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

# Thesis Project Form

**Title (tentative):** Reinforcement learning with spiking neural network models and chips

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## Description

**Motivation and application domain**

Biologically inspired model that uses spiking neural networks combined with a â€œwakeâ€• and a â€œsleepâ€• phase learning phase have been recently proposed ad implemented.

**General objectives and main activities**

The goal of the thesis is to implement the neural dynamics in real-time onto the DYNAP-SE mixed-signal spiking neural network chip. The neural network chip will be interfaced to a computer in-the-loop that will be used to implement the reinforcement-learning protocol. The goal is to validate the model and verify its robustness to biologically relevant constraints, such as limited precision, low resolution, sensitivity to noise, and in-homogeneity of neuron and synapse circuits.
Accordingly, the main tasks will be the following ones:
â€¢ implement an on-chip a recurrent spiking network capable to learn in a supervised fashion the world model;
â€¢ build the agent-module that will be interfaced to a computer in-the-loop, which will be used to implement the reinforcement-learning protocol;
â€¢ validate the model and verify its robustness to biologically relevant constraints;
â€¢ benchmark the architecture on standard discrete control tasks.

**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
- 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