

# CSC200: Lecture 1 continued

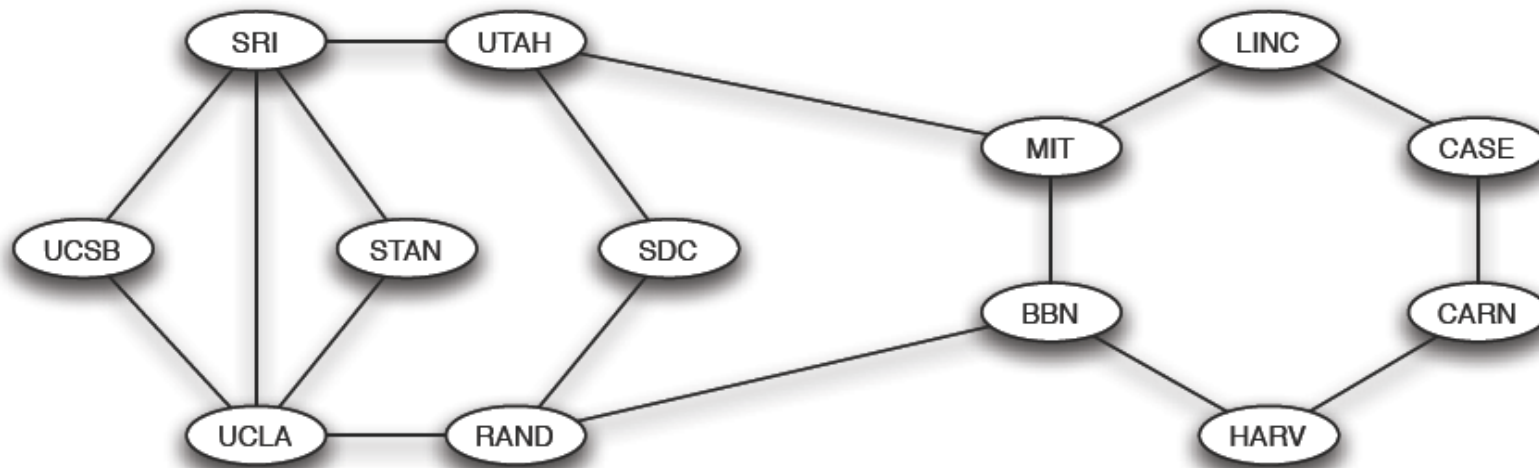
- *Social and Economic Networks: Models and Applications*
- The course would be better titled as *Social, Economic and Information Networks: Models and Applications*
- Allan Borodin
  - `bor@cs.toronto.edu`; 978-6416; SF2303B
  - The course is usually co-taught but this year I am the sole instructor although there will be guest lectures.
- As stated last time, the text is : D. Easley, J. Kleinberg. *Networks, Crowds, and Markets: Reasoning About a Highly Connected World*. Cambridge University Press, 2010.

# Social and Economic Networks

- Who is part of a social network? economic network?
  - Facebook: 750 million active users, 50% use on a given day, avg. 130 friends (current)
  - Groupon: 500 markets, 50 million users, \$1B in savings (2010)
- What about before you joined Facebook? used Groupon?
- Who is in your social network? Friends, family, schoolmates, clubs, co-workers, ...
  - how have you “used” your networks?
    - Introduced yourself to a friend of a friend
    - joined a club/team/social activity because of a friend
    - found a job through an acquaintance
    - made aware of a product that was “popular” amongst friends
- We’re all part of countless social and economic networks

