

Syllabus

Please check each week for updates to that week's readings, assignments and materials.

Important: Many of the lectures have embedded in them quizzes pertaining to interactive demos. The in-video quiz may ask you to run a NetLogo model. If your browser is unable to load NetLogo applets, please refer to [this page](#) for setup instructions.

For the readings, rather than linking to the publisher's site for articles, I have provided links to Google Scholar queries, where you can find the publisher's versions, but also alternative sources.

Week 1: What are networks and what use is it to study them?

Concepts: nodes, edges, adjacency matrix, node degree, connected components.

Video	Slides	Extras
introduction	PPT PDF	NetLogo: visually detecting communities
software tools	PPT PDF	
network basics	PPT PDF	
Gephi demo		download and install Gephi

Datasets

- [Dining table partners](#)
- [Lada's anonymized Facebook network](#)

Recommended reading

- Easley & Kleinberg, *Networks, Crowds and Markets*, [Ch1. Overview](#).
- Albert-László Barabási, *Network Science*, [Ch 1. Introduction](#)
- Albert-László Barabási, *Network Science*, [Ch 2, sections 2-6,9](#)

Recommended popular science books (optional bedside reading)

- [Linked](#) by Albert-László Barabási
- [Six Degrees](#) by Duncan Watts.
- other notables: [Nexus](#) by Mark Buchanan and [Connected](#) by Nicholas Christakis and James Fowler.

Assignment 1: available Monday March 4th, due Friday March 15th

Calculate basic properties of your Facebook social network (or Lada's, your choice), using Gephi. The assignment is not due until the following Friday to allow folks joining the course late to catch up and for the teaching staff to iron out any software kinks. However, beware that assignment 2 is due the following Tuesday March 19th, so get this one in before the deadline, is our advice.

Week 2: Random network models: Erdos-Renyi and Barabasi-Albert

Concepts: connected components, giant component, average shortest path, diameter, breadth-first search, preferential attachment Activities: Create random networks, calculate component distribution, average shortest path, evaluate impact of structure on ability of information to diffuse

Video	Slides	Extras
intro remarks for week 2		
Erdős-Renyi random graphs	PPT PDF	NetLogo: Erdos-Renyi Random Graph Generator
Model insights and realism	PPT PDF	NetLogo: Giant Component NetLogo: Lattice Percolation NetLogo: Two giant components? NetLogo: Random graph models
growth models	PPT PDF	NetLogo: Random and preferential attachment
Google Hangout with Ed Chi and David Huffaker of Google on SNA @ Google	PDF	

Datasets

- [ER Random Graph Net Logo File](#)
- [Growth and Preferential Attachment Net Logo File](#)

Recommended reading

- (for the mathematically minded:) Newman, M. E. J. [The Structure and Function of Complex Networks](#). SIAM Review. 45 (2003): Section IV (Random Graphs) p. 20-24 and Section VII (Models of network growth) p.30-37.
- AL Barabási, R Albert, [Emergence of scaling in random networks](#), Science, 1999.

Assignment 2: due Tuesday 3/19

Understand how network structure (generated by different models) affects the diffusion of information and other agents over the network.

Project for programming option

Programming assignment 1

Week 3: Network centrality

Concepts: betweenness, closeness, eigenvector centrality (+ PageRank), network centralization Activities: calculate and interpret node centrality for real-world networks.

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Video	Slides	Extras
Degree, closeness, betweenness	PPT PDF	
Directed and eigenvector centrality	PPT PDF	PageRank demo
applications (optional)	PPT PDF	
fitting power laws (optional)	PPT PDF	
Bonus: Cameron Marlow (Facebook) on SNA and data science at Facebook (disclosure: Lada is on leave at Facebook this academic year)		

Recommended reading

- A Clauset, CR Shalizi, MEJ Newman, [Power-law distributions in empirical data](#), SIAM review, 2009.
- RS Burt, [Structural holes and good ideas](#), American Journal of Sociology, 2003.
- L Page, S Brin, R Motwani, T Winograd, [The PageRank citation ranking: bringing order to the Web](#), Stanford technical report.

