# TS10: Thematic Session: Spatio-temporal and extreme statistical analysis

Tuesday 1 July, 14:00–16:00 • Room 106

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**Ana Cristina Moreira Freitas** (Universidade do Porto )

Time: 14:00–14:24

**Extremal index, rare events point processes, clustering and periodicit**

We consider stationary stochastic processes arising from dynamical systems by evaluating a given observable along the orbits of the system. We focus on the occurrence of extremal observations corresponding to exceedances of high thresholds, which is related to the entrance in certain neighbourhoods of the set of points where the observable is maximised. We study extreme value laws and rare events point processes both in the absence and presence of clustering of exceedances.

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**Ana Ferreira** ( Instituto Superior Técnico da Universidade de Lisboa )

Time: 14:24–14:48

**Non-stationary extremes: a spatio-temporal scedasis approach**

Recently tail expansions for the empirical distribution and quantile functions have been obtained, under usual maximum domain of attraction conditions and non-stationarity conditions [1]. The later relate to the existence of scedasis in the marginal distributions and a tail distributions equivalence property, a way to extend "independent and identically distributed" assumptions. The results provide basic tools for extending and developing novel estimators along with asymptotic properties. We illustrate the results with some theoretical examples and an application.

[1] Einmahl J.H.J., Ferreira A., de Haan L., Neves C. and Zhou C. (2022). Spatial dependence and space-time trend in extreme events. Annals of Statistics, 50, 30-52. https://doi.org/10.1214/21-AOS2067

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**Fernanda Cipriano** (Universidade Nova de Lisboa)

Time: 14:48–15:12

**Invariant measures for a class of stochastic third grade fluid equations in 2D and 3D bounded domains**

TBA

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**Jorge Milhazes Freitas** (Universidade do Porto )

Time: 15:12–15:36

**Spatio-temporal analysis of multivariate extremes for dynamical systems**

We establish a theory for multivariate extreme value analysis of dynamical systems. Namely, we provide conditions adapted to the dynamical setting which enable the study of dependence between extreme values of the components of $R^d$-valued observables evaluated along the orbits of the systems. We study this cross-sectional dependence, which results from the combination of a spatial and a temporal dependence structures. We give several illustrative applications, where concrete systems and dependence sources are introduced and analysed.

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**Lígia Henriques-Rodrigues** (University of Évora)

Time: 15:36–16:00

**Improved Estimation of the Extreme Value Index for Risk Assessment: Bias-Reduced Methods and Applications**

Estimating the extreme value index (EVI) plays a central role in extreme value theory, as it governs the tail heaviness of probability distributions and directly informs the quantification of risks associated with rare and extreme events. In heavy-tailed settings—where the EVI is positive—the Hill estimator is a standard tool, though it is often affected by bias, which can distort risk estimates and undermine inference. This work introduces new families of bias-reduced estimators for the EVI, aiming to enhance estimation accuracy, particularly in finite samples. A comparative analysis is carried out, focusing on generalized Hill-type estimators available in the literature. Through Monte Carlo simulations, the performance of these new estimators is evaluated, with particular attention to their implications for risk estimation. The

practical value of the proposed methods is further illustrated with an application to an environmental dataset, demonstrating how improved EVI estimation can lead to more reliable assessments of extreme event risk. Joint work with Frederico Caeiro and M. Ivette Gomes

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