Dynamic regulation of resource transport induces criticality in interdependent networks of excitable units

SV ,[1,*] ,[2,] S ,[3] [4]

[1]Department of Computer Science, Universit of Colorado at Boulder, Boulder, Colorado 80309, USA
[2]Department of Applied Mathematics, Universit of Colorado at Boulder, Boulder, Colorado 80309, USA
[3]Department of Ph sics, Universit of Arkansas, Fa etteville, Arkansas 72701, USA
[4][illegible]h sics, Universit of Mar land, College Park, Mar land 20742, USA

secondar glial network 10 12. We emphasie, however, that our results could be applicable to other s stems that operate at or near a critical point ,13,14.

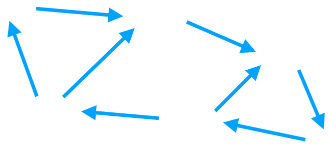
II. MODEL

. 8 , : A B (. 1).

A. Neural network dynamics

T N $n = 1, 2, \ldots, N$, M

ogesh.irkarcolorado.edu
uan.Restrepocolorado.edu



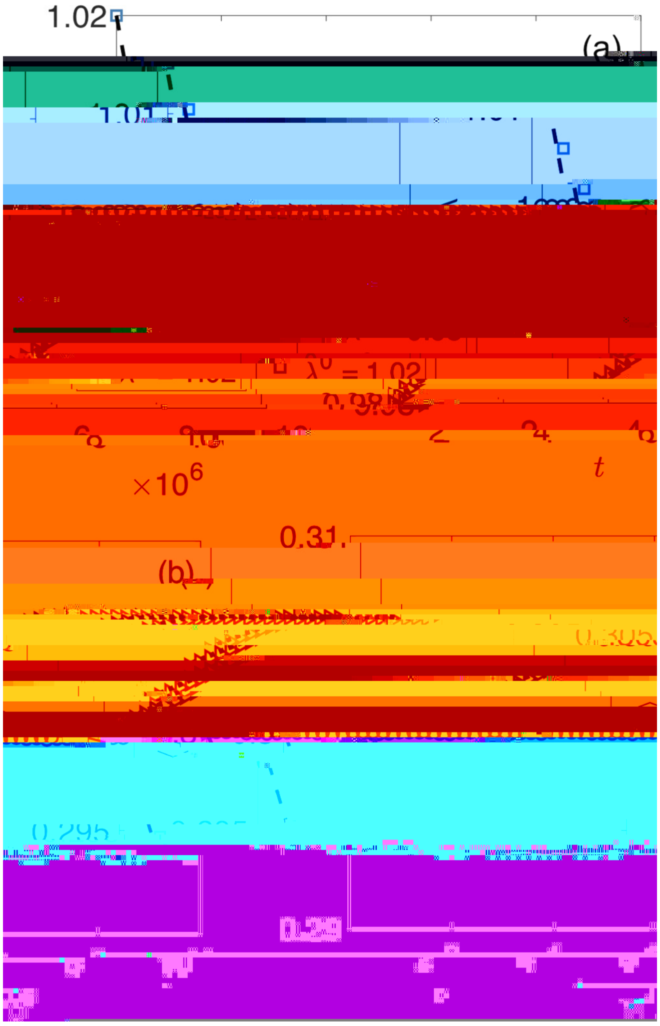


FIG. 2. ( ) λ^t, $\lambda^0 = 1, 0.98, 1.02$ ( ) A $R^t = \sum_i R_i^t/N$ *3-D map with noise* (9), (11), (13).

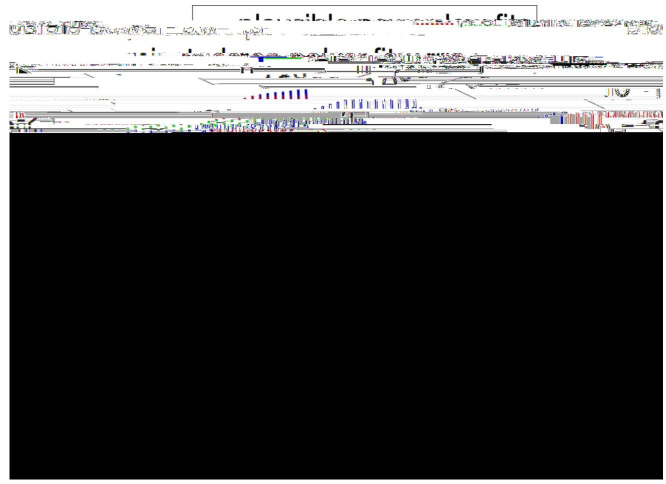


FIG. 3. $P(L)$ C_1. 10% $P(L) \propto L^{\gamma}$ $\gamma \approx -3/2$

$\lambda^t = 1$ 2( ), λ^t $\lambda^0 = 1, 0.98, 1.02$ ( ), λ^t 1 (4). 2( ), $R^t = \sum_i R_i^t/N$,

A 15, $S(t) = \sum_m s_m^t/N$, S^t S^*, $S^t < S^*$ $t < t_1$, $t > t_2$ $S^t \geqslant S^*$ $t_1 \leqslant t \leqslant t_2$). L $L =$ $N \sum_{t=t_1}^{t_2} S^t$, ( )

$D = D_G = D_S = 5 \times 10^{-5}$ C_1 C_2 10^{-8} 10^{-2} $C_2/C_1 = 1/6$ $S^* = 0.15$, $P(L)$, 19 p L 19, L, . . .,

; ( ) B w_{nm} R_{nm} $\langle w \rangle$ $\sum_{n,m} w_{nm} R^t_{\eta(n,m)} \approx \langle w \rangle \sum_{n,m} R^t_{\eta(n,m)}$; ( ) B k (B). B , .

, t:

$$R^t = \frac{1}{T} \sum_i R^t_i. \tag{4}$$

A . (2) ,

$$R^{t+1} = R^t + C_1 + \frac{D_S}{T} \sum_{\eta=1}^{M} R^t_\eta \sum_{i=1}^{T} G_{i\eta} - \frac{D_S}{T} \sum_{i=1}^{T} R^t_i \sum_{\eta=1}^{M} G_{i\eta}. \tag{5}$$

k B , $\sum_{\eta=1}^{M} G_{i\eta} = k$. , B B , $\sum_{i=1}^{T} G_{i\eta} = 1$,

$$R^{t+1} = R^t + C_1 + \frac{D_S}{T} \sum_{\eta=1}^{M} R^t_\eta - k D_S R^t. \tag{6}$$

T $\sum_{\eta=1}^{M} R_\eta$ B . B w_{nm} R_{nm} (B), B $W^t_{nm} = w_{nm} R^t_{nm}$ B :

$$\sum_{\eta=1}^{M} R^t_\eta = \frac{1}{\langle w \rangle} \sum_{n,m} W^t_{nm}. \tag{7}$$

, , -

FIG. 4. … λ^t … 1, $\sigma_\lambda = \sqrt{\langle(\lambda^t - 1)^2\rangle_t}$ … C_1. T… $\lambda = 1$ … C_1 … $-3/2$.

… $0 \leqslant S \leqslant 1$, … $C_1/(kC_2)$

1 S . , S . , Z. Z , 10, 0124848 (2015).
2 S . B. S , . . S , S . , B . . . 106, 058101 (2011).
3 . . , A . 45, 167 (2003).
4 . . S . , . 19, 88 (2013).
5 S . A. S , . . B . . 22, 437 (1969).
6 A. , . . , , T. , . . , B . 3, 857 (2007).