RAVSim

Run-time Analysis and Visualization Simulator

A quick start user manual,

Current RAVSim Version: v1.0,

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About RAVSim

RAVSim stands for Run-time Analysis and Visualization Simulator. It is solely designed with the aim of helping early-stage researchers and students to fully understand the mechanism of SNNs where users can interact with the simulator in run-time by providing the essential parameters. Practically, RAVSim is used to simulate LIF by using a noisy input model.

RAVSim is developed on a graphical programming language platform called LabVIEW (Laboratory Virtual Instrument Engineering Workbench) [1].

Leaky Integration and Fire by using the Noisy Input model (NLIF) [2] has been implemented to perform run-time simulation. Furthermore, it is capable of Spike detection by using the continuous noisy input, Spike detection by using input current, and generating a winner takes all network (WTA) [3], which establishes communication between the neurons.

This short document will teach you how to use RAVSim to perform run-time experiments. The RAVSim (v1.0) is an open-source simulator and it is available publicly at *https://github.com/Rao-Sanaullah/RAVSim*. The video demo of RAVSim can also be seen at *https://www.youtube.com/watch?v=Ozv0MXXj89Y* .

Basic Requirements

A graphical programming approach LabVIEW Runtime 2021 or above.
A minimum computer requirement:

- Processor: i3 CPU @ 2.3 GHz
- RAM: 4.0 GB
- System Type: 32/64-bit OS
- Operating System: Mac OS, Window

To install Runtime LabVIEW:
https://www.ni.com/kokr/support/downloads/softwareproducts/download.labview.html#305931

1. Analysing the SNN model using RAVSim

This section will learn how to analyze and visualize the SNN model in RAVSim.

1.1. Launching RAVSim

The front interface/welcome page of RAVSim, shown in Figure 1, will appear when you double-click on **RAV*Sim.app*** (for MAC OS) or **RAV*Sim.exe*** (for Windows OS).

