PHSX815: Computational Methods in Physical Sciences
Project 4
Peer Review Input

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Overview

For Project 4, I plan to employ Stability Analysis to systems of differential equations and find stable points of the system. In many cases, there doesn't exist an analytical solution to systems with nonlinear interacting dynamics. An alternative to numerical simulation is phase plane analysis. It is an important technique for studying the behavior of nonlinear systems. For example, many parts of the qualitative theory of differential equations and dynamical systems deal with asymptotic properties of solutions and the trajectories—what happens with the system after a long period of time. The simplest kind of behavior is exhibited by equilibrium points, or fixed points, and by periodic orbits. If a particular orbit is well understood, it is natural to ask next whether a small change in the initial condition will lead to similar behavior. Stability theory addresses the following questions: Will a nearby orbit indefinitely stay close to a given orbit? Will it converge to the given orbit? In the former case, the orbit is called stable; in the latter case, it is called asymptotically stable and the given orbit is said to be attracting. I plan to implement the standard procedure for stability analysis on Python and apply it a variety of systems.

What I would like to learn from peer review

Obviously, the scope of applying Stability Analysis to actual physical processes is very very vast. I would like to take suggestions as to specific examples that I could implement the analysis to (e.g.: simple fluid flows), and gain insights regarding the kind of questions that I could aim to answer in the context of Project 4. I look forward to hearing from you.