CREST - GENES
Cours doctoraux 2020 – 2021

Information-theoretic methods in computer science and statistics

Yury POLYANSKIY
MIT

SCHEDULE	Tuesday	07th January 2020 14th January 2020	De 15h30 à 18h00 De 15h30 à 18h00	Salle 2001
	Thursday	09th January 2020 16th January 2020	De 10h à 12h30 De 10h à 12h30	Salle 2001

Abstract :
This course will overview how techniques and ideas originating in information theory have been used (classically and recently) for deriving sharp impossibility results in various disciplines.
We will start with a basic introduction of entropy, KL divergence and mutual information and see how their simple properties (convexity, chain rule, data processing) lead to impressive results in combinatorics and probability (e.g., counting subgraphs, bounding permanents and volumes of orthogonal projections in Euclidean spaces).
The main part of the course will be focused on studying the strong data processing inequality (SDPI), which bounds the amount of loss of the mutual information upon traversing through a noisy channel. As applications we will discuss: Ising and Potts models on trees, random colorings on trees, community detection, spiked Wigner model, Z_2-synchronization, fault-tolerant computing and distributed estimation. This wide range of domains can be treated in a surprisingly unified way via the concept of SDPI.

Literature :

* Y. Polyanskiy, Y. Wu, "Lecture notes on Information Theory," MIT (6.441), UIUC (ECE 563), Yale (STAT 664), 2012-2017 ;
* Y. Polyanskiy and Y. Wu, "Strong data-processing inequalities for channels and Bayesian networks," In Convexity, Concentration and iscrete Structures, part of The IMA Volumes in Mathematics and its Applications, vol. 161, Springer-Verlag, New York, 2017 ;
* Y. Polyanskiy and Y. Wu, "Application of information-percolation method to reconstruction problems on graphs," arxiv:1806.04195, Jun. 2018 ;
* W. Evans, C. Kenyon, Y. Peres, and L. J. Schulman, "Broadcasting on trees and the Ising model," The Annals of Applied Probability, vol. 10, no. 2, pp. 410–433, May 2000 ;
* W. S. Evans and L. J. Schulman, "Signal propagation and noisy circuits," IEEE Transactions on Information Theory, vol. 45, no. 7, pp. 2367–2373, November 1999 ;
* A. Sly, "Reconstruction of random colourings," Communications in Mathematical Physics, vol. 288, no. 3, pp. 943–961, June 2009 ;
* U. Hadar, J. Liu, Y. Polyanskiy and O. Shayevitz, "Communication complexity of estimating correlations, " Proc. 51st ACM Symp. on Theory of Comp. (STOC), 2019 ;
* J. Duchi, M. Jordan, M. Wainwright, and Y. Zhang, "Optimality guarantees for distributed statistical estimation," arXiv preprint, 2014.[Online]. Available: http://arxiv.org/abs/1405.0782