5.8 Part 1: Neuron Basics

Neuron Basics

- Neurons activate to send pulses to other neurons.
- This activation is governed by the amount of *voltage/potential energy.*

Voltage 101

- Voltage is energy stored by charges.
- Charges are positive or negative.
- Opposites attract, likes repel.
- In the cell, think of pairing positive and negative charges.
- Positive and negative pair → Low voltage (maybe negative even).
- Do examples of low and high voltage.

Neuron Dynamics

- Neuron made up of a bunch of fixed, *negative* charges.
- Two ions: potassium (K) and sodium (Na), both positive charges.
- Two gates: one lets out K, another lets in Na.
- There are a couple of modes a neuron can be in.
- Mode 1: Rest. Draw picture of cell with lots of minus; bunch of K, fewer Na.

  - Somewhat high K, sparse amount of Na.
  - Number of positive charges roughly balances the negatives.
  - Hence, low voltage (possibly negative).
- Mode 2: Activating a pulse
- Draw picture with cell; high K and low Na inside, low K and high Na outside.
  - Na channel opens with trigger (voltage reaches a threshold value)
  - LOTS of Na floods in (Voltage spikes quickly).
  - K channel opens, slow outflow of Na and K.
    (voltage drops slowly).
  - Na blocker also activates slowly (slowly stops the quick Na flow)
  - potential slowly decreases; cell reverts back to rest.

What are we going to do?

- Essentially, there are three mechanisms at play here:
  1. A quick increase in voltage (flooding of Na)
  2. A slow decrease in voltage (releasing of K)
  3. A slow decrease in voltage (blocking of Na channel)
- Moral of this class: any time there are multiple mechanisms, a (system of) differential equation(s) will rigorously model the resulting dynamics.
- We saw this in the predator-prey system: multiple mechanisms (feeding, growth, death) all combined into a system of DE for the two populations.

- Here, our goal is a system of DE modeling the different mechanisms.
- What we hope to get: a model that describes the neuron behavior, and maybe a glimpse at emergent properties (neuron failure, for instance)
- Also, a model that is easy to adapt to similar situations.