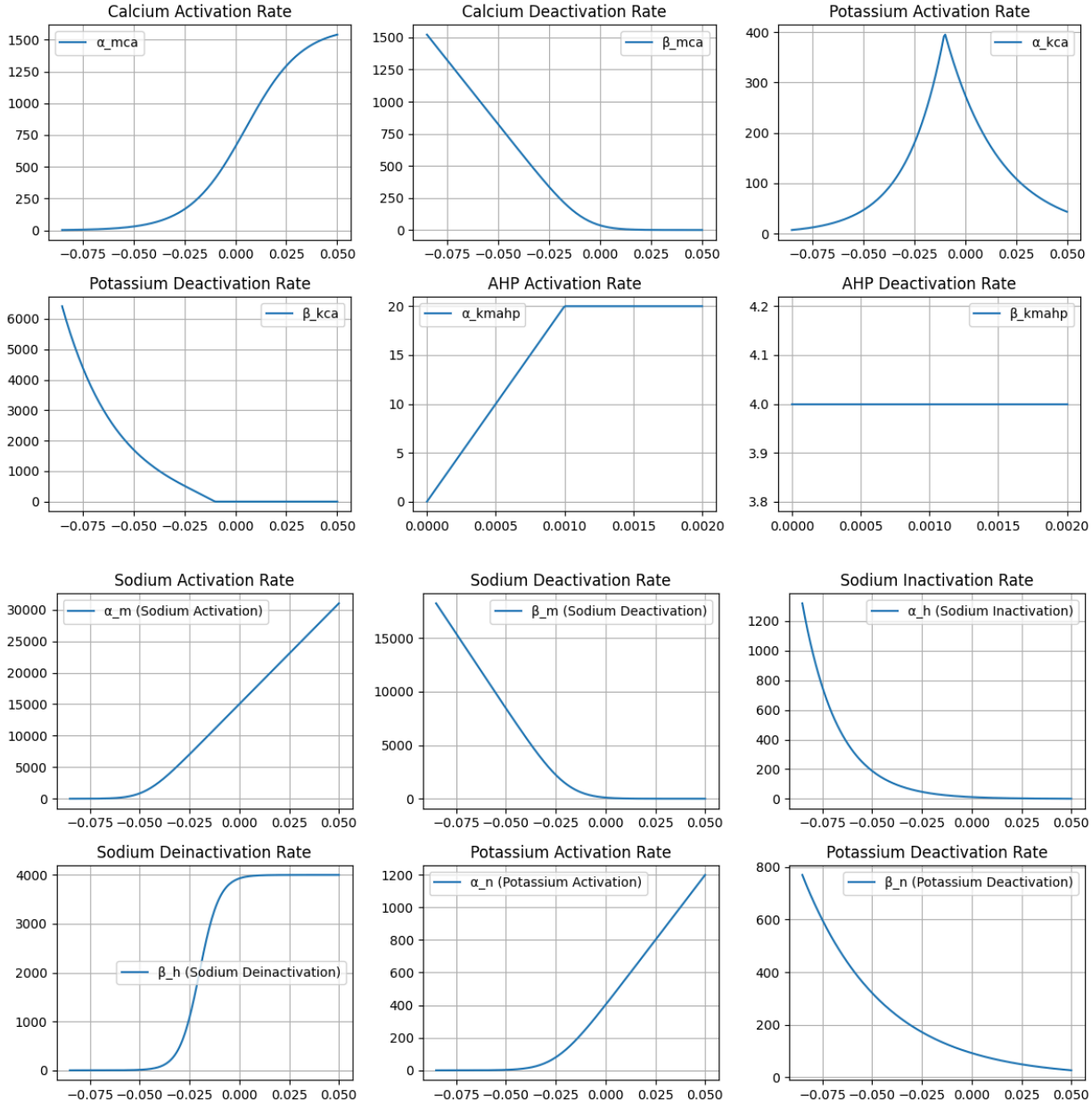
Tutorial 4.3

Stan Wan

Step 1&2: Import and rate constants (line 1 - 71)

