BioE 332 Lecture 8:
Programming Neurogrid -- the python way

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Spring 2011

Updated by Kwabena Boahen

Spring 2012

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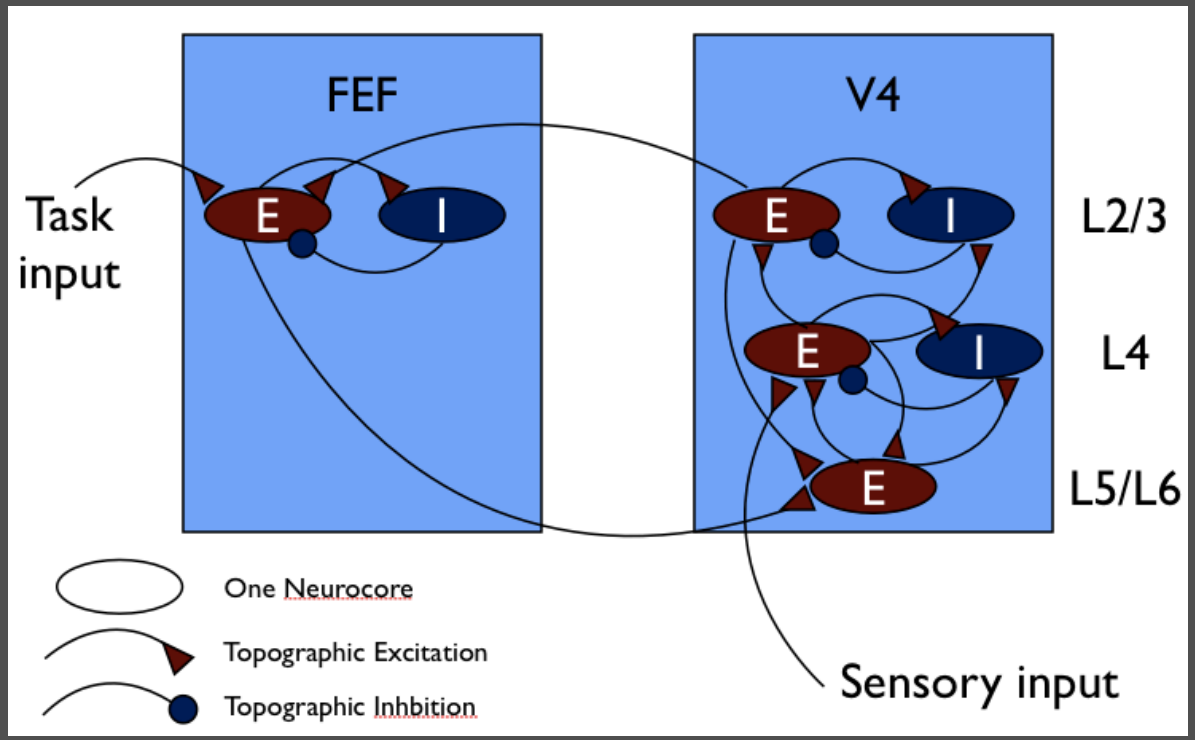
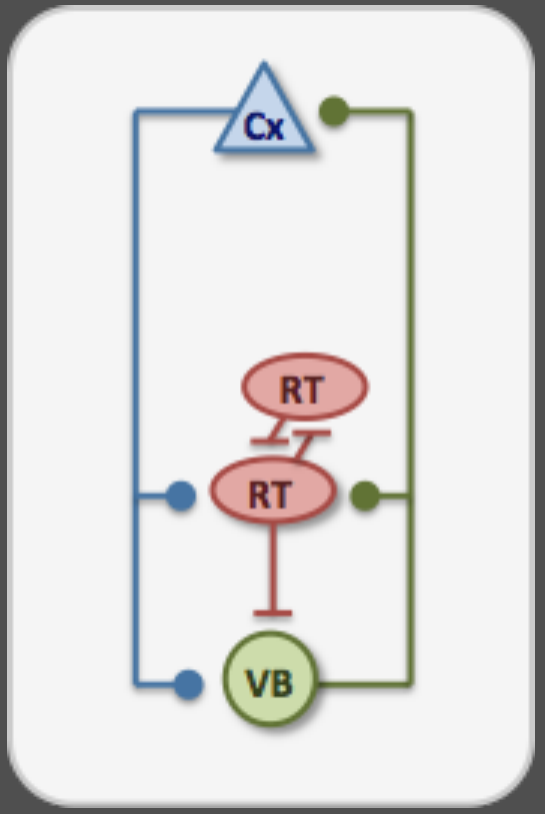
Spring 2013