Reading for assignment

- Wayne E. Baker & Robert R. Faulkner, [The Social Organization of Conspiracy: Illegal Networks in the Heavy Electrical Equipment Industry](#), *American Sociological Review*, 58(6), 1993.
- Sinan Aral and Marshall Van Alstyne, [Network Structure and Information Advantage](#), working paper (full, longer paper published as [The Diversity-Bandwidth Trade-Off](#), American Journal of Sociology, 2011).

Assignment 3

due Tuesday March 26th.

- [part 1 \(PageRank competition\)](#)
- [part 2 \(reading & analysis\)](#)

Optional programming assignment 2

due Tuesday March 26th.

Week 4: Community structure

Concepts: community structure, modularity, overlapping communities Activities: detect and interpret disjoint and overlapping communities in a variety of networks (scientific collaborations, political blogs, cooking ingredients, etc.)

Video	Slides	Extras
Why community structure matters	PPT PDF	toy opinion formation model
	PPT	

Cliques, k-cores and all that	PDF	clique finding demo
Detecting communities	PPT PDF	
Bonus: Igor Perisic and Sam Shah talk about SNA at LinkedIn		

Recommended reading

- MEJ Newman, [Modularity and community structure in networks](#), PNAS 103 (23), p. 8577-8582 (2006).
- Palla et al., '[Uncovering the overlapping community structure of complex networks in nature and society](#)', Nature 435, 814-818 (9 June 2005).
- Santo Fortunato, [Community detection in graphs](#), Physics Reports 486, 75-174 (2010) (a great reference of the developments over the past decade, but not necessarily a quick read).

HW 4

Due Tuesday April 2nd.

Optional programming assignment 3

Due Tuesday April 2nd.

Week 5: Small world network models, optimization, strategic network formation and search

Concepts: small worlds, geographic networks, decentralized search Activity: Evaluate whether several real-world networks exhibit small world properties, simulate decentralized search on different topologies, evaluate effect of small-world topology on information diffusion.

Video	Slides	Extras
Small world experiments	PPT PDF	
Clustering and motifs	PPT PDF	
Small world models	PPT PDF	NetLogo: Watts Strogatz Small World Model NetLogo: Search in a Small World (Kleinberg's model)
Origins of small worlds	PPT PDF	NetLogo: Rewiring for optimal topology

Datasets

- [Lada's Facebook network](#)
- [Gnutella peer-to-peer filesharing network](#)

Recommended reading

- Easley & Kleinberg, Networks, Crowds and Markets, [Ch20. The Small-World](#)

Phenomenon.

- Watts & Strogatz, [Collective Dynamics of Small World Networks](#), Nature 393, 440-442 (4 June 1998).
- Travers & Milgram, [An Experimental Study of the Small World Problem](#), Sociometry, Vol. 32, No. 4 (Dec., 1969).

Additional reading mentioned in the lectures

- Kilworth & Bernard, [The Reveral Small-World Experiment](#), Social Networks, 1 (1978/79) 159-192.
- Kilworth, McCarthy, Bernard & House. (2006). [The Accuracy of Small World Chains in Social Networks](#). Social Networks 28(1): 85-96.
- Dodds, Muhammad, and Watts, [An Experimental Study of Search in Global Social Networks](#)", Science, 301, 827-829 (2003).
- D. J. Watts, P. S. Dodds, and M. E. J. Newman. [Identity and Search in Social Networks](#), Science, 296, 1302-1305 (2002).
- Jon Kleinberg, [The Small-World Phenomenon, An Algorithmic Perspective](#).
- J. Kleinberg. [Small-World Phenomena and the Dynamics of Information](#). Advances in Neural Information Processing Systems (NIPS) 14, 2001.
- Mathias & Gopal, [Small worlds: How and why](#), PRE 2001.
- Gastner & Newman, [The spatial structure of networks](#), Michael T. Gastner and M. E. J. Newman, Eur. Phys. J. B 49, 247-252 (2006).