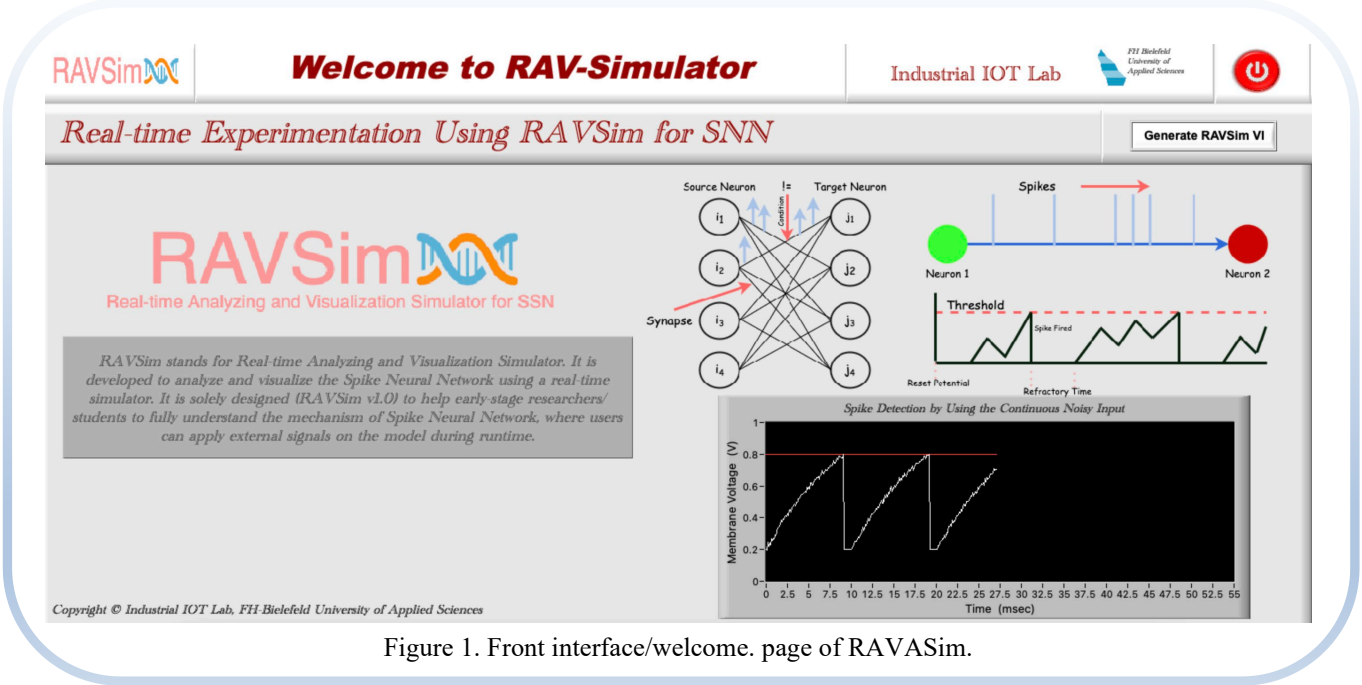


Figure 1. Front interface/welcome. page of RAVASim.

On the bottom right side of the corner, the simulation is only for demonstration purposes by using the NLIF model. However, the same model is also used in the run-time simulation VI, where a user can analyze and visualize the model by increasing/decreasing the parameters, all during runtime.

1.2. RAVSim Menu Bar

A menu bar is **a graphical control element that contains drop-down menus**.

The menu bar's purpose is to supply a common housing for window- or application-specific menus which provide access to such functions as closing the RAVSim tool, interacting with a WTA network model manually, and looking at the default parametric values of the LIF model, or displaying help or contact information.

Figure 2. Menu tab showing the drop-down listed features of a RAVSim tool.

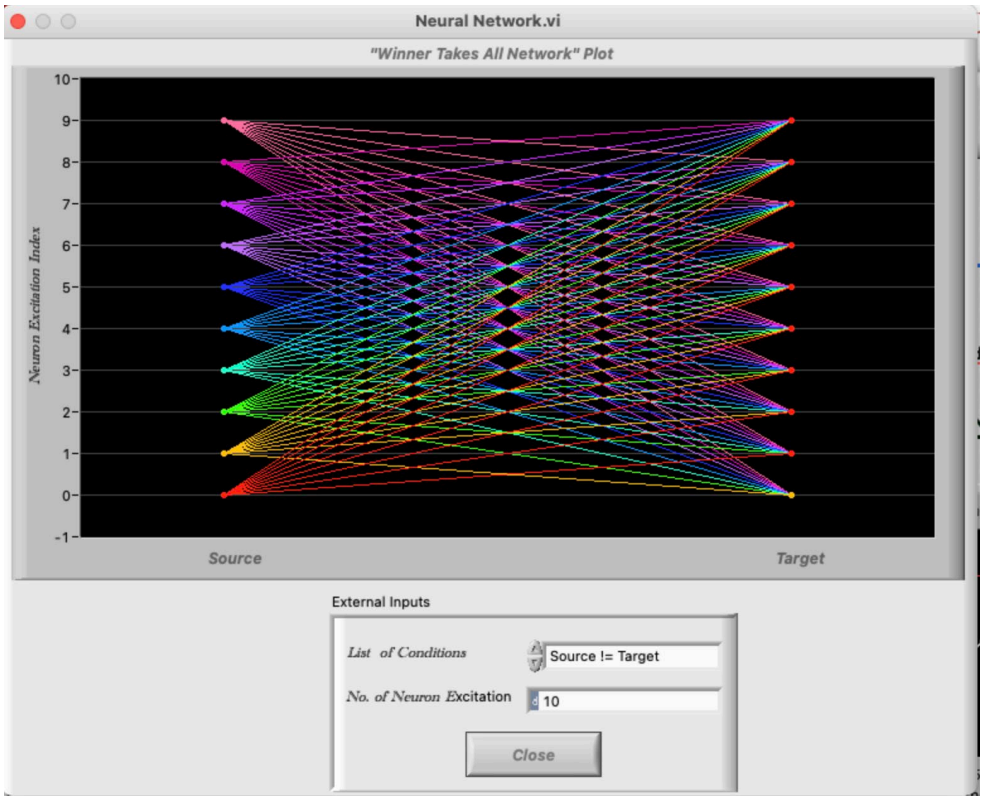


Figure 3. By using the drop-down menu, users can use a manually generated WTA network.

