Study programme(s): Applied Mathematics – Data Science

Level: Master studies

Course title: Information Theory for Networks

Lecturer: Dušan Jakovetić

Status: elective

ECTS: 6

Requirements: Basics of theory of probability

Learning objectives

- Understanding basic information measures: entropy, mutual information
- Understanding the concept of compression of information sources and fundamental limits
- Understanding the concept of information recovery from imperfect observations (either through transmission or some other noise additive transformation) and fundamental limits
- Fundamental limits of information compression and transmission in large networks of nodes

Learning outcomes

- Ability and experience in applying information-theoretic methods on real-world problems
- Ability to recognize the potential for information-theoretic reasoning across wide application areas

Syllabus

Theoretical instruction

Introduction to Information Theory: Entropy, AEP Lemma, Source Coding (Compression) Theorem; Mutual Information (KL Distance), Channel Capacity, Channel Coding (Noisy Information Recovery) Theorem

Single-Hop Network Graphs

Compression and Noisy Information Recovery limits in specific single-hop graph examples: Multiple Access, Broadcast, Relays: Introduction and capacity results.

General (Multi-Hop) Network Graphs:

Information Flows, Max-Flow Min-Cut Theorem, Network Coding, Networking and Information Theory, Coding for Computing, Coding for Storage Systems

Practical instruction

Application examples in communication systems, neuroscience, epidemiology, genomics, finance etc.; Implementation of the taught methods in MATLAB; Application of selected methods on real-world examples through the course project.

Literature

19. T. Cover and J. Thomas: Elements of Information Theory, Wiley, 1991.
20. A. El-Gamal, Y-H. Kim: Network Information Theory, Cambridge University Press, 2011

Weekly teaching load				Other: 0
Lectures: 2	Exercises: 3	Other forms of teaching: 0	Student research: 0	

Teaching methodology

Lectures; revisions of the material; active students' participation in problem solving; knowledge tests – colloquia; application of the taught material on real-world examples within the course project.

Grading (maximum number of points 100)

Pre-exam obligations		**Points**	**Final exam**	**points**
Colloquia	Course project	60 = 30 (Colloquia) + 30 (Course project)	written exam	40