Project Status

Neo Cortical Microcircuit

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Overview

- Background
- The Problem
- Methodology
- Implementation
- Results
- Next Steps

Background

- Traditional Neural Network are good for only what you train them to do.
- They are vulnerable to noisy data and parameters.
- Using a combination of signal patterns, inherent behavior (or personality) and external stimulus, get some output (respond or ignore) for the external stimulus.
- The model is analogous to real life brain cell functioning.

The Problem

- Modeling Neocortical Locks:
  - Modeling of Neocortical Locks from the Lock and Key model.
  - Lock is the network of neurons, consisting of excitatory and inhibitory cells.
  - Key is the external stimulus, ideally consisting of random audio or video stimulus from the environment.
  - Objective is to find a lock which resonates quite perfectly with a given key (i.e. has same phase as key, when the key is applied).
  - Later on, let the network learn based on reward and punishment scheme. (e.g. Hebbian learning).

Methodology

- Model a network of neurons which will have some inherent behavior (Lock).
- Introduce a signal as an external stimulus to the post-synaptic cells (Key).
- Idea is to adjust the strength of the synaptic conductance (G) from pre-synaptic cells to the post-synaptic cell to get the lock to resonate with the key.

Methodology

- Other parameters to model are:
  - Short and long term synaptic dynamics.
  - Number of neurons in the network.
  - The inherent behavior of the neurons.
  - Synaptic connections between the two types of neurons.
  - “Threshold” of the “Compartment”.
  - Spike shape, if needed.
  - “Absolute use” value of the synapse in case of learning.
  - Type of learning, duration, FSV (Frequency of Sampling Value), and various other parameters.

Methodology

- Results:
  - Expected result is to obtain reproducible, unique response from the lock for a particular given key pattern.
  - Further part of project is to develop a network of neurons which learns as it experiences external stimulus.

