Doctoral Course I
Title: Multiuser Information Theory with Applications to Wireless Networks

Duration: 12h
Time frame: March 12 – 23, 2018

Background: A course on digital/wireless communications, and a first course in information theory (e.g., Chapters 1,2,3,4,5,7,8,9,10 from Cover & Thomas, Elements of Information Theory, 2nd Ed., Wiley).

Syllabus:

1) Review of fundamental information theory results, and in particular asymptotic equipartition property, covering and packing lemmas, Fano inequality, and the general structure of achievability and converse proofs in information theory. (1h)

2) One-hop network communication scenarios: multiple access channel (MAC), broadcast channel (BC), and interference channel (IC). (1h)

3) The MAC capacity region, and its application to MIMO-MAC (vector-Gaussian case). (3h)

4) The BC capacity region, and its application to MIMO-BC (vector-Gaussian case). (3h)

5) Optimization problems on MIMO-MAC and MIMO-BC using uplink-downlink duality and the polymatroid structure (e.g., optimal joint power control and user scheduling). (2h)

6) Gaussian IC: generalized degrees of freedom for the 2-user case, and optimality of treating interference as noise (TIN) for the K user case. Relation to link scheduling and power control in D2D networks. (2h)

Course organization:

Tuesday 13/3 (2h)
Wednesday 14/3 (2h)
Thursday 15/3 (2h)
Monday 19/3 (2h)
Wednesday 21/3 (2h)
Thursday 22/2 (2h)

Recommended reading (after this introductory course, in order to gain more insight and deeper knowledge on the topics):

- A. El Gamal and Y-H. Kim, *Network Information Theory*, Cambridge Univ. Press, Cambridge UK, 2011. (slides from this book are available at http://arxiv.org/abs/1001.3404)
- G. Kramer, *Topics in Multi-User Information Theory*, Foundations and Trends in Networking, 2008, http://www.nowpublishers.com/article/Details/CIT-028