

The importance of different timings of excitatory and inhibitory pathways in neural field models

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Abstract

Neural field models are used to study the dynamics of large-scale neural networks. In these models, the spatial and temporal evolution of the average firing rate of a population of neurons is described by a set of coupled partial differential equations. The excitatory and inhibitory pathways are represented by different terms in the equations. The timing of these pathways is crucial for the model's behavior. We investigate the importance of different timings of excitatory and inhibitory pathways in neural field models. We show that the timing of these pathways can significantly affect the model's dynamics, including the emergence of oscillations and the formation of spatial patterns. We discuss the implications of these findings for understanding the role of timing in neural networks.

Keywords:

Introduction

Neural field models are a class of models used to study the dynamics of large-scale neural networks. They are based on the idea that the average firing rate of a population of neurons can be described by a set of coupled partial differential equations. The excitatory and inhibitory pathways are represented by different terms in the equations. The timing of these pathways is crucial for the model's behavior. We investigate the importance of different timings of excitatory and inhibitory pathways in neural field models. We show that the timing of these pathways can significantly affect the model's dynamics, including the emergence of oscillations and the formation of spatial patterns. We discuss the implications of these findings for understanding the role of timing in neural networks.

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$$\rho(\omega) = \rho(\omega + \omega_0) \quad (1)$$

$$\rho(\omega) = \frac{1}{2\pi} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \rho(\omega') e^{-i(\omega - \omega')t} dt \quad (2)$$

...

$$\rho(\omega) = \rho(\omega + \omega_0) \quad (3)$$

...

$$\rho(\omega) = \rho(\omega/v_+ + \omega_0) + \rho(\omega/v_- - \omega_0) \quad (4)$$

$$\rho(E) = \int_{-\infty}^{\infty} \rho(\omega) e^{-E\omega} d\omega = \left(\frac{\Gamma}{\omega_0} \right) \frac{1}{1 + E/\omega_0} \quad (5)$$

$$\rho(\omega) = \frac{\Gamma(\omega_0 + \omega/\omega_0)}{(\omega_0 + \omega/\omega_0)^2 + \Gamma^2/\omega_0^2} \quad (6)$$

$$\omega_0 = v/v_0$$

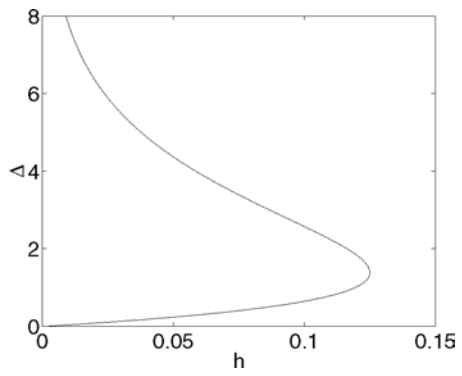
$$\left\{ \frac{\omega_0 + \omega/\omega_0}{\omega_0} \right\} \rho(\omega) = \Gamma \frac{\omega_0 + \omega/\omega_0}{(\omega_0 + \omega/\omega_0)^2 + \Gamma^2/\omega_0^2} \quad (7)$$

$$\frac{\partial}{\partial \omega} \left(\omega_0 + \frac{\omega}{\omega_0} \right) \rho(\omega) + \omega \frac{\partial}{\partial \omega} \rho(\omega) = \Gamma \left(\omega_0 + \frac{\omega}{\omega_0} \right) \rho(\omega) \quad (8)$$

$$\rho(\omega) = \Theta(\omega) \quad (9)$$

Stationary bump solutions

... & ...



$$\rho = \rho' = \Gamma = \Delta = \dots$$

(& ...)

$$A(\Delta) = \begin{bmatrix} \dots & \dots \\ \dots & \dots \end{bmatrix}$$

$$(\dots) = (\dots) - (\dots)$$

$$\rho(\dots) = \frac{\dots}{|\dots|} \dots \quad \rho(\dots) = \int_{-\infty}^{\infty} \dots \dots$$

