Implementing the Hodgkin Huxley Model

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You guys are awesome!

Outline of our 10-slide presentation

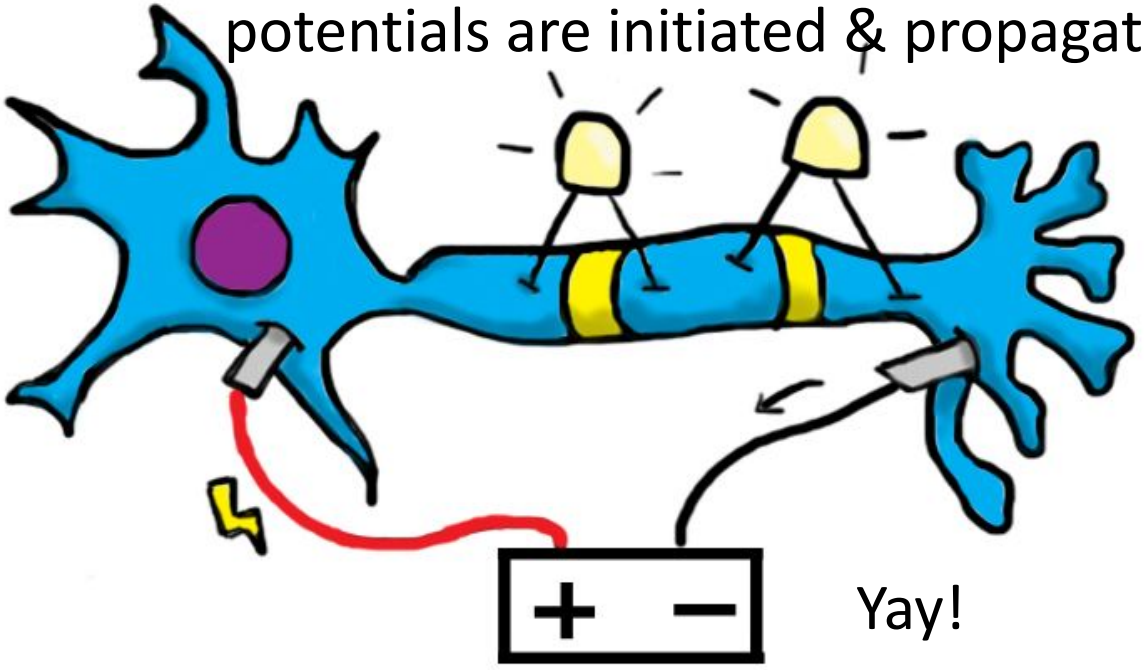
- Reviewing the Hodgkin Huxley Model

  (Simplifying it so you can explain it to your future grandchildren)

- Showing the model implementation
- Manipulating the model

Why implement H-H?

Because it describes how action potentials are initiated & propagated!



Yay!

Four equations approximate the electrical characteristics of a neuron

$$I = C_m \frac{\mathrm{d}V_m}{\mathrm{d}t} + \bar{g}_{\mathrm{K}} n^4 (V_m - V_K) + \bar{g}_{\mathrm{Na}} m^3 h (V_m - V_{Na}) + \bar{g}_l (V_m - V_l),$$

capacitance | K current | Na current | leaky current

$$\frac{dn}{dt} = \alpha_n(V_m)(1-n) - \beta_n(V_m)n$$

rate of change of n (probability of K channel being open)

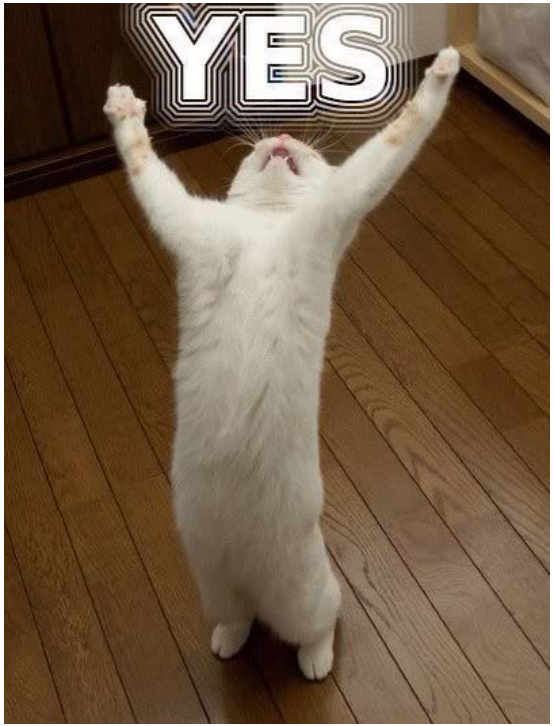
$$\frac{dm}{dt} = \alpha_m(V_m)(1-m) - \beta_m(V_m)m$$

