# Semester projects
## Complex Networks, Course 303A, Spring, 2009

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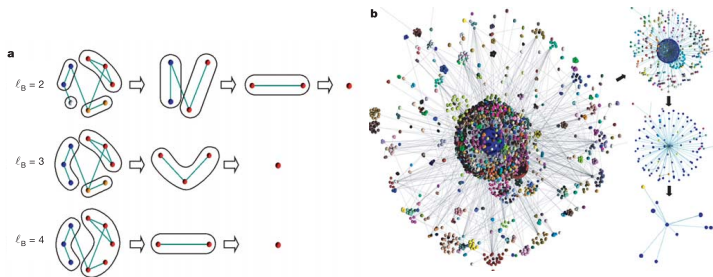# Outline

# Semester projects

Requirements:

1. $\approx$ 5 minute introduction to project (fourth week)
2. 15 to 20 minute final presentation
3. Report: $\geq$ 5 pages (single space), journal-style

# Narrative hierarchy
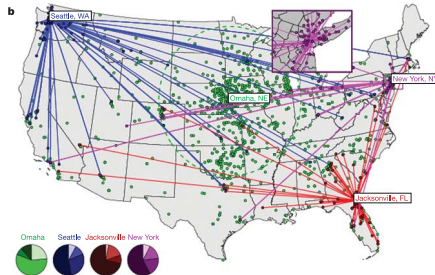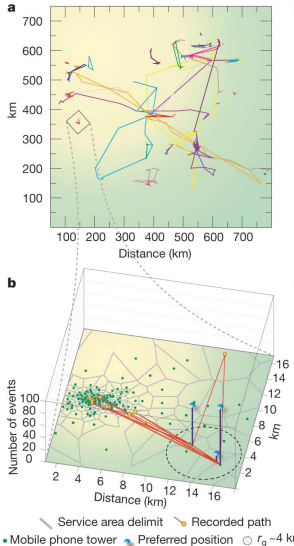
Presenting at many scales:

- ▶ 1 to 3 word encapsulation, a soundbite,
- ▶ a sentence/title,
- ▶ a few sentences,
- ▶ a paragraph,
- ▶ a short paper,
- ▶ a long paper,
- ▶ . . .

# topics

- ▶ Develop and elaborate an online experiment to study some aspect of social phenomena
- ▶ e.g., collective search, cooperation, cheating, influence, creation, decision-making, etc.

# topics

- Explore "self-similarity of complex networks" [11, 12] First work by Song *et al.*, Nature, 2005.
- See accompanying comment by Strogatz [13]

# topics

- Study Hidalgo et al.'s "The Product Space Conditions the Development of Nations" [6]
- How do products depend on each other, and how does this network evolve?

# topics

- ▶ Study movement and interactions of people.
- ▶ Brockmann *et al.*[2] "Where's George" study.
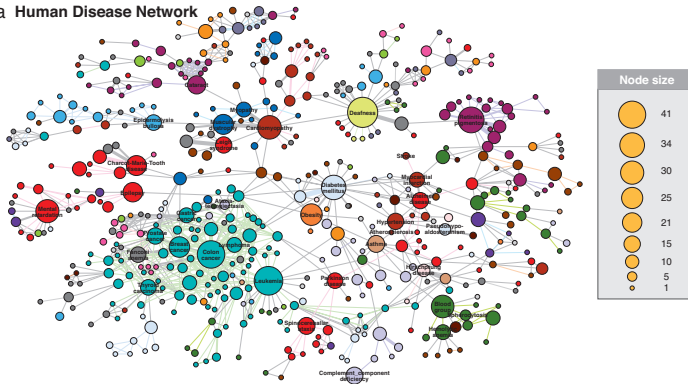- ▶ Barabasi's group: tracking movement via cell phones[5].

# topics

▶ Study the human disease and disease gene networks (Goh *et al.*, 2007):



a **Human Disease Network**

# topics

- Study collective tagging (or folksonomy)
- e.g., del.icio.us, flickr
- See work by Bernardo Huberman et al. at HP labs.

# topics

- ▶ Study games (as in game theory) on networks.
- ▶ For cooperation: Review Martin Nowak's recent piece in Science: "Five rules for the evolution of cooperation." [9]
- ▶ Much work to explore: voter models, contagion-type models, etc.

# topics

- ▶ Semantic networks: explore word-word connection networks generated by linking semantically related words.
- ▶ More general: Explore language evolution
- ▶ One paper to start with: "The small world of human language" by Ferrer i Cancho and Solé [4]
- ▶ Related: Study spreading of neologisms.