# Visualizing Networks: Graphs

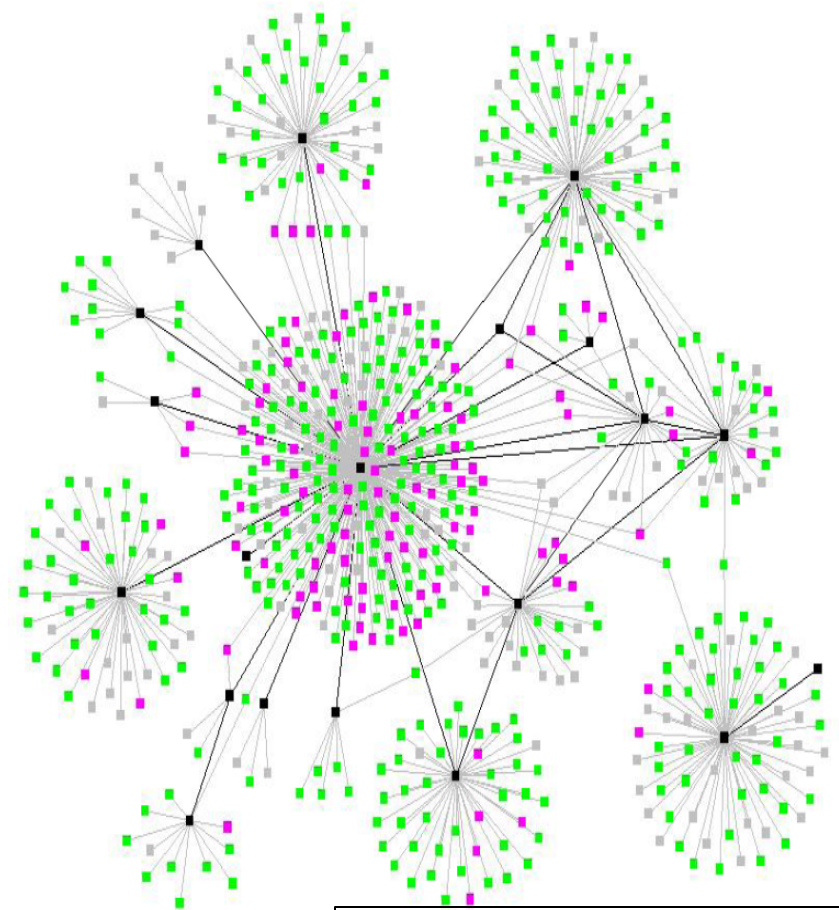
- Can visualize networks formally as *graphs*
  - *nodes*: entities (people, countries, companies, organizations, ...)
  - *edges*: relationship between entities (friendship, classmates, did business together, viewed the same web pages, ...)
    - edges may be *directed* or *weighted*



Internet: Dec. 1970  
[E&K, Ch.2, Fig 2.3]

