Complexity

Science

Complexity Seminars 2022-2023

Last Updated 24th January 2023.

Organiser: Tim Evans (Centre for Complexity Science)

This is a preliminary list. Please check the events listed on the Centre for Complexity seminars page for current information.

The Centre for Complexity Science at Imperial College hold a series of research seminars, *usually* every second Tuesday at **12.00 noon** in the Gabor Seminar Room, room 611 of the Electrical & Electronic Engineering (EEE) building (see Imperial campus map). Note a few seminars are held at different times and/or locations.

SPRING TERM

Special Colloquium Noon Tuesday 17/1/23 in Physics Lecture Theatre 1

Speaker: Mogens Høgh Jensen
Niels Bohr Institute, University of Copenhagen, Denmark

Title: Complexity in Nature

Abstract:

This colloquium will be a pedagogical introduction to the field of complexity science.

Complex phenomena are found throughout nature, from ice crystals to the flow of ocean currents. These emergent patterns and behaviours can often be understood and described using fractals and chaos theory. In recent years, research has led to a new paradigm – that the dynamics of simple physical systems can give rise to complex behaviour. This is also seen in the biological world, where living systems – from ecosystems containing many species down to single cells and proteins – exhibit complex behaviour which can be successfully modelled using computer simulations. Complexity is also seen in human society, manifesting itself in activities on social media such as Twitter. Even financial markets show evidence of emergent complex dynamics.

Seminar Noon Tuesday 31/1/23 in EEE room 611

Speaker: Pedro Martinez Mediano
Title: Information decomposition as a link between biological and artificial brains

Abstract:

One of the key principles of information processing is that it is substrate-independent – i.e. the same computation can be implemented by multiple systems obeying different physical laws. In this talk, I will illustrate how the principles of information decomposition (in particular, metrics of synergy and redundancy) can provide such a substrate-independent description of computation in complex systems by linking biological and artificial brains. First, I will show results obtained from fMRI data showing that regions of the brain responsible for high-level cognitive processes are synergy-rich, while areas responsible for sensory input and motor output are redundancy-rich. Then, I will show results from a study of artificial neural networks, showing that synergy increases as neural networks learn novel tasks, possibly aiding in the process of generalizing learned representations; while redundancy helped the network sustain random perturbations. Together, these results suggest different functional roles of synergy and redundancy for computation in complex systems.

Complexity Seminars, 2022

Seminar Noon Tuesday 14/2/23 in EEE room 611

Speaker: Robert Peach
Honorary Research Fellow, Department of Brain Sciences, Imperial College London
Title: Frequency mixing from the single-neuron to the human brain

The brain is composed of billions of neurons whose individual oscillatory dynamics together orchestrate rich neural activities that regulate cognitive, perceptual, and behavioural states, and facilitate information transfer across the cerebrum. The oscillatory signals are subject to multiple non-linear transformations as they converge and diverge within and between neuronal networks. In the fields of electronics and acoustics, it is well known that the application of non-linearities through diodes or transistors to the sum of two oscillations generates novel oscillations at the sum and difference frequencies of the inputs, forming the foundations of communications technology. This process is known as frequency mixing or the heterodyne principle, but until now has seen little investigation within the field of neuroscience. In this seminar we will explore frequency mixing in the context of neural data, either evoked through stimulation or existing endogenously, and introduce statistical methods that are capable of identifying these frequency mixing interactions. We will emphasise recent results providing evidence that the single neuron acts as a mixer and that mixing interactions can be observed in the human brain.

Seminar Noon Tuesday 28/2/23 in EEE room 611

Speaker: Johannes Pausch
Title: Phases of Feed-forward Neuronal Network Activity: From Avalanches to Cellular Automata

Abstract:

Neuronal network activity is often measured in form of voltage fluctuations and, after some data processing, avalanches are usually extracted as signatures of collective behaviour. In my talk, I will discuss where these avalanches come from and whether we should attach a lot of meaning to them. I will then dig deeper by looking at a more microscopic model of the dynamics: a feed-forward network of leaky-integrate-and-fire neurons. Here, we can identify several phases of activity and we can trace back avalanche dynamics to a more microscopic picture. In particular, we will need to distinguish between causal avalanches and an avalanche definition that is based on excursions of activity. Furthermore, we will also look at the interesting low-noise limit of cellular automata.

Seminar Noon Tuesday 14/3/23 in EEE room 611

Speaker: Federico Botta
Department of Computer Science, University of Exeter
Title: Using data science to understand society and support policy makers

Abstract:

The rapid increase in data availability has opened up novel opportunities for policy makers to design policies based on better, more up-to-date data about the state of society. In this talk, I will first discuss how data and data science can be used to better understand our society, such as measuring travel flows or estimating the English index of multiple deprivation. I will then share my experience of collaborating with a range of UK policy makers, such as the data science team in 10 Downing Street, and discuss how research can be co-designed to deliver impact.