

# SYA14 - Neuromorphic Computing

## Lab 3

### 1 Objective

In this lab, we will generate spike trains using different coding techniques.

### 2 Prerequisite

The following are the prerequisites of this exercise:

- Python
- Knowledge about coding techniques

### 3 Ex 3.1: Coding Design

#### 3.1 Rate Coding

**Spike Count Rate** This method is determined by the average number of spikes in an interval time as shown in Eq. (2).

$$v_{sc} = \frac{n_{spike}}{\Delta t} \quad (1)$$

#### 3.2 Temporal Coding

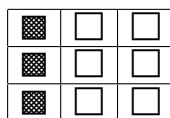
**Time-to-first-spike:** The idea is to encode the latency information of the first spike event given a stream of spikes, where the precise timing of the spikes indicates the strength of the stimulation  
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$$v_{tsf} = \frac{\text{time-step of the spike}}{\text{total number of time-steps}} \quad (2)$$

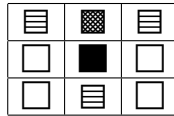
#### 3.3 Exercise content

Generate the spikes for the following patterns:

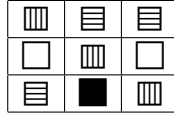
Pattern 01:



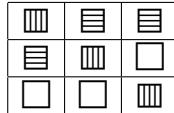
Pattern 02:



Pattern 03:



Pattern 04:



The normalized values are:

- : 1.0
- : 0.8
- : 0.6
- : 0.4
- : 0.0

## 4 Ex 3.2: Reconstruction of spikes

In this exercise, we will write a Python program to reconstruct the spikes into actual values. By using the output spikes of Ex 3.2, we rebuild the input values and compare the difference between the values are used to generate the spikes and the values are reconstructed.

### 4.1 Exercise content

- Download an image from the internet (or your own photo).
- Crop and scale the image to a size of  $128 \times 128$
- Convert the image to grayscale. Normalize the pixels to the maximum value.
- Generate spikes using Ex 3.1
- Reconstruct the image from spikes.
- Compare the differences between the input grayscale image and the reconstructed images.
- Perform for each coding technique

## 5 Ex 3.3: RTL design of coding generator

### 5.1 Exercise content

1. Write the RTL equivalence (in Verilog HDL) of the Python code.
2. Generate the spikes
3. Compare the differences between RTL and Python.

## 6 Submission format and Deadline

Your report should be prepared in English and should contain the following:

1. Your name, your ID, and the Lab #.
2. All reports
3. Submission format: soft copy.

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Note: This Laboratory is designed for the book <sup>1</sup>

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<sup>1</sup>Book: Neuromorphic Computing Principles and Organization 1st, Edition, ISBN-10: 3030925242, ISBN-13: 978-3030925246, Publisher: Springer, May 2022.