration under voltage clamp. (D-E) Current response to steps in voltage from a holding potential of $V_m = -60$ mV. (F) Current-voltage relation of the steady-state current (t = 400 ms) indicating a reversal potential of E = -80 mV and no inactivation. (G) Conductance-voltage relation at steady-state takes the form of a sigmoid. (H) Sigmoids of the form $m(V)^n$ fit to the model data indicating that n = 4 is the best fit. (I) R^2 correlation of the sigmoid fits at various powers where n = 4 is an exact fit.

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- 69 This is a short text to acknowledge the contributions of specific colleagues, institutions, or agencies that
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