Basics of Computational neuron

Thursday, 20 November 2025 5:28 PM

#The logic Behind LIF

- Water coming in = input current
  Higher current = faster filling
- Water level = membrane voltage
  Voltage rises as current enters
- Hole at the bottom = leakage
  Voltage slowly leaks out
- If water reaches the top = spike
  Voltage hits threshold → neuron fires
- After firing, bucket empties instantly
  Voltage resets.

Key Terms

- membrane Potential (V)
  The internal voltage of the neuron
  Starts low, Builds up, then spikes
- Threshold
  A voltage level at which the neuron fires.
- Reset voltage
  After spike, voltage returns here.
- Input Current (I)
  External stimulations (like sensory input)
- Leakage
  Voltage naturally decay over time.

How a computation Neuron Works Internally (LIF model)

Equation

$$\frac{dV}{dt} = -(V/\tau) + I$$

$-(V/\tau)$ is the neuron is losing some of its voltage over time.

$+I$ is the neuron is receiving input current that increases voltage.

- The loop (every millisecond)

Step A: Add Input

Voltage += input voltage

Step B: Apply leakage

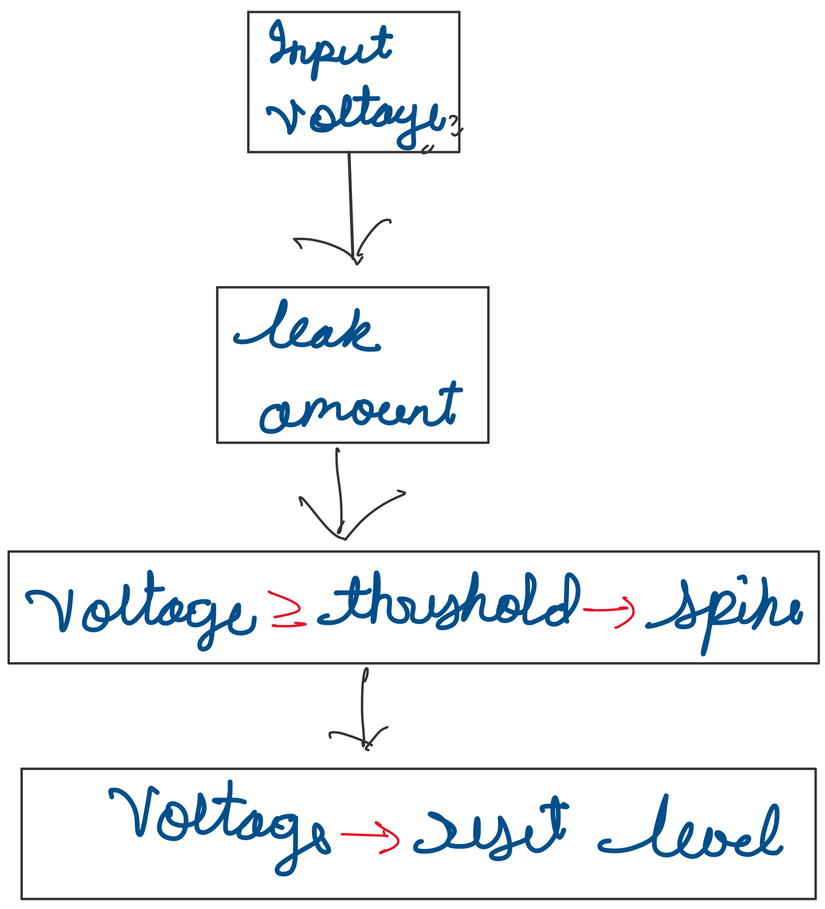
Voltage -= leak amount

Step C: Compare the threshold

If voltage ≥ threshold → spike

Step D: After spike

Voltage → rest level



Spike Train = Brain Communication

- Rapid spike → "Urgent signal"
- Slow spike → "calm state"
- Bursts → "Fear or attention"
- Random patterns → "Exploration or noise"

3 Parts of spike train