

# Neocortical View (NCV)

## A 3D Visualization Tool for Complex and Large-Scale Neural Networks

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### ABSTRACT

Neuroscientists are constantly pursuing better technology to help them study the physiological processes behind memory, learning, and cognition. Computational models of the brain can be generated at an anatomical level; however, analyzing simulation results can be difficult due to the lack of comprehensive visualization tools. Neocortical View hopes to serve as an essential tool to help scientists and researchers better understand the relationships between neurons and their interactions by allowing them to view simulations in 3D.

### WHAT IS NCV?

Neocortical View, or NCV, is a graphical front-end that connects to the Neocortical Simulator through a network and will allow users to build models, distribute simulations across available hardware, and view the current network state in 3D. It has an intuitive graphical user interface enabling the user to customize how the models are rendered and displayed with an array of various options.

### BACKGROUND

The Neocortical Simulator (NCS), developed by the Brain Computation Lab at UNR, is a real-time simulator for complex, large-scale neural networks. It utilizes GPUs for parallel computation and can run simulations using common neuron models such as Izhikevich and leaky integrate-and-fire representations. NCS also allows users to simulate custom models by designing their own plug-in interfaces.

### INTERFACE

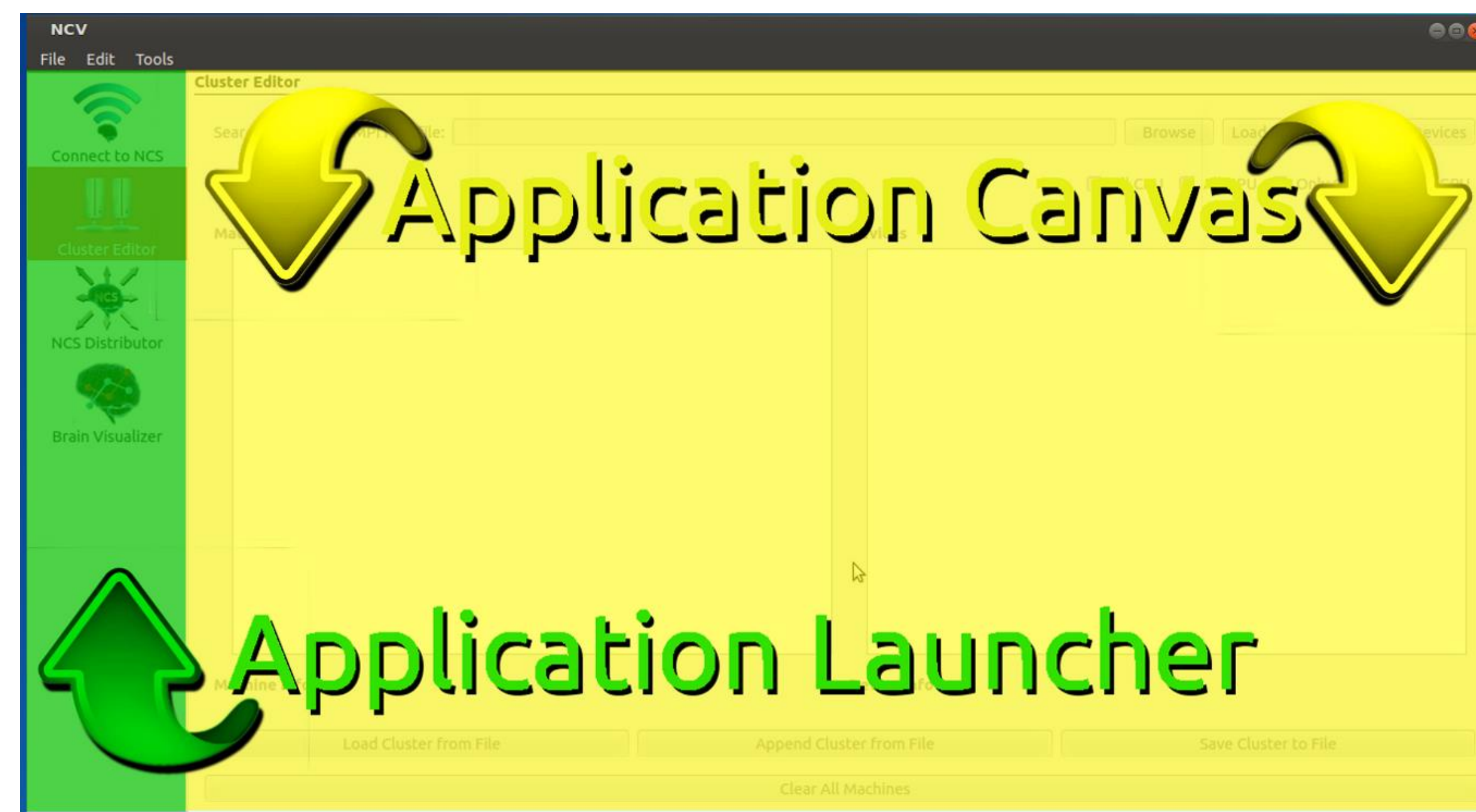


Figure 1: Application Canvas and Application Launcher

- Simulation startup, communication and analysis mechanisms are abstracted into an intuitive user interface.
- The application launcher allows users to easily load application plugins that are displayed on the application canvas.
- In addition to using built-in functionalities, developers can also expand the application by implementing plugin components which can be integrated into the application at run time.

### VISUALIZATION

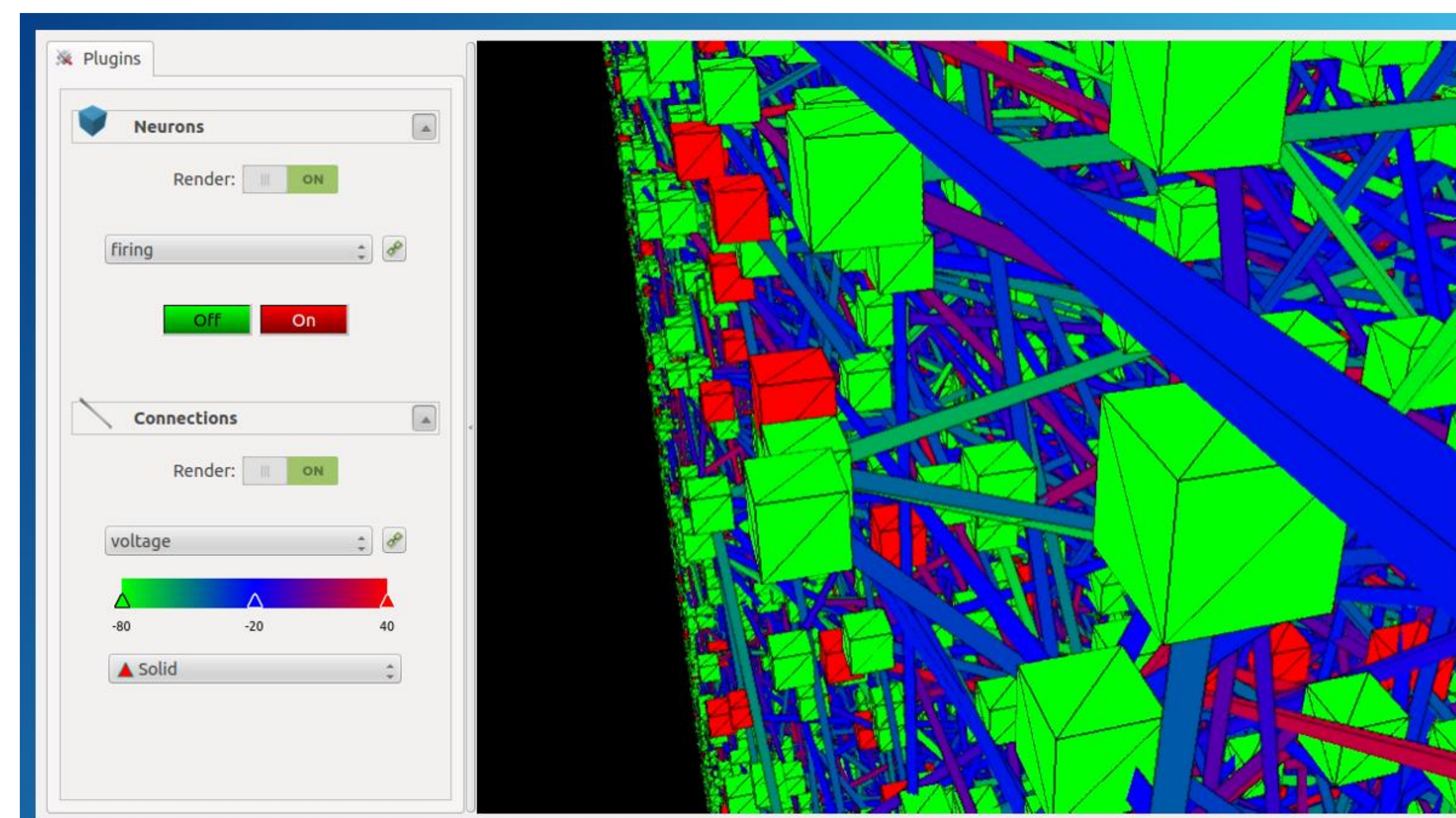


Figure 2: Color customization and visualization canvas

- Simulated brain topology is rendered in 3D and can be customized in real time.
- Neurons are represented as cubes and neuron connections are represented as rectangular pipes.
- Users can customize the domain of simulation attributes by selecting a myriad of color options from a color ribbon defined by gradient markers.

