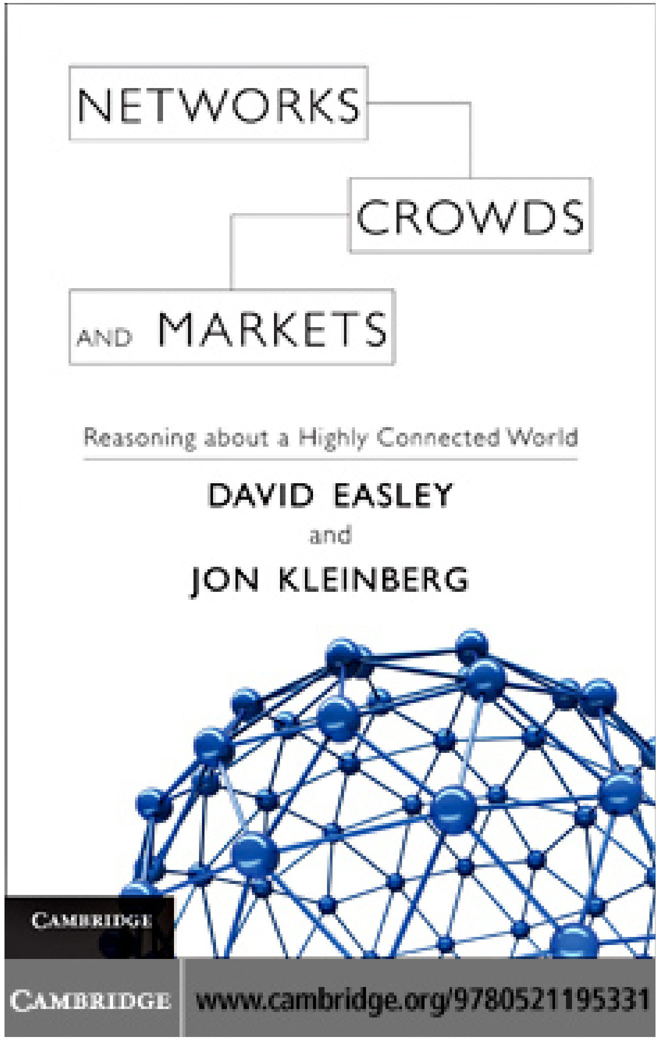
Selected Chapter Figures from the book "Networks, Crowds, and Markets"

Textbook



- We will see chapters 1, 2, 3, 4, 5, 13, 14, 18, 20 of the book “Networks, Crowds, and Markets” by David Easley and Jon Kleinberg