# topics

- Investigate safety codes (building, fire, etc.).
- What kind of relational networks do safety codes form? How have they evolved?

# topics

- ▶ Statistics: Study Peter Hoff's (and others') work on latent variables.
- ▶ Idea: explain connection pattern in a network through hidden individual or dyadic variables
- ▶ This method has been applied to the study of international relations networks.
- ▶ Related and large: explore work on p* networks.

# topics

- ▶ Study Stuart Kauffman's *nk* boolean networks which model regulatory gene networks [7]

# topics

- ▶ Engineering: Read and critically explore Bejan's book "Shape and Structure, from Engineering to Nature." [1]
- ▶ Bejan asks why we see branching network flow structures so often in Nature—trees, rivers, etc.

# topics

- ▶ Explore work by Doyle, Alderson, et al. as well as Pastor-Satorras et al. on the structure of the Internet(s).

# topics

▶ Review: Study Castronova's and others' work on massive multiplayer online games. How do social networks form in these games? [3]

# topics

- Study bipartite networks: structure and dynamics
- Rich and interesting both mathematically and practically speaking.

# topics

- Study scientific collaboration networks.
- Mounds of data + good models.
- See seminal work by De Solla Price[10]. plus modern work by Redner, Newman, *et al.*

# topics

- Study Kearns et al.'s experimental studies of people solving classical graph theory problems [8]
- "An Experimental Study of the Coloring Problem on Human Subject Networks"
- (Possibly) Run some of these experiments for our class.

# topics

- ▶ Biology: Study leaf network patterns (taken).
- ▶ Key on very interesting work by Xia.
- ▶ Classic Monge problem: how to move stuff from one place to another.
- ▶ Bulk flow versus network flow.

# topics

- Vague/Large:
  Study amazon's recommender networks.

**Customers Who Bought This Item Also Bought**



Harry Potter Schoolbooks:
Fantastic Beasts and... by
J.K. Rowling
★★★★☆ (465)  $10.19

The Tales of Beedle the Bard,
Collector's E... by J. K.
Rowling
★★★★☆ (153)

Harry, A History: The True
Story of a Boy Wizar... by
Melissa Anelli
★★★★☆ (52)  $10.88

Inkdeath (Inkheart) by
Cornelia Funke
★★★★☆ (41)  $16.49

# topics

- ▶ Vague/Large:
  Study network evolution of the Wikipedia's content.

# topics

- ▶ Vague/Large: How is the media connected? Who copies whom?
- ▶ Possibly use NY Times API.
- ▶ http://memetracker.org/
- ▶ Problem: Need to be able to measure interactions.

# topics

- ▶ Vague/Large:
  Anything interesting to do with large-scale networks in evolution, biology, ethics, religion, history, influence, food, international relations, ...

# References I

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Cambridge Univ. Press, Cambridge, UK, 2000.

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The scaling laws of human travel.
*Nature*, pages 462–465, 2006.

📄 [3] E. Castronova.
*Synthetic Worlds: The Business and Culture of
Online Games*.
University of Chicago Press, Chicago, IL, 2005.

📄 [4] R. Ferrer i Cancho and R. Solé.
The small world of human language.
*Proc. R. Soc. Lond. B*, 26:2261–2265, 2001. pdf (⊞)

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📄 [5] M. C. González, C. A. Hidalgo, and A.-L. Barabási.

Understanding individual human mobility patterns.
*Nature*, 453:779–782, 2008. pdf (⊞)

📄 [6] C. A. Hidalgo, B. Klinger, A.-L. Barabási, and R. Hausman.
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📄 [7] S. Kauffman.
*The Origins of Order*.
Oxford, 1993.

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[8] M. Kearns, S. Suri, and N. Montfort.
An experimental study of the coloring problem on
human subject networks.
*Science*, 313:824–827, 2006. pdf (⊞)

[9] M. A. Nowak.
Five rules for the evolution of cooperation.
*Science*, 314:1560–1563, 2006. pdf (⊞)

[10] D. J. d. S. Price.
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*Science*, 149:510–515, 1965. pdf (⊞)

[11] C. Song, S. Havlin, and H. A. Makse.
Self-similarity of complex networks.
*Nature*, 433:392–395, 2005. pdf (⊞)

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[12] C. Song, S. Havlin, and H. A. Makse.
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*Nature Physics*, 2:275–281, 2006. pdf (⊞)

[13] S. H. Strogatz.
Romanesque networks.
*Nature*, 433:365–366, 2005. pdf (⊞)