INDAM MEETING:

HYPERBOLIC DYNAMICAL SYSTEMS IN THE SCIENCES

CORINALDO (ITALY)
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Mathematical Neuroscience: from neurons to networks

The tools of dynamical systems theory are having an increasing impact on our understanding of patterns of neural activity. In the first part of my talk I will introduce some of the more popular single neuron models and explain their behaviour in terms of bifurcation diagrams, phase-planes and phase-response curves. For limit cycle oscillators I will review the coupled oscillator approach that has provided a framework for understanding behaviour in neural networks with weak synaptic and gap junction coupling. I will then show how results for strong coupling can be obtained by focusing on a specific class of spiking neural models, namely (non-smooth) planar integrate-and-fire models. In the second part of my talk I will describe how to build tractable tissue level models that maintain a strong link with biophysical reality. These models typically take the form of nonlinear integro-differential equations. Their non-local nature has led to the development of a set of analytical and numerical tools for the study of waves, bumps and patterns, based around natural extensions of those used for local differential equation models. Here I will present an overview of these techniques, and discuss the relevance of neural field models for describing the brain at the large scales necessary for interpreting EEG data.