**Visualize ODE With SciPy**

Mason Lohnes, Reece Gerhart

Department of Technology, Grand Canyon University

CST-305: Principles of Modeling and Simulation Lecture and Lab

Dr. Robert Citro

September 14th, 2025

**Responsibilities and Completed Tasks by Each Team Member**

Members of the team collaborated on all parts of the assignment. However, Reece focused more on the coding aspect, and Mason focused more on the documentation.

**System Performance Context Description**

* **Environment:** Desktop Python with NumPy, SciPy, and Matplotlib.
* **Load:** 10 seconds simulated time at 10,000 points.
* **Performance Metrics:** Computation time and numerical accuracy versus the analytical solution.
* **Use Case:** Moderate workloads.

**Specific Problem Solved:**

We solved the simple harmonic oscillator second-order ODE, which is: d2y​/dt2+ω2y=0. Where y is displacement, ω is the angular frequency, and t is time. This equation helps to describe springs, pendulums, and vibrations.

**The Mathematical Approach for Solving It:**

* Defined variables and initial conditions.
* Expressed the system in first-order form to compute both velocity (first derivative) and acceleration (second derivative).
* Used two arrays to hold displacement and velocity points.
* Computed the analytical solution for comparison

**The Approach for Implementation in Code:**

1. Define the problem – specify the ODE and parameters.
2. Set initial conditions – starting displacement and velocity.
3. Define time range – 0 to 10 seconds, 10,000 samples.
4. Solve the ODE numerically using SciPy.
5. Compute analytical solutions for accuracy checking.
6. Visualize results using matplotlib.

**The Use of Sources:**

We used a few different sources to do this project. First, we needed a source to teach us about the ODE harmonic Oscillator. For this, we used Elementary Differential Equations and Boundary Value Problems and Classical Mechanics. Next, we needed to research how to use the python libraries, and for this we used A Guide to NumPy.

**Screenshots:**

**A screen shot of a computer

AI-generated content may be incorrect.**

**Bibliography**

Boyce, W. E., & DiPrima, R. C. (2017). Elementary Differential Equations and Boundary Value Problems (11th ed.). Wiley.

H. Goldstein, C. Poole, & J. Safko. (2002). Classical Mechanics (3rd ed.). Addison-Wesley.

Oliphant, T. E. (2006). A Guide to NumPy. Trego Publishing.