

Mechanisms for Extreme Event Generation (MEEG)

8 – 12 July 2019 @ Snellius

It is still not well understood why extreme events in complex systems in fields as diverse as space plasma physics, astrophysics, geo-physics, climatology and meteorology, finance and economics, material sciences, laboratory (fusion) plasma physics, to biophysics and evolution ecology, sometimes deviate from power law behaviour. Indeed, there remains many unanswered questions concerning the generating mechanisms of extreme events and their relationship with the rest of the statistics. Most importantly, why does a wide range of dynamic phenomena from many fields display such similar trends and characteristics? Observational evidence suggests that searching for universal signatures – an inter-disciplinary approach – could be the way forward when looking for answers to these questions, specifically, why do extreme events occur in the first place?

Consolidating and expanding already existing collaborations in extreme risk modelling, MEEG allowed to bring together an international group of researchers from a wide range of research disciplines and pursue an inter-disciplinary approach for reaching the aims of the workshop: 1.) Advance the understanding of the mechanisms driving the occurrence of power laws by exploring the available theoretical models and methods, including self-organized criticality, percolation, and non-equilibrium phase transitions. 2.) Gain insight into the physics of extreme events beyond the observed power laws and other signatures of apparent scale-free behaviour. 3.) Review the state of the art in statistics and machine learning in outliers and extreme events detection and identification, as well as invent new methods in particular for finite data sets, and in the presence of non-stationarity. For this purpose, four sub-groups were defined with each participant associated with one of them: 1.) Extreme Events in Cosmic Geophysics, Solar and Astrophysics, 2.) Extreme Geo-hazards, Climate and Weather, Biophysics, Evolutionary Ecology, 3.) Financial Market Bubbles, Crashes and Crises, 4.) Extreme Events in Laboratory (Fusion) Plasma, Material Failure.

The four introductory plenary talks on Monday introduced participants to the phenomena associated with the sub-groups. Plenary sessions covering the various fields were held on Tuesday and Wednesday. Following each session participants broke into sub-groups to discuss among themselves and thereafter reconvened to present outcomes of their discussions to the other participants. The objective was to identify differences and similarities between the various phenomena by focussing on parameters used to describe the phenomena, as well as techniques and methods to study them. On the second day of the workshop the first “commonalities” between several phenomena from different sub-groups had been identified. Having “broken the ice” a more informal setting was established and for the rest of the week participants enthusiastically asked questions and discussed during the plenary sessions resulting in that sub-group discussions became part of the plenary discussions. However, this did not jeopardize the objective and it was successfully reached based on the outcomes of these inter-disciplinary plenary discussions. Thursday was considered an inter-disciplinary day with focus on talks that were relevant for more than one sub-group. On Friday sub-group outcomes were consolidated and presented, and post-workshop activities discussed.

To further and facilitate communication between different fields a dedicated MEEG website for the scientific community will be built and act as a hub for studying extreme events. Outputs of the workshop including roadmaps and recommendations for this emerging inter-disciplinary research field, as well as a preliminary glossary list of terms and their respective definitions (interpretations) as function of phenomena will be made available on the website. They will also be included in a jointly authored MEEG paper that will present the aims and outcomes of the workshop. Future MEEG related endeavours will also include participation of the user communities that could potentially be interested in the usage of the scientific results for the mitigation (warning) of extreme events.

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