Week 2 – part 1: Biophysics of neurons

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Neuronal Dynamics:
Computational Neuroscience of Single Neurons

Week 2 – Biophysical modeling:
The Hodgkin-Huxley model

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2.1 **Biophysics of neurons**
- Overview

2.2 **Reversal potential**
- Nernst equation

2.3 **Hodgin-Huxley Model**

2.4 **Threshold in the Hodgkin-Huxley Model**
- where is the firing threshold?

2.5. **Detailed biophysical models**
- the zoo of ion channels

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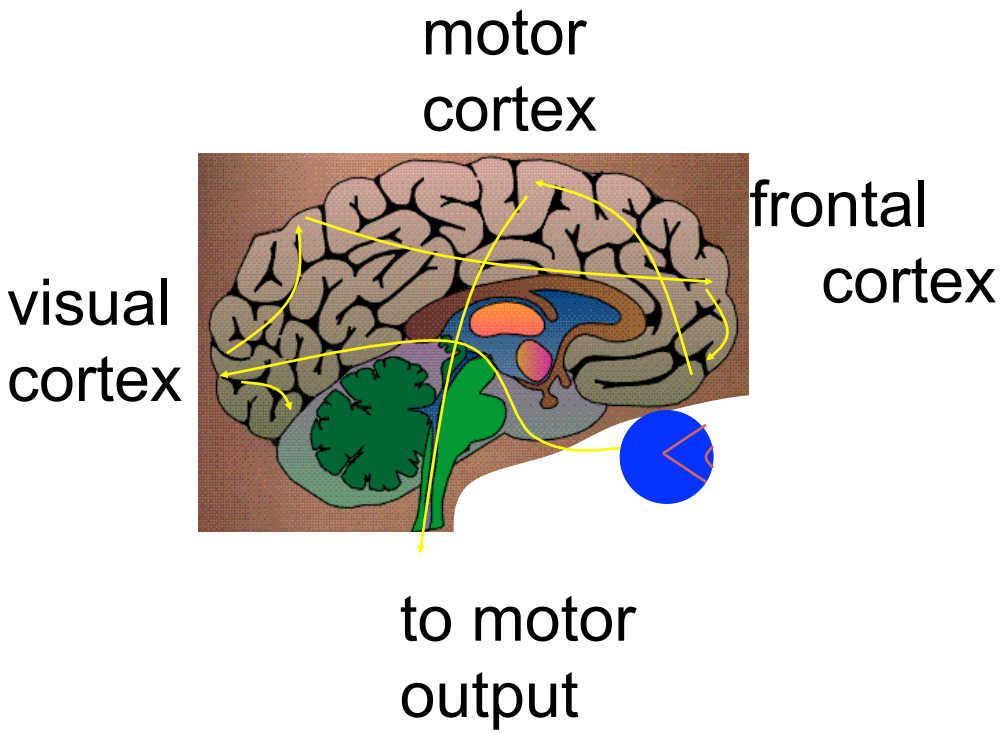
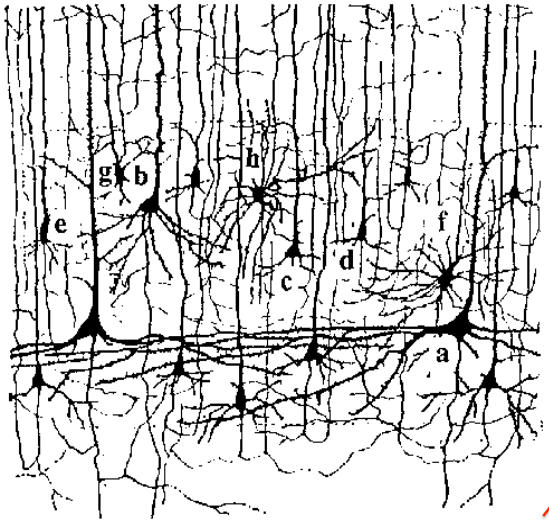
Neuronal Dynamics – 2.1. Introduction

