LEZIONE LAGRANGIANA
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Estimation of time to a tipping point

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ABSTRACT: In recent years there has been an increasing awareness of the risks of collapse or tipping points in a wide variety of complex systems, ranging from human medical conditions, pandemics, ecosystems to climate, finance and society. They are characterized by variations on multiple spatial and temporal scales, leading to incomplete understanding or uncertainty in modelling of the dynamics. Even in systems where governing equations are known, such as the atmospheric flow, predictability is limited by the chaotic nature of the system and by the limited resolution in observations and computer simulations. In order to progress in analyzing these complex systems, assuming unresolved scales and chaotic dynamics beyond the horizon of prediction as being stochastic has proven itself efficient and successful. When complex systems undergo critical transitions by changing a control parameter through a critical value, a structural change in the dynamics happens, the previously statistically stable state ceases to exist and the system moves to a different statistically stable state. To establish under which conditions an early warning for tipping can be given, we consider a simple stochastic model, which can be considered a generic representative of many complex two state systems. We show how this provides a robust statistical method for predicting the time of tipping. The method is used to give a warning of a forthcoming collapse of the Atlantic meridional overturning circulation.
References: Peter D. Ditlevsen and Susanne Ditlevsen (2023), Warning of a forthcoming collapse of the Atlantic meridional overturning circulation. *Nat Commun* 14, 4254

SHORT BIO: Susanne Ditlevsen is full Professor of Statistics and Stochastic Models in Biology, in the Department of Mathematical Sciences of the University of Copenhagen, where she heads the group of

statistics and probability theory. Prof. Ditlevsen's research focuses on statistical inference for stochastic processes, mathematical biology, stochastic non-linear dynamics and mathematical neurosciences.

Prof. Ditlevsen completed her Ph.D. in 2004 at the University of Copenhagen, under the supervision of Prof. Sørensen with a dissertation titled 'Modeling of physiological processes by stochastic differential equations'.

In 2012 Prof. Ditlevsen became an elected member of the International Statistical Institute, and in 2016 she was elected to the Royal Danish Academy of Sciences and Letters. She is the recipient of many awards and grants, including the Female Research Leader Award of the Danish Council for Independent Research as PI (750K Euro). Presently, Prof. Ditlevsen is Elected vice-president in the natural sciences of the Presidium of the Royal Danish Academy of Sciences and Letters, Council member of the Bernoulli Society for Mathematical Statistics and Probability, and member of the Scientific Steering Committee of the Isaac Newton Institute for Mathematical Sciences (Cambridge, UK).

In 2023 she attracted widespread newspapers attention thanks to her *Nature Communications* paper on climate risks related to the forthcoming collapse of the Atlantic meridional overturning circulation.

Susanna Terracini
Direttrice del Dipartimento