

BT6270 : Computational Neuroscience

Assignment 2

General Instructions:

- ✓ The goal of this assignment is simulating and Understanding FitzHugh-Nagumo neuron model taught in the class.
- ✓ This is an individual assignment.
- ✓ You may use MATLAB or PYTHON for your implementation.
- ✓ You have to turn in the well commented code along with a detailed report of the study.
- ✓ Your report should contain answers for all of the questions/cases asked below.
- ✓ Look at the end of the assignment for submission instructions.
- ✓ **Submission deadline: 12th October, 2021 (23:59).**

Simulate the two variable FitzHugh-Nagumo neuron model using the following equations :

$$\frac{dv}{dt} = f(v) - w + I_m$$

where $f(v) = v(a - v)(v - 1)$

$$\frac{dw}{dt} = bv - rw$$

where $a=0.5$; choose $b, r = 0.1$

Use single forward Euler Integration

$$dv/dt = \Delta v / \Delta t$$

$$\Delta v(t) = v(t+1) - v(t) = [f(v(t)) - w(t) + I_{ext}(t)] * \Delta t \text{ given } v(0) \rightarrow v(\Delta t) \rightarrow v(2 * \Delta t) \rightarrow \dots$$

Case 1: $I_{ext} = 0$

(a) Draw a Phase Plot superimposed (use hold on command in MATLAB)

(b) Plot $V(t)$ vs t and $W(t)$ vs t and also show the trajectory on the phase plane for the both cases

(i) $V(0) < a$ and $W(0) = 0$

(ii) $V(0) > a$ and $W(0) = 0$

Case 2: Choose some current value $I_1 < I_{\text{ext}} < I_2$ where it exhibit oscillations. Find the values of I_1 and I_2 .

(a) Draw a Phase Plot for some sample value of I_{ext}

(b) Show that the fixed point is unstable i.e., for a small perturbation there is a no return to the fixed point (show the trajectory on the phase plane) – also show limit cycle on the phase plane

(c) Plot $V(t)$ vs t and $W(t)$ vs t

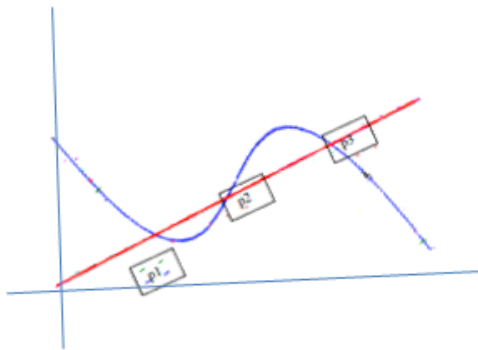
Case 3: Choose some $I_{\text{ext}} > I_2$

(a) Draw a Phase Plot for some sample value of I_{ext}

(b) Show that the fixed point is stable i.e., for a small perturbation there is a return to the fixed point (show the trajectory on the phase plane)

(c) Plot $V(t)$ vs t and $W(t)$ vs t

Case 4: Find suitable values of I_{ext} and (b/r) such that the graph looks as phase plot shown as below.



(a) Redraw the Phase plot

(b) Show stability of P1, P2, P3

(c) Plot $V(t)$ vs t and $W(t)$ vs t

Submission Instructions

Enclose all your programs, plots and report in a single zip folder

Please submit a compressed zip or tar file named as <ROLLNO>_A2.zip by uploading it to the moodle. Report should be very clear and all assumptions should be clearly highlighted.