BrainScaleS Workshop

4th HBP School

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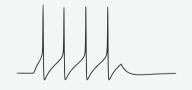
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First Section

Analog Neuromorphic Hardware



observations



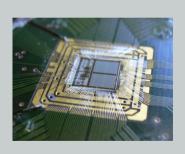


mathematical model





hardware realization



Roadmap 2004

Spikev

single chip

system

neurons

· 384 LIF

2010

HICANN

• 180 nm CMOS

• 512 AdFx

neurons

2015

20 Wafer System

HICANN DLS

2017

4 million neurons0.9 billion synapses 65 nm CMOS
PPU:
 integrated
 processing
 unit for

advanced plasticity

neurons
• 130 billion
synapses

2022

500 Wafer System

· 500 million

oses 2

PyNN API documentation

https://neuralensemble.org/docs/PyNN/0.7/api/api-0.7.html

Look out for:

- pynn.Population
- pynn.Projection
- pynn.*Connector

Creating (groups of) neurons

Create populations of neurons:

```
params = {
    "v_thresh": -60.0
  }
neurons = pynn.Population(42, pynn.IF_facets_hardware1, cellparams=params)
```

Get a list of default neuron parameters:

```
\begin{picture}(100,0) \put(0,0){\line(0,0){100}} \put(0,0){\line(0,0){10
```

Generating stimuli

Create a stimulus from a spike train:

```
spike_train = np.arange(10.0, 101.0, 10.0)
stimulus = pynn.Population(1, pynn.SpikeSourceArray, {"spike_times": spike_train})
```

There is also a Poisson spike source:

```
poisson_params = {
    "start": 10.0,
    "duration": 100.0,
    "rate": 5.0
    }
stimulus = pynn.Population(1, pynn.SpikeSourcePoisson, poisson_params)
```

Synaptic connections

Recording observables

Spike times:

```
neurons.record()
...
spikes = neurons.getSpikes()
```

Analog membrane traces:

```
pynn.record_v(neurons[0], "")
```

- only one analog-to-digital converter (ADC)
- → one can record a single neuron at a time