Information Theory (0432 L 654) – WS 2016-2017

Course Documents: use the ISIS system.
`https://isis.tu-berlin.de/`
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(include "Information Theory WS 2016-2017" in subject line)
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Lectures: Thursday 16:00 – 18:00, room HFT-TA 101

Advised pre-requisites (background):

- Elementary Probability & Random Processes.
- Linear algebra.
- Elementary calculus and function analysis.

Exams, grading policy and homework:

- **Exam:** Written test (closed books) (optional oral examination).
- The test is CLOSED BOOKS. **You are allowed to use *one* sheet of paper (two sides) of standard A4 format in order to annotate formulas**.
- The exam (test) contributes for:
  1. 30/100 pts for the Module 40101 (STuPO2010/13) *Information Theory and Coding (ET).*
  2. 40/100 pts for the Module 40106 (STuPO2010/13) *Information Theory and Coding (TI).*
  3. 50/100 pts for the Module 40230 (STuPO2015) *Information Theory.*
- The course has no formal graded homework. Problem sets are posted and solutions are given and discussed, in order to help student's preparation for the final test.

Course objectives and content:

- Brief review of probability theory for discrete random variables.
- Definition and main properties of entropy, cross-entropy (information divergence) and mutual information, basic relations and convexity properties, data processing inequality, Fano inequality.
- Typical sequences and typical sets, fundamental lemmas of typicality.
- Data compression, Human codes, arithmetic codes, notion of universal lossless source coding (Lempel-Ziv algorithm).

- Channel coding, capacity of discrete memoryless channels, capacity-cost function, proofs of achievability and converse of the channel coding theorem.
- A short overview of channel coding and its applications.
- Brief review of continuous random variables, probability density functions, differential entropy.
- Gaussian channels, spectral efficiency, waterfilling power allocation with relation to bit-loading and OFDM.
- Rate-distortion theory and quantization, reverse waterfilling with relation to subband coding, successive refinement coding, with reference to scalable image and video coding.
- Advanced topics (time permitting): a selection of topics at the boundary of today's research will be presented. Examples are: non-stationary non-ergodic channels and sources via the "information spectrum methods", application to fading and MIMO channels, performance of codes in the finite length regime and "channel dispersion", channel coding and source coding with side information and channel with states.

Advised textbook:

- T. Cover and J. Thomas, *Elements of Information Theory,* 2nd Ed., Wiley Interscience, 2006.
- IMPORTANT: you can access an electronic version of this book using the Wiley Online Library `http://onlinelibrary.wiley.com/`. This can be accessed from TUB machines (you must be on-campus or have a VPN for home access). Use the *Advanced Search* option on the main webpage (e.g., search for `Title = Elements`, and `Author = Cover`).