Human Brain Project

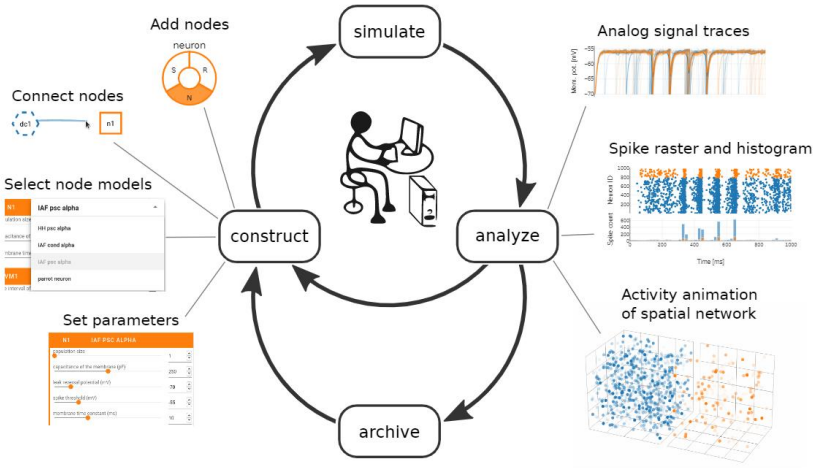
Universität Trier

UNI FREIBURG

JÜLICH Forschungszentrum

NEST Desktop

EASY-TO-USE WEB-BASED EDUCATIONAL TOOL FOR COMPUTATIONAL NEUROSCIENCE, ALLOWING TO PERFORM NEST SPIKING NEURAL NETWORK MODELLING, SIMULATION VISUALISATION AND ANALYSIS THROUGH A GRAPHICAL USER INTERFACE



TECHNOLOGY DESCRIPTION

NEST Desktop is a web-based GUI application for NEST Simulator, an advanced simulation tool for the computational neurosciences. NEST Desktop enables the rapid construction, parametrization, and instrumentation of neuronal network models. It is suitable for the application in educational context of computational neuroscience as it is easy to use, simple to install (using Docker or the online version in EBRAINS with no need for installation) and offers a comprehensive toolset for modeling, executing and analyzing spiking neural networks.

Our aim is to expand the international footprint of NEST Desktop to support the improvement of European neuroscience curricula. This leaflet, together with the annexed videos, showcase the utility of NEST Desktop so that university lecturers who wish to integrate it into their courses can get an overview of the tool and potentially collaborate with the NEST Desktop team in the future.

APPLICATION & MARKET POTENTIAL

Education
NEST Desktop enables teaching computational neuroscience to students without prior coding knowledge in a highly intuitive and interactive manner

Research
NEST Desktop is also used by SNN researchers for early testing and fast prototyping

All tools in one web application
NEST Desktop offers modeling, simulation, analysis and visualisation tools in a single web-based app

Access to high-end simulation technology
NEST Desktop gives easy access to the high-end simulation engine NEST and its underlying scripting code

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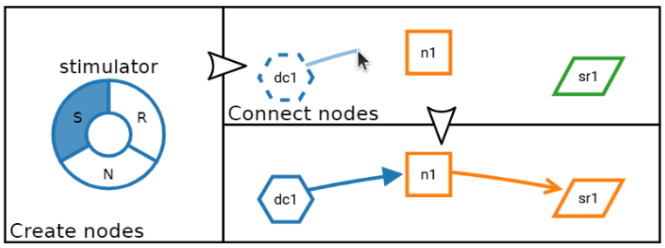
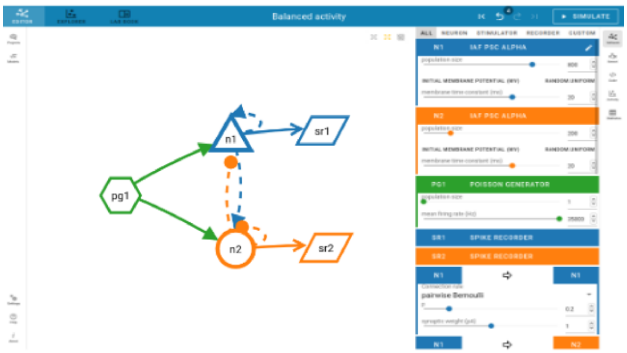
NEST DESKTOP SNAPSHOTS

NETWORK EDITOR

MAIN WORKSPACE TO GRAPHICALLY CONSTRUCT AND PARAMETRISE THE SNN NETWORK.

