Wireless random-access networks and spectra of random graphs

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Stellingen

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Wireless Random-Access Networks and Spectra of Random Graphs

van

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1. For complete bipartite graphs, the distribution of the transition time divided by its mean is exponential, truncated polynomial or deterministic, depending on the relation between the number of initially active nodes and the aggressiveness of their activation rates.

   [Chapter 2]

2. For arbitrary bipartite graphs, a randomized constructive algorithm can be defined to determine the most likely paths leading to the transition. The algorithm is greedy, in the sense that it always chooses the node that adds the least to the transition time, and consistent, in the sense that different paths lead to the same order of the mean transition time.

   [Chapter 3]

3. For dynamic bipartite graphs, the order of the mean transition time depends on the speed of the dynamics. In the case of fast, regular or competitive dynamics, it is the reciprocal of the edge rate.

   [Chapter 4]

4. For non-dense non-sparse Erdős-Rényi random graphs, the empirical spectral distribution of the adjacency matrix converges to a semicircle law. Instead, for inhomogeneous Erdős-Rényi random graphs, it converges to the free multiplicative convolution of the standard semicircle law with the law that controls the inhomogeneity of the connection probabilities.

   [Chapter 5]

5. For dense inhomogeneous Erdős-Rényi random graphs with connection probabilities having a multilicative structure, around the minimum of the rate function and near its extreme points, balanced perturbations of the graphon, consisting of a small perturbation throughout the unit square, carry the minimal cost.

   [Chapter 6]

6. A large class of thermodynamical systems undergoing a phase transition exhibits the phenomenon of metastability. The system instead of undergoing the right phase transition, remains for a long time in an apparently stationary situation until some external perturbation or some spontaneous large fluctuation will "nucleate" the new phase, starting an irreversible process leading the system to the true equilibrium phase.

   [Cassandro, Galves, Olivieri, Vares, J. Stat. Phys. 35, 603–634, 1984]

7. In wireless networks, understanding metastability properties of random-access protocols is important to improve the network performance. The asymptotic behavior of the first hitting times between maximum-occupancy configurations provides fundamental insights into the average packet transmission delay and the temporal starvation which may affect some devices of the network.

   [Nardi, Zocca, Borst, J. Stat. Phys. 162, 522–576, 2016]

8. For centuries, the primary territory of probability theory was to model uncorrelated or weakly correlated systems via the law of large numbers or the central limit theorem. Random matrix statistics is essentially the first and only general computable pattern for complicated correlated systems, and it is conjectured to be ubiquitous.

   [Erdős, Yau, Bull. Amer. Math. Soc. 49, 377–414, 2012]

9. The structure of an Erdős-Rényi random graph conditional on a large deviation can be expressed in terms of a variational problem involving graphons. Surprisingly, even a simple example such as the number of triangles yields an interesting double phase transition.

   [Chatterjee, Varadhan, Eur. J. Comb. 32, 1000–1017, 2011]

10. A famous saying attributed to Albert Einsten reads: "If you can't explain it simply, you don't understand it well enough". Interestingly, mathematics, which follows simple logic and patterns, can be very challenging to explain.

11. Writing a mathematical paper and converting a van into a campervan have a lot in common.