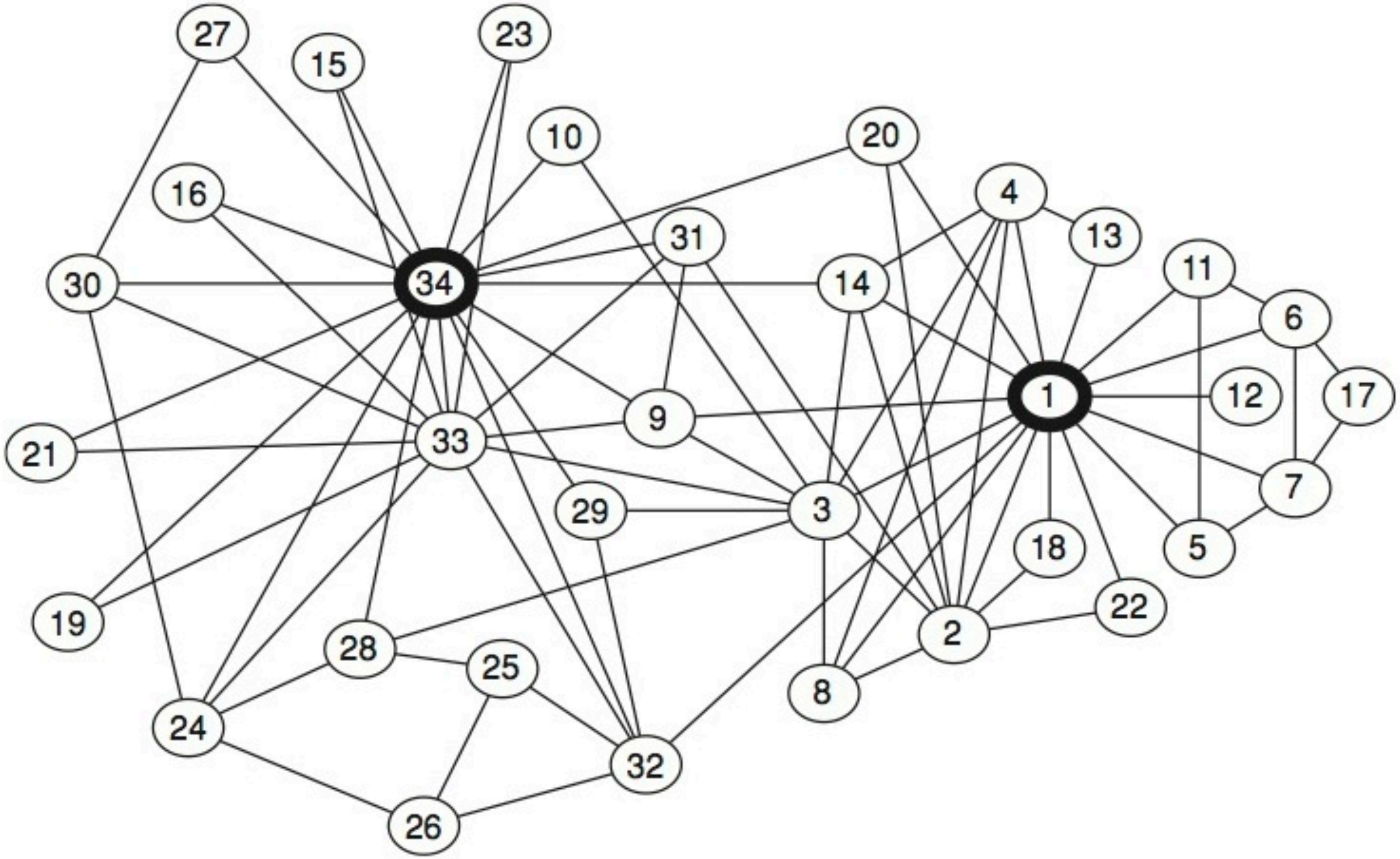


Figure 1.1. The social network of friendships within a 34-person karate club [421]. (Drawing from the *Journal of Anthropological Research*.)