I imported PR_dend_gating, PR_soma_gating from pm_functions.py. And 6 outputs generated by each function are plotted by a vector of the membrane potential (between -0.085V and 0.050V) and a vector of calcium concentration (between 0 and 2 × 10^-3M)



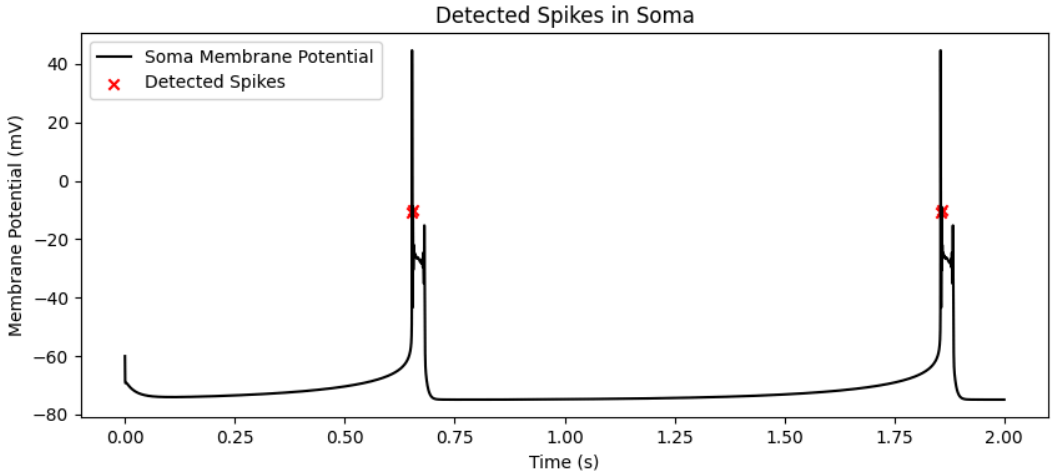
Above are rate constants for Dendrite gating, below are rate constants for Soma gating.

Step 3&4: Simulating the PR Model and Detect Somatic Spikes (line 74 -209)

This simulation models the Pinsky-Rinzel two-compartment neuron, where:

- Dendritic compartment generates calcium spikes.
- Somatic compartment generates action potentials.

The simulation runs for 2 seconds with a 2 μs timestep and solves the differential equations governing ion channel gating and membrane potential dynamics.
The functions and parameters implemented were the same from figure 4.16, except the doubled k-value and G_Link = 50nS.

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Number of detected spikes: 4
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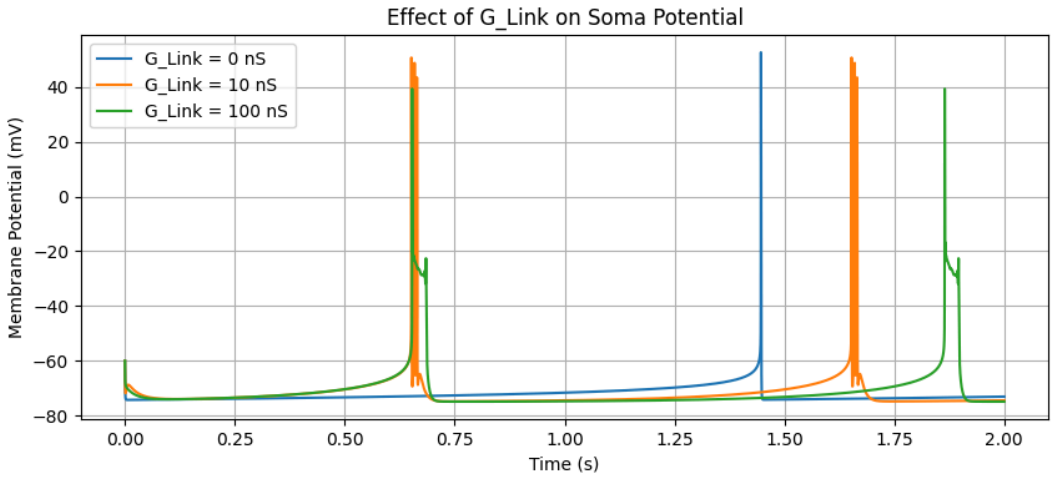
In the 2s time period, two bursts (almost exactly with a 1s interval between) are generated and the **number of spikes** returned by my code is **4**.