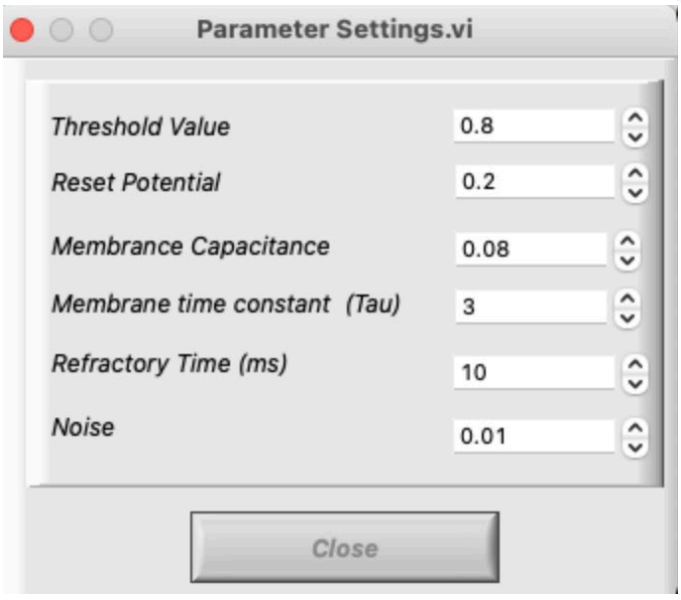


Figure 4. By using the drop-down menu,
users can see the default parametric values of a model.

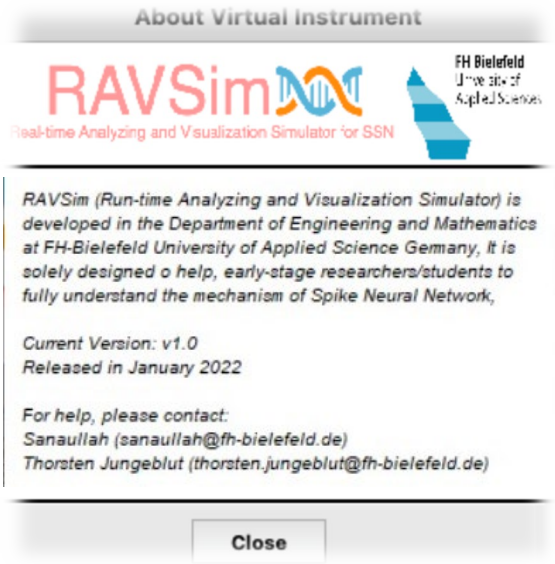


Figure 5. By using the drop-down menu from a **Help list**, users can see the relevant information

2. Generating a Run-time Simulation Enjoinment

As soon as the "Generate RAVSim VI" button is clicked the user will enter into (Shown in Figure 6) the run-time simulation environment. And a “Run_Spikes.vi“ dialogue box will pop up, where the user can enter the desired values of the parameters for analyzing and visualizing the simulations in run-time. The users can enter these values immediately or they can go with the default values and can also change the values accordingly during the time of the simulation.