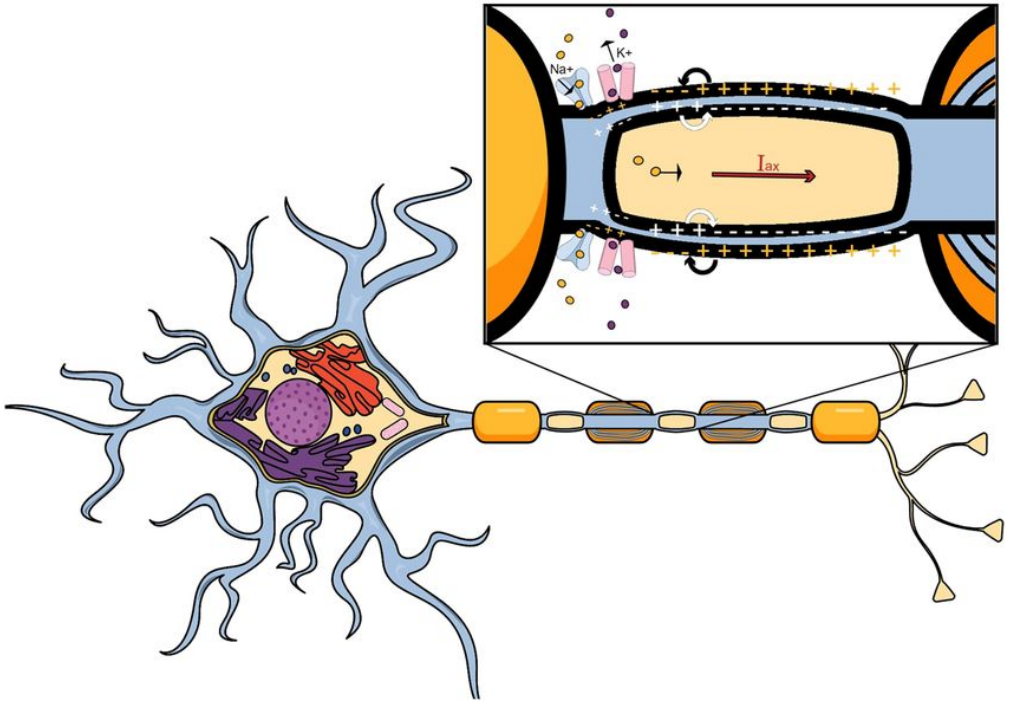
rate of change of m (probability of Na activation channel being active (open channel))

$$\frac{dh}{dt} = \alpha_h(V_m)(1-h) - \beta_h(V_m)h$$

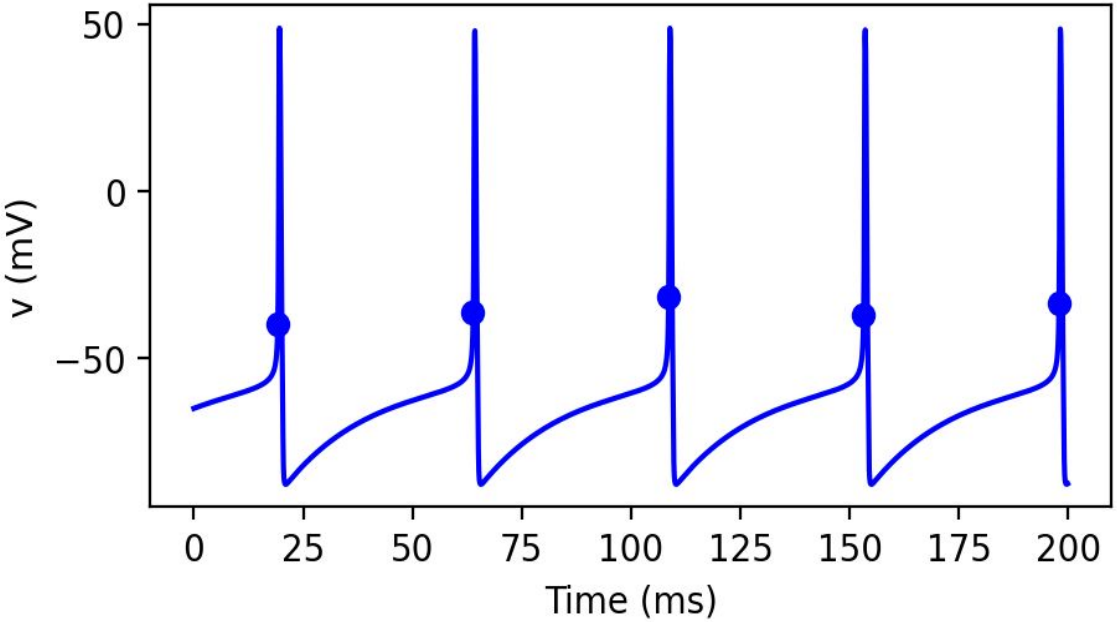
rate of change of h (probability of Na inactivation channel being inactive (open channel))

