ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Learning &
Adaptive Systems

Experiment Design for Differential Equations

Mojmír Mutný Andreas Krause
Computer Science, ETH Zürich, 8092 Switzerland

1 Motivation

Differential equations serve as the foundation for comprehending natural processes that unfold over time, enabling us to design, control, and adapt them to meet our specific requirements. To harness their potential, it is essential to uncover the mathematical relationships which define them in order to make use of this sophisticated framework.

Nonetheless, mastering differential equations often necessitates a nuanced, trial-and-error approach that involves observing numerous evolutions of the system under study. To enhance the efficiency of this learning process, it is crucial to adopt a methodical strategy for exploration, which is where experimental design plays a pivotal role.

Statistical experiment design refers to the systematic process of planning, organizing, and conducting experiments in such a way as to generate reliable and valid data for statistical analysis and inference [Chaloner and Verdinelli, 1995].

2 Challenge

In this project, we would like to build on ideas of previous publications, namely, [Mutný and Krause, 2022] and [Mutný et al., 2023] in order to apply the framework of experiment design in challenging situations where non-linear processes govern the relationships, and adapt to real conditions.

In the end, we would like to control these differential equation in such manner as to extract as much information as possible. Application towards cells growth is expected.

3 Background

We seek a highly motivated candidate with a strong background in machine learning, statistics and differential equations.

In case of interest, please ask for details: Mojmír Mutný (mojmir.mutny@inf.ethz.ch).

References

[Chaloner and Verdinelli, 1995] Chaloner, K. and Verdinelli, I. (1995). Bayesian experimental design: A review. *Statist. Sci.*, 10(3):273–304.

[Mutný et al., 2023] Mutný, M., Janik, T., and Krause, A. (2023). Active exploration via experiment design in markov chains. In *Proceedings of the 26th International Conference on Artificial Intelligence and Statistics* (*AISTATS*).

[Mutný and Krause, 2022] Mutný, M. and Krause, A. (2022). Experimental design of linear functionals in reproducing kernel hilbert spaces. In *Proc. Neural Information Processing Systems* (*NeurIPS*).