Reading for assignment

Liben-Nowell et al. [Geographic Routing in Social Networks](#), PNAS 102(33):11623-11628, 2005.

HW 5 small worlds

due Tuesday April 9th.

The only remaining programming assignment is the project, due Tuesday April 22nd.

Week 6: Contagion, opinion formation, coordination and cooperation

Concepts: simple contagion, threshold models, opinion formation Activity: Evaluate via simulation the impact of network structure on the above processes

Video	Slides	Extras
6A: diffusion and topology	PPT PDF	NetLogo model of diffusion on an Erdos-Renyi topology NetLogo model of diffusion in a network that is grown either randomly or preferentially NetLogo model of diffusion over a small-world topology
6B: complex contagion, adoption, mobilization		NetLogo model of simple and complex contagion NetLogo model of choice diffusion
6C: coordination and		NetLogo graph coloring problem on a small world

Datasets

- [NetLogo model of innovation](#)

Homework 6

due Tuesday April 16th.

Recommended reading

- Easley & Kleinberg, Networks, Crowds and Markets, [Ch19.Cascading Behavior in Networks](#)
- Damon Centola and Michael Macy, [Complex Contagions and the Weakness of Long Ties](#), American Journal of Sociology, 113(3), 2007.
- David Lazer and Allan Friedman, [The Network Structure of Exploration and Exploitation](#), Administrative Science Quarterly, 52(4), p. 667-694, 2007.
- Michael Kearns, Siddarth Suri, Nick Montfort, [An Experimental Study of the Coloring Problem on Human Subject Networks](#), Science 313, 824 (2006).

Week 7: Cool and unusual applications of SNA

Video	Slides	Extras
7A: introductory remarks		
7B: recipe recommendation using ingredient networks (optional)	PDF , PPT	
Laszlo Barabasi on networks and medicine		
Cesar Hidalgo on the product space network and economic development		
YY Ahn on the flavor network		

Homework 7

due Tuesday April 23rd.

Recommended reading*Economic development*

- C. A. Hidalgo, B. Klinger, A.-L. Barabási, and R. Hausmann. [The Product Space Conditions the Development of Nations](#), Science 27 July 2007: 317 (5837), 482-487.
- C.A. Hidalgo and R. Hausmann, [The building block of economic complexity](#), PNAS, 106(26), 2009.

Recipes and ingredient networks

- YY Ahn, SE Ahnert, JP Bagrow, AL Barabási, [Flavor network and the principles of food pairing](#), Nature Scientific Reports, 2011.
- CY Teng, YR Lin, LA Adamic, [Recipe recommendation using ingredient networks](#), Web Science 2012.

Human disease network

- Goh et al. [The human disease network](#), PNAS 104(21), 2007.
- AL Barabási, N Gulbahce, J Loscalzo, [Network medicine: a network-based approach to human disease](#) Nature Reviews Genetics, 2011.

- D Lusseau, [The emergent properties of a dolphin social network](#), Proc. Roy. Soc. B, 2003.

Week 8: SNA and social media + leftover topic of network resilience

Since we are having interviews with researchers working @ Google Plus, LinkedIn and Facebook throughout the course, the last week will be devoted to the leftover topic of resilience and to student projects via Google Hangout.

Video	Slides	Extras
8A: network resilience	PDF , PPT	Guess: network resilience
8B: resilience and assortativity	NetLogo: assortativity and resilience	
8C: resilience and the US power grid		
8D: concluding remarks		

Recommended reading

- R Albert, H Jeong, AL Barabási, [Error and attack tolerance of complex networks](#), Nature, 2000.
- R. Kinney, P Crucitti, R Albert, V Latora, [Modeling cascading failures in the North American power grid](#), EPJB 2005.
- Damon Centola, [The spread of behavior in an online social network experiment](#), Science, 2010.
- Sinan Aral and Dylan Walker, [Creating social contagion through viral product design: A randomized trial of peer influence in networks](#), Management Science, 2011.
- Bakshy, Rosenn, Marlow, and Adamic, [The role of social networks in information diffusion](#), Proc. WWW, 2012

HW 8 due Tuesday April 30th.