Deep Learning for Chaos Detection

Carmen Mayora-Cebollero, **Roberto Barrio**,
Ana Mayora-Cebollero, **Sergio Serrano**[1], **Álvaro Lozano**, **Rubén Vigara**[2],
Antonio Miguel, **Alfonso Ortega**[3]

SUMMARY

Chaos detection can be considered one of the most important problems that we have to take into account if we want to study the behaviour of a dynamical system. Although it can be solved using classical techniques as Lyapunov Exponents (LEs) [1], recently some authors have proposed to apply Deep Learning [2].

Deep Learning (DL) is the branch of Machine Learning that uses Artificial Neural Networks (architectures based on multiple layers) to learn from data with several levels of abstraction. Researchers have obtained pretty good results using DL to perform non-mathematical tasks, so it is natural to try to apply it in mathematical problems (and in particular, dynamical systems problems). In this talk, we introduce some state-of-the-art techniques that we have used for chaos detection, we show the obtained results and we compare them to the ones that we can obtain with classical techniques as LEs [3].

Keywords: Dynamical Systems, Deep Learning, Chaos Detection

AMS Classification: 37Mxx, 68T07

References

[1] R. Barrio and S. Serrano. A Three-Parametric Study of the Lorenz Model. *Physica D* **229**(1), 43–51, 2007.

[2] N. Boullé, V. Dallas, Y. Nakatsukasa and D. Samaddar. Classification of Chaotic Time Series with Deep Learning. *Physica D* **403**, 132261 (10 pages), 2020.

[3] R. Barrio, Á. Lozano, A. Mayora-Cebollero, C. Mayora-Cebollero, A. Miguel, A. Ortega, S. Serrano and R. Vigara. Chaos Detection with Deep Learning. *Preprint*, 2022.

[1]Department of Applied Mathematics
University of Zaragoza, Spain
email: `cmayora@unizar.es` / `rbarrio@unizar.es` / `amayora@unizar.es` / `sserrano@unizar.es`

[2]Department of Mathematics
University of Zaragoza, Spain
email: `alozano@unizar.es` / `rvigara@unizar.es`

[3]Department of Electronic Engineering and Communications
University of Zaragoza, Spain
email: `amiguel@unizar.es` / `ortega@unizar.es`