Complexity Theory Introduction Course

This course is an introduction to the core concepts of complex systems theory, an exciting new area that is offering us a fresh perspective on issues such as understanding our financial system, the environment and large social organizations. The aim of this course is to bring the often abstract and sophisticated concepts of this subject down to earth and understandable in an intuitive form. After having started with an overview to complex systems this course will focus upon five of the core concepts.

Systems Thinking & Theory: We will start with two sections on systems theory and systems thinking, this should introduce students to the bigger picture of why complex systems is seen as a new paradigm in science; what exactly this new paradigm is; why we need it and lastly how it differs from our traditional methods of scientific inquiry.

Nonlinear Systems: The term nonlinear science and complex systems are often used interchangeably showing how essential the concept of non-linearity is to this subject. In this section we draw the distinction between linear and nonlinear systems and see why it matters. The second part of this section covers the subject of chaos theory and the dynamics of nonlinear systems.

Network theory: networks in general have arisen in almost all fields of inquiry in the past few decades making it one of the most active and exciting areas of scientific study. We will explore many different types of networks, their properties and examples in the real world from social networks to logistics networks. This section will conclude by looking at graph theory, the mathematical foundations that lie behind networks.

Complex adaptive systems: CAS is increasingly being used to model a wide variety of systems from, electrical power grids to economies and cultures it represents a powerful new way of seeing the world. This section will also cover CAS's close relative cybernetics and the basic concept of adaptation and evolution. Self-organization is another of the foundational concepts within complex systems that is proving particularly relevant to the world of the 21st century as we see collaborative self-organization is more than just a social phenomenon, we explore how it is in fact ubiquitous in our world from the formation of fish schools to magnetization and traffic jams.