NETWORK PROPERTIES CAN BE MODIFIED THROUGH THE CONTROLLER PANEL (RIGHT), WHICH PRESENTS THE NODES AND THEIR CONNECTIONS WITH THEIR CORRESPONDING COLOUR-CODED PARAMETERS.





VISUAL NETWORK CONSTRUCTION

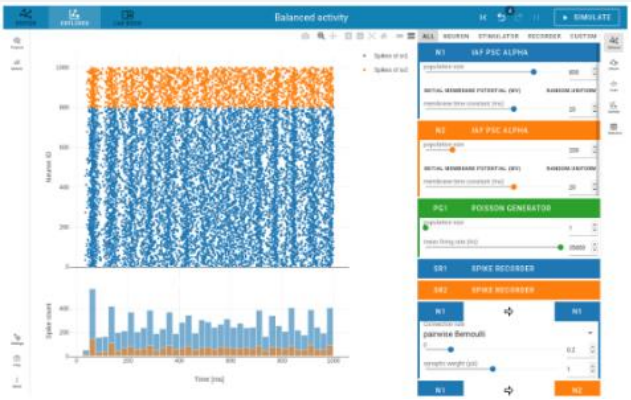
MOUSE RIGHT-CLICKS OPENS CREATION PANEL FOR STIMULATORS (S), NEURONS (N) AND RECORDERS (R).

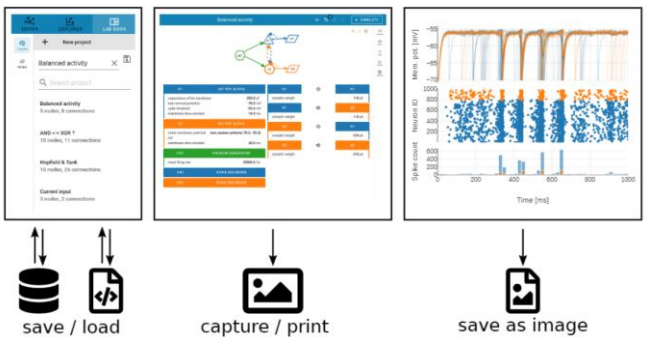
THESE ARE SELECTED FROM THE RANGE OF NEST MODELS AND CAN BE FURTHER PARAMETRISED.

ACTIVITY EXPLORER

SIMULATED ACTIVITY DATA IS VISUALISED TOGETHER WITH THE NETWORK PARAMETERS, ALLOWING TO EXPERIMENT DIRECTLY WITH HOW THE NETWORK PROPERTIES AFFECT THE RESULTS.

SPIKE TIMES AND MEMBRANE POTENTIALS CAN BE DISPLAYED ACROSS TIME WHILST SPIKE COUNTS CAN BE VISUALISED IN 2D AND 3D SPACE.





