

Spike Trains

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2:07 PM

Goal to learn about spike patterns, Rate & Emotional Logic

1. What is a spike train?

A spike train is just a series of spikes over time:

1 1 1 1

Each "1" is a spike = the neuron firing.

That's it.

But the spacing between spikes carries meaning.

2. Why does the brain use spikes?

Because spikes are:

- fast
- reliable
- energy-efficient
- easy to detect
- hard to corrupt
- good for long distance communication

3. Firing Rate = how many spikes in a time window

Example:

Time = 1 second

Spikes = 10

→ firing rate = 10 Hz

This tells how "active" the neuron is.

Emotional meaning:

- High rate → stress, anxiety, strong input
- Low rate → calm
- Medium rate → neutral

4. Inter-Spike Interval (ISI)

ISI = time between two spikes,

Example:

1 1
 ^-----^
 ISI

Emotional meaning:

- Short ISI → fast spiking
- Long ISI → slow spiking
- Irregular ISI → unstable (stress/anxiety)
- Very regular ISI → calm or focused

5. Bursty Firing

Burst = a cluster of spikes together:

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This happens when the neuron is reacting suddenly or strongly.

Emotional meaning:

- Burst = fear, shock, sudden strong emotion
- Appears in amygdala-like circuits

6. Rhythmic Firing

Spikes occurring at regular intervals:

1 1 1 1 1

Emotional meaning:

- Rhythm = focus, attention, steady state
- Happens in stable circuit (PFC, motor cortex)

7. Noisy/Irregular Firing

Spikes with no clear pattern:

1 1 1 1 1 1 1

Emotional meaning:

- anxiety
- stress
- unpredictability

This is important for your emotional classifier.

8. Why spike trains matter for your project

You will generate spike trains for:

- Calm
- Stress
- Fear
- Excitement

The ML model will learn from:

Firing rate

ISI

Bursts

Rhythm

Randomness

Spike trains = dataset.

Summary:-

- Spike train = sequence of neuron spikes
- Brain uses spikes instead of continuous signals
- Firing rate shows activity level
- ISI shows timing precision
- Burst firing = strong reaction
- Rhythmic firing = steady emotional state
- Irregular firing = anxiety/stress
- Spike features → used for emotion classification.