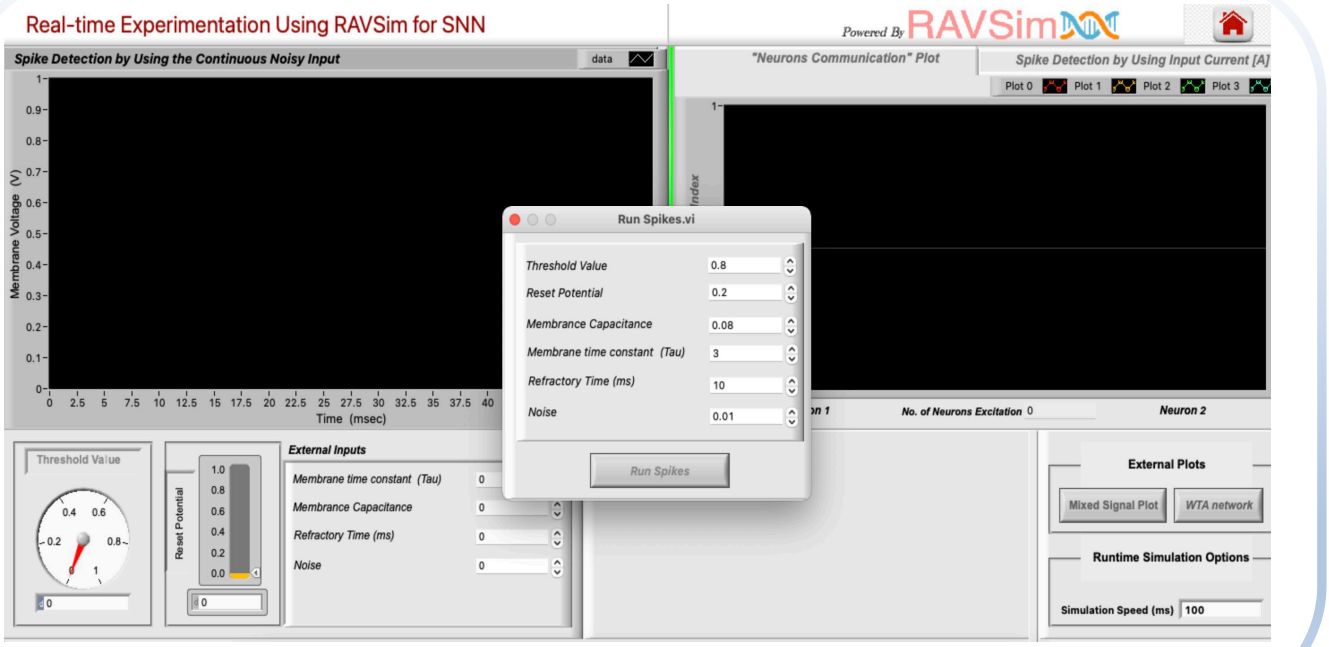


Figure 6. RAVSim Virtual Instrument specifically for a LIF model

2.1. Runtime Experimentation VI

Run-time experimentation of the RAV-Simulator provides a lot of flexibility for the user to interact with the SNN model at any point in time. Figure 7 shows the simulator's screen overview after hitting the “Run Spike” button.

Plots in Figure 7, show the spikes generated with the values which the user has inserted. And they can change the values of the parameters like the threshold, reset potential, etc during the run-time. The right plot, show the spike detection by using continuous noisy input and the left plot shows the users, how neurons are communicating with each other and how many times one neuron is interacting with the other, and the left plot menu option 2nd, visualize the plot that shows the detection of spikes using the input current.

Once the simulation is started, the user can increase or decrease the parametric values of a model by using the left bottom “external Parameter Values” table and observing their effects on the SNN model during run time.

