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Homework 1.2: Integrate-and-fire model

Minimal current for firing

1/1 point (graded)

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

Consider the passive membrane model

$$au rac{d}{dt}u = -\left(u - u_{rest}
ight) + RI\left(t
ight).$$

with a threshold at $u=\theta>u_{rest}$. If the membrane potential reaches the threshold, the neuron is said to fire and the membrane potential is reset to u_{rest} . The injected current is a step of magnitude $I\left(t\right)=I_0\Theta\left(t-t_0\right)$ where $\Theta\left(.\right)$ is the Heaviside function. What is the minimal current I_0 to reach the threshold, assuming $u\left(t=t_0\right)=u_{rest}$?

 $I_{min} = ?$

$$igcirc$$
 $I_{min}=rac{ heta-u_{rest}}{ au}$

igcirc $I_{min}=rac{u_{rest}- heta}{ au}$

The relationship between the amplitude of the step current and the resulting new level of neuron potential is calculated by:

$$u(t) = u_{\text{rest}} + RI_0 \exp(-(t - t_0)/\tau)$$

where for $t \to \infty$, $u(t) \to u_{\rm rest} + RI_0$

$$\bigcirc I_{min} = au\left(heta - u_{rest}
ight)$$

Therefore, denoting the firing threshold as heta, and setting u(t)= heta, and can rearrange the equation to get an expression for I_0

$$\theta = u_{\text{rest}} + RI_0$$

$$I_0 = \frac{\theta - u_{\text{rest}}}{R}$$

$$igcirc$$
 $I_{min}=rac{ heta}{R}$

igcirc $I_{min}=rac{u_{rest}}{R}$

我的理解是step function, 电流是持续的, 你只要找到最小的能让电路的电压到阈值的电流, 就是欧姆定律就够。

$$lue{0} I_{min} = rac{ heta - u_{rest}}{R}$$

$$\bigcirc$$
 $I_{min}=rac{u_{rest}\!-\! heta}{R}$



Submit

You have used 1 of 1 attempt

✓ Correct (1/1 point)

Gain function

1/1 point (graded)

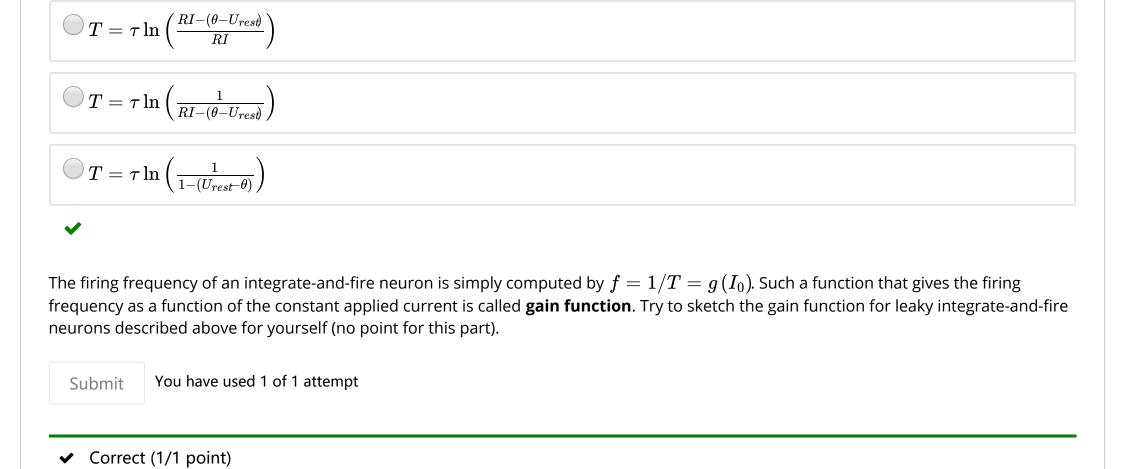
Let us compute the interspike interval T for constant input $I_0 \geq I_{min}$.

$$T = ?$$

这里处理的时候要注意第一点不能对负数log,第二点是ln前面的负号可以放到ln里面的负指数。

$$lefter$$
 $T= au\ln\left(rac{RI}{RI-(heta-U_{rest})}
ight)$

$$igcap T = au \ln \left(rac{I}{I - R(heta - U_{rest)}}
ight)$$



Discussion

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