

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

¹University of Colorado at Boulder, Boulder, Colorado 80309, USA
University of Arkansas, Fayetteville, Arkansas 72701, USA
University of Colorado at Boulder, Boulder, Colorado 80309-0526, USA
University of Maryland, College Park, Maryland 20742, USA
(01, 01, 01, 01, 01, 01)

Abstract: We study the stabilization of critical dynamics in multilayer networks through feedback control and resource transport. We focus on the case of a multilayer network with a critical point at the topological transition. We show that resource transport, as modeled by a reaction-diffusion equation, can stabilize the critical point and induce learning dynamics. We analyze the stability of the critical point and the resulting learning dynamics, and show that resource transport can be used to stabilize the critical point and induce learning dynamics.

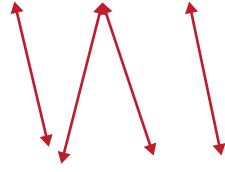
10.110 / . 0 10

I. INTRODUCTION

The study of critical dynamics in multilayer networks has been a central topic in network science. In particular, the critical point at the topological transition is of great interest. We study the stabilization of critical dynamics in multilayer networks through feedback control and resource transport. We focus on the case of a multilayer network with a critical point at the topological transition. We show that resource transport, as modeled by a reaction-diffusion equation, can stabilize the critical point and induce learning dynamics. We analyze the stability of the critical point and the resulting learning dynamics, and show that resource transport can be used to stabilize the critical point and induce learning dynamics.

The study of critical dynamics in multilayer networks has been a central topic in network science. In particular, the critical point at the topological transition is of great interest. We study the stabilization of critical dynamics in multilayer networks through feedback control and resource transport. We focus on the case of a multilayer network with a critical point at the topological transition. We show that resource transport, as modeled by a reaction-diffusion equation, can stabilize the critical point and induce learning dynamics. We analyze the stability of the critical point and the resulting learning dynamics, and show that resource transport can be used to stabilize the critical point and induce learning dynamics.

* Corresponding author: [email address]



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

$$R_i^{t+1} = R_i^t + C_1 + D_G \sum_{j=1}^T U_{ij} R_j^t - \check{S} R_i^t + D_S \sum_{m=1}^M G_{im} R^t - \check{S} R_i^t, \quad (4)$$

$$R^{t+1} = R^t + D_S \sum_{i=1}^N R_i^t - \check{S} R^t - C_2 S_m^t, \quad (5)$$

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 $R \geq 0$, 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 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

Handwritten scribbles and marks at the top left of the page.

Handwritten scribbles and marks at the top right of the page, including the number 94.0 and the text 10(01).

$\times 10^4$

... 112,1 10 (01).
 ... 27, (00).
 d ... et al, ...
 ... 513,5 (00).
 Il ... 261, (1).
 ... 106,05 101 (011).
 ... 86,0 1 0 (01).