

Characterization of the sequential nature of neuronal dynamics: Experimental recordings, computational models and novel stimulation neurotechnologies

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Universidad Autónoma de Madrid

Alicia Garrido Peña. PhD thesis Seminar
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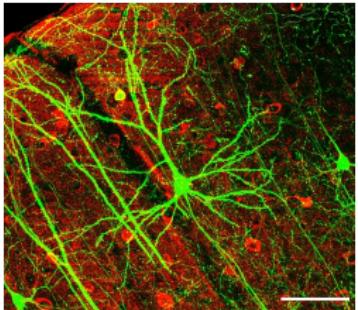
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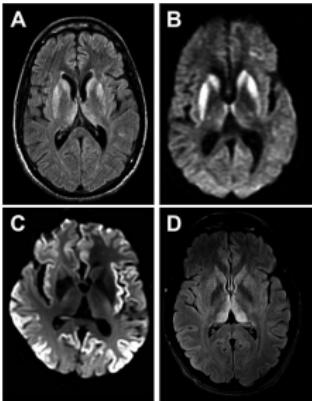
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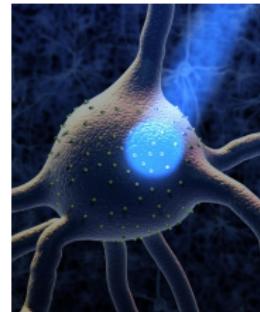
Neuroscience



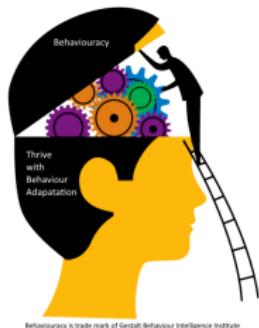
Neurobiology



Clinical Neuroscience



Neurotechnology

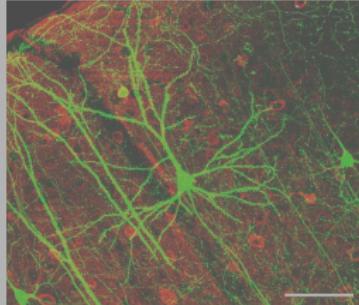


Cognitive Neuroscience

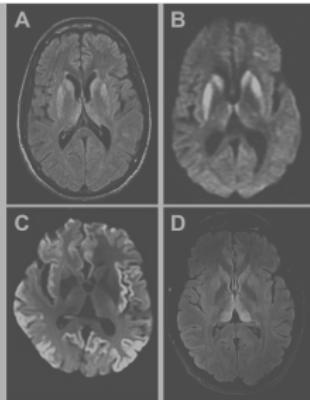


Computational Neuroscience

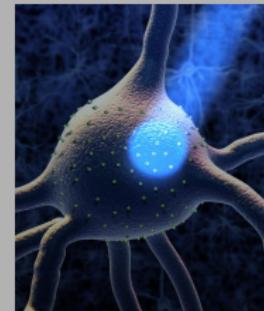
Neuroscience



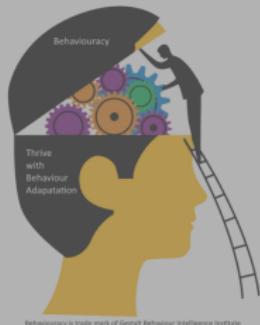
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Computational Neuroscience

Approach

- Neurocomputational Perspective

Approach

- ❑ Neurocomputational Perspective
- ❑ Bottom-up approach

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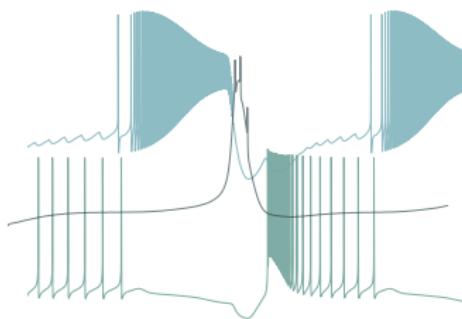
From ionic channels

Approach

- Neurocomputational Perspective
- Bottom-up approach



From ionic channels



To minimal circuits

Approach

- ❑ Neurocomputational Perspective
- ❑ Bottom-up approach
- ❑ Combining electrophysiology

Approach

- ❑ Neurocomputational Perspective
- ❑ Bottom-up approach
- ❑ Combining electrophysiology and computational work

Neuronal and Networks Dynamics

Neuronal electrical activity is often described in terms of the evolution of membrane voltage caused by the flow of ionic channels between the inside and outside of the cell.