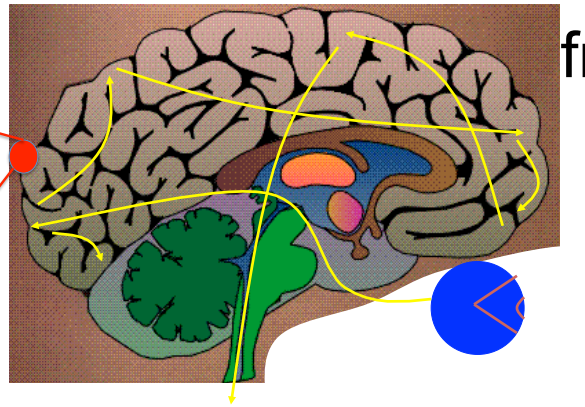


Neuronal Dynamics – 2.1. Introduction

10 000 neurons
3 km wires



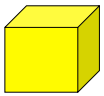
motor
cortex



frontal
cortex

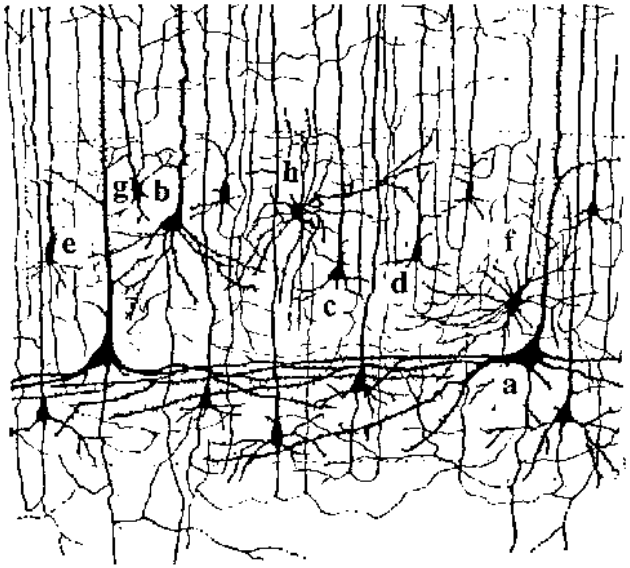
to motor
output

Neuronal Dynamics – 2.1 Introduction



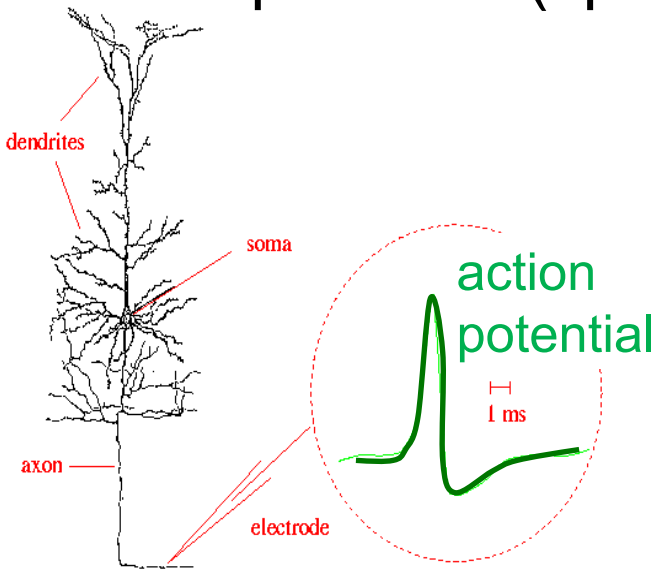
1mm

10 000 neurons
3 km wires



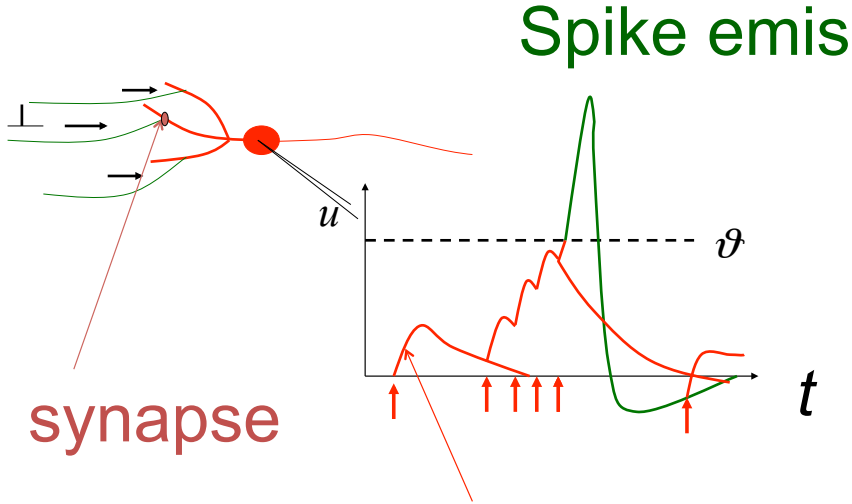
Ramon y Cajal

Signal:
action potential (spike)



How is a spike generated?

Review of week 1: Integrate-and-Fire models



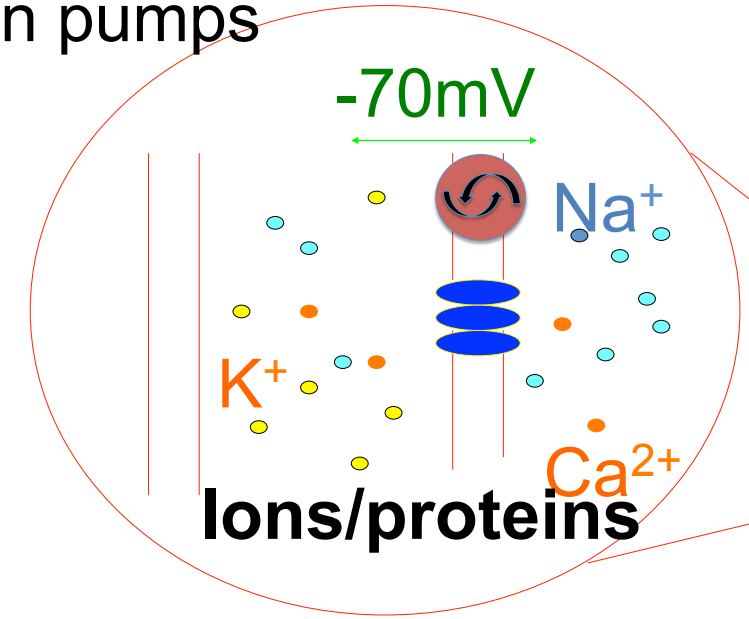
-spikes are events
-triggered at threshold
-spike/reset/refractoriness

Neuronal Dynamics – week 2: Biophysics of neurons

Cell surrounded by membrane

Membrane contains

- ion channels
- ion pumps



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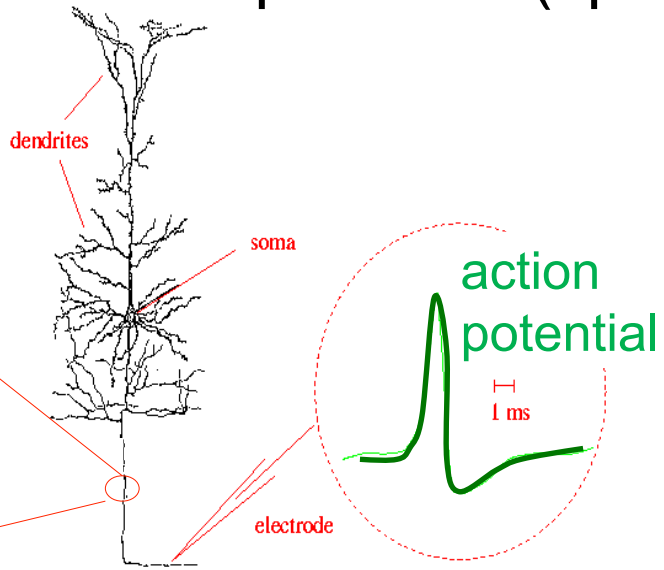