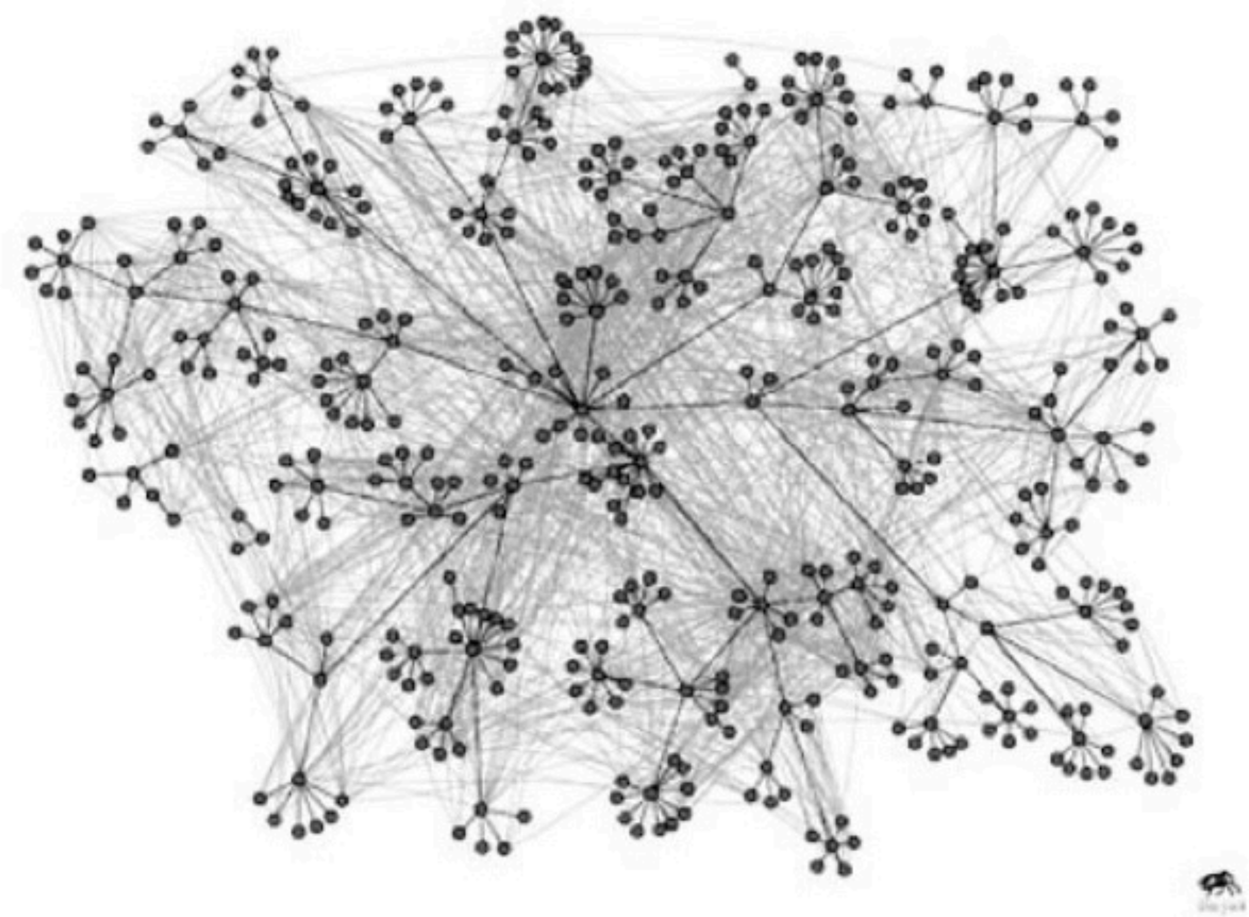


Figure 1.2. Social networks based on communication and interaction can be constructed from the traces left by online data. In this case, the pattern of e-mail communication among 436 employees of the Hewlett Packard Research Lab is superimposed on the official organizational hierarchy [6]. (Image from http://www-personal.umich.edu/ladamic/img/hplabsemailhierarchy.jpg, courtesy of Elsevier Science and Technology Journals.)

