iqr Tutorial 01-Creating a simulation_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:
  - System
  - Process
  - Group & its properties (neuron type, topology)
  - Random Spike Neuron & properties (probability, amplitude)
  - Cycles Per Second (CPS)
  - Space plot, Time plot & Sync plots
- Create a simulation containing a group of cells that spike randomly
- Run the simulation and see the output using Space Plots and Time Plots.
- Build your first iqr system

Advice

- Go slowly.
- It is important that you understand what you are doing. Try to assimilate the concepts (group of neurons, process, synapses, time plot, CPS, arborization, etc) when their appear. Otherwise you will be lost for future exercises.
- Keep a copy of the "***iqr User Manual***" handy, and make sure you read the corresponding section in the manual when new concepts are introduced. Checking each concept there will save a lot of time.
- It is also important that after the practicum you create back-ups of every file.
- Don't forget to save your simulation after you make modifications:
  - File → Save As and give it a name like **Tutorial 1**.

Introduction

iqr is a tool for creating and running simulations of large-scale neural networks. The key features are: graphical interface for designing neuronal models, graphical on-line control of the simulation, change of model parame-

ters at run-time, on-line visualization and analysis of data, the possibility to connect neural models to real world devices such as cameras, mobile robots, etc; predefined interfaces to robots, cameras, and other hardware, open architecture for writing own neuron, synapse types, and interfaces to hardware.

Models in iqr are organized in different levels: the top level is the system and contains an arbitrary number of processes and connections. Processes in turn consist of an arbitrary number of groups.

- At the process level it can be defined if a process is a standard process or if it connects the system to external hardware. Each process works as a logical unit in which groups of neurons can be defined. Such a logical unit is responsible for a specific task at your system.
- A group is defined as a specific aggregation of neurons of identical type, specific in terms of the topology (i.e. spatial arrangement) of the neurons in the group being a property of the group.
- Connections are used to feed information from group to group. A connection is defined as an aggregation of synapses of identical type, plus the definition of the arrangement of the synapses.