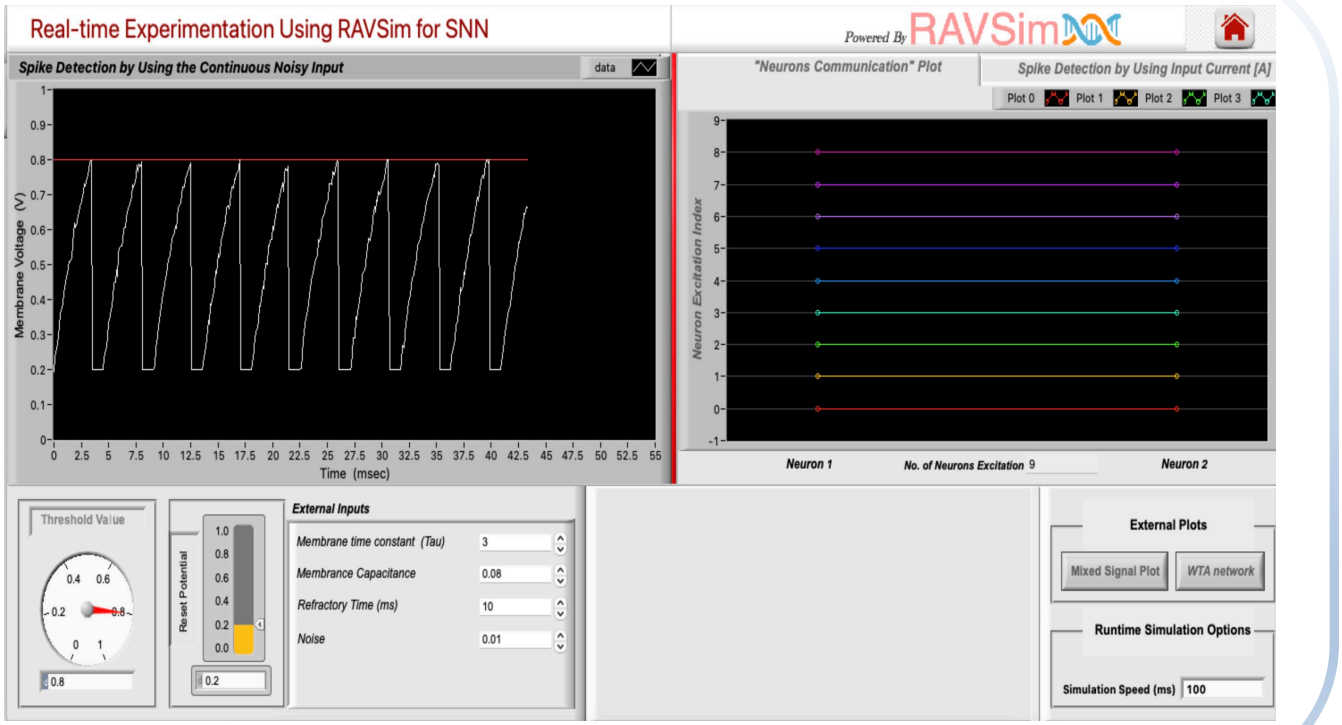
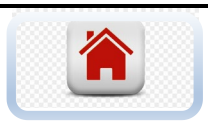


Figure 7. Run time Experimentation of RAV-Simulator for SNN.

Figure 7 also shows the screenshot of the run-time simulation of a LIF by using continuous noisy input and neuron communication plot taken randomly. This figure shows that unlike NLIF events with default parametric values, users can interact with the model and change the concentration of model input to any level and at any instant of time. In case the concentrations of the input model are required to be triggered to threshold level instantly, the neuron communication plot displays the runtime graphically neuron excitation results.

3. Additional features in RAVSim



If a **STOP** button (icon located at the top right corner in Figure 7.) is pressed, "RAVSim VI" navigates the user back to the home screen.

In Figure 7, in the bottom right we have provided the selection of the external plots, mixed-signal plots, and WTA network for the ease of the user and also change the runtime simulation values. With the mixed-signal plot, one can visualize the graphs of the input currents and the continuous signals values which are depicted in figure 8. It also allows the user to capture the graphs for documentation or reporting purposes which will be saved in the relative path of the simulator. In order to go back to the run-time environment, click on the "Continue Simulation" button.

And for navigating to the WTA mechanism the user has to click on the "WTA Network" in external plots and a window will pop up, where we can visualize the neuron communication graph which is shown in figure 9. Two types of communication graphs can be analyzed at this moment with two different conditions. The first one is the source index equal to the target index and in the second one, the source index of the neuron is not equal to the target index. We can select the required graph from the "list of conditions" dropdown. We also capture the graphs, or we can continue back to the simulation.