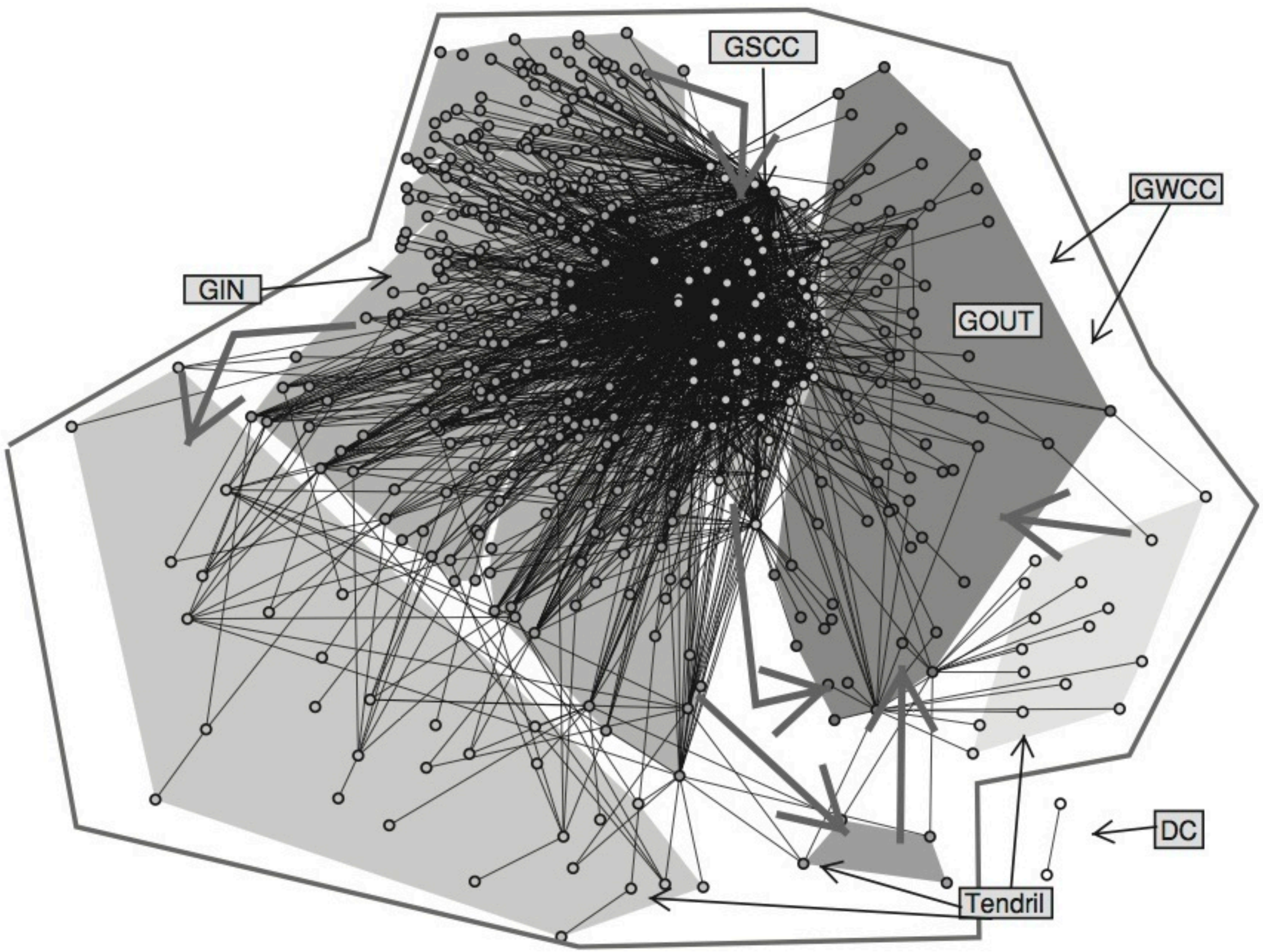


Figure 1.3. The network of loans among financial institutions can be used to analyze the roles that different participants play in the financial system and how the interactions among these roles affect the health of individual participants and the system as a whole. The network is annotated in a way that reveals its dense core, according to a scheme that we describe in Chapter 13. (Image from Bech and Atalay, [50].)

