**SNN TUTORIAL**

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**Document version: 1.1**

**Version log**

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| ***Version*** |  | ***Date*** |
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| ***1.1*** | ***Update LIF*** | ***16.6.2023*** |
| ***1.0*** | ***Init*** | ***16.6.2023*** |

# Neuron Modeling

## Leaking Integrated and Fire (LIF)

1. Modeling (ODE)

The dynamics of the membrane potential V(t), in the LIF neuron model is given by the equation



*V*(*t*) - membrane potential

*C* – membrance Capacitance

*gL* – leak condution

*EL* - leak reversal potential

*Iapp –* is the externally applied current (positive for current flowing into the cell)

When V(t) ≥ VT, a spike is issued and V(t) is reset to EL

(We will write this as V (t)→ EL).

1. Simulation parameter

C= 300 pF,

gL = 30 nS,

VT = 20 mV and

EL = -70 mV

1. Simulation

+ Write an expression for the steady state value of the membrane potential

ODE in steady state means:



Therefore





Spike is issued when *VS* > *VT*

So, we can calculate the minimal *Iapp* value (*IC*), that can generate output spike.



Substitudes, we get:



+ Simulate N neurons

Check *main.m*

*Main.m* scripts call 3 other functions for LIF model, anh user defined plot

## Izhikevich model

1. Modeling (ODE)



When V (t) ≥ vpeak, V (t)→c and U(t)→U(t) + d

By varying the parameters C; Er; Et; kz; a; b; c and d, a variety of neuronal behaviors can be modeled.

1. Simulation parameters

Some parameters sets and their names:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | *C*[*pF*] | *kz*[*mS/V*] | *Er*[*mV*] | *Et*[*mV*] | *a*[*kHz*] | *b*[*nS*] | *c*[*mV*] | *d*[*pA*] | *vpeak*[*mV*] |
| RS | 100 | 0.7 | -60 | -40 | 0.03 | -2 | -50 | 100 | 35 |
| IB | 150 | 1.2 | -75 | -45 | 0.01 | +5 | -56 | 130 | 50 |
| CH | 50 | 1.5 | -60 | -40 | 0.03 | +1 | -40 | 150 | 25 |

1. Simulation

## Hodgkin-Huxley

## Adaptive Exponetial Integrated and Fire (AEF)

# Tempotron

# Network and Spike-Timing Dependent Plasticity (STDP)