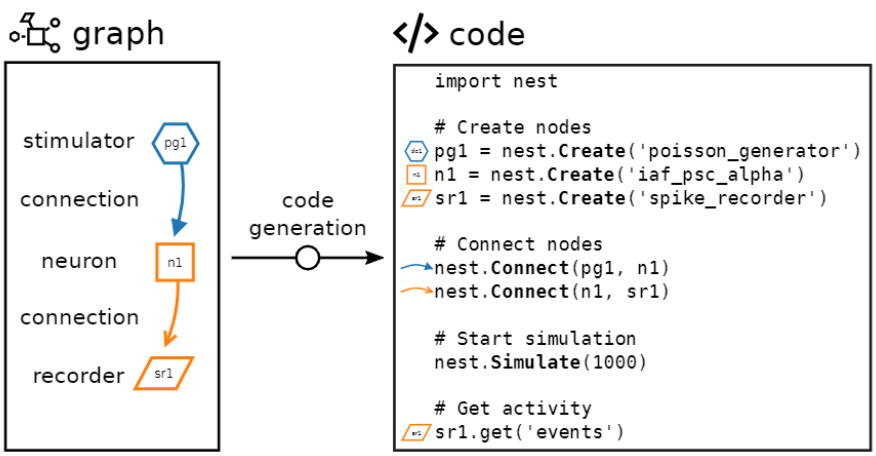
PROJECT ARCHIVING AND EXPORT

THE NEST DESKTOP PROJECT MANAGER ALLOWS USERS TO LOAD PRE-EXISTING NETWORKS OR LOAD SAVED PROJECTS.

NETWORKS CAN BE SCREENSHOT AND ACTIVITY GRAPHS CAN BE EXPORTED AS IMAGES FOR STUDENT SUBMISSIONS AND EVALUATION.

PYNEST CODE GENERATION THROUGH GUI NETWORK CONSTRUCTION.

VISUAL ELEMENTS ARE ASSOCIATED WITH GENERATED CODE LINES, GRANTING STUDENTS EXPOSURE TO THE UNDERLYING PROGRAMMING LANGUAGE AND FACILITATING THEIR POTENTIAL TRANSITION TO CODING.



NEST DESKTOP SNAPSHOTS

Various simulators, such as NEST, come with a highly versatile programming interface, which give full control of the simulation to the scientist. However, programming interfaces tend to add an additional barrier when it comes to studying computation neuroscience: basic courses need to first focus on teaching the programming language before students can begin modeling and analysing spiking neural networks.

NEST Desktop reduces this barrier by providing an easy-to-use Graphical User Interface that allows to model, simulate and analyse NEST-driven SNNs, allowing to complement computational neuroscience teaching through experimental learning. It provides over 50 neuron models and 10 synapse models, and students can model simulations from scratch or import existent networks from a large and well-documented repository. The GUI generates a textual script in PyNEST that is fed into the NEST Simulator, granting students direct access to important features of the NEST simulator without knowledge of the simulator control language while also giving them exposure to the underlying Python-based scripts.

INTUITIVE GUI-DRIVEN COMPUTATIONAL NEUROSCIENCE ENTRY-POINT TOOL FOR NOVICE STUDENTS WITHOUT PRIOR PROGRAMMING KNOWLEDGE

SUCCESSFULLY TRIALLED IN VARIOUS COURSES ON COMPUTATIONAL NEUROSCIENCE AT THE UNIVERSITY OF FREIBURG:

- SIMPLE NEURON MODELS (BSC LEVEL)
- BIOPHYSICS OF NEURONS AND NETWORKS (MSC LEVEL)

ITS USE RESULTED IN MORE EFFICIENT LEARNING, IMPROVING STUDENT MOTIVATION AND PERFORMANCE

OPEN-SOURCE, COMMUNITY DRIVEN DEVELOPMENT, DOCKER-RIZED, INTEGRATED INTO THE EBRAINS INFRASTRUCTURE.

SUPPORTED BY EXTENSIVE USER DOCUMENTATION FREELY AVAILABLE IN https://nest-desktop.readthedocs.io/en/latest/

Interested lecturers can find a guide on how NEST Desktop can be integrated into neuroscience courses. It covers course design, structure, modality of teaching and objectives, as well as course protocol preparation.

The guide provides sample assignments for BSc and MSc students, including possible experiments and questions. Some have an embedded video tutorial showcasing how a student would tackle the experiments using NEST Desktop

This is available at:
https://nest-desktop.readthedocs.io/en/latest/lecturer/

In addition, The NEST desktop team has released a paper detailing:

- The technical details of nest desktop (client-server architecture, implementation and installation)
- Its main components and functions
- Two case studies of the tool, portraying its use in the classroom and by SNN researchers

It is available at:
https://www.biorxiv.org/content/10.1101/2021.06.15.444791v2.full

REFERENCES

- EBRAINS Installation: https://ebrains.eu/service/nest-desktop
- Code Repository:https://github.com/nest-desktop/vue-app
- Docker Hub: https://hub.docker.com/r/babsey/nest-desktop

CONTACT

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