Neurogrid is Designed for Hierarchical and Modular Networks



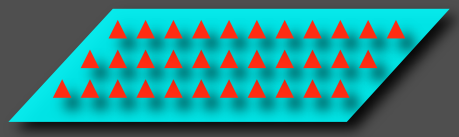
Nick Steinmetz



Christine Lee

Network Structures

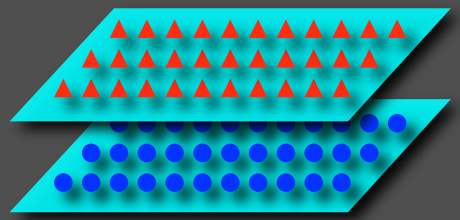
Pool



- Neurons of the same model
- Integer width by height
- Each neuron identified by unique integer coordinate
- Disable neurons to get custom shapes and/or densities

```
>>> p = Pool(nrn_quad, width = 65,
height = 65)
```

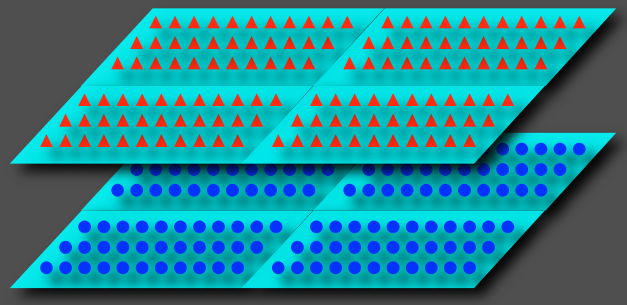
Group



- A collection of network structures (pools, groups, arrays)

```
>>> t = Group()
>>> t.AddChild(p)
```

Array

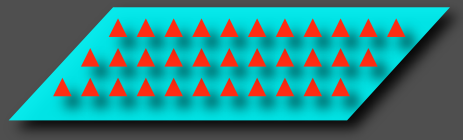


- An array of a base network structure (pools, groups, arrays) with specified repetitions in width and height

```
>>> a = Array(base = t, w = 2, h = 2)
```