### INCLUDED PLUGINS

Beyond the visualization component, NCV provides additional built-in application plugins to facilitate other essential simulation capabilities.

### NCS CONNECTION INTERFACE

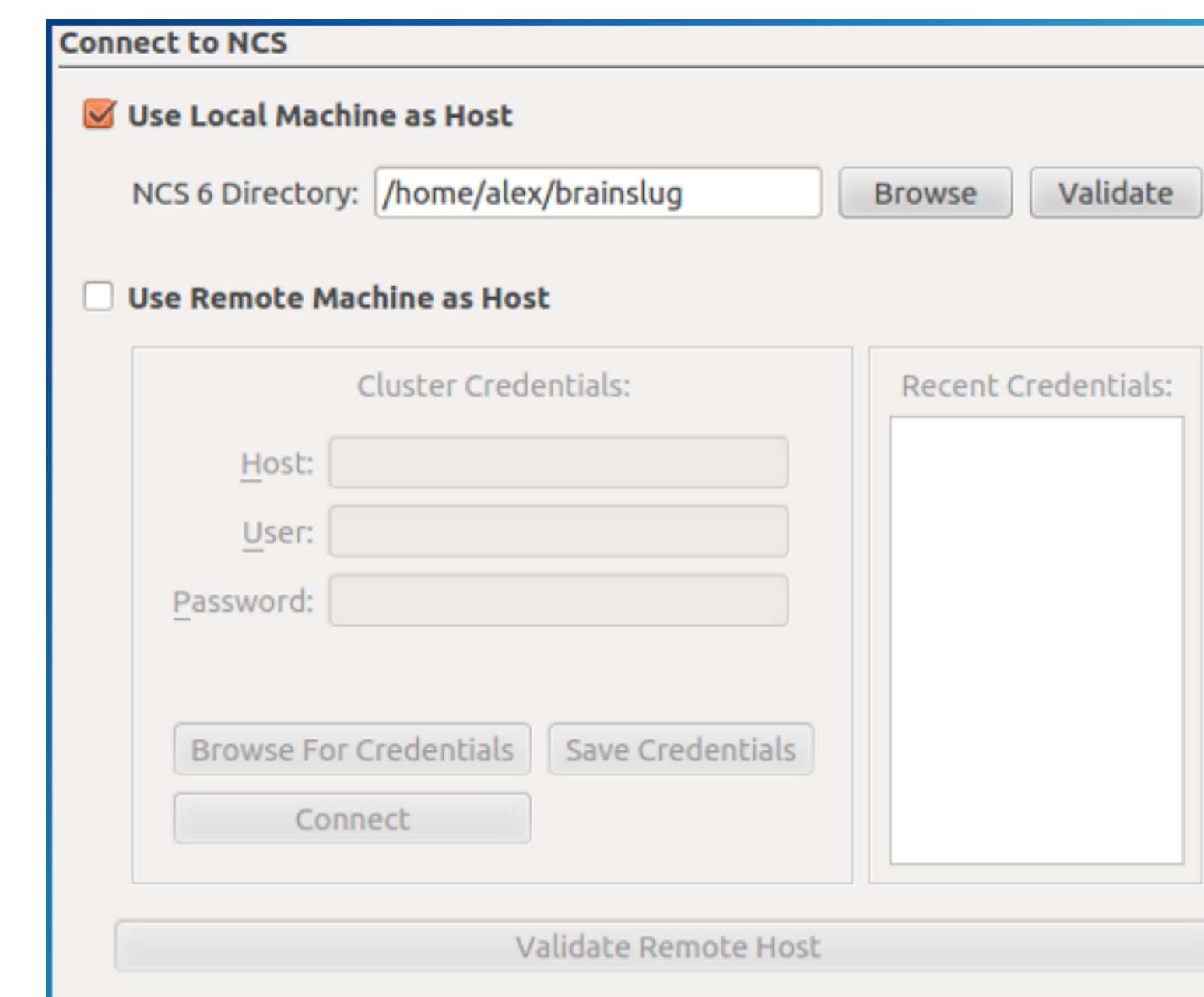


Figure 3: NCS connection interface allows users to select distribution host

The NCS connection interface allows users to connect, validate, and launch NCS in two ways:

- **Local NCS installation:** the user can enter the installation path of NCS and any missing NCS components will be detected.
- **Remote NCS connection:** the user can connect to NCS remotely by providing SSH login credentials for the desired machine.

