



# Data Science Problems and Hidden Discrete Dynamical Systems

DESCI LONDON HACKATHON

Matteo Manzi, Enzo Caceres

2023/01/02

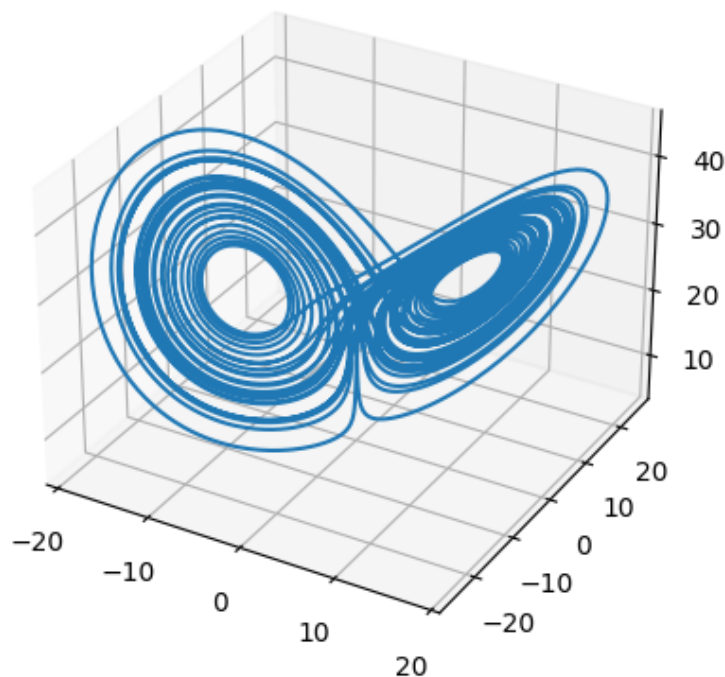
# Data Science Problems and Hidden Discrete Dynamical Systems

## abstract

DeSci London Hackathon is a hackathon event taking place on the 12th and 13th of January 2023. This hack is aimed at anyone interested in DeSci. The event will have two tracks – code and no-code. All submissions will be open source.

### Step 1: Machine Learning: Supervised Learning

We have noisy observations associated with a deterministic dynamical system and we are interested in best fitting, in some sense, these high-dimensional observations with a target scalar observation, related to the same system.



**Figure 1:** Hello Lorenz!

See (Vahid Nateghi 2022) and (Champion et al. 2019) for additional context.

### **Step 2: Convex Optimization**

The estimated targets are part of a pipeline sending them to a convex optimizer which returns a fitness different from your fitness. You cannot modify the convex optimizer.

See (Diamond and Boyd 2016) for additional context.

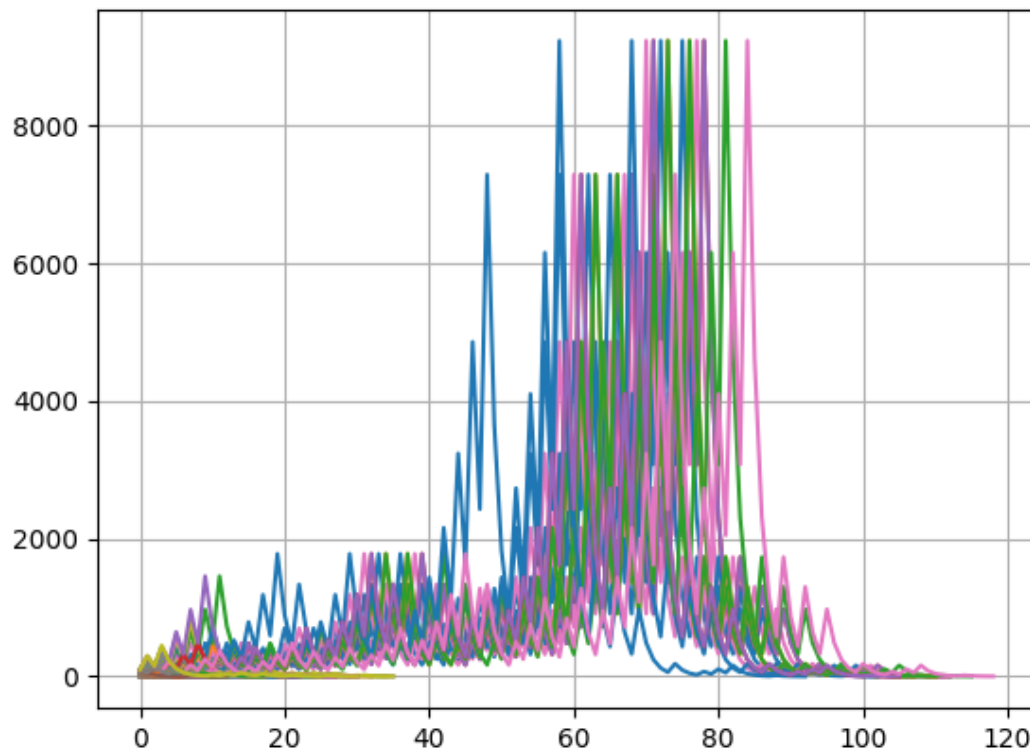
### **Step 3 Convex Optimizer-in-the-loop backpropagation**

You can use backpropagation to train your model against the post-optimizer fitness.

See (Agrawal et al. 2019) for additional context.

### **Bonus Problem**

Award for this problem: 1M dollars. Good luck.



**Figure 2:** Prove the Collatz conjecture.

See (Tao 2019) for additional context.

## References

Agrawal, Akshay, Brandon Amos, Shane Barratt, Stephen Boyd, Steven Diamond, and Zico Kolter. 2019. “Differentiable Convex Optimization Layers.” arXiv. <https://doi.org/10.48550/ARXIV.1910.12430>.

Champion, Kathleen, Bethany Lusch, J. Nathan Kutz, and Steven L. Brunton. 2019. “Data-Driven Discovery of Coordinates and Governing Equations.” *Proceedings of the National Academy of Sciences* 116 (45): 22445–51. <https://doi.org/10.1073/pnas.1906995116>.

Diamond, Steven, and Stephen Boyd. 2016. “CVXPY: A Python-Embedded Modeling Language for

Convex Optimization.” arXiv. <https://doi.org/10.48550/ARXIV.1603.00943>.

Tao, Terence. 2019. “Almost All Orbits of the Collatz Map Attain Almost Bounded Values.” arXiv. <https://doi.org/10.48550/ARXIV.1909.03562>.

Vahid Nateghi, Matteo Manzi. 2022. “Machine Learning Methods for Nonlinear Reduced-Order Modeling of the Thermospheric Density Field.” *Preprint*. <https://doi.org/10.13140/RG.2.2.12431.05280>.