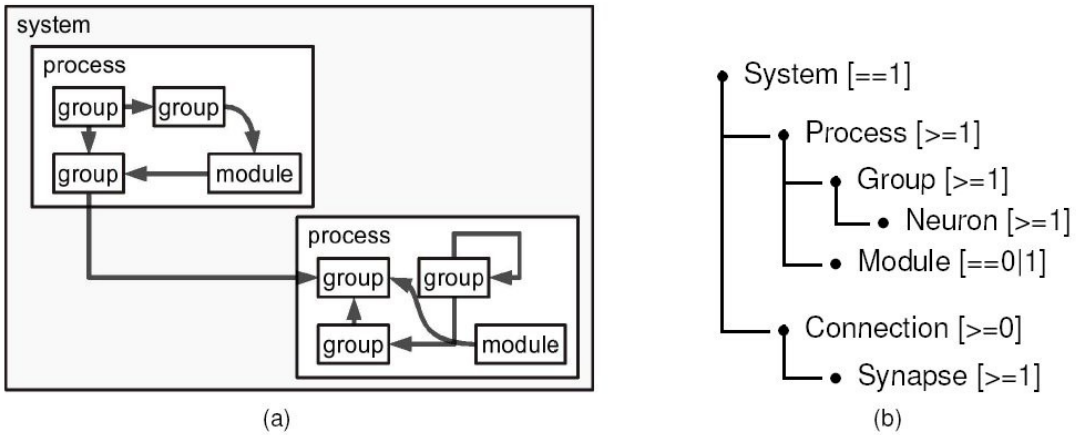

Figure 1: iqr basic conceptual schemes

Building the System

- First of all, you have to create a **process** using the *process button* in the button bar. This will happen at the **system level**. To do this, press the process ('*P*') button and then move the mouse to the "diagram editing panel" and press left button again. A grey square *'New Process 1'* should have been created (Figure 2).
- Once the process is created, you edit its name by editing its properties. Change the name to ***"Tut 1 Process"***. A new **tab** appears when the process is created. If you click on it, it shows the contents of that process (i.e.: groups and connections) as shown in Figure 3.
- Click the *"Tut 1 Process"* tab. Start adding groups that will performance inside the process by clicking on the *group icon.*
- Now edit the properties of the new group and set:
  - Set ***'Group Name'*** as 'RandomSpikeGroup'.
  - Set the *type* of the ***Topology*** as 'TopologyRect' and click there '*edit*'. Make it 10 cells wide and 10 cells high (it will be used again in later exercises). Note: *Topology* refers to the packing of the cells within the group. In this case *TopologyRect* means that every field in the lattice is occupied by one neuron.

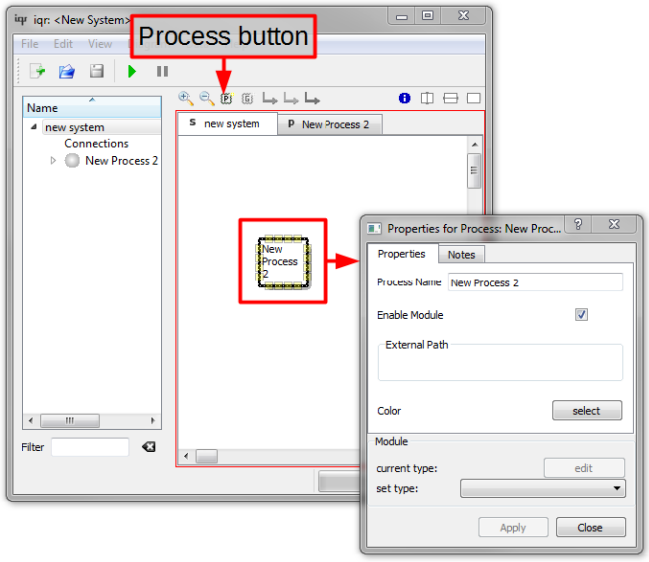

Figure 2: Process creation and process properties

- Set the '***Neuron type***', the **type** of the neuron, to **RandomSpike.** Then press *edit* and give it a ***spiking 'Probability'*** of 0.42 and set the '***Spike Amplitude'*** to 1.0.

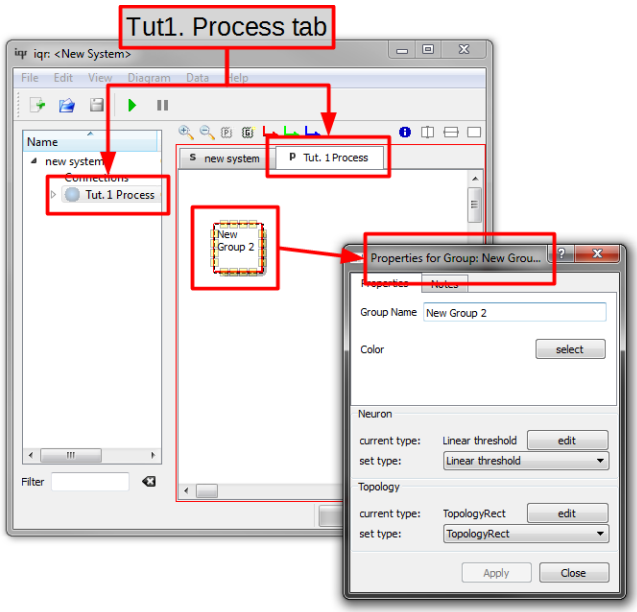

Figure 3: Group creation inside a process and group properties

Exercise

Step 1. Set cycles per second (CPS) to 25:

- Go to File → System Properties. Set 'Cycles Per Second' (CPS) to 25. Press 'tab' key and then OK. (CHECK: open again the same menu to make sure CPS is set as you wanted.).
- Check also 'Sync Plots' to make sure every event is represented in real-time in the space and time plots.

Step 2. Press the Play button to start the simulation.