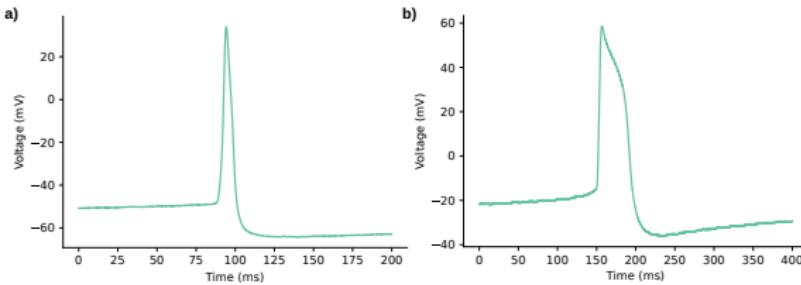
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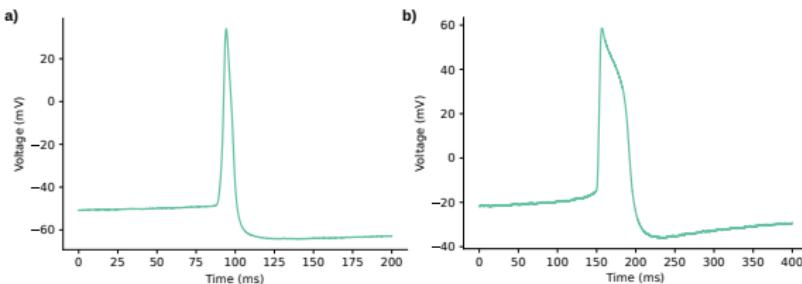
In terms of the spike waveform:



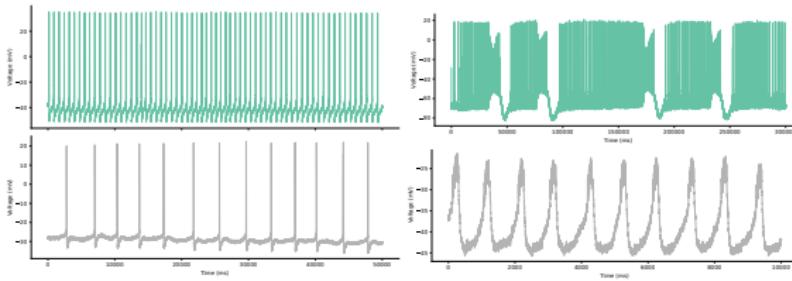
Neuronal and Networks Dynamics

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In terms of the spike waveform:



And the type of spiking activity: tonic firing, bursting, etc.

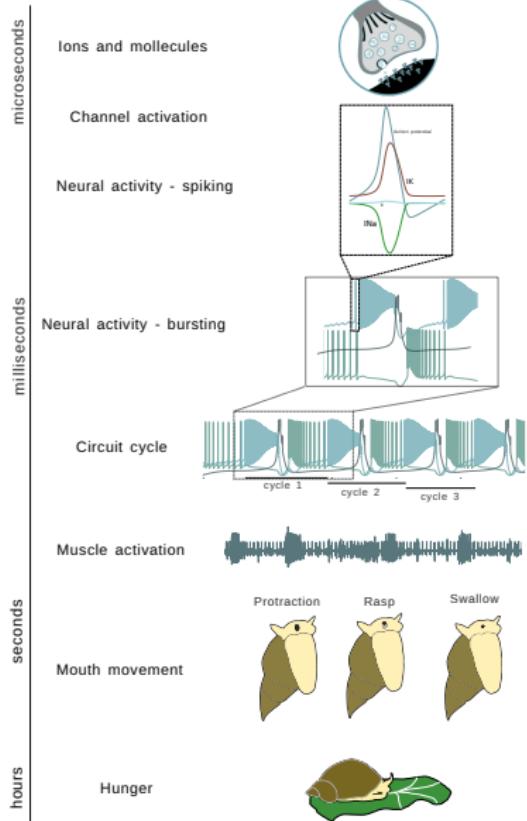


The sequential nature of neural dynamics

- There are sequential processes at different time-scales.

