Homework 1.3: Different integrate-and-fire models

Different possible models

3/3 points (graded)

Please make sure that you have read this link carefully before answering the following questions.

The general form of an integrate-and-fire model is

$$\tau \frac{d}{dt} u = F(u) + RI(t)$$

where $F(u)$ is an appropriate function and $I(t)$ is the injected current. Three popular choices for the function F are the following.

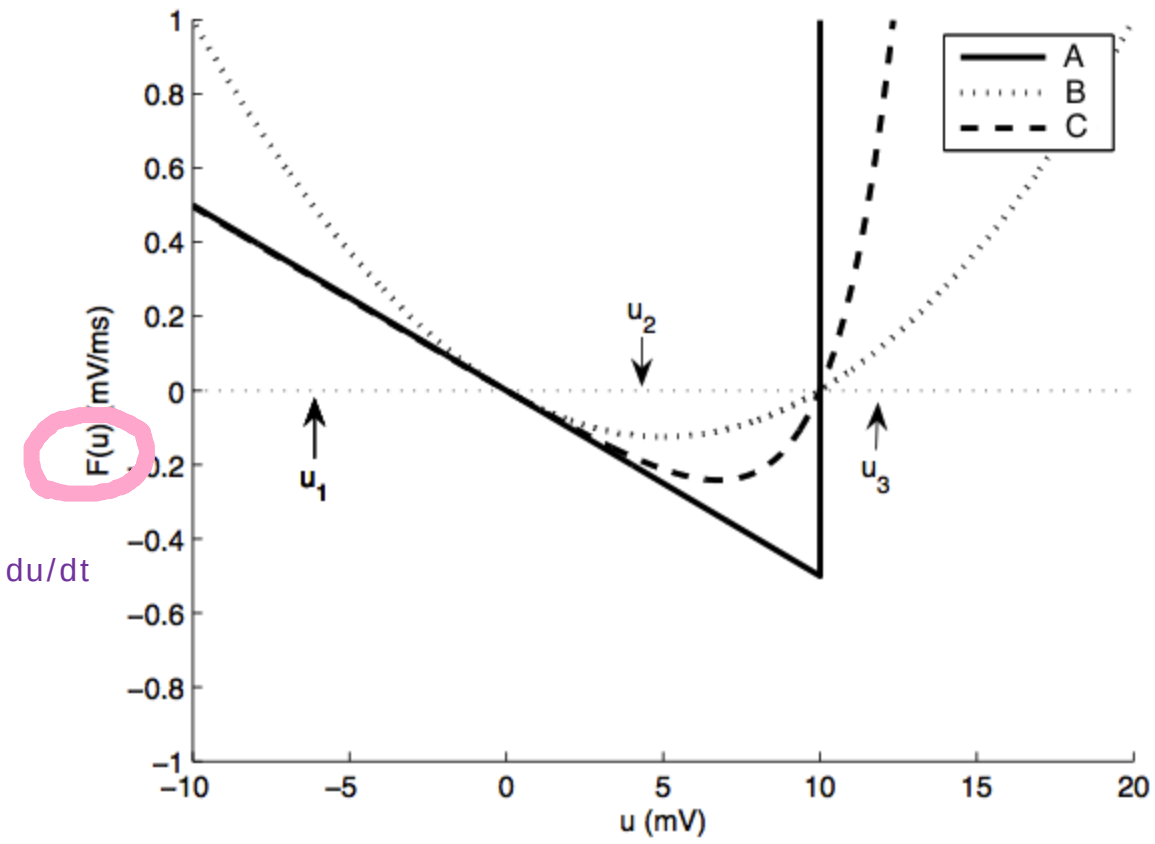
LIF: Leaky integrate-and-fire $F(u) = -(u - u_{rest})$ for $u_{th} > u$

QIF: Quadratic integrate-and-fire $F(u) = k(u - u_{rest})(u - u_{th})$

EIF: Exponential integrate-and-fire $F(u) = -(u - E_L) + \Delta e^{\frac{u-ue}{\Delta}}$

Based on the following figure, to which curves **LIF**, **QIF**, and **EIF** models are associated respectively? Enter the capital letters of the corresponding curves with no space between them. For instance the answer might be BAC or CBA or ...

ABC ✔



Identify the spike threshold u_{th} and the resting potential u_{rest} in mV based on the figure above. Enter just a number in each following box.