# Why Study such Networks?

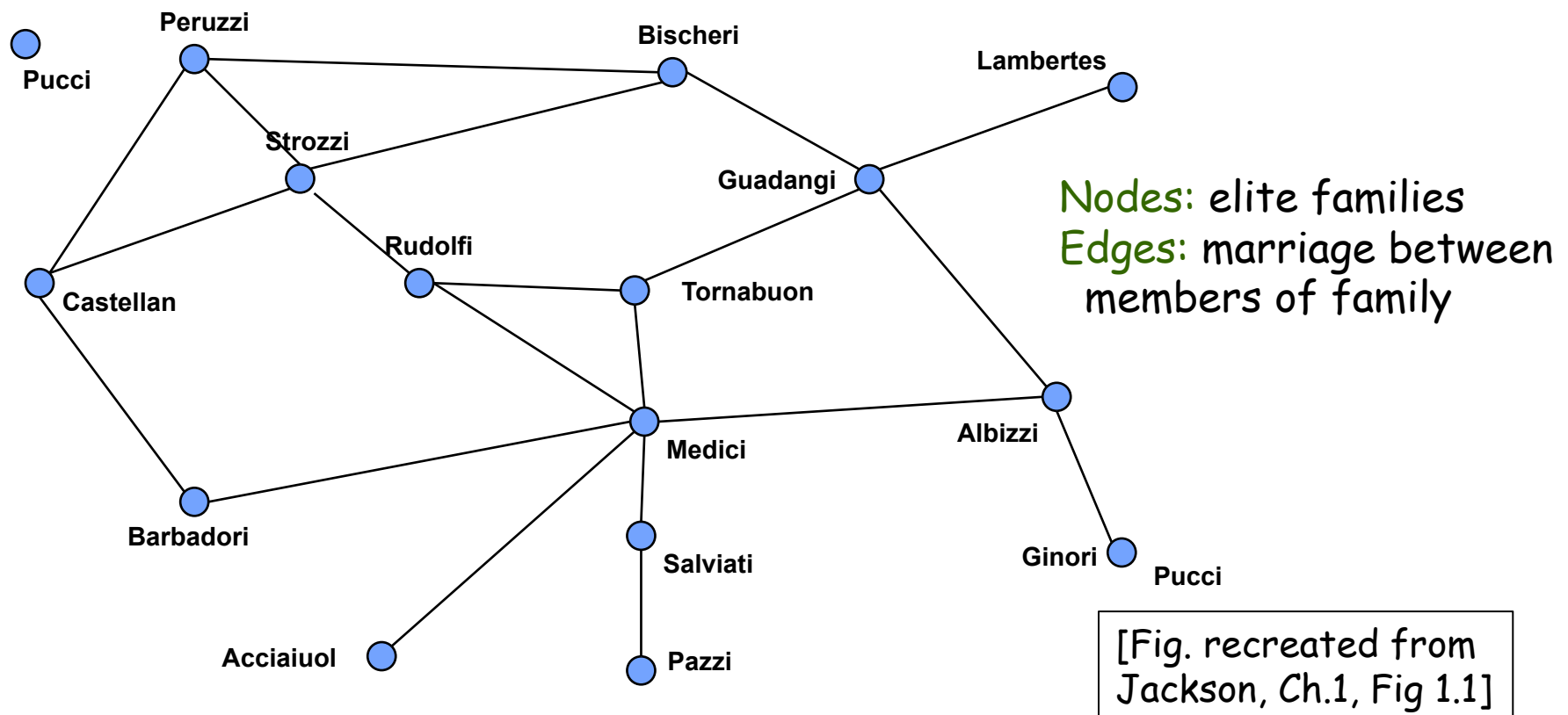
- *Social scientists*: structure of networks help explain a rich variety of human behavior, interactions, characteristics
  - Sociologists, economists, political scientists, etc.
- *Biological and medical scientists*: structure of networks help explain spread of disease, genetic variation, etc.
- *Computer scientists*: let's see in a few minutes



[Andre et al, 2007;  
see: E&K, Ch.1, Fig. 1.12]

