LMU: Fakultät für Physik

When Machine Learning meets Complex Systems

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Exercise Sheet 4

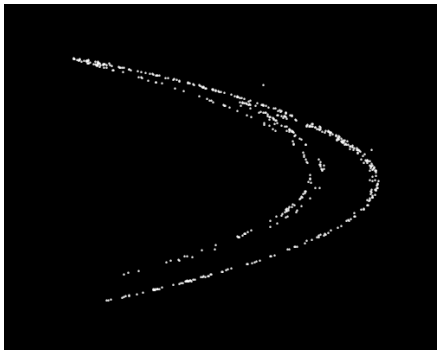
(Please prepare your answers until Friday, 12th of December 2025)

Exercise 4.1: Next-Generation Reservoir Computing For this exercise a jupyter notebook with an implementation of the next-generation reservoir computing (NGRC) architecture is provided. You will investigate the properties of the NGRC with respect to its regression parameter and the required training length by performing a basic hyperparameter scan. (Some hyperparameter configurations of NGRC lead to instable predictions, some dont) Feel free to test this architecture for different scenarios or use different evaluations!

Exercise 4.2: Controlling with Next-Generation Reservoir Computing In this exercise you will build a next-generation reservoir computing control mechanism based on the Sarangapani control. For further information read https://arxiv.org/pdf/2307.03813.pdf. A jupyter notebook is provided which guides you through the setup. The idea of the control mechanism consists of three parts.

1) As we assume to not have any information on the underlying governing equations of the Henon map data, we want to use next-generation reservoir computing here to learn the dynamic.

2) With the Sarangapani control approach, we want to perturb the dynamic of the Henon map



(a) Slightly perturbed Henon map data used for training.

(b) Applying the NGRC based control mechanism to bound the dynamic of the Henon map into a 4-period orbit.

data at each time step such that it is controlled into the target dynamic, in our case the 4-period orbit.

3) Therefore, additional to learning the dynamic we need to learn how the dynamical system reacts to perturbations. If this is successful, we can create custom perturbations that drives the Henon map into our target dynamic.

Exercise 4.3: Multifunctional Next-Generation Reservoir Computing TBD