$$\rho(\dots) = \frac{\dots}{\dots}$$

$$\dots = \dots - \dots - \Gamma \dots - \dots$$

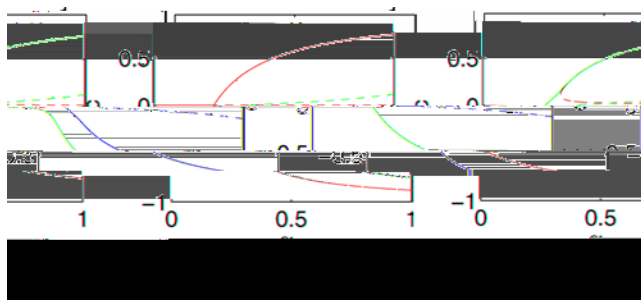
$$\mathcal{E}(\dots) = \dots < \dots \quad \mathcal{E}(\dots) = \dots$$

$$\mathcal{E}(\dots) = \dots + \omega \dots$$

E_{\dots}

$$\rho = \rho' = \Gamma = \Delta = \dots$$

... t t t



$(\quad) \quad t \quad = -\Gamma \quad (\quad = \dots, \Gamma = \dots)$
 $(\quad) \quad t \quad \neq -\Gamma \quad (\quad = \dots, \Gamma = \dots)$
 $\Gamma < \dots$
 $v = v = \dots = \dots = \dots$
 $\Gamma \quad = \dots = -\Gamma$
 $\neq (\quad) \quad \& (\quad) \quad t \quad t \quad t \quad t \quad t$
 $\& (\quad) \quad t \quad t \quad t \quad t \quad t$
 $= -\Gamma \quad t \quad t \quad t \quad t \quad t$
 $(\quad) \quad t \quad t \quad t \quad t \quad t$
 $(\quad) \quad \& \quad \&$

• ④ .

$$= \left[\frac{- \quad (-\Delta)}{- \quad -/} \right] - \Gamma \left[\frac{- \quad (-\Delta)}{- \quad -/} \right]. \quad ($$

t t t . Geo35806f935887068)T1948070(s)P108870.74ff(1210587399.464215815947672326362



$$= \dots, v = \gamma = \gamma = \dots, \Gamma =$$

(& $-\Gamma >$)

\approx .

$=$.

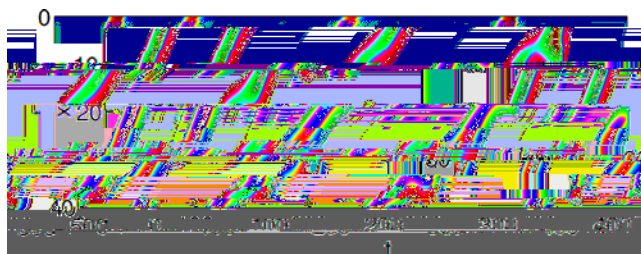
(

& (&)

Other solutions

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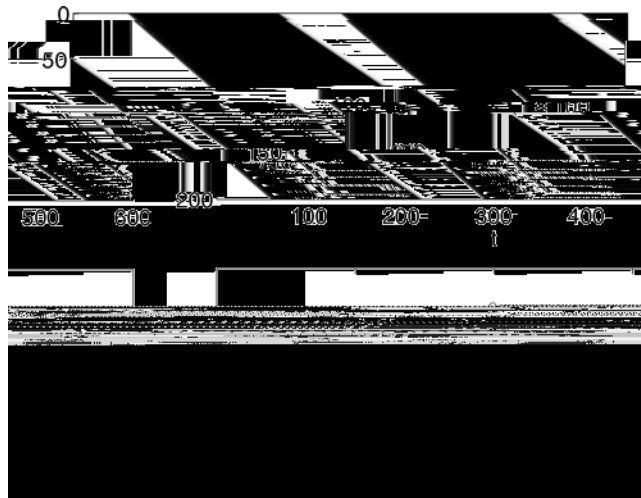
• \mathcal{E}



tt t t t = t t t

 t t t t t t t

 t t t t t t t



... & ...

$$\begin{aligned}
 &= \frac{\Gamma(-)}{\dots} - \frac{\Gamma(-)}{\dots} \geq \dots \\
 &= (-\Gamma + \frac{\Gamma(+)}{\dots} - \frac{\Gamma(+)}{\dots}) < \dots
 \end{aligned}$$

... & ...

$\tilde{v}(\infty) = \Theta(\dots)$
 $\tilde{v}(\infty) = \Theta(\dots)^{-k/k}$
 $\&$
 $v = v = \infty$

Acknowledgements

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References

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