# Assignment

SAiDL Summer of Code: Exploring applications of Spiking Neural Networks

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1. Implement a Leaky Integrate and Fire model considering it equivalent to a RC circuit (Refer to section 4.1 of the book Spiking Neuron Models: Single Neurons, Populations, Plasticity) in Python using the libraries numpy and matplotlib. The LIF neuron is modeled using the following equation:

$$\tau \tfrac{du}{dt} = -u + IR$$
$$u(t^{(f)}) = \nu$$
$$lim_{t->t^{(f)}, t>t^{(f)}} = u_{rest}$$
$$u = u_{rest} \; if \; t^{(f)} \; < \; t \; < \; t^{(f)} + t_{refrac}$$

Values: C= 5 uF, R= 2 KOhm, $u_{rest}$= 0 mV, $t_{refrac}$= 5 msec, $\nu$ = 1 mV
(Hint: See Euler method)

a .Simulate the model for 100 msec with a suitable timestep. Plot the input current vs. time graph and the membrane potential (u) vs. time graph for when the input current (I) is:

I. I = 2uA for 10ms <= t <= 75ms; I = 0Amp otherwise
II. I = 1.5uA for 0ms <= t <= 100ms
III. I = 5sin($\omega$t) uA where $\omega = 45\frac{deg}{msec}$
IV. I = -2sin($\omega_1$t) + 3sin($\omega_2$t) + cos($\omega_3$t) uA where $\omega_1 = 45\frac{deg}{msec}$, $\omega_2 = 60\frac{deg}{msec}$, $\omega_3 = 30\frac{deg}{msec}$

b. Notice that for steady current, the neuron constantly fires with a frequency $\nu_{firing}$. This is dependent on the input current (I). Show this dependency by plotting the $\nu_{firing}$ vs. I curve.

2. Create an Artificial Neural Net in numpy which computes the XOR/XNOR of two bit binary numbers depending on a third input. The following table shows the input and outputs.

| INPUT TO ANN | | | |
|---|---|---|---|
| Bit 1 | Bit 2 | XNOR(0)/XOR(1) | Output |
| 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 |
| 0 | 0 | 1 | 0 |