

Draft of the lecture

Piotr Cholda

October 25, 2017

1 Graph Modeling of Networks

1.1 Graph theory in network modeling

1. Network science.
2. *Regular* graph.
3. Milgram's experiment (1967).
4. The Watts-Strogatz's model, the so-called small-worlds. Clustering coefficients.
5. Probability distribution function for node degrees.
6. The Erdős-Rényi model for random networks (the so-called Poisson's model), a bell shape curve for node degree distribution.
7. Discovery of *scale-free networks* (Barabási: hyperlinks), power law for distribution of node degrees, a heavy/fat-tailed distribution, Pareto principle (80/20), topological hubs.
8. The Albert-Barabási model for graph evolution (preferential attachment).

1.2 Exercises

1. Select two natural numbers n and m , so that $5 \leq n, m \leq 10$. There is a bipartite graph $K_{n,m}$. Draw this graph, find its diameter, and tell if this graph is: (a) Eulerian, (b) regular. Select an edge and find its centrality. Select a vertex and find its centralities.

1.3 Reading

1.3.1 Contents of the lecture

Problems described in this lecture are generally dealt with in the following position:

- Mung Chiang. *Networked Life. 20 Questions and Answers*. Cambridge University Press, Cambridge, UK, 2012 (chapter 3, chapters 8-10).

Course: Telecommunication Network Design
Teacher: Piotr Cholda piotr.cholda@agh.edu.pl
Studies: Electronics and Telecommunications
Speciality: Networks and Services
Semester: 2nd sem. MSc stud., Fall

1.3.2 Auxiliary references

- Albert-László Barabási. Scale-Free Networks. *Scientific American*, 5:60–69, May 2003: scale-free networks (be critical about claims on the Internet’s Achilles’ heel!).
- Ernesto Estrada. *The Structure of Complex Networks. Theory and Applications*. Oxford University Press, Oxford, UK, 2009: network complexity analysis (with applications in various sciences).
- Ted G. Lewis. *Network Science. Theory and Applications*. John Wiley & Sons, Inc., Hoboken, NJ, 2009: how to infer network properties on the basis of graph measures.
- Mark E. J. Newman. Random Graphs as Models of Networks. In Stefan Bornholdt and Heinz Georg Schuster, editors, *Handbook of Graphs and Networks. From the Genome to the Internet*. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany, 2003: network modeling with graph theory, interesting data on existing networks.