# Abstract

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Dynamical systems provide a fundamental framework for understanding how various systems evolve over time, with applications spanning physics, engineering, biology, economics, and neuroscience. Historically, analysis focused on finding exact solutions which remains the ultimate goal of quantitative analysis. However, many modern systems are too complex to generate exact solutions, prompting the development of alternative methods. One such approach involves invariant manifolds, which reveal the qualitative behavior of orbits near saddle points and enable the sorting of trajectories without requiring exact solutions. Although useful, these tools were historically limited to local approximations of the global manifold. Recent advances in computational power, however, have allowed mathematicians to extend local invariant manifolds to their global representations, greatly expanding the range of problems that can be analyzed by this method. This paper outlines the standard notation and definitions used in dynamical systems and introduces the graphical intuitions that support them. It presents basic tools of analysis, introduces invariant manifolds in both continuous and discrete systems, and demonstrates the process of computing a local manifold. The discussion then turns to two modern methods for computing global manifolds and an example of their application to a problem in neurochemistry. The paper concludes with a wider look at the role invariant manifolds play in chaos as the fundamental underlying structure of dynamical systems.