iqr Tutorial 03-Changing Synapses & Logging Data_LONG

iqr tutorials will provide you with a practical introduction to using the neural simulation software and give you an insight into the principles of connectionist modeling. They are intended to be complementary to the detailed operation manual.
The home page of iqr is at iqr.sourceforge.net. Up to date information, documentation and tips and tricks ca be found in the iqr wiki (sourceforge.net/p/iqr/wiki/Home/).
The repository of iqr packages is here: sourceforge.net/projects/iqr/files/. iqr is open source software. You can browser the entire source code of iqr here: http://sourceforge.net/p/iqr/code/HEAD/tree/. Please contribute to iqr by reporting bug (sourceforge.net/p/iqr/bugs/) and requesting features (sourceforge.net/p/iqr/feature-requests/).

Aims

- Understand and assimilate the basic principles and concepts of iqr:
  - Connection type: inhibitory
  - Neuron properties
  - Arborization
- Try out different connection types.
- Manipulate the states of cell groups at run-time and see how the cells are affected.
- Draw some patterns using the state manipulation panel and play them. Save the patterns for future uses.
- Record simulation data for later analysis using the DataSampler.

Introduction

1. Arborization

Arborization is a way of having more complex connection between neuron groups. Basically it defines how given a specific connection between two neurons (defined with the *pattern* property), this is extended to the adjacent neurons. There are two options: **receptive field** and **projective field** (Figure 1).

- *Receptive Field*: a single connection can connect several pre-synaptic neurons to one pot-synaptic neuron.
- Projective field: one pre-synaptic neuron projects information over a group of post-synaptic neurons.

You may want to use the *connection plot* when defining arborization to make sure every connection is as you specify.

Hence, a connection in iqr can comprise several axons, synapses and dendrites from a biological point of view. In iqr terms, this will be defined as a matrix of connectivity.

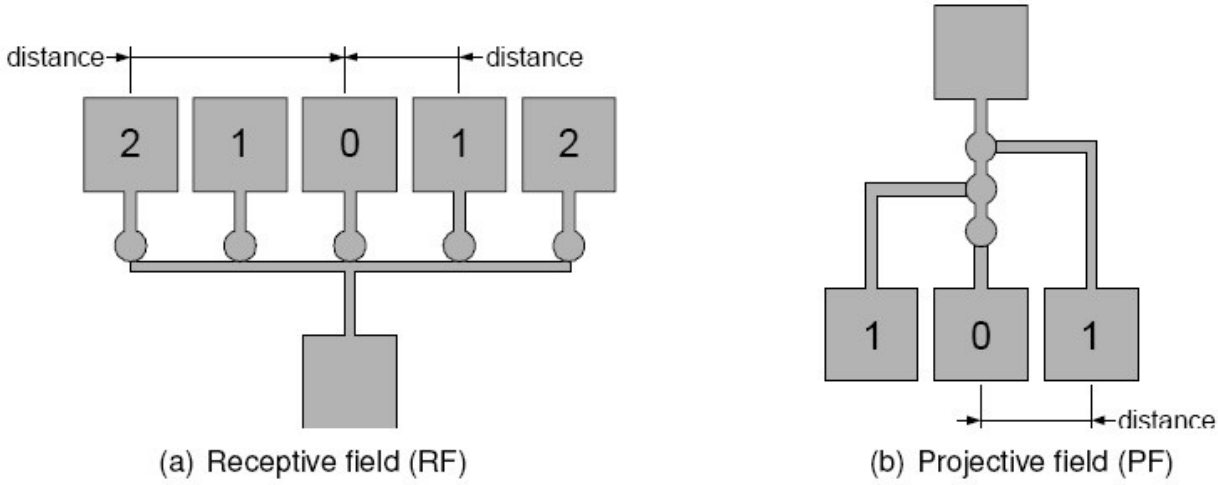

Figure 1: Receptive field and Projective field in the context or arborization

PLEASE, check the manual for further and deeper explanation and diagrams.

2. Inhibitory connection

In previous chapters we played only with excitatory connections. In this case we will play with the inhibitory type. In this case, the increase of the activity of the pre-synaptic neuron makes a reduction of the membrane potential of the post-synaptic neuron. So if a post-synaptic neuron has two inputs, one inhibitory and one excitatory, the output of the activity of this neuron will be reduced thanks to its inhibitory input. You can also check these types of connections in the *connection plot.*

3. State Manipulation Panel

The state manipulation panel is a tool to manipulate directly the activity of a specific neuron group. .

PLEASE, check the manual for a complete guide of use.

4. Data Sampler

DataSampler (Figure 3) allows you to save data during a simulation. You can save in a text file different parameters of activity (input, output, membrane potential) from the neuron groups you want. This is to log the simulations and to have data in a text format that can be later read and analyzed in other programs like Excel, SPSS, Octave, Matlab, etc. It works very easily just by dragging from the space plots the neurons you want to log into the data sampler interface and selecting the appropriate options.