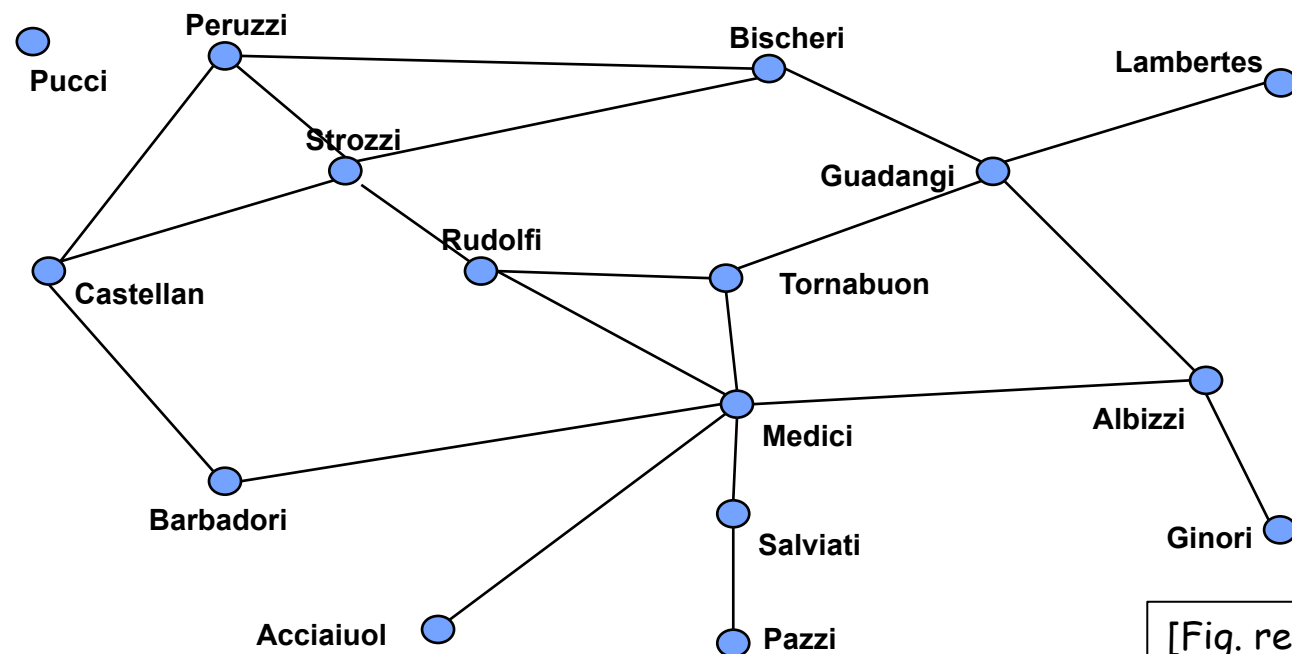
# Florentine Marriage Network [Ansell, Padgett 1993]

- Used to explain rise in power of Medici family
  - Florence in mid-1400s; Medici's did not stand out as especially wealthy or politically connected, yet rose to dominate: Why?



# Florentine Marriage Network [Ansell, Padgett 1993]

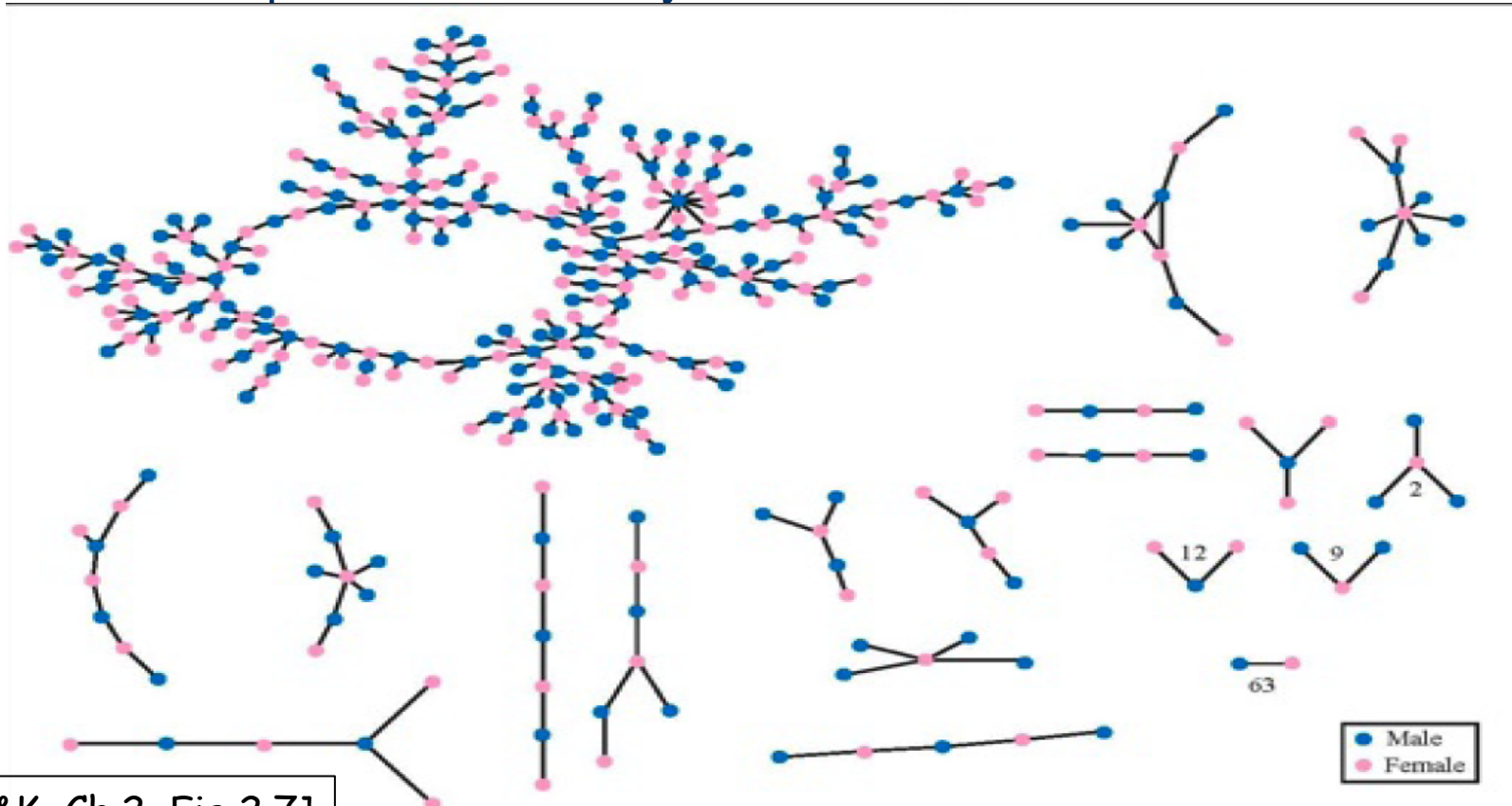
- Medici connected to more families, but not by much
- More importantly: lie *between* most pairs of families
  - shortest paths between two families: coordination, communication
  - Medici lie on 52% of all shortest paths; Guadagni 25%; Strozzi 10%