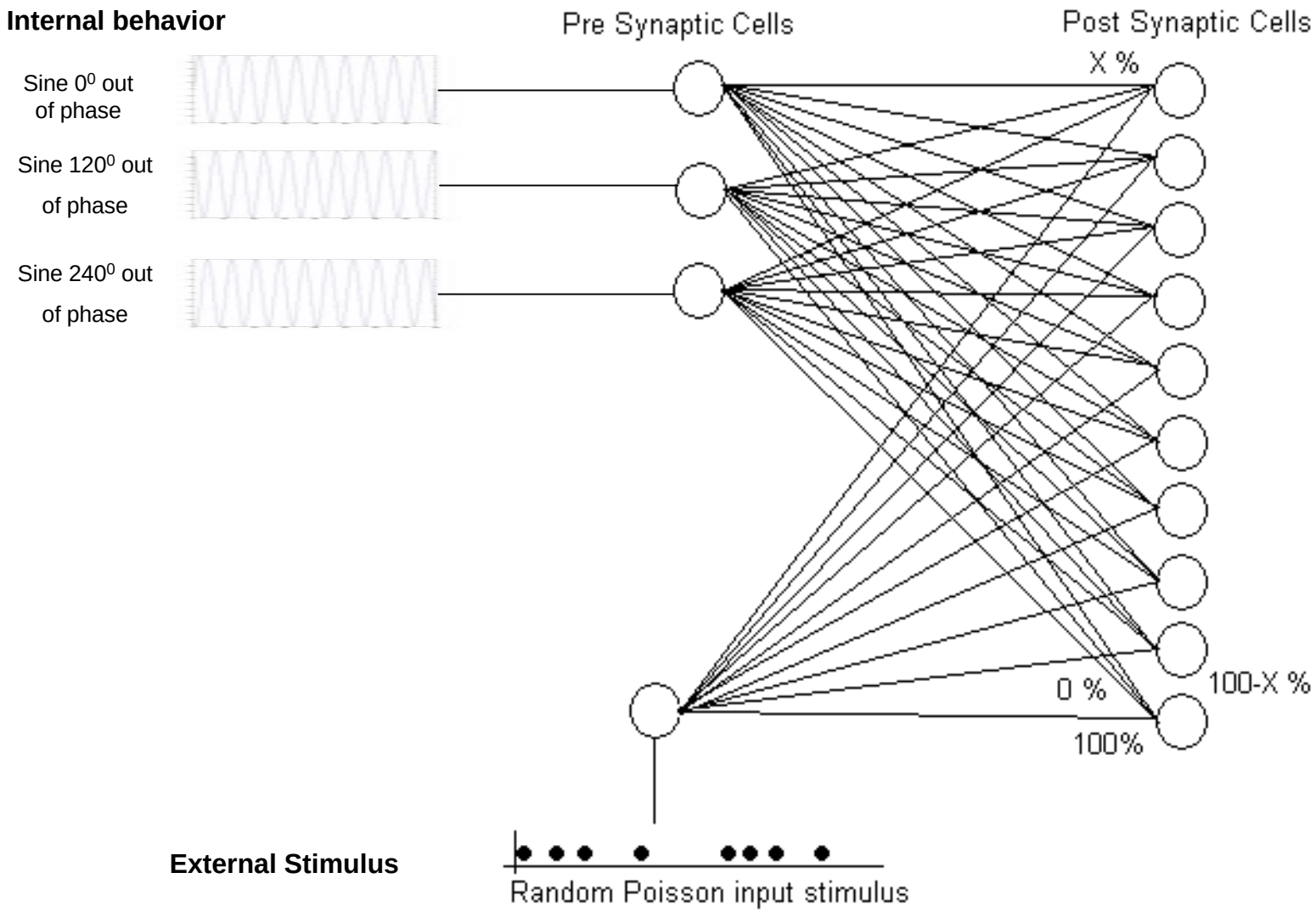
Implementation

- Implementation modules:
  - The neural network model (*.in files) generating the behavior of the lock.
  - Programs in Matlab for analyzing the report files from NCS and for interpreting the results.

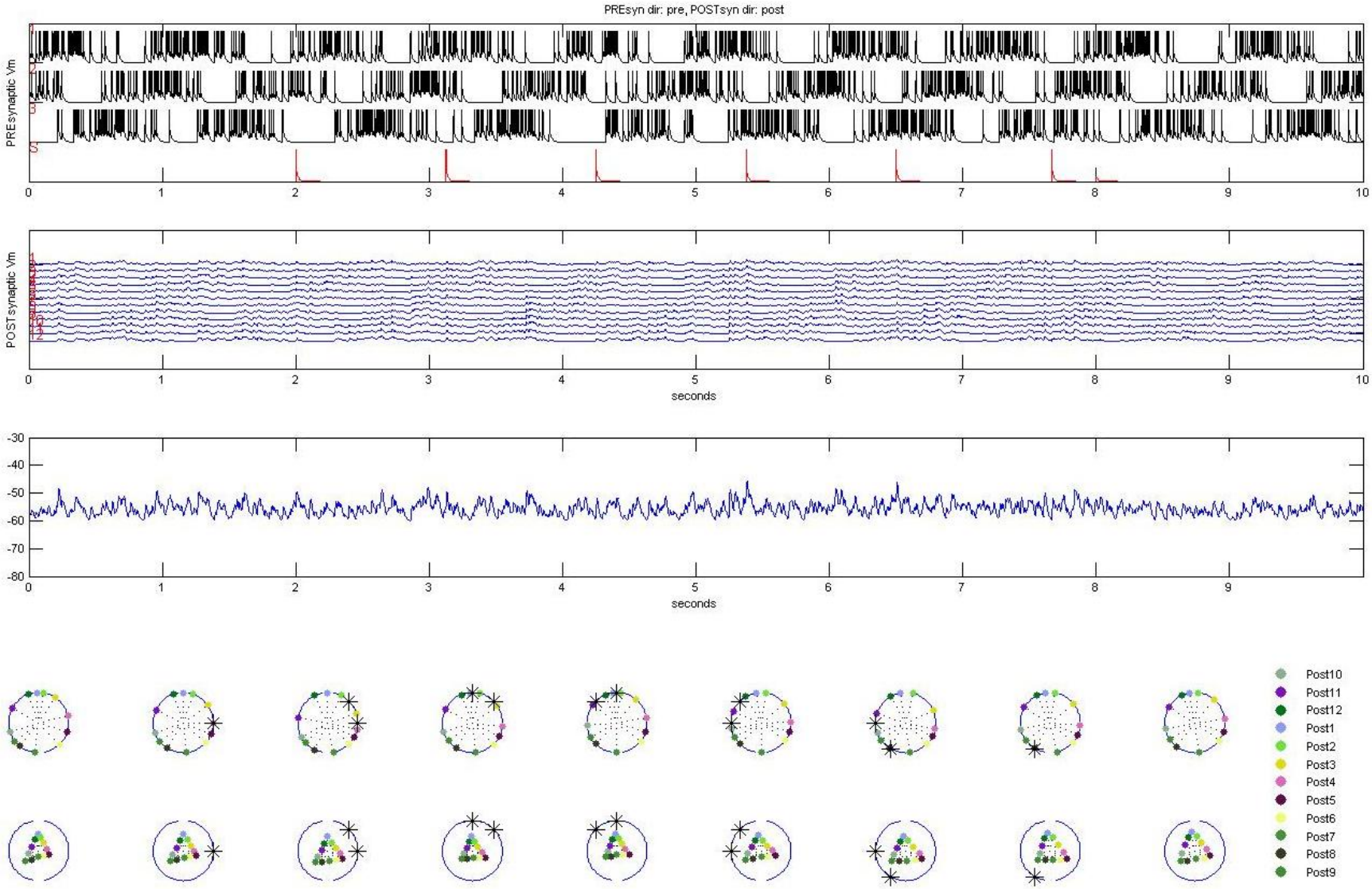
Implementation

- Software and Languages:
  - Neo Cortical Simulator developed in GBCL. Accepts the *.in files as an input.
  - Matlab 7.0, mostly for analyzing the results.
  - Pre-developed Python scripts for automating the generation of *.in file.
- Environment:
  - Windows XP and Linux (NCS clusters).