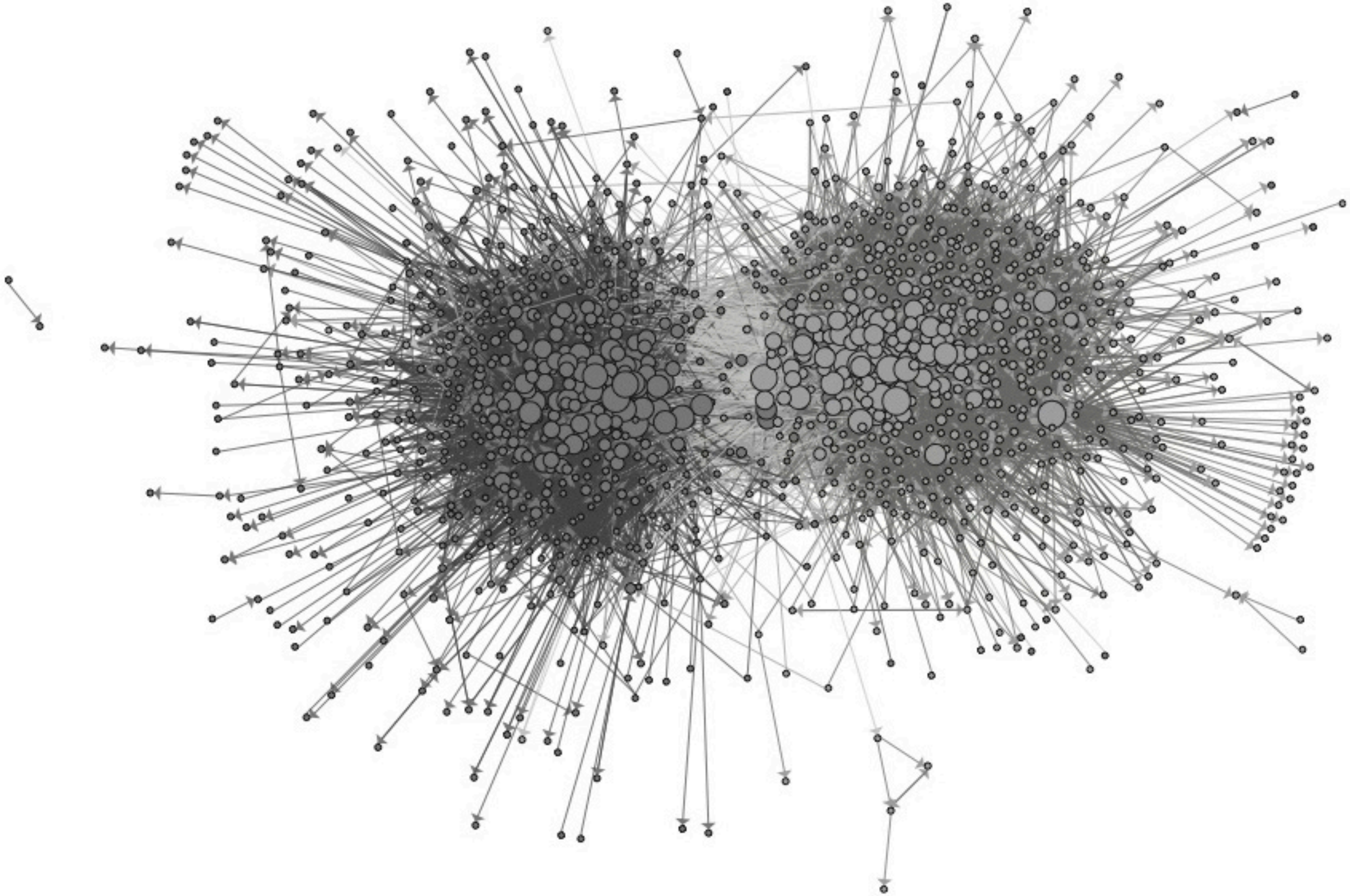


Figure 1.4. The links among Web pages can reveal densely knit communities and prominent sites. In this case, the network structure of political blogs prior to the 2004 U.S. presidential election reveals two natural and well-separated clusters [5]. (Image from Association for Computing Machinery, Inc.; http://www-personal.umich.edu/ ladamic/img/politicalblogs.jpg.)

