SympNets & PNNs: Intrinsic structure-preserving networks for identifying Hamiltonian & Poisson systems

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This talk is about new machine learning tools Symplectic networks (SympNets) and Poisson neural networks (PNNs) which can learn Hamiltonian/Poisson systems from data. We prove the universal approximation theorems of both neural networks within the class of symplectic/Poisson map. We showed that any symplectic/Poisson map can be approximately factorized into unit triangular matrix-like maps in a simple form, i.e. SympNets/PNNs. Simulation results shows that by incorporating prior knowledge into the neural networks, even very small size SympNets/PNNs can generalize well, and are able to handle both Hamiltonian/Poisson systems with data points resulting from short or long time steps.