UNIVERSITY OF GOTHENBURG

PHYSICS

FIM780 Information Theory for Complex Systems, 7.5 higher education credits

Information Theory for Complex Systems, 7,5 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Physics on 2006-11-01 and was last revised on 2017-06-13 to be valid from 2017-06-13, spring semester of 2017.

Field of education: Science 100%
Department: Physics

Position in the educational system

The course FIM780 is a programme course in the Complex Adaptive Systems programme, as well as a single subject course at the University of Gothenburg.

The course can be part of the following programmes: 1) Applied Data Science Master's Programme (N2ADS), 2) Complex Adaptive Systems, Master's Programme (N2CAS), 3) Physics of Materials and Biological Systems, Master's Programme (N2PMB) and 4) Physics, Master's Programme (N2PHY)

Main field of studies	*Specialization*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Entry requirements

Basic undergraduate mathematics and probability theory.

Learning outcomes

After successfully completing this course the students will be able to

- Define and use the basic concepts of information theory: Shannon entropy, relative entropy, complexity measures based on these
- Use information theory to characterise both cellular automata and low-dimensional chaos
- Understand the connection between information theory and statistical mechanics
- Use geometric information theory to characterise patterns in spatically extended systems like pictures
- Explain how information is flowing in chemical self-organising systems exhibiting pattern formation

Course content

The course introduces the students to important concepts in information theory that can be used to describe and characterise complex systems. The concepts are applied to a number of areas in complex systems: cellular automata, fractals, chemical self-organisation, and chaos. The main aim is to give students the knowledge and skills to apply information theory to a wide variety of different systems. The course also gives a presentation of the connections between information theory and physics, primarily statistical mechanics and thermodynamics.

- Basic concepts of information theory
  - Shannon entropy, relative information, complexity measures
- Information theory for symbol sequences and lattice systems
  - correlations and randomness in symbol sequences
- Information theory and physics
  - entropy in physics and its relation to randomness in information theory
- Cellular automata
  - order and disorder in the time evolution of various cellular automaton rules
- Geometric information theory
  - presentation of an information-theoretic framework for characterising patterns
- Self-organising chemical systems
  - flows of information in the process of pattern formation
- Chaotic systems and information
  - flows of information from micro to macro in chaotic systems

Form of teaching

The examination will be based homework assignments (10%) and a final exam (90%).

Language of instruction: English

Assessment

Grades

The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).
The examinator must be informed within a week after the course starts if a student would like to receive ECTS grades.

Course evaluation

Web-based course evaluation