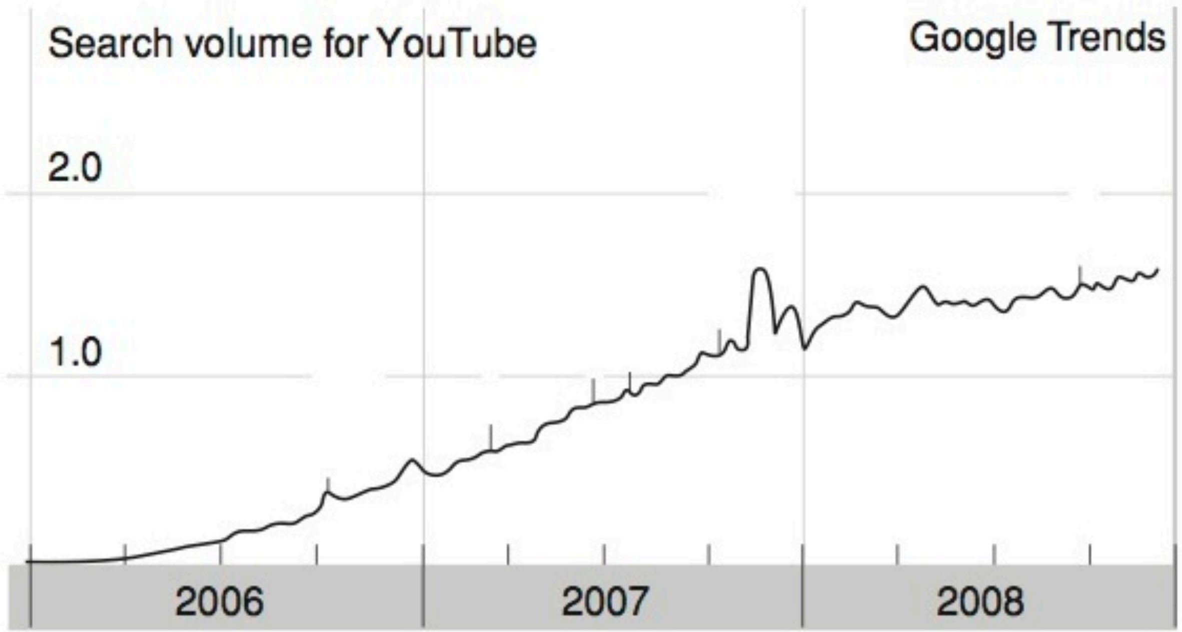


Figure 1.5. The rapidly growing popularity of YouTube is characteristic of the way in which new products, technologies, or innovations rise to prominence through feedback effects in the behavior of many individuals across a population. The plot depicts the number of Google queries for YouTube over time. The image comes from the site Google Trends (http://www.google.com/trends?q=youtube); by design, the units on the *y*-axis are suppressed in the output from this site.

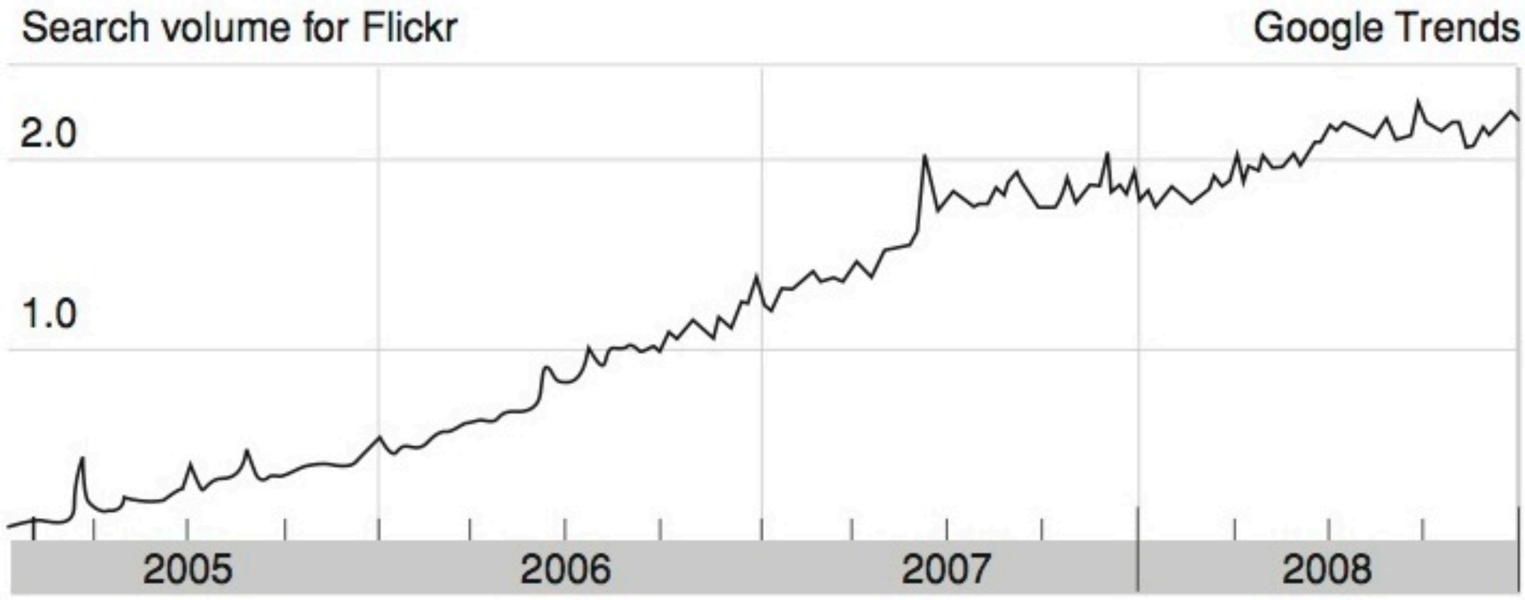


Figure 1.6. This companion to Figure 1.5 shows the rise of the social media site Flickr; the growth in popularity has a very similar pattern to that of other sites, including YouTube. (Image from Google Trends, http://www.google.com/trends?q=flickr.)