[Fig. recreated from Jackson, Ch.1, Fig 1.1]

# Romantic Relationships [Bearman et al, 2004]

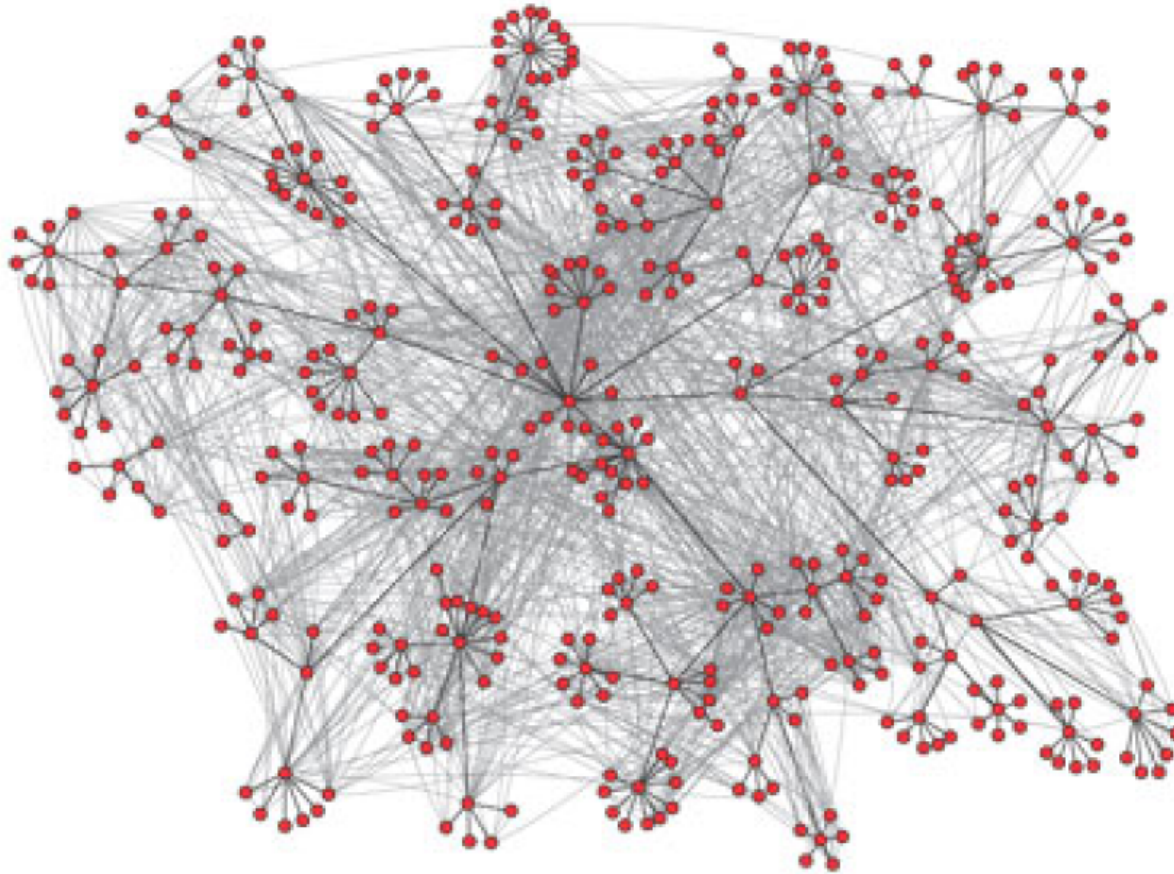
- Dating network in US high school over 18 months.
  - illustrates common “structural” properties of many networks
  - what predictions could you use this for?



