Feedback control stabilization of critical dynamics via resource transport on multilayer networks: How glia enable learning dynamics in the brain

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I. INTRODUCTION

[illegible] [1,2] [3,4] [5] [6] 1( ) [7] [5] [8 11] [12,13]

[illegible] [13,14] [15] [16,17] [18,19] [20,21] [18] [22] [23] [24]

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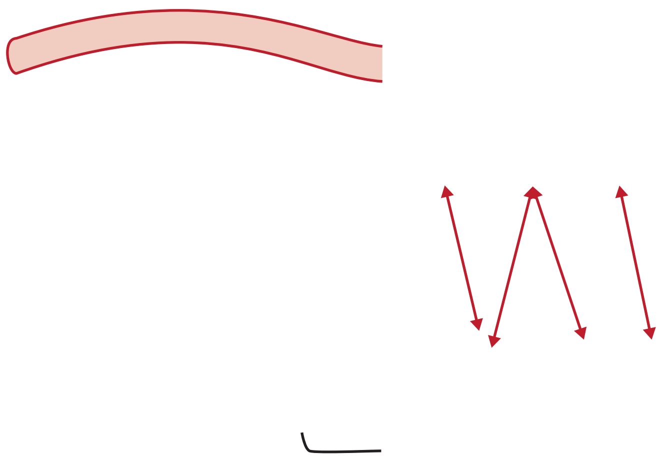

B. Resource-transport dynamics

Resource diffuses between glia through their connection network (characterized by the adjacency matrix U) and between glia and the synapses they serve (via the glial-neural connection network characterized by the adjacency matrix G). Our model for the evolution of the amount of resource R_i^t at glial cell i and the amount of resource R^t at synapse is

$$R_i^{t+1} = R_i^t + C_1 + D_G \sum_{j=1}^{T} U_{ij} \left(R_j^t - R_i^t \right)$$

$$+ D_S \sum_{=1}^{M} G_i \left(R^t - R_i^t \right), \qquad (4)$$

$$R^{t+1} = R^t + D_S \left(R_{i(\ )}^t - R^t \right) - C_2 s_{m(\ )}^t, \qquad (5)$$

where D_G is the rate of diffusion between glial cells, and D_S is the rate of diffusion between glia and synapses. Moreover, we enforce $R \quad 0$, i.e., if Eq. (5) yields $R^{t+1} < 0$, then we replace it by 0. The first term on the right hand side of Eq. (4), R_i^t, is the amount of resource in glial cell i at time t. The parameter C_1 denotes the amount of resource added to each glial cell at each time step (e.g., supplied by capillary blood vessels). For simplicity, we assume each glial cell has the same C_1. The last two terms are the amount of resource transported to glial cell i, respectively, from its neighboring glial cells and from the synapses that it serves.

In Eq. (5), the first term denotes the amount of resource at synapse at time t. The term proportional to

$\times 10^4$

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