

Exercise for Program Synthesis

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1 Generate some Data from the given system

In this exercise, you are given two dynamical systems. Your task is to generate synthetic data that describes their evolution over time. The systems are defined as follows

System 1

$$\dot{x} = x - 0.1xy, \quad \dot{y} = -1.5y + 0.075xy.$$

System 2

$$\dot{x} = 1 - x - \frac{xy}{4}, \quad \dot{y} = (2z - 1)y, \quad \dot{z} = \frac{x}{4} - 2y^3.$$

Here, \dot{x} , \dot{y} , and \dot{z} represent the change in the variables in one time step. You may assume that time progresses in discrete steps.

Your Task

- Choose initial conditions for each system.
- Select a number of time steps to simulate.
- The resulting data will serve as the input for the program synthesis step.

Build a Simple Program Synthesiser

Using the data generated in Part 2, your goal is to construct a simple synthesiser capable of recovering the governing equations of the system. You may restrict your search space to **polynomial dynamical systems of degree at most 3**. You may also assume that the number of variables is known in advance (two for System 1, three for System 2).

Requirements

Your synthesiser should: Explore for candidate polynomial models of degree 3 such that fits the data .

It is not important that you exactly recover the original differential equations. The goal is to show your reasoning process and how you translate a program-synthesis concept into an implementation.