[E&K, Ch.2, Fig 2.7]

# HP Email Network [Adamic, Adar 2005]

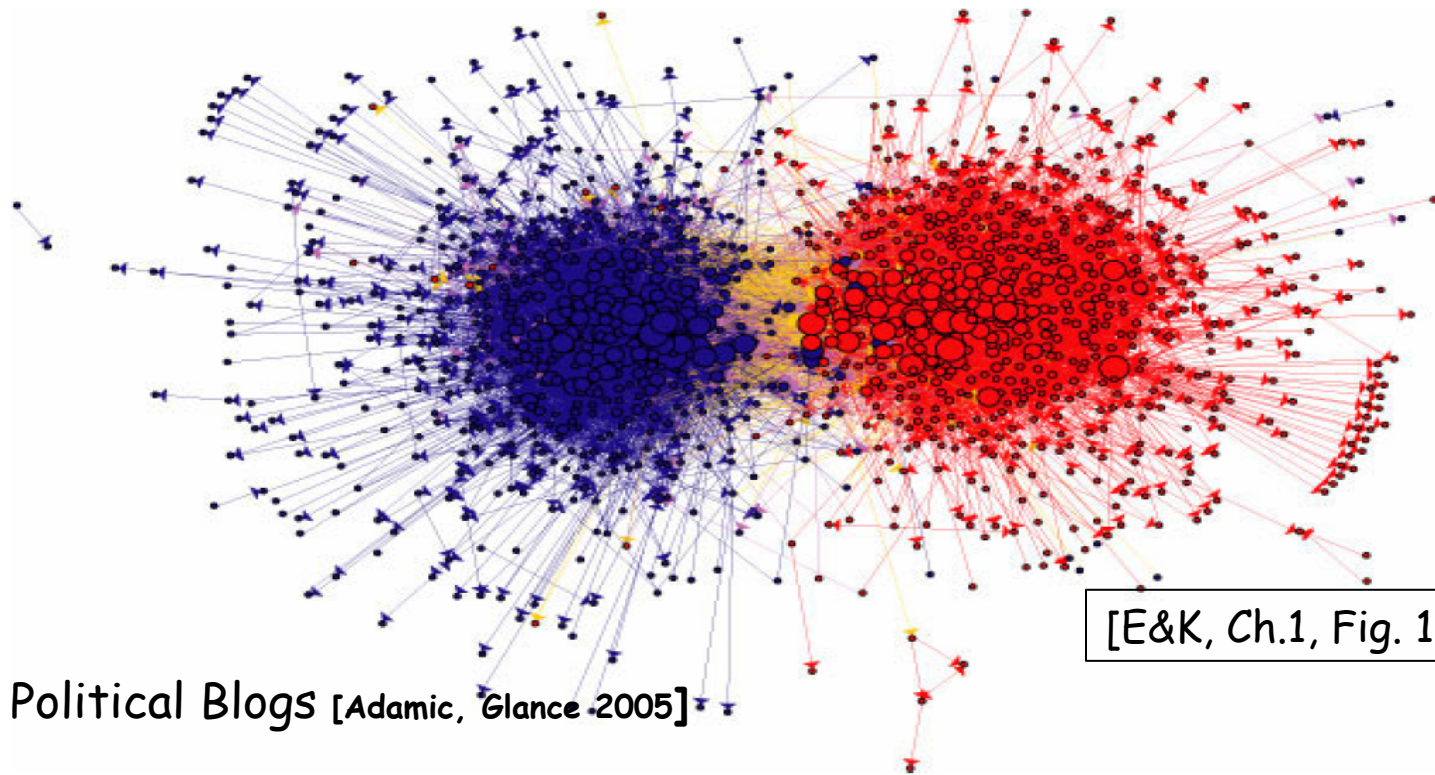
- 465 nodes from HP Research Lab, any email comm.
- What conclusions can you draw?