Neuronal Dynamics – week 2: Biophysics of neurons

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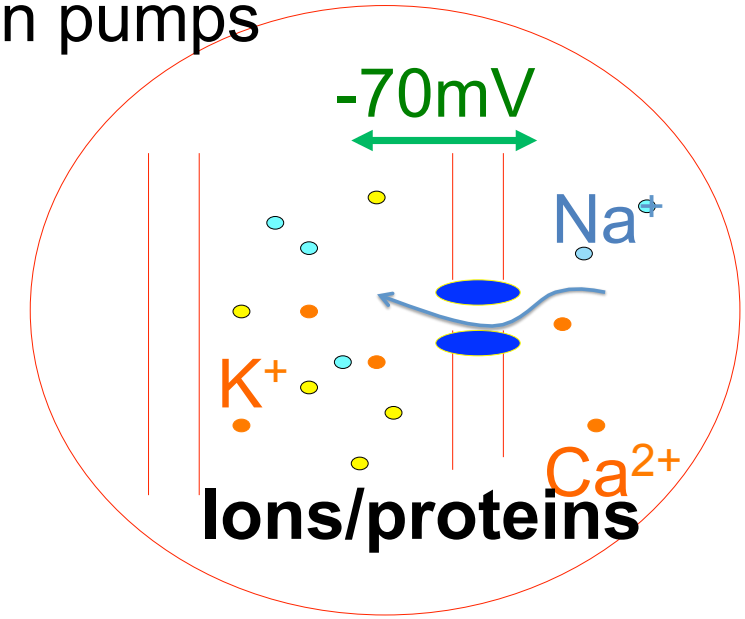

Resting potential -70mV
→ how does it arise?

Ions flow through channel
→ in which direction?

Neuron emits action potentials
→ why?

Neuronal Dynamics – 2. 1. Biophysics of neurons

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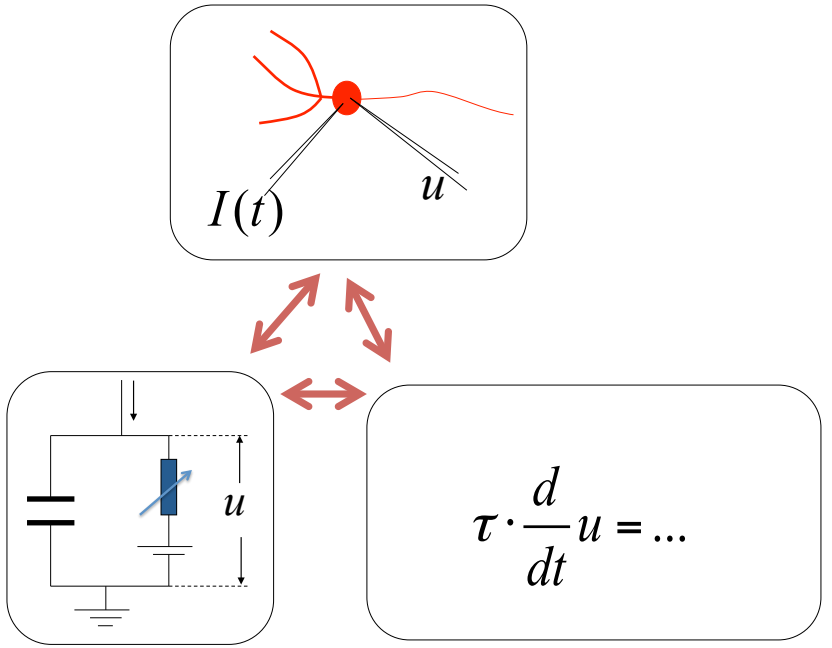
→Hodgkin-Huxley model

Hodgkin&Huxley (1952)
Nobel Prize 1963

Neuronal Dynamics – 2. 1. Biophysics of neurons



→Hodgkin-Huxley model

Hodgkin&Huxley (1952)
Nobel Prize 1963

Neuronal Dynamics – Exercises 2.1

In a natural situation, the electrical potential inside a neuron is

[ ] the same as outside
[ ] is different by 50-100 microvolt
[ ] is different by 50-100 millivolt

Neurons and cells

[ ] Neurons are special cells because they are surrounded by a membrane
[ ] Neurons are just like other cells surrounded by a membrane
[ ] All cells have a cell membrane

Ion channels are

[ ] located in the cell membrane
[ ] special proteins
[ ] can switch from open to closed

If a channel is open, ions can

[ ] flow from the surround into the cell
[ ] flow from inside the cell into the surrounding liquid

Multiple answers possible!