16 Cell Neural Network



Results



Result of the previous slide's non-spiking network for combinations of Pre-Syn1, 2 and 3 (100%) and single, shifted Poisson signal applied to Pre-Syn 4 cells applied to Post-Syn 1 to 12 cells.

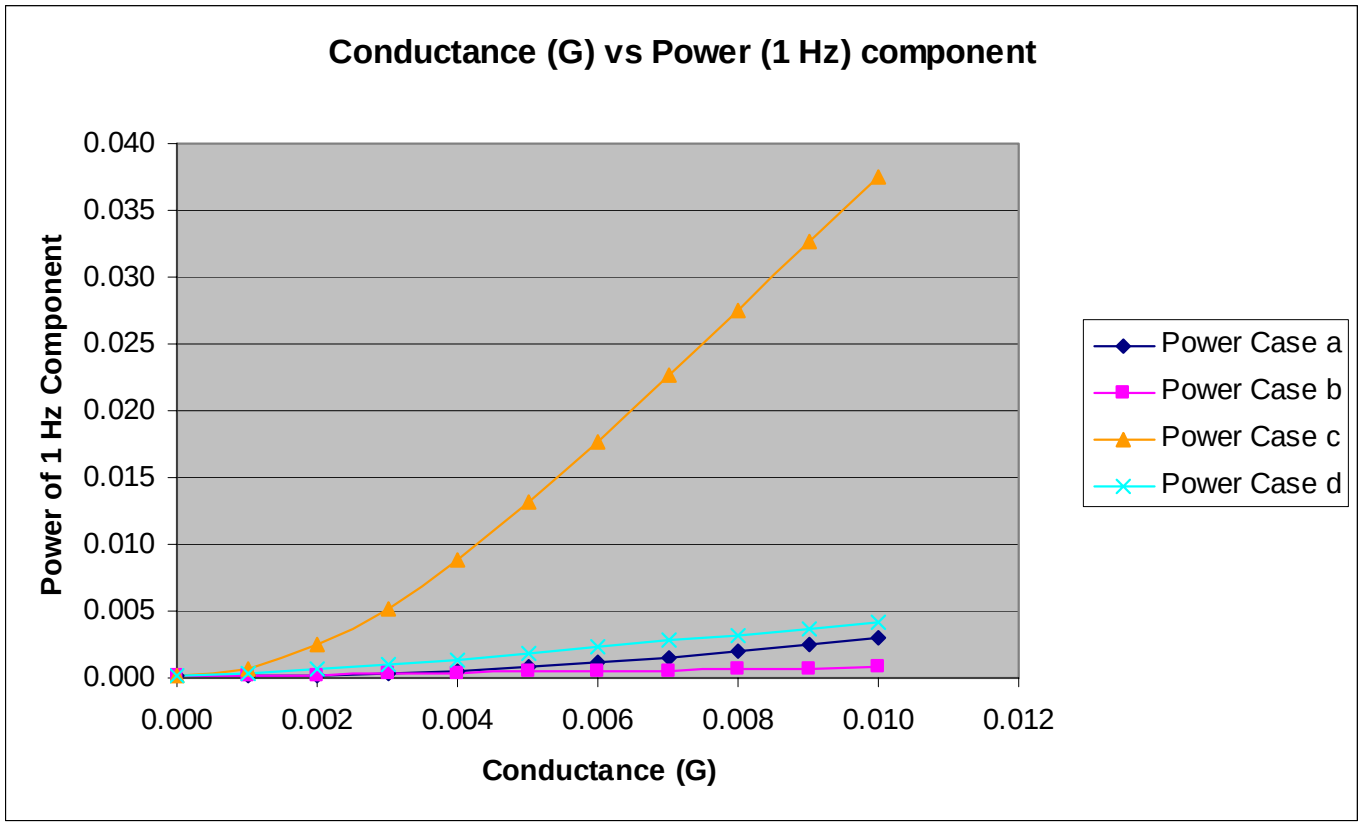
Results

Case a: Single spike at 1 Hz

Case b: Single spike at various phase differences of - 0, 45, 90, 135, 180 and 240

Case c: Multiple spike at 1 Hz

Case d: Multiple spike at various phase differences of - 0, 45, 90, 135, 180 and 240



Synaptic Conductance (G) vs. Power of 1 Hz component in Avg. Global potential.

Next Steps

- Matlab analysis programs development is almost done.
- Simulate the network with different parameters to determine the optimum parameter values.
- Change the external stimulus to other random type of signals.
- Increase the number of cells and use of python for auto-generation of brain model file.
- Self-tuning (learning) network (lock) as per the stimulus (key).

Thank You