$u_{th} = ?$

10 ✔

10

$u_{rest} = ?$

0 ✔

0

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✔ Correct (3/3 points)

Analysis of neural behaviour

1/1 point (graded)
Consider three different values u_1, u_2 and u_3 as depicted in figure above as the initial values of the membrane potential.

Which of the followings describe correctly the evolution of the membrane potential $u(t)$ assuming that there is no external input, i.e., $I(t) = 0$.

- [x] For $u(t=0) = u_1$, the voltage increases slowly to the resting potential because $F(u_1)$ is positive.
- [ ] For $u(t=0) = u_1$, the voltage decreases to the resting potential because the derivative of $F(u)$ at u_1 is negative.
- [ ] For $u(t=0) = u_2$, the voltage increases rapidly to the spiking threshold and neuron fires.
- [x] For $u(t=0) = u_2$, $F(u)$ is negative and the voltage decreases slowly to the resting potential.
- [x] For $u(t=0) = u_3$, $F(u)$ is positive and large, and the membrane potential increases rapidly to infinity and it is equivalent to firing.
- [ ] For $u(t=0) = u_3$, the membrane potential decreases rapidly to the resting potential which is a stable fixed point.

reset ?

✔

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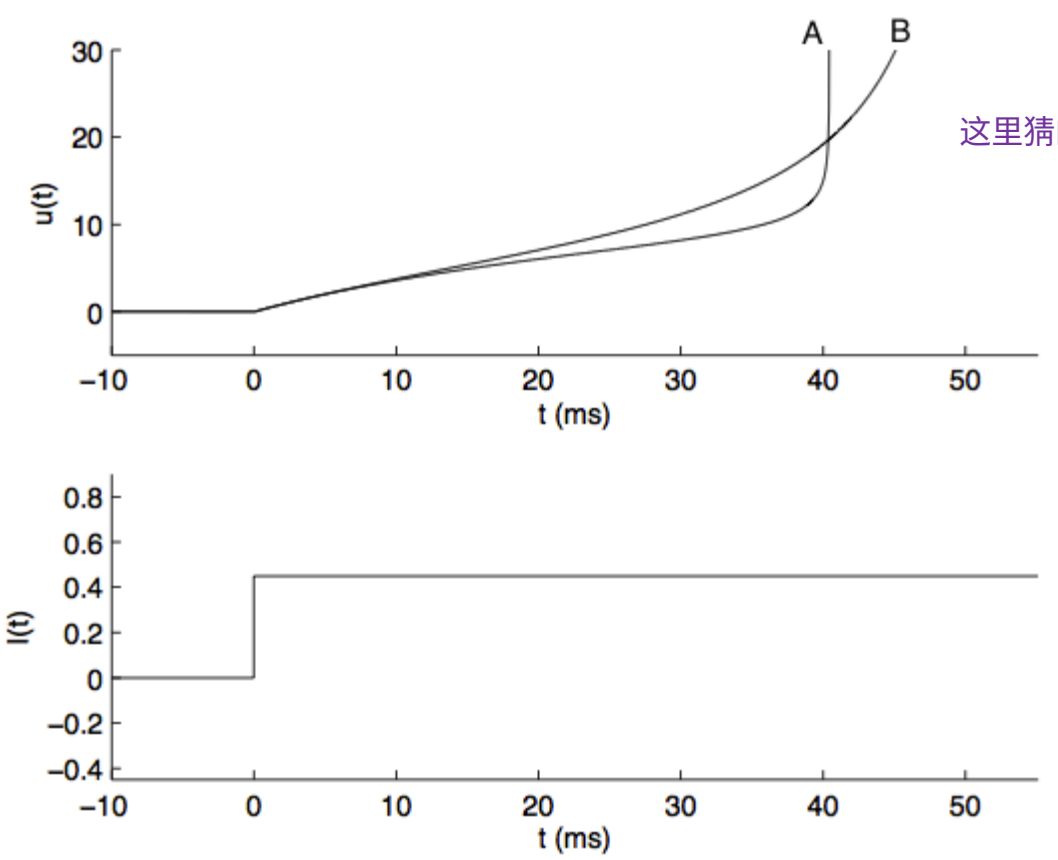
✔ Correct (1/1 point)

Quadratic vs. Exponential IF model

1/1 point (graded)
Consider the two voltage traces shown in the following figure (top) in response to a step current (bottom). Determine which of the two models was used to generate trace A and B respectively.

- ( ) QIF - EIF
- (•) EIF - QIF

✔



这里猜的，A更快吧

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✔ Correct (1/1 point)

Discussion

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