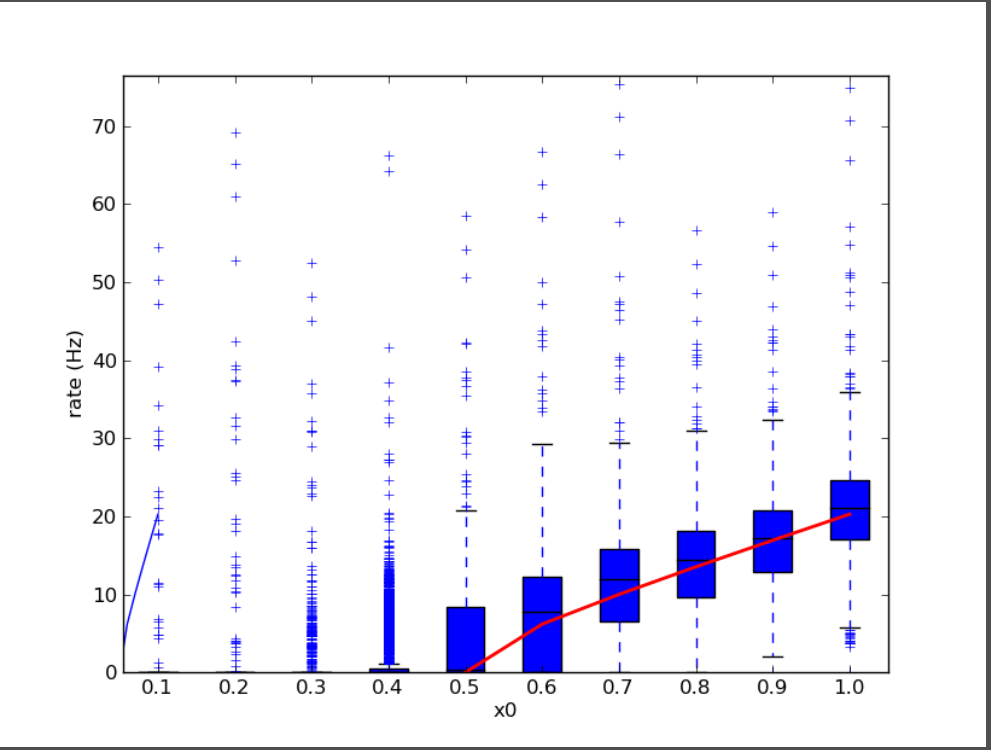
FI Curve with a Pool of Neuron

Pool

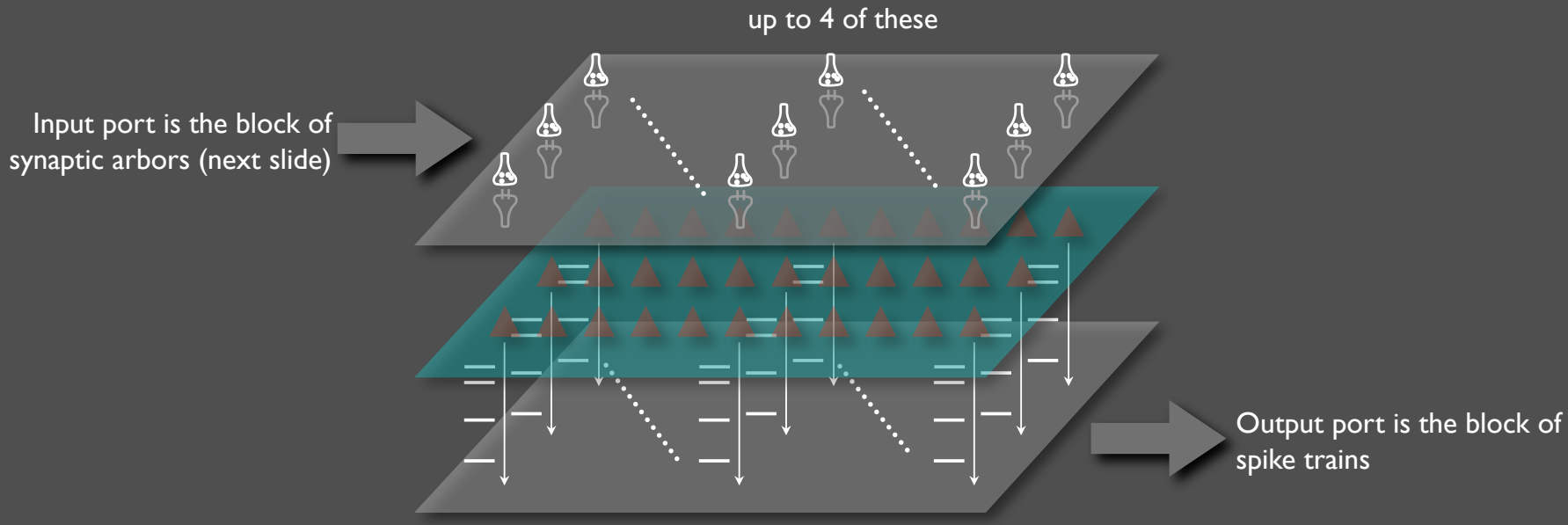


- Neurons of the same model
- Integer width by height
- Each neuron identified by unique integer coordinate
- Disable neurons to get custom shapes and/or densities

```
>>> # Set the input value
>>> x0 = .5
>>>
>>> # Create the quadratic neuron model
>>> som_quad = Soma("quadratic", {"tau": 10e-3})
>>> nrn_quad = Neuron("quad_neuron", som_quad)
>>>
>>> # Make a Pool of 64 by 64 quadratic neurons
>>> p = Pool(nrn_quad, 64, 64)
>>>
>>> # Map the Pool to hardware
>>> MapNetwork(p)
```