Step 5: Assess Model Behavior with Different G_Link Values (line 212 - 226)

Runned the simulation for different coupling conductances (G_Link = 0 nS, 10 nS, 100 nS) and observed how Soma potential changes.



Timing of Bursts:

The bursts occur at different times for different G_Link values. Smaller G_Link (0 nS) results in bursts that occur later compared to larger G_Link (100 nS).

Spike Characteristics:

0 nS (blue): The soma bursts less frequently, and the spikes are sharper.

10 nS (orange): More frequent bursting, and bursts occur earlier compared to G_Link = 0 nS.

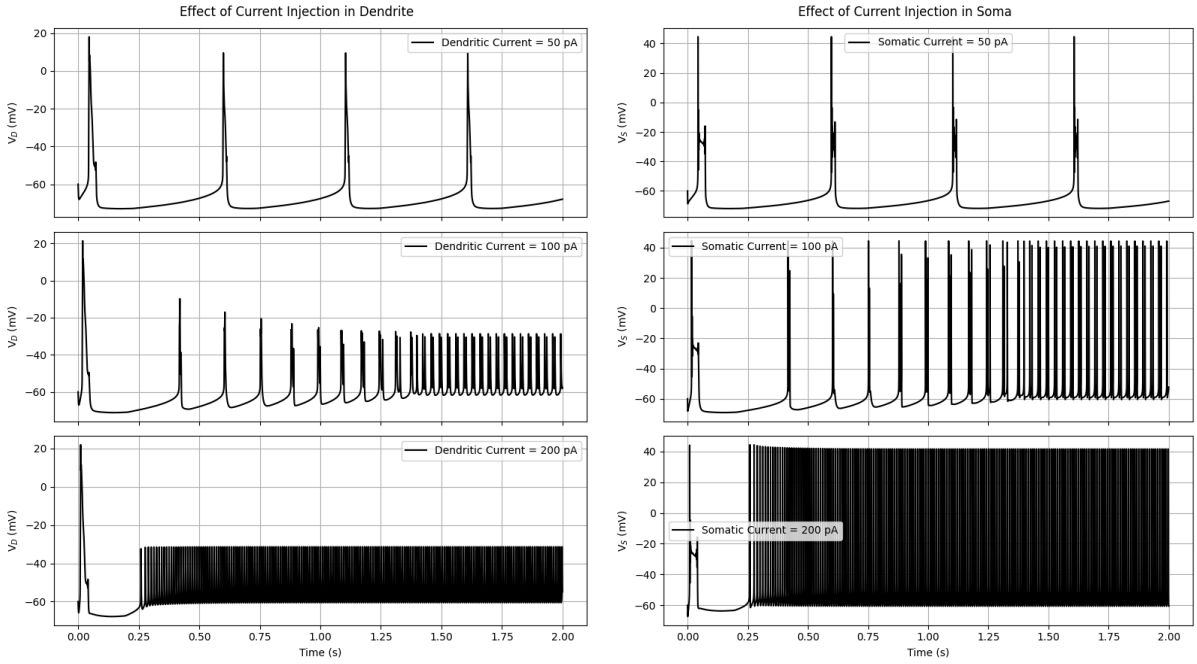
100 nS (green): Bursts are more frequent, and the soma potential fluctuates more before bursting.

Amplitude of Soma Spikes:

The peak spike amplitude is relatively similar across conditions. However, the transition from the resting state starts earlier as G_Link increases.

Step 6: Injecting Current into Soma vs. Dendrite (line 228 - 263)

Injected different currents (50 pA, 100 pA, and 200 pA) into either the soma or dendrite and compared their effects.



The common effect by increasing the intensity of injected current in soma and dendrite is the increase in firing frequency.

Soma injection leads to more regular and immediate responses, while dendrite injection modulates bursting patterns.

At high currents, the neuron enters a tonic firing mode and has irregular oscillations in dendrite.

In contrast, soma-driven firing is more stable than dendrite-driven firing.