UNIVERSITY OF GENOA
DEPARTMENT OF INFORMATICS, BIOENGINEERING, ROBOTICS AND SYSTEMS ENGINEERING
MASTER'S PROGRAM IN BIOENGINEERING

Thesis Project Form

Title (tentative): Emerging properties in the covariance of spike trains of a population of interconnected mixed-signal silicon neurons

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Description

Motivation and application domain

Spiking neural networks aim to bridge the gap between neuroscience and machine learning, using biologically realistic models of neurons for efficient and effective information processing and representation.
As rate coding is not sufficient to capture the intrinsic richness of information impressed in spike trains, correlation among spike trains is frequently advocated. (Linear) correlation is, however, generally difficult to justify in non-linear nervous systems.

General objectives and main activities

The objective of the thesis project is to assess the hypotheses under which the internal transfer of covariance among different parts of a network of interconnected mixed-signal silicon neurons is linear, notwithstanding the intrinsic nonlinear response of individual neurons.
Specifically, one should analyze under which conditions (that are typically satisfied in a model of the primary retinocortical pathway of an active visual system) linear 1st-order dynamics of node-to-node correlations emerge in an interconnected population of LIF neurons.

Training Objectives (technical/analytical tools, experimental methodologies)

The student will learn to employ different methodologies and instrumentation, including:
- Modeling of spiking neural networks using the Python Brian neural network simulator
- Investigation of E-I balanced networks
- Acquisition of signals from a silicon retina producing streams of spikes in response to temporal contrast changes (DAVIS silicon retina sensor)
- Programming scalable multi-core dynamic neuromorphic asynchronous spiking neural network processors (DYNAP-SE)

Place(s) where the thesis work will be carried out: INI (ETH and University of Zurich)

Additional information

Maximum number of students: 1

Financial support/scholarship: Borsa mobilita' paese extra -EU