Connecting Pools Through Ports

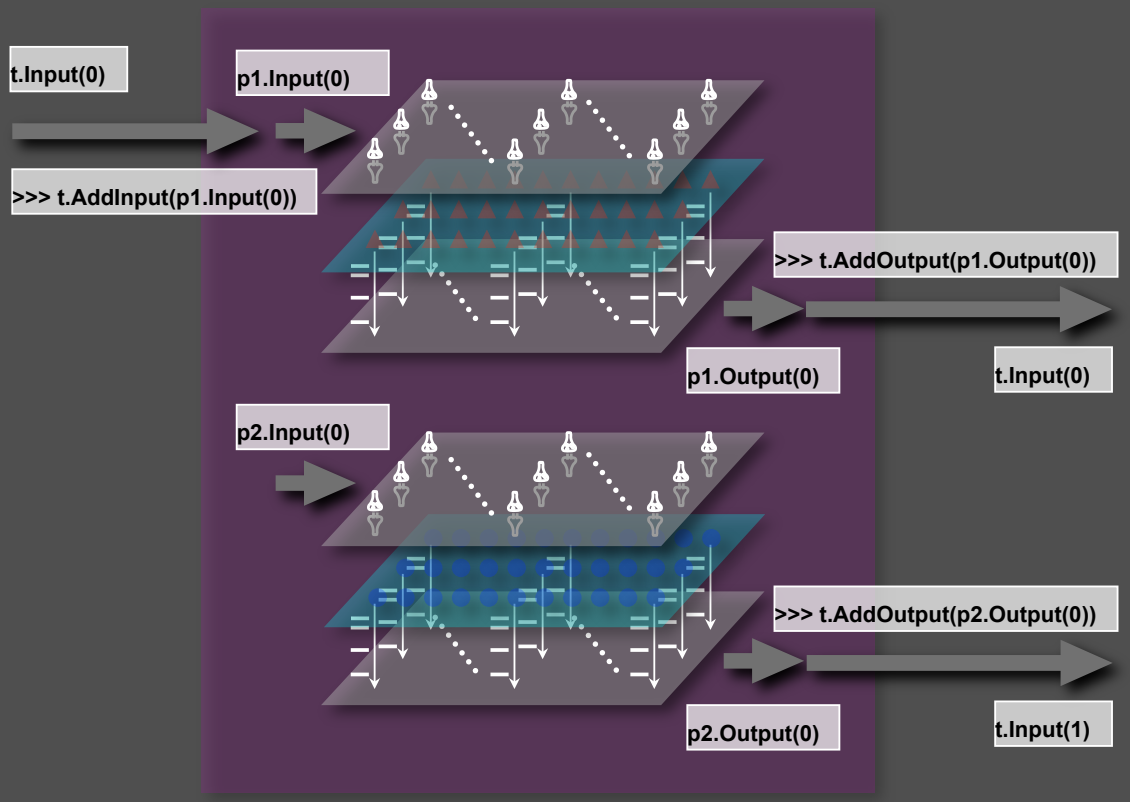


- Connect output port to input port = Projection (later slides)
- Ports are attached to pools, therefore, they inherit width and height of the pool
- A port's arbors and spike trains have the same coordinate system as its pool's neurons

Taking Ports to the Next Level

Create a group:

```
>>> t = Group()
>>> t.AddChild(p1)
>>> t.AddChild(p2)
```



Vertical Projections

- Sends spike train at (x, y) in the output port to arbor at (x, y) in the input port (topographic)
- Input/output ports must have same widths and heights, but don't have to have the same number of neurons

```
>>> # Making a Group
>>> g = Group("2pop")
>>> g.AddChild(p1)
>>> g.AddChild(p2)
>>>
>>> # Mutually connect
>>> g.VerticalProject(p1.Output(0), p2.Input(0))
>>> g.VerticalProject(p2.Output(0), p1.Input(1))
```

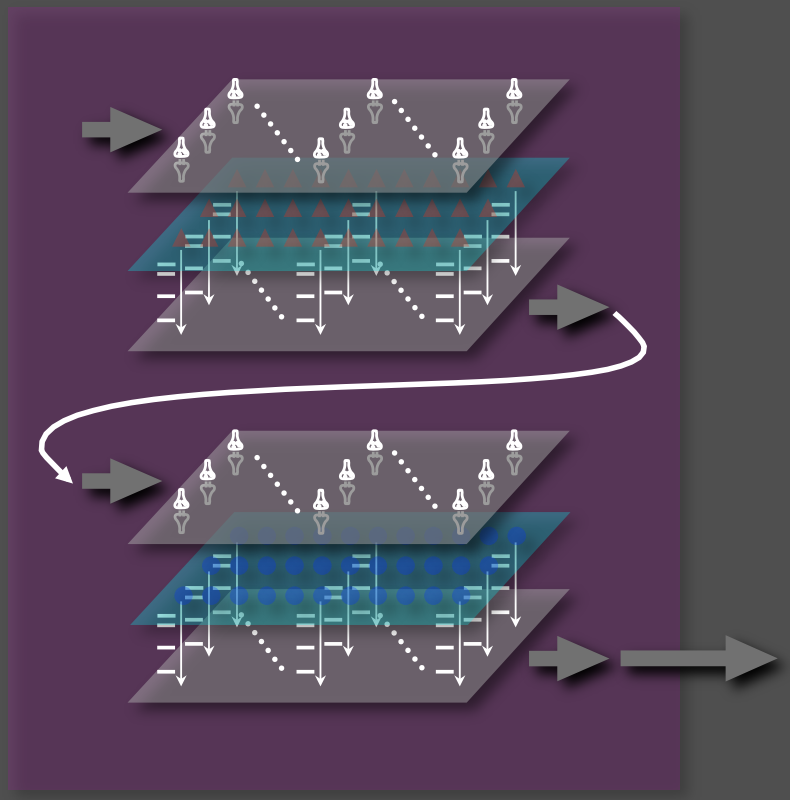
Horizontal Projections

- Sends spike train at (x1, y1) in the output port to arbor at (x2, y2) in the input port (point-to-point)
- Input/output ports must have same widths and heights, but don't have to have the same number of neurons
- You can specify a weight w < 1 that specifies the probability that a spike is delivered
- Requires the daughterboard

