1 Task 1: Koopman Operator - Points 10/100

1. Explain the idea behind the Koopman operator.
2. What are the problems it is trying to solve.
3. (Optional/ Bonus: 10 points) Implement a version of the Koopman operator and apply it to an example dataset. Compare it to Koopman Operator in Python

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2 Task 2: DMD - Points 25/100

1. Describe the DMD method and how it is linked to the Koopman operator.
2. Implement the DMD method.
3. (Optional/ Bonus: 5 Points) Compare it to DMD in datafold

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3 Task 3: EDMD - Points 35/100

1. Describe the EDMD Method as provided in [2].
2. Compare the EDMD method with the DMD method. How are they similar / different.
3. Implement the EDMD algorithm without using library implementation (ODE solvers and eigenvalue calculators are allowed) .

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4 Task 4: EDMD vs DMD - Points 20/100

1. Apply the DMD algorithm on a sample dataset provided in [1] (or subsequent chapters).
2. Test your EDMD algorithm on a dataset from [2] and compare the results with the ones from the paper.
3. Apply your EDMD and DMD algorithms on the on Limit Cycle dataset in `https://datafold-dev.gitlab.io/datafold/tutorial_06_basic_edmd_limitcycle.html` and compare the results.
4. (Optional/ Bonus: 5 points) Compare it to EDMD in datafold

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5 Task 5: EDMD for Crowd Simulation - Points 10/100

1. Apply the EDMD method on the fire evacuation scenario provided and discuss the results. Use a simple evacuation out of a single room with a door of 1.8m width, and 100 pedestrians starting 20 meters away from it. Try to model their center of gravity $(1/100 * \Sigma x_i, i = 1, \dots 100)$ with the Koopman operator.
2. (Optional/ Bonus: 5 Points) Apply the DMD method on the same crowd simulation data and compare the results to the EDMD method.

References

[1] J Nathan Kutz, Steven L Brunton, Bingni W Brunton, and Joshua L Proctor. *Dynamic Mode Decomposition: Data-Driven Modeling of Complex Systems*, chapter Chapter 1: Dynamic Mode Decomposition: An Introduction. SIAM, 2016.

[2] Matthew O. Williams, Ioannis G. Kevrekidis, and Clarence W. Rowley. A data–driven approximation of the koopman operator: Extending dynamic mode decomposition. *Journal of Nonlinear Science*, 25(6):1307–1346, Dec 2015.