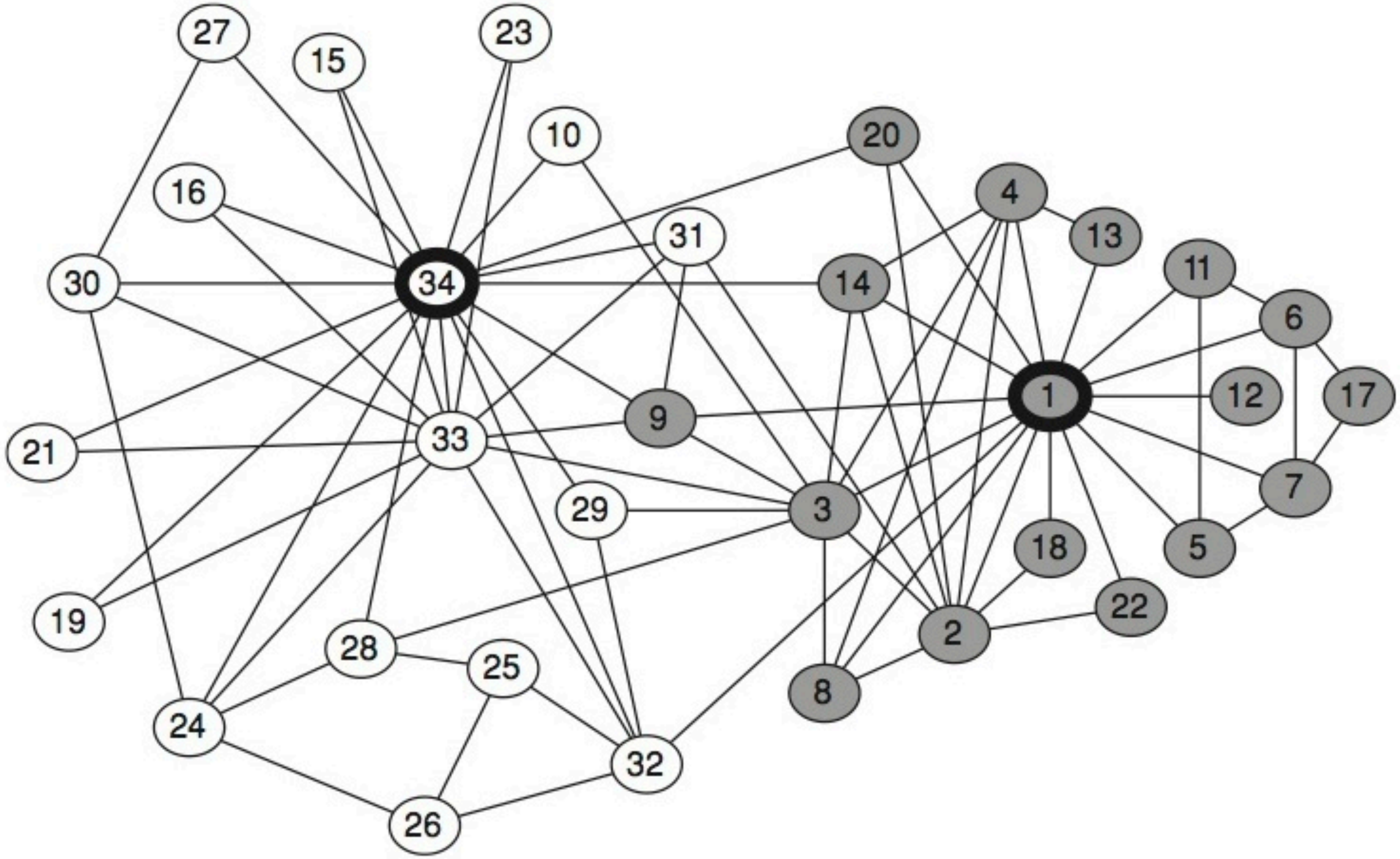


Figure 1.7. From the social network of friendships in the karate club from Figure 1.1, we can find clues to the latent schism that eventually split the group into two separate clubs (indicated by the two different shadings of individuals in the drawing).