1. Press right button over the neuron group, and bring up the space plot to watch the cells spiking - don't forget to select the 'live data' check box and choose the cell state variable that you want to watch (activity means only when the cell spikes). In brief, the space plot shows the state of each cell in a group in the plot area.

- Q1. What do you see? Which is state is being represented? Is it similar to the bottom diagram in Figure 4?
- Q2. What does each small square represent?
- Q3. Can you see activity of two different times in space plot or it is just instantaneous information?

2. Press right button again over the neuron group (without quitting the space plot) and bring up a time Plot as well. Check again 'live data' and the same cell state variable as the space Plot. In brief, time plot shows the states of neurons against time.

- Q1. Explain what you see.
- Q2. Are you watching in the time plot the activity of one neuron, the average of the whole group of the total activity of the whole group?

3. Try to play with the properties of the neuron group (such as Probability, Spike Amplitude and Size of the Group). STOP the simulation before changing those parameters.

- Q1. What does that 'Probability' means?
- Q2. What happens if you set probability to '1'?
- Q3. What happens in the space plot if you change spike amplitude? And in the time plot?
- Q4. What about the size of the group? Describe the effects in both type of diagrams.
- Q5. Can you perceive any substantial difference in the space plot?

4. Now, drag only 1 cell from the space plot in the time plot.

- Q1. What do you see?
- Q2. What about dragging a group of 4 cells for example?
- Q3. Does it give you the sum of the individual activities of the average of the selected group? Play with different combination of cells to discover it.

5. What does the "CPS:" in the bottom-left corner of the window mean? Change the values in File → System Properties and check how the simulation speed changes (e.g.: CPS = 1; CPS = 2; CPS = 10. Take care because CPS=0 gives you the maximum speed the machine can give and it might freeze the system).

- Q1. What is a CYCLE in IQR?

- Q2. Can you see different cycles at the same time in a space Plot?
- Q3. Can you see different cycles at the same time in a time Plot?

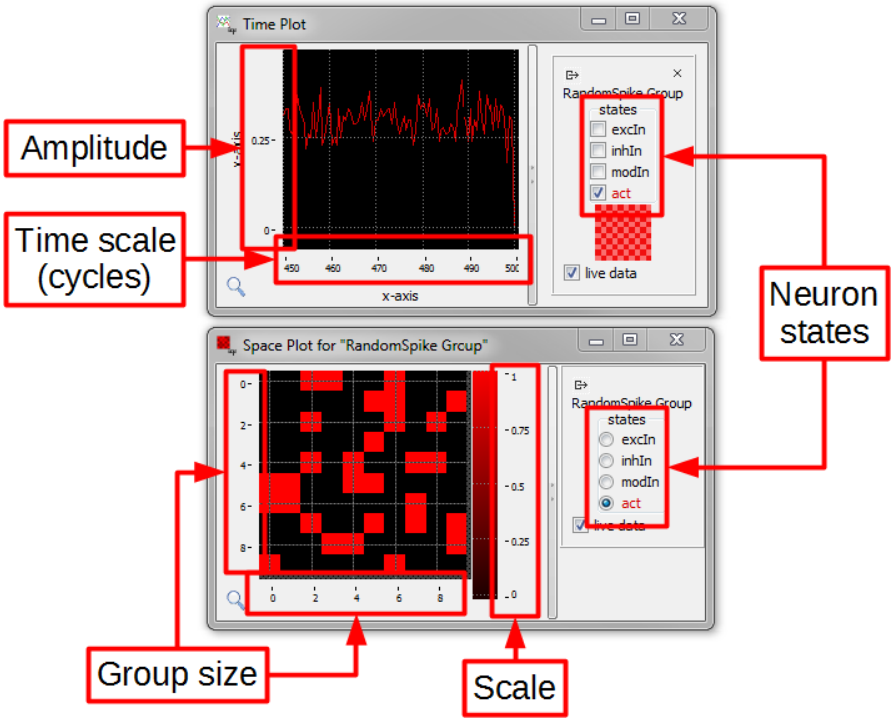

Figure 4: Time and space plots