[E&K, Ch.1, Fig. 1.2]

# Information Networks

- Reflect links among *information sources*
- Entities may be web resources, scientific articles, etc.
  - such link structure underlies web search (e.g., Google)
  - what can this reveal?



Links among Political Blogs [Adamic, *Glance* 2005]

# Why Study such Networks in CS?

## ■ *Computer scientists:*

- computer networks/devices increasingly mediate interactions
  - *online resources (catalogs, blogs, tweets), search tools, online social networks, recommender systems, etc.*
- has changed the breadth and nature of interactions
  - *consider stamp collecting: 1970s vs. today*

## ■ CS vital to modeling and analysis of S&E&I networks

- mediates interactions (understands, facilitates, data collection)
- sophisticated algorithms needed to search and analyze massive data sets
- algorithms for “intervention”: change entities/network
  - *find friends; vaccination points; effective marketing; economic stimulus; etc.*

# Economic Interactions

- Interactions not just social: often economic transactions and self-interest are motivating factors
  - network structure can possibly predict economic outcomes
  - may want to facilitate interactions that lead to “good” outcomes
- Computer networks radically increase who can conduct business with whom
  - “search costs” for goods and services are facilitated.
  - Amazon, Ebay, global buying consortia, etc.
  - Web advertising: Google runs massive auctions every second
    - 34,000 queries/second; 3B per day

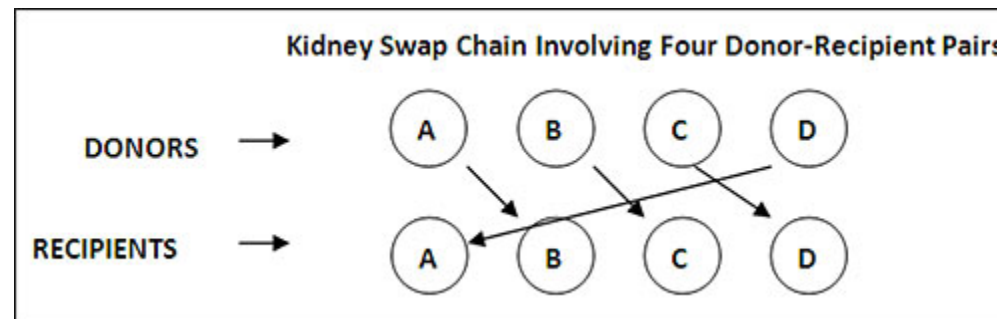
# Game Theory and Incentives

- How should you bid to show your ad on Google?
  - depends on its value to you, but also *how you think others will bid*