Each screenshot is saved at the location, where "Documents/Screenshot/Screenshot_name".

Alert – When the **STOP** button is pressed, the user navigates to the home page and the stop button on the home page can be used to terminate the RAVSim tool immediately.

Tip – The functionality of graphical plots, including simulation colors, can be changed by using a left click on the plot legend and selecting the desired drop-down option.

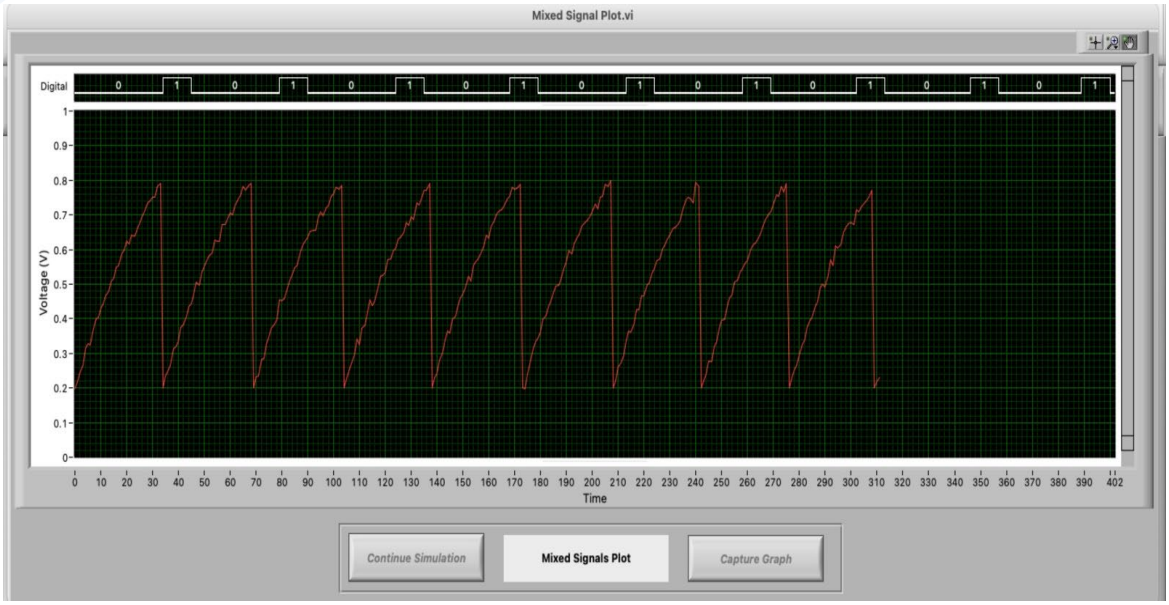


Figure 8: Mixed-Signal Plot

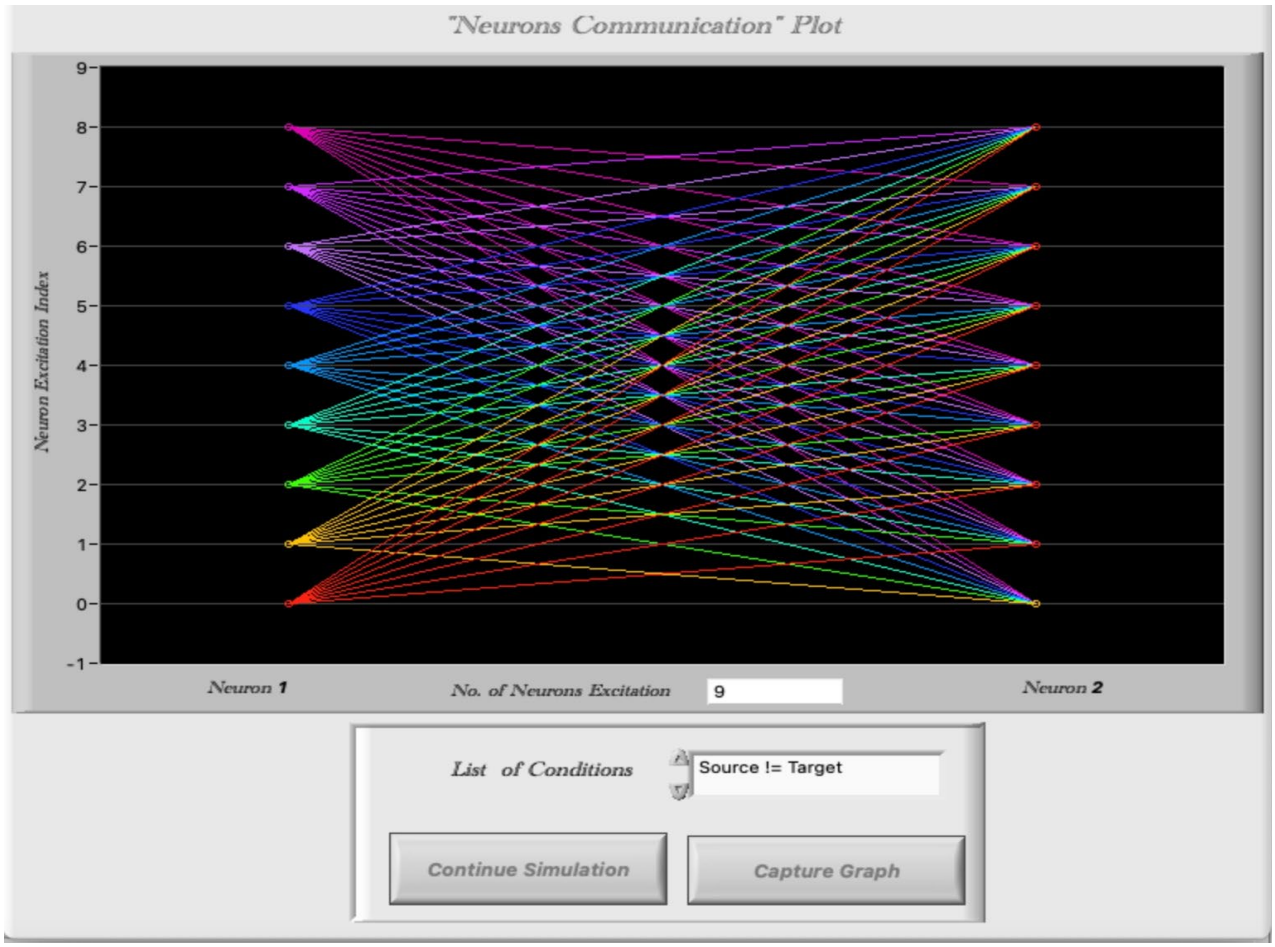
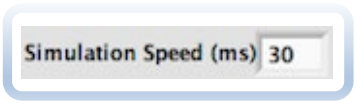


Figure 9: WTA Mechanism

The runtime simulation option, available in RAVSim v1.0, is shown at the bottom right corner of a VI in Figure 7. The option is described below:



- **Simulation Speed**: This option allows the user to increase or decrease the simulation speed by entering the numerical values which are considered milliseconds values.

Alert – Make sure the triggered threshold value is always greater than the membrane reset potential.

Refer

[1]. NI LabVIEW, https://www.ni.com/de-de/shop/labview.html.

[2]. Gr gory Dumont, Jacques Henry, and Carmen Oana Tarniceriu. Noisy threshold in neuronal models: connections with the noisy leaky integrate-and-fire model. Journal of mathematical biology, 73(6):1413–1436, 2016.

[3]. Yanqing Chen. Mechanisms of winner-take-all and group selection in neuronal spiking networks. Frontiers in computational neuroscience,11:20, 2017.