A Complex Systems Approach to Study Human Nature: An introduction to the analytical toolbox of Complexity Science

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This workshop will provide an introduction to some of the formal models, research methods and analytical techniques that allow for the study of human behaviour from a complex systems perspective. Complexity research transcends the boundaries between the classical scientific disciplines and is a hot topic in physics, mathematics, biology, economy and psychology. Its focus is a description and explanation of behaviour based on *interaction dominant dynamics*: Many processes interact on different temporal and spatial scales and behaviour emerges out of those interactions through physical processes such as self-organization or soft-assembly.

Contrary to what the name might suggest, complexity research is often about finding simple models or collective variables with which a wide range of different behavioural modes can be described. This approach differs fundamentally from the more classical approaches in which behaviour is considered the additive result of many independent, component processes (*component dominant dynamics*) and the goal of research is to identify efficient causes of behaviour.

The main focus of the workshop will be hands-on experience with data-analysis using the R statistical computing environment. No special background knowledge is required to participate.

Program:

**I. Introduction to the mathematics of change**

* Modelling (nonlinear) growth
* Predator-Prey dynamics and Deterministic Chaos
* Basic timeseries analysis

**II. Quantifying Recurrences in State Space**

* Takens' Theorem and State-Space reconstruction
* Recurrence Quantification Analysis of continuous and categorical data
* Cross-Recurrence Quantification Analysis of dyadic interaction

**III. Complex Structure: Fractal Scaling and Network Topology**

* Scaling phenomena in time and trial series of human behaviour and phyisology
* Small-world and Scale-free networks
* Advanced topics: Multi-fractals, Complexity Matching, Networks of networks