Lund University, Department of Automatic Control

Ph.D. course 'Network Dynamics'

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This course will provide an introduction to and some analysis of the main mathematical models used to describe large networks and dynamical processes that evolve on networks. Motivation and applications will be drawn from social, economic, natural, and infrastructure networks, as well as networked decision systems such as sensor networks.

This course is designed for an audience of Ph.D. students with some mathematical background (in particular, probability and linear algebra at an intermediate level), possibly from the programs in Automatic Control, Mathematics, Mathematical Statistics, Physics, ...

Below is a tentative program for 12 2-hours lectures in the 2nd quarter term (October 24 – December 9, 2011)

(1) Introduction, motivation, and basic notions of graph theory [2]

(2) Markov Chains I [10, 1, 8]

(3) Markov Chains II [10, 1, 8]

(4) Branching Processes, Erdös-Rényi graph I [3, 6, 5]

(5) Erdös-Rényi graph II [3, 6, 5]

(6) Configuration model, random graphs with given degree distribution [6, 5]

(7) Small worlds [6, 5]

(8) Power laws and preferential attachment [6, 5]

(9) Dynamics I (epidemics, percolation, opinion dynamics, ...) [9, 11, 7, 6, 4, 5]

(10) Dynamics II [9, 11, 7, 6, 4, 5]

(11) Dynamics III [9, 11, 7, 6, 4, 5]

(12) Bayesian learning [7]

References

[1] D. Aldous and J. Fill, *Reversible Markov chains and random walks on graphs*, monograph in preparation, 2002.

[2] B. Bollobás, *Modern graph theory*, Springer, 1998.

[3] ——, *Random graphs*, Cambridge University Press, 2001.

[4] C. Castellano, S. Fortunato, and V. Loreto, *Statistical physics of social dynamics*, Reviews of Modern Physics **81** (2009), 591–644.

[5] M. Draief and Laurent Massoulié, *Epidemics and rumors in complex networks*, Cambridge University Press, 2010.

[6] R. Durrett, *Random graph dynamics*, Cambridge University Press, 2006.

[7] M.O. Jackson, *Social and economic networks*, Princeton University Press, Princeton, New Jersey, 2008.

[8] D.A. Levin, Y. Peres, and E.L. Wilmer, *Markov chains and mixing times*, American Mathematical Society, 2010.

[9] T.M. Liggett, *Interacting particle systems*, Springer-Verlag, 1985.

[10] L. Lovász, *Random walks on graphs: a survey*, Royal Society Mathematical Studies **2** (1993), 1–46.

[11] F. Vega-Redondo, *Complex social networks*, Cambridge University Press, 2006.