PLEASE, check the manual for a complete guide of use.

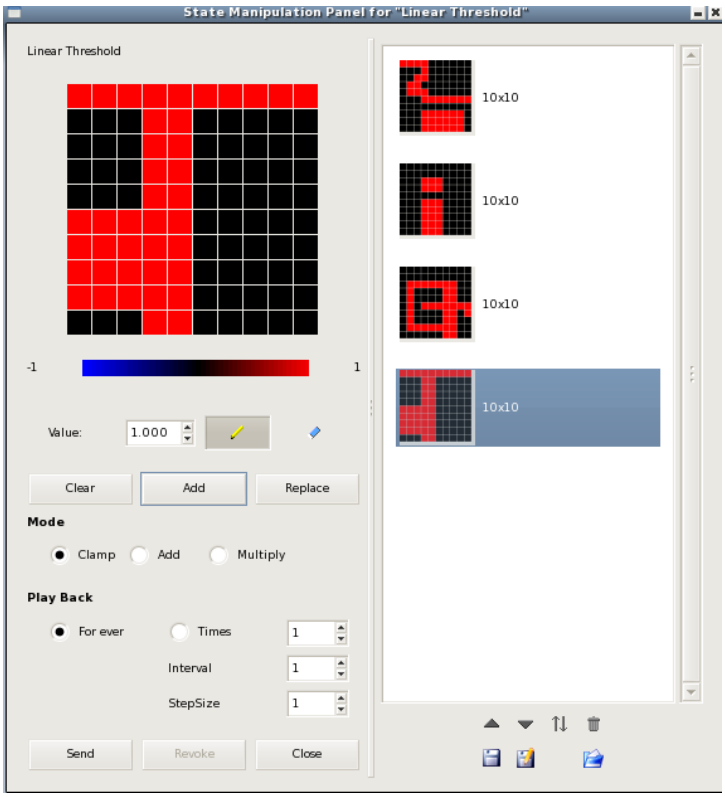

Figure 2: State manipulation panel

Building the System

- Create a copy of the simulation you used in Tutorial 2 and call it Tutorial 3 and start with it. Rename also the process.
- Delete the Sigmoid neuron group.
- Set the Linear Threshold group properties:
  - Threshold = 0;
  - Membrane Persistence = 0;
- Change the size of the Linear Threshold group using the Topology option to 30 by 30 neurons (if the computer goes slow, reduce it to 10x10 for example).
- Change the size of the Random Spike group to 1 single neuron. Save the simulation when you have finished.

Exercise

Start the simulation, and bring up the Space Plot and observe the activity in the Linear Threshold group.

1. We want to modify the connection parameters to generate a rectangular, circular and elliptic activation of

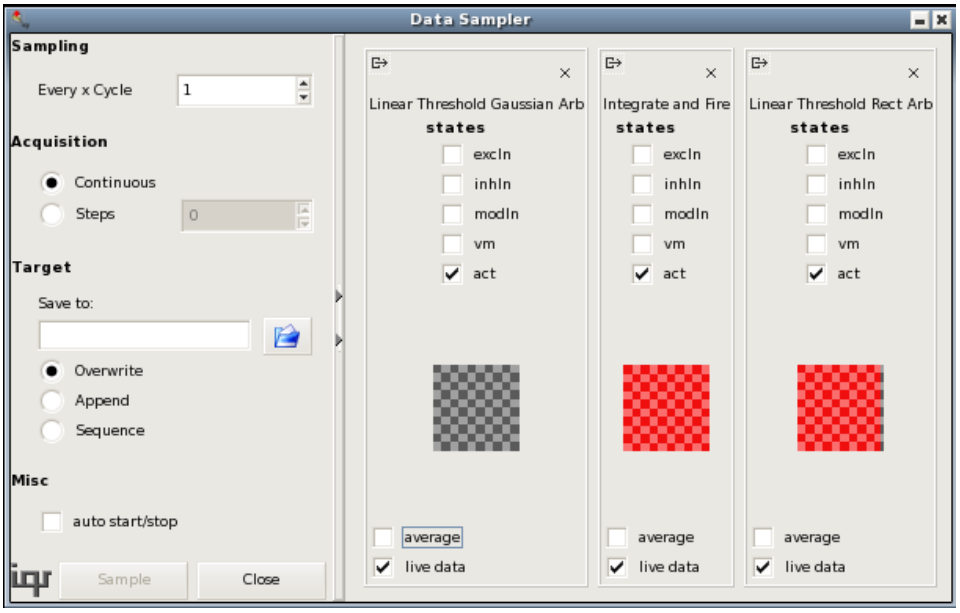

Figure 3: DataSampler

the post-synaptic neuron group. For that modify the **arborization** properties (Projective Field) and the **attenuation**. In the circular and elliptic case, when using attenuation, you should get space plots similar to Figure 4. It may be a good idea to check the connection plot to make sure the connection scheme is well set.