### HARDWARE SPECIFICATION INTERFACE

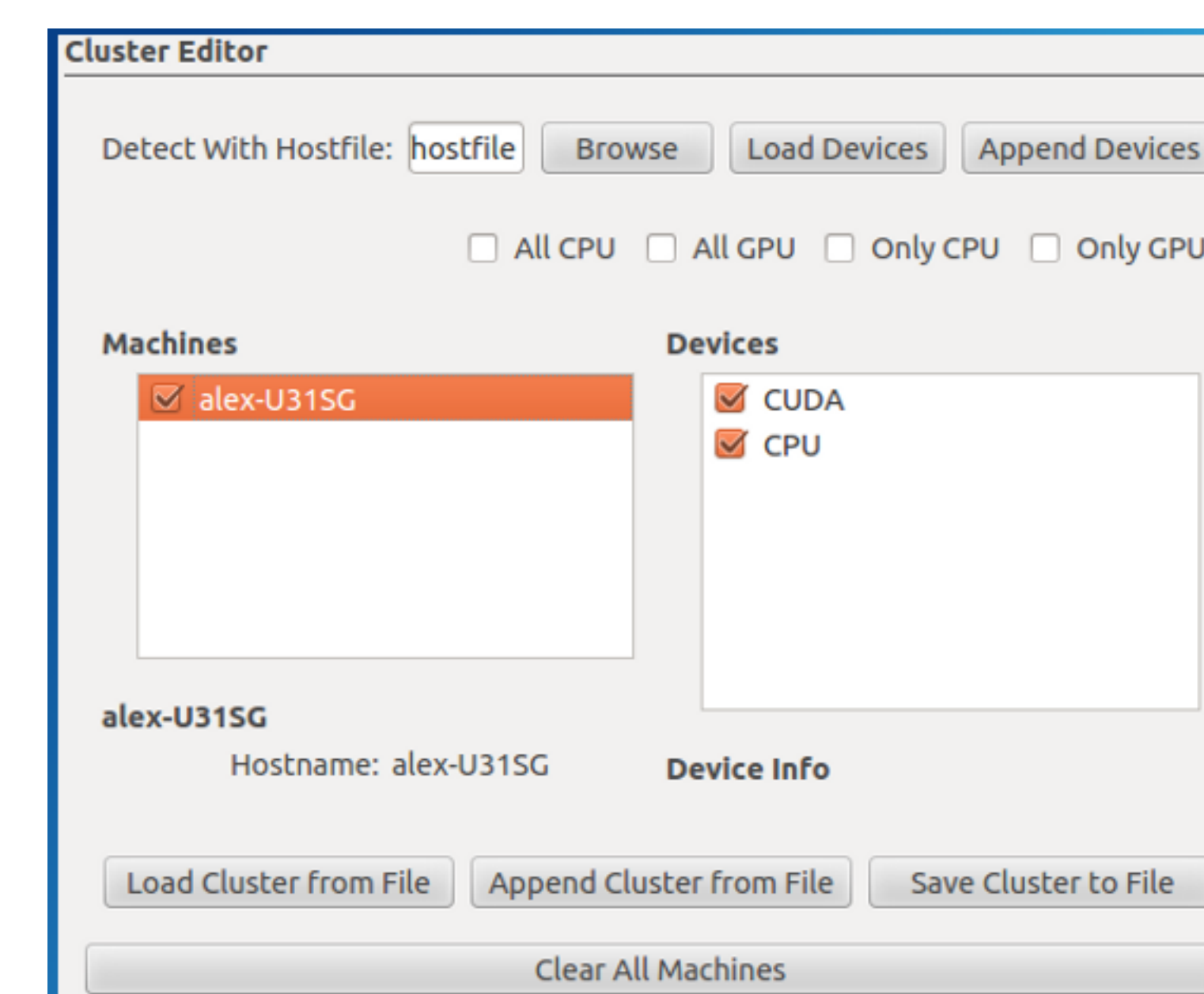


Figure 4: Hardware specification interface allows users to select hardware

The hardware specification interface allows users to select what hardware to use for the simulation and enables them to utilize hardware from other systems on the network for the simulation to run in a parallel environment.