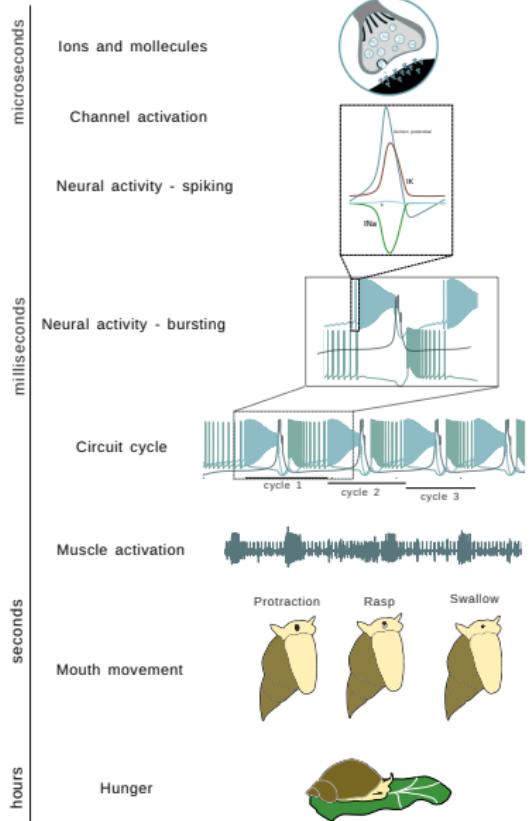
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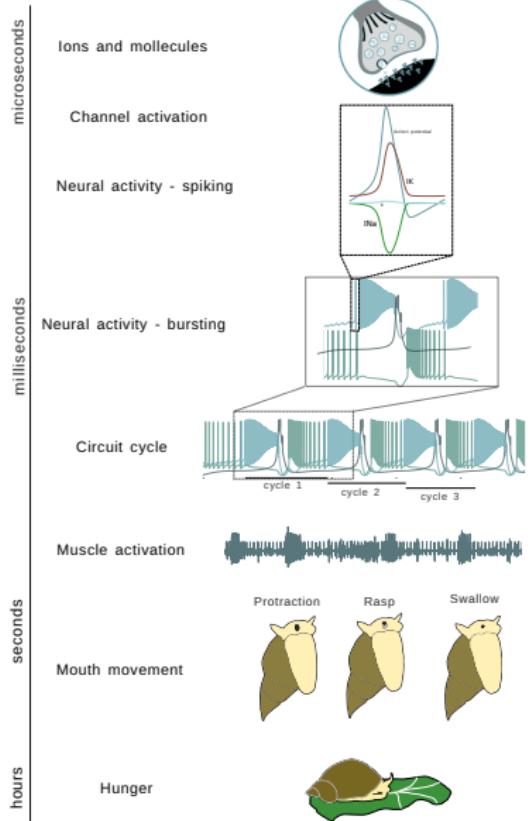
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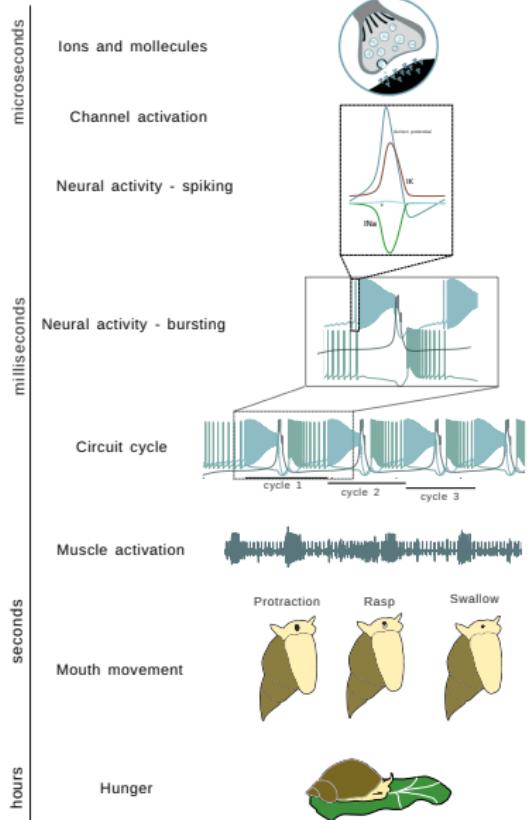
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- Motor control, speech, decision making, etc.