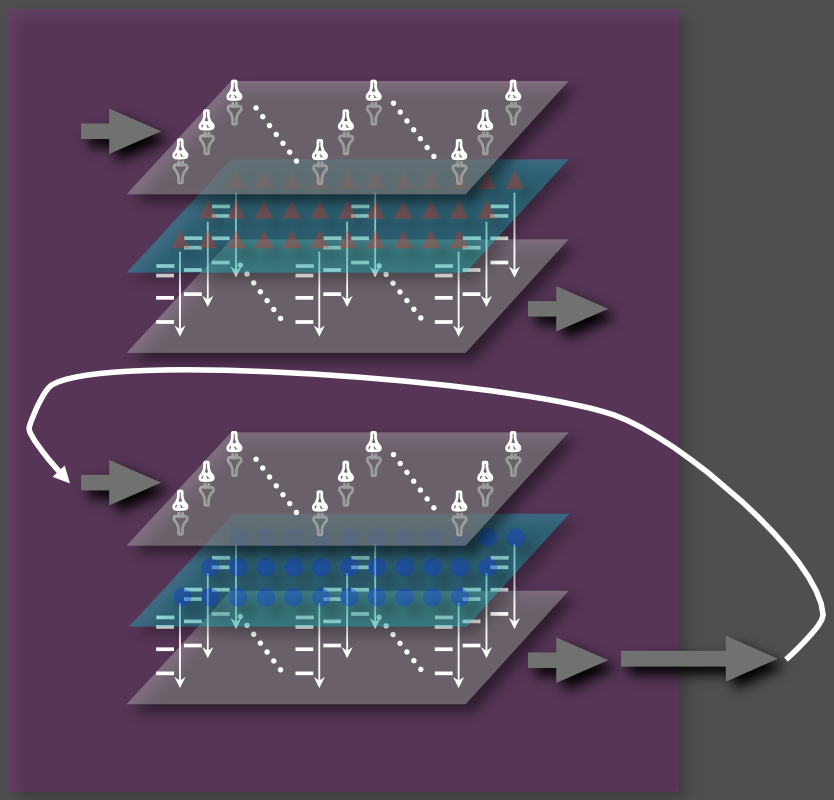
```
>>> # Making a Group
>>> g = Group("2pop")
>>> g.AddChild(p1)
>>> g.AddChild(p2)
>>>
>>> # Point-to-point connection
>>> g.HorizontalProject(p2.Output(0), x1, y1, p1.Input(0), x2 , y2 , 0.1)
```

Projections are owned by network structures, and are only to be made between ports at the same level of network hierarchy

OK



NOT OK



2 Population Interaction

```
>>> # Making model for first population
>>> syn1 = Synapse(“syn_generic”, {“erev”: .1, “tau_syn”: 10e-3, “lambda”: .6})
>>> som1 = Soma(“quadratic”, {“x0”: .7,’ “tau”: 10e-3})
>>> som1.AddSynapse(syn1)
>>> nrn1 = Neuron(“pop1_nrn”, som1)
>>> p1 = Pool(nrn1, 64, 64)
>>>
>>> # Making model for second population
>>> syn2 = Synapse(“syn_generic”, {“erev”: .1, “tau_syn”: 10e-3, “lambda”: .6})
>>> som2 = Soma(“quadratic”, {“x0”: .7, “tau”: 10e-3})
>>> som2.AddSynapse(syn2)
>>> nrn2 = Neuron(“pop2_nrn”, 64, 64)
>>> p2 = Pool(nrn2, 64, 64)
>>>
>>> # Making a Group
>>> g = Group(“2pop”)
>>> g.AddChild(p1)
>>> g.AddChild(p2)
>>>
>>> # Mutually connect
>>> g.VerticalProject(p1.Output(0), p2.Input(0))
>>> g.VerticalProject(p2.Output(0), p1.Input(1))
>>>
>>> # Map the network
>>> MapNetwork(g)
```