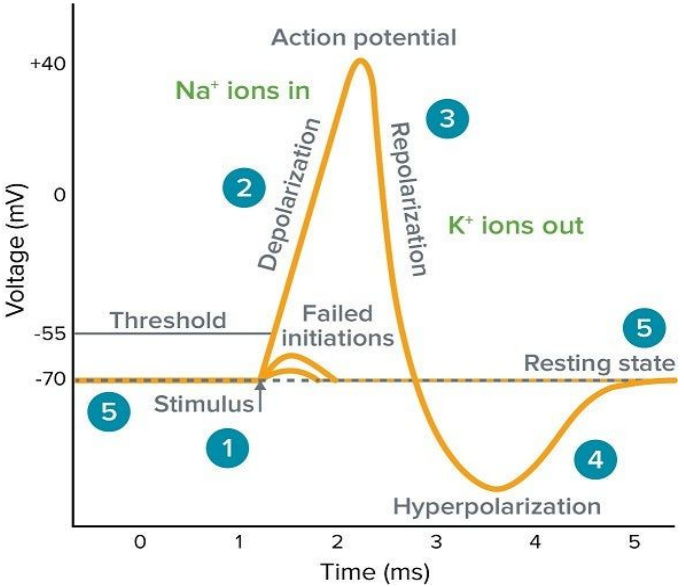
Once more: the H-H Model describes how action potentials are initiated & propagated using four equations





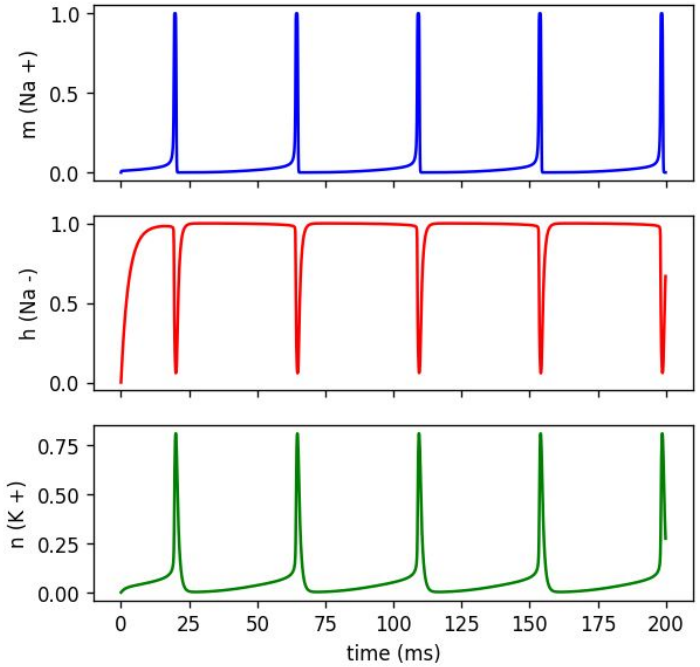
H-H spiking neuron showing beautiful action potentials & the 5 phases of each





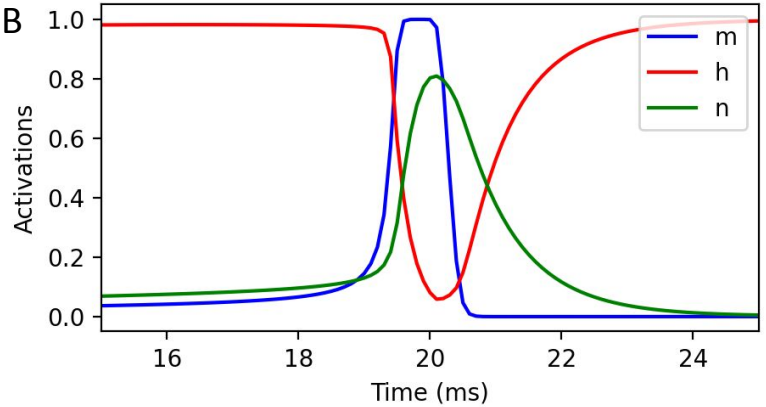
n, m active & h inactive during action potentials

