Oral communication (Mathematics in sustainability and climate change)

Multivariate extreme values for dynamical systems

Romain Aimino[a], Ana Cristina Moreira Freitas[b], Jorge Milhazes Freitas[c], Mike Todd[d]

[a] Institution: Centro de Matemática & Faculdade de Ciências da Universidade do Porto, Porto, Portugal
E-mail: romain.aimino@fc.up.pt

[b] Institution: Centro de Matemática & Faculdade de Economia da Universidade do Porto, Porto, Portugal
E-mail: amoreira@fep.up.pt

[c] Institution: Centro de Matemática & Faculdade de Ciências da Universidade do Porto, Porto, Portugal
E-mail: jmfreitas@fc.up.pt

[d] Institution: Mathematical Institute, University of St Andrews, North Haugh, St Andrews, Scotland
E-mail: m.todd@st-andrews.ac.uk

Abstract

The study of rare events and extreme value theory for dynamical systems is recent but has experienced a vast development in the last decade, partly motivated by applications to climate dynamics where dynamical systems (such as the Lorenz models) provide accurate description of meteorological phenomena. In the context of dynamical systems, all previous works have focused on the univariate extreme value theory, leaving unexplored the question of understanding the interplay between the extremes in the different components of a vector-valued observation. But this insight is of crucial importance in climate dynamics, where the influence between extremal observations of different variables (such as pressure and temperature) as well as their spatial and temporal dependence is vital for predicting extreme weather events.

The main goal of our work [1] is to introduce the first (to our knowledge) theoretical results on multivariate extreme value theory for dynamical systems. In this talk, I will briefly discuss the classical theory of multivariate extreme values for iid and stationary sequences of random vectors, with an emphasis on the notion of multivariate extremal index function, and I will then present our results about stationary processes generated by vector-valued observations for chaotic dynamical systems. I will also provide simple concrete examples for which the computations of the extremal index function can be explicitly carried out. This is a joint work with A.C.M. Freitas, J.M. Freitas and M. Todd.

This work was partially financed by FCUP, Department of Mathematics, by Portuguese public funds through FCT – Fundação para a Ciência e a Tecnologia, I.P., in the framework of the projects PTDC/MAT-UR/4048/2021, 2022.07167.PTDC and CMUP's project with reference UIDB/00144/2020.

References

[1] R. Aimino, A.C.M. Freitas, J.M. Freitas, M. Todd, *Multivariate extreme value for dynamical systems*. Preprint, (2024)