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Distributed delays and stability in artificial neural networks

We consider a distributed delay neural network representation of a conceptual model of spatial memory in the form of the system

$$\frac{dU_i(t)}{dt} = -b_i U_i(t) + \sum_{j=1}^{N} a_{ij} \int_{-\infty}^{t} K_{ij}(t-s) g\big(\beta U_j(s)\big)\, ds + F_i(t), \quad i = 1, \ldots, N.$$

Sufficient conditions are derived for the uniqueness and global asymptotic stability of a stationary solution. Local analysis is used to determine stability boundaries for many delay distributions, in terms of possibly complex eigenvalues of a matrix closely related to the (not necessarily symmetric) connection matrix of the network. These results are compared to the discrete delay case, and an illustrative application is semi-numerically examined.