A



n,m,h against time

B



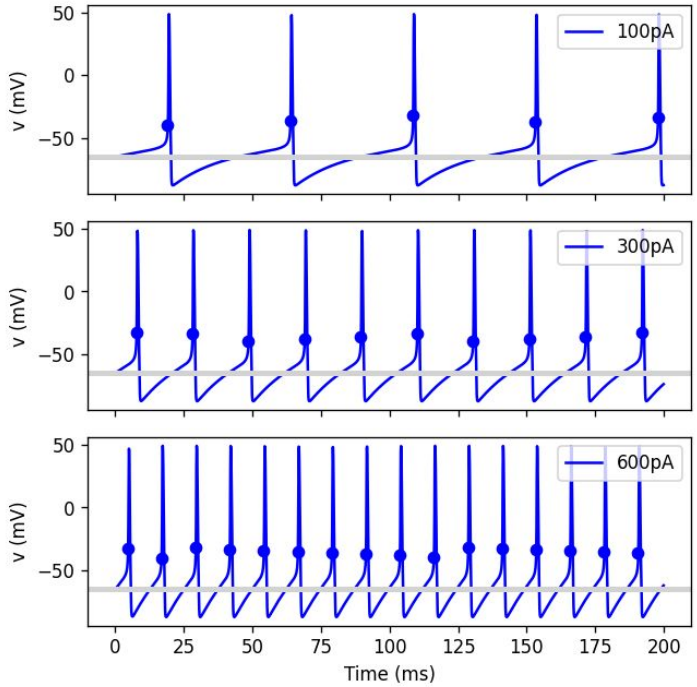
Combined & zoomed in

m= Na activation

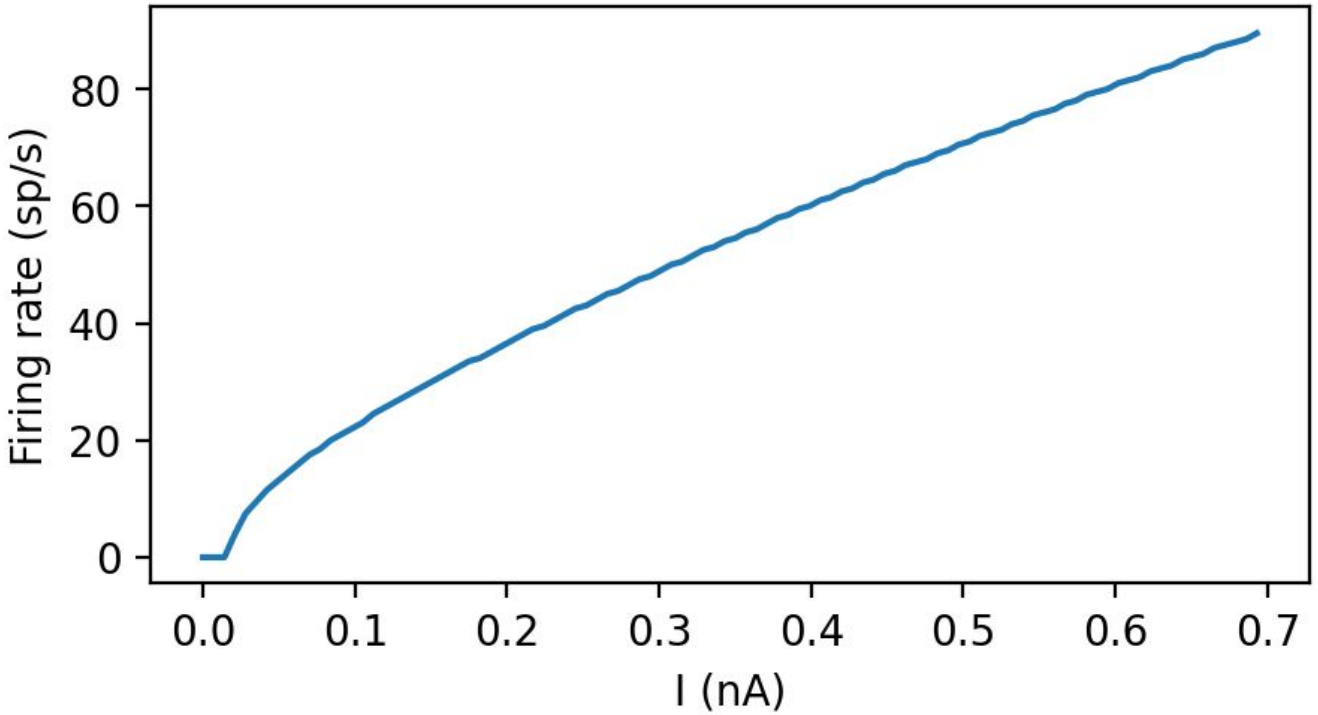
h= Na inactivation

n= K activation

Lets manipulate the model now :)
Increasing the input current increases the spiking



The firing frequency increases with an increasing current



Conclusion

- Understand the propagation of action potential
- Formulated HH model mathematically
- Implemented the HH Model in Brian 2
- Introduced the gating variables to model opening of ion channels

Thank you!