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Handbook of Brain Connectivity

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Abstrak

The fluid nature of perceptual experience and the transient repetition of patterns in neurophysiological data attest to the dynamical character of neural activity. An approach to neuroscience that starts from this premise holds the potential to unite neuronal connectivity and brain activity by treating space and time in the same framework. That is the philosophy of this chapter. Our goals are threefold: Firstly, we discuss the formalism that is at the heart of all dynamical sciences, namely the evolution equation. Such an expression ties the temporal unfolding of a system to its physical properties and is typically a differential equation. The form of this equation depends on whether time and space are treated as continuous or discrete entities. Secondly, we aim to motivate, illustrate and provide definitions for the language of dynamical systems theory - that is, the theoretical framework that integrates analysis and geometry, hence permitting the qualitative understanding and quantitative analysis of evolution equations. To this end we provide a mini-encyclopedia of the basic terms of phase space analysis and a description of the basic bifurcations of dynamics systems. Our third aim is to provide a survey of single neuron and network models from a historical and pedagogical perspective. Here we first trace microscopic models from their birth in the 1950?s showing how the neuronal firing properties can be understood as a bifurcation in the underlying phase space. Then we review the spatiotemporal network dynamics, which emerges as a function of the networks anatomical connectivity.