### ARCHITECTURE

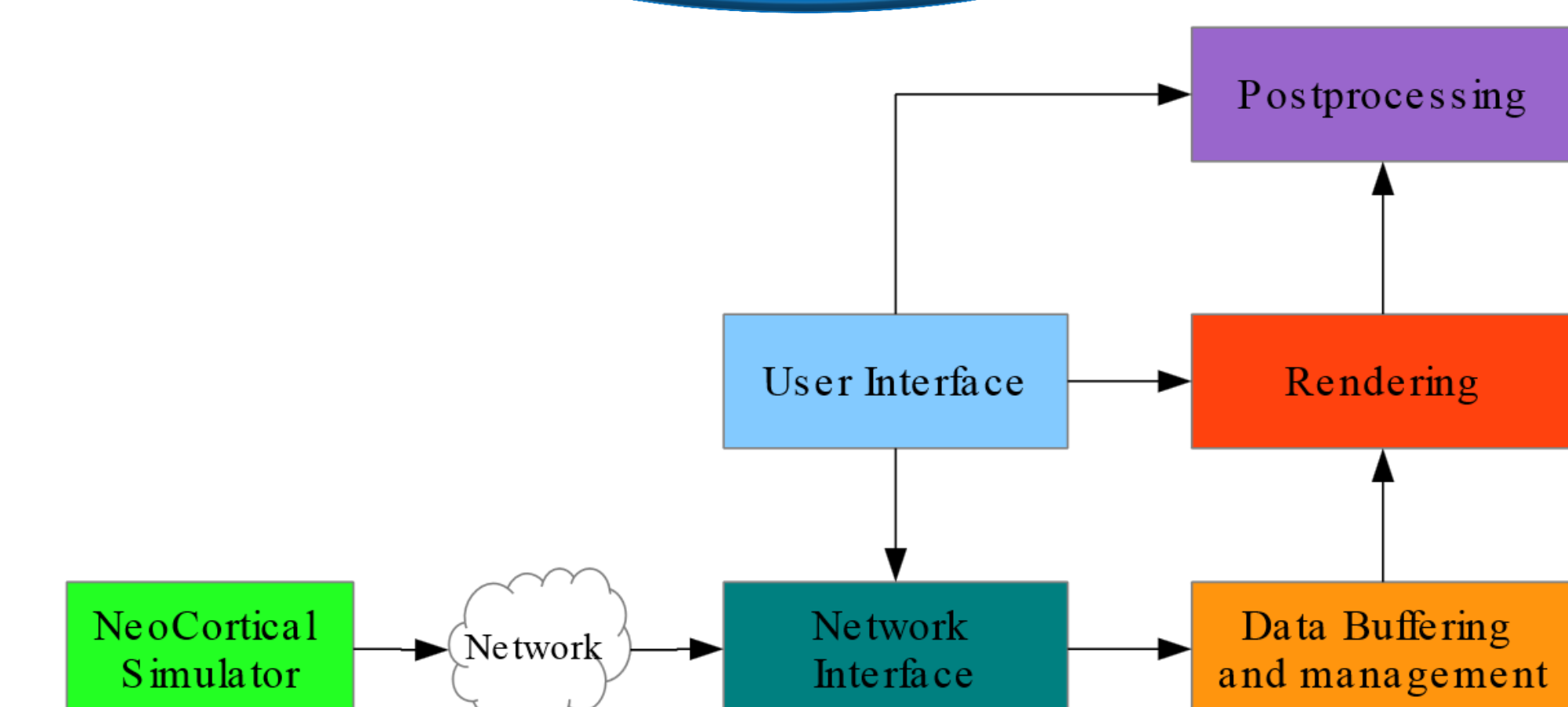


Figure 5: Diagram of NCS architecture

NCV consists of three major modules:

- **Networking Components:** manage preparing and launching simulations in addition to gathering update data.
- **Rendering Pipeline:** interfaces with the graphics hardware to display the current model.
- **User Interface:** allows the user to interact with the other modules, retrieve additional information from them, and affect their behavior.

### CONCLUSION

NCV is a highly accessible and customizable application. Its cross-platform capabilities allow users to run simulations on most modern day laptops or desktops with Windows or Linux operating systems. The intuitive interface allows scientists with limited technical knowledge to run simulations. Additionally, the presentation and scope of running simulations can be easily customized to eliminate irrelevant results. By using NCV, scientists will hopefully be able to enhance their understanding of neocortical processes at an anatomical level.

### FUTURE WORK

- Visual editor for model construction.
- Connect to live, real-time simulations.
- Ability to interface with additional simulators.

### ACKNOWLEDGEMENTS

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