Turning an analysis technique into a tool: Identification and simulation of Hamiltonian systems using inverse modified equations

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Hamiltonian systems arise for instance, in classical mechanics, plasma physics, and sampling problems. If a system of ordinary differential equations forms a Hamiltonian system, then the Hamiltonian structure guarantees important qualitative aspects of the dynamical system, such as a lack of attractors, energy conservation, and is related to further topological properties of the phase portrait and conservation laws. Learning Hamiltonian structure from trajectories is an important task in system identification theory. Another challenge is to simulate Hamiltonian dynamics using numerical methods while preserving important structural properties under discretisation. Inverse modified differential equations have recently been introduced as an analysis technique for Hamiltonian neural networks. In this talks I would like to show how to turn this analysis technique into a tool for system identification and structure preserving simulations.