- Q1. Write values in the table

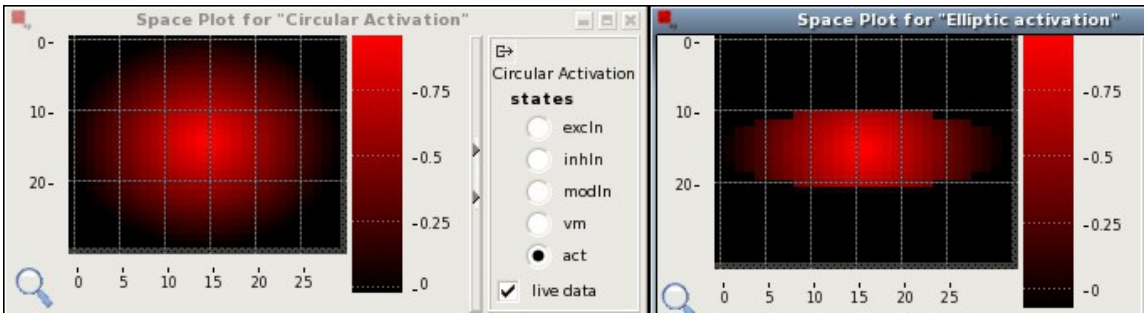

Figure 4: Circular and elliptic activation

2. Now, repeat the exercise trying to get a Gaussian activation of the post-synaptic neuron group. Again, modify the **arborization** properties (Projective Field) of the synapse and the **attenuation**. You should get a space plot similar to Figure 5. The 3-d view of this activation should be similar to Figure 6.

- Q1. Write values in the table

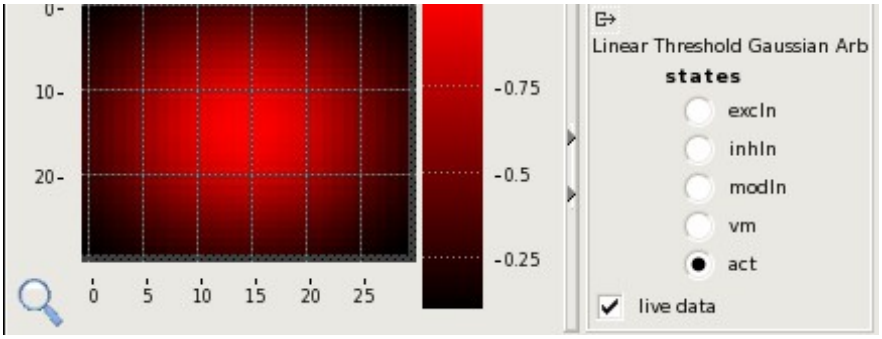

Figure 5: Gaussian activation

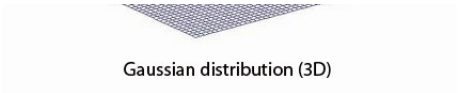

Figure 6: Example in 3d of a gaussian distribution

Connection	Rectangular	Circular	Elliptic	Gaussian
Pattern				
Arborization				
Attenuation				
Synapse				

3. Stop the simulation. Create an **inhibitory connection** from the Integrate and Fire group to the Linear Threshold one using the blue arrow icon, and set the synapse type to "*Uniform fixed weight*" (this means that every connection between the pre-synaptic neuron group and the post-synaptic neuron has the same weight/gain). Run the simulation again.

- Q1. What do you see?
- Q2. Which is the difference between an excitatory and inhibitory synapse? Check the membrane potential state using the time plot to verify what is happening.

  Now we want the Linear Threshold group to have a **receptive field** that respond to surrounding excitation. This means that every post-synaptic neuron must integrate the activity of more than one neuron of the pre-synaptic group. Change the Linear Threshold group dimensions to 1 neuron and the RandomSpike group to 10 by 10.

  4. Change also the connection settings to achieve the correct **receptive field**.
- Q1. Which are the new parameters?

Connection	Rectangular	Circular	Gaussian
Pattern			
Arborization			
Attenuation			
Synapse			

5. Use the **state manipulation panel** on the RandomSpike group to generate a *circular, rectangular* and *gaussian* like activation. Bring up the Time Plot of the Linear Threshold group.

- Q1. When is it responding maximally?

6. Open the Data Sampler under the "Data" menu. Save some data from the cell groups of your choice. Open the data file in OpenOffice or Excel.

- Q1. What you see in the file?