The sequential nature of neural dynamics

- ❑ There are sequential processes at different time-scales.
- ❑ Many behaviors and actions are governed by sequential processes
- ❑ Motor control, speech, decision making, etc.
- ❑ Sequential dynamical invariants might have a crucial role in neural coordination to autonomously establish a balance between the robustness and flexibility required for effective function.



Studying neural dynamics in computational models

- Computational models are powerful tools to study neural dynamics

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Conductance-based models

Voltage equation	$C \frac{dV}{dt} = I - g_K n^4(V - E_K) - g_{Na} m^3 h(V - E_{Na}) - g_L(V - E_L)$		
	Activation variables	Inactivation variable	
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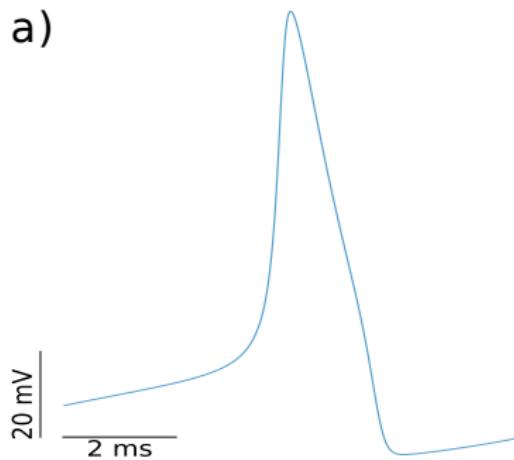
By different combinations of ionic channels we can achieve different activities and waveform shapes

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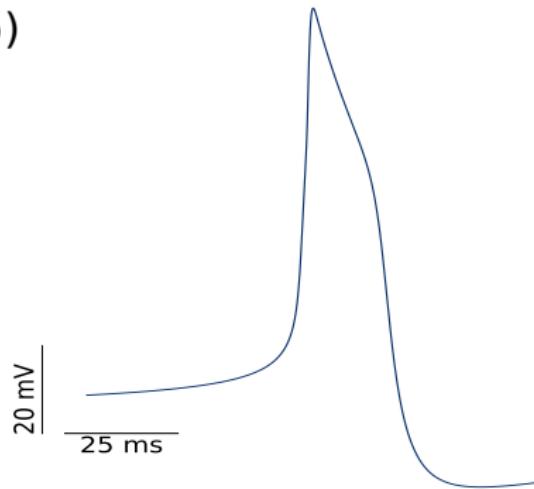
Conductance-based models

By different combinations of ionic channels we can achieve different activities and waveform shapes

a)



b)



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Conductance-based models

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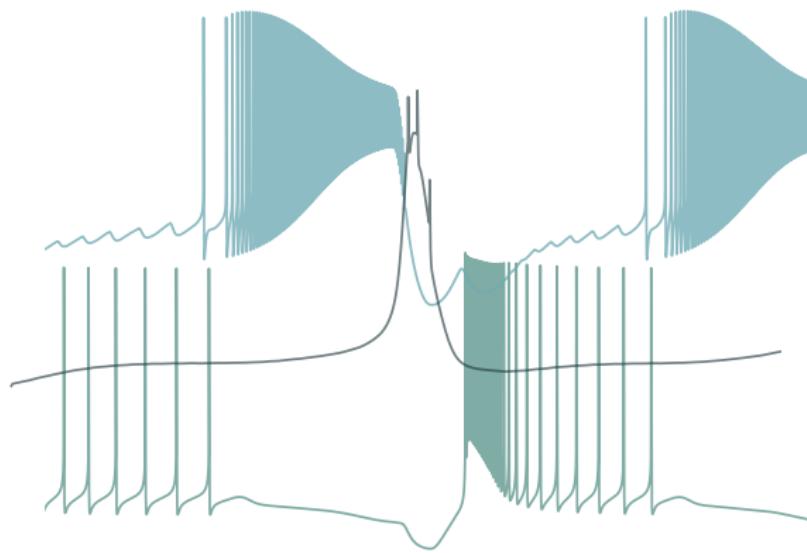
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 - ❑ Ease of breeding and reproduction.
 - ❑ Full description of their systems.

Neural stimulation

Motivation and Objectives

Conclusion



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