The screenshot shows a Google search for "toronto's best clubs" in a Mozilla Firefox browser. The search results are displayed on the left side of the page, and a map of Toronto is shown on the right. The search results include several links to websites like ClubCrawlers.com, My Apartment Nightclub, and Devil's Mix 2011 Party Crawl. The map shows the location of the search results in Toronto, with markers A, B, and C. The browser's address bar shows the search URL, and the search bar contains the text "toronto's best clubs".

# Kidney Exchange: Swap Chains

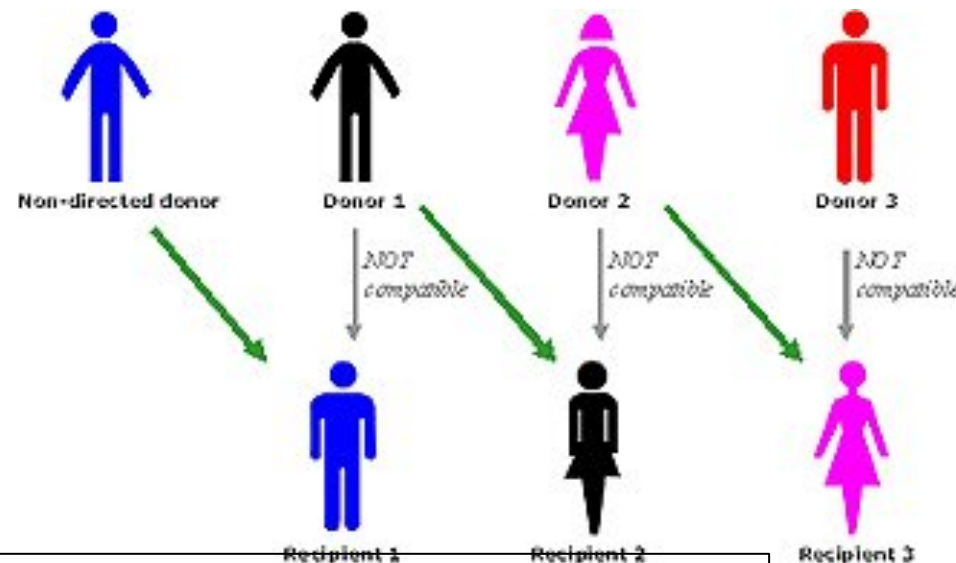
- Waiting list for kidney donation: 80K in US, 3K in Canada
- Live kidney donation common in N.A. to get around waiting list problems: requires *donor-recipient pairs*
- Exchange: supports willing pairs who are incompatible
  - allows multiway-exchange
  - supported by sophisticated algorithms to find matches
- But what if someone reneges?
  - require simultaneous transplantation!



Dartmouth-Hitchcock Medical Center, NH, 2010

# Kidney Exchange: Altruistic Donor Chains

- How do you get around simultaneity requirement?
- Altruistic donor chains
  - longest such chain is over 16 donors long at the moment



[NEAD Chain: image from <http://www.kidney.org/transplantation/livingdonors/infoPrograms.cfm>]

# Course Overview

- Basic Graph Theory (Ch.2)
- Social Network Phenomena (Ch.3-4); perhaps Chapter 5
- Game Theory and Auctions (Ch.6,8,9)
  - plus supplementary material (e.g. combinatorial auctions)
- Matching and Markets on Networks (Ch.10-12)
  - plus supplementary material (e.g. stable matching)
- Information Networks and the Web (Ch.13-15)
- Dynamics of Networks (Ch.16-18, 19-21)
- Aggregation of Information and Preferences (Ch.22, 23)
  - plus supplementary material (e.g. social choice/voting rules)