Homework 5.3: Stochastic spike arrival

Stochastic spike arrival

1/1 point (graded)

Consider a neuron with a passive membrane,

$\tau \frac{d}{dt} u = -(u - u_{rest}) + RI(t).$

Calculate the average value of membrane potential as a function of the presynaptic rate ν if the current coming from the presynaptic activity is:

$I(t) = \sum_f \alpha(t - t^f)$

where $\alpha(t)$ is the arbitrary presynaptic current shape which has value only for $t \geq 0.$

t^f denotes the spike time. Suppose that $\beta(t)$ is the response of neuron to $I(t) = \alpha(t)$. In other words, $\beta(t) = \frac{R}{\tau_m} \int_{-\infty}^{\infty} e^{-(t-s)/\tau_m} \theta(t-s) \alpha(s) ds$ is the postsynaptic potential shape, and θ is the heaviside function.

Hint: Knowing that $\alpha(t) = \int_{-\infty}^{\infty} \alpha(s) \delta(s-t)$, integrate the passive membrane equation keeping explicitly the δ-function. Under the assumption of stochastic spike arrival we have $< \sum_f \delta(t - t^f) >= \nu$. Note that $<.>$ denotes the average.

- (selected) $u_{rest} + \nu \int_{-\infty}^{\infty} \beta(s) ds$
- $u_{rest} + \nu^2 \int_{-\infty}^{\infty} \beta(s) ds$
- $u_{rest} + \frac{R\nu}{\tau} \int_{-\infty}^{\infty} \beta(s) ds$
- $u_{rest} + \frac{R\nu^2}{\tau} \int_{-\infty}^{\infty} \beta(s) ds$
- $R\nu \int_{-\infty}^{\infty} \beta(s) ds$
- $u_{rest} + R\nu$
- $\frac{R\nu^2}{\tau}$

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You have used 1 of 1 attempt

Discussion

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