BioE 332 Lecture 8:

Programming Neurogrid -- the python way

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Neurogrid is Designed for Hierarchical and Modular Networks

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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

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

Group
• A collection of network structures (pools, groups, arrays)

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

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

```plaintext
>>> a = Array(base = t, w = 2, h = 2)
```
# Set the input value
>>> x0 = .5

# Create the quadratic neuron model
>>> som_quad = Soma("quadratic", {"tau": 10e-3})

# Make a Pool of 64 by 64 quadratic neurons
>>> p = Pool(nrn_quad, 64, 64)

# Map the Pool to hardware
>>> MapNetwork(p)
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:

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

```python
>>> t.AddInput(p1.Input(0))
```

```python
>>> t.AddOutput(p1.Output(0))
```

```python
>>> t.AddOutput(p2.Output(0))
```

```python
>>> t.Input(0)
```

```python
>>> t.Input(1)
```

```python
>>> t.Input(0)
```
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

```python
>>> # 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

```python
>>> # 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
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)