# Cortical representation of touch model conversion

## Progress

[GitHub Repository](https://github.com/MetaCell/Cortical-representation-of-touch-in-silico/tree/develop)

**Sprint 1** (September 28 - October 12)

* Take off meeting and set objectives
* Read through all original Matlab code
* Implemented loading of Matlab files and parameters into Python
* Create netpyne populations/cells using GenericCell class and cellsList to set individual properties (location + dynamics)

**Sprint 2** (October 12 - October 26)

* Modified Izhikevich model (.mod) to add nonlinear mechanism (adaptation); compared against Matlab code and matched perfectly
* All cells instantiated with this adaptive model, and individual cell properties (dynamics)
* Implemented connections; each conn has individual weight and delay, implemented using netpyne conn rules
* Each connection synapse also has specific params, is stochastic and has learning -- not possible in netpyne high-level specs, so implementing at the instantiated network / NEURON level
* Working on implementing synaptic failure and short-time depression

**Sprint 3** (October 26 - November 9)

* Completed nmodl mechanisms with short-term learning and synaptic failure.
* Implemented thalamic inputs, reading the external spike trains from .mat and setting them as VecStims.
* Started writing documentation with description of implementation and preliminary results: <https://docs.google.com/document/d/15llbohOaF6sc3veGudJw6pDJwHrHRoV5/edit?usp=sharing&ouid=106121444155591878003&rtpof=true&sd=true>
* Preliminary results 1) with thalamic inputs (no cortical conn), 2) full network (all conn) but only 3 secs
* Issues running full-scale python model on laptop for 6 sec - out of memory.
* Issues running full Matlab model to compare results - out of memory
* Setting up a VM with 80 cores on Google Cloud so can run parallel simulation
* Next steps:

1) Generate multitrials, different thalamic inputs, different controlled seeds, etc

2) Generate plots and analysis to compare with original results (paper figs?) and tune if needed.

3) Implemented STDP.

**Sprint 4** (November 9 - November 23)

**Sprint 5** (November 23 - December 7)

**Sprint 6** (December 7 - December 21)

## 

## 

## Workflow (Eugenio’s annotations)

* Read and understand matlab code. Order: 10^4 lines of code. (2-3 weeks).
* Assembling network from .mat. Individual load of neurons and conns, categorized as proper populations and rules, even when they have to be individually loaded. Coupling individual loading of different parameters in NetPyNE (2-3 weeks)
* Assembling thalamic inputs. These will represent barreloid inputs (as a population). (1 week)
* Testing single neuron dynamics. Coding adaptive Izhikevich model in NEURON. Coupling with NetPyNE. Individual parameters (from a distribution, already given) (2-3 weeks)
* Testing failure rate and stochastic synaptic events. Coding in NEURON. Coupling with NetPyNE. (2-3 weeks)
* Testing synaptic plasticity (STP, STD, STDP). Idem (2-3 weeks)
* Assembling multitrial numerical experiment, including seed control keeping in mind stochastic events in NEURON (2-3 weeks)
* Creating analysis to compare to paper results (2-3 weeks)
* Extension: Defining spike trains from barreloids within NetPyNE (whisker inputs given, as these data was manually curated). (~2-3 weeks)
* Extension: Connectivity, Peter's rule based. beyond 3 months
* Extension: Calcium imaging? beyond the 3 months. simple implementation: double exponential filter (converts spike trains to smaller time series)

## Validation Metrics

## Notes

## Reference

**Useful links**

- Github: <https://github.com/DepartmentofNeurophysiology/Cortical-representation-of-touch-in-silico>

- Preprint: <https://www.biorxiv.org/content/10.1101/2020.11.06.371252v3.full.pdf>

**Features**

**-** Mouse barrel cortex (S1); 3 columns (this can be set) each of 640x300x300 um (cuboid)

- 2 layers (L2/3 and L4); 6 cell types; 15 populations

- Soma resolution using data microscopy data; realistic cell densities

- Izhikevich point neurons

- Connectivity: prob of conn based on exp data (presyn axon and postsyn dend distributions)

- Input: whisker data (angle and curvature) generates thalamic inputs (Poisson filter neurons)

- Example simulation: 3 columns with L2/3 and L4, thalamic inputs from whisker data (Svoboda)

- Synaptic short-term depression and potentiation

- (optional) Direct whisker modulation by motor cortex

- (optional) STDP L2/3 <-> L4

- Data model:

- L2/3 and L4 cells: x,y,z location (actually, radial coords); cell type; barrel/column; exc/inh

- conn data

- thalamic inputs

- configuration

- Paper results:

- Variability of stimulus representation

- Stimulus evoked representation in L2/3 and L4

- Visualization of the presynaptic population contributing to a postsynaptic action potential

- STDP as function of whisker deprivation

- Network response to in vivo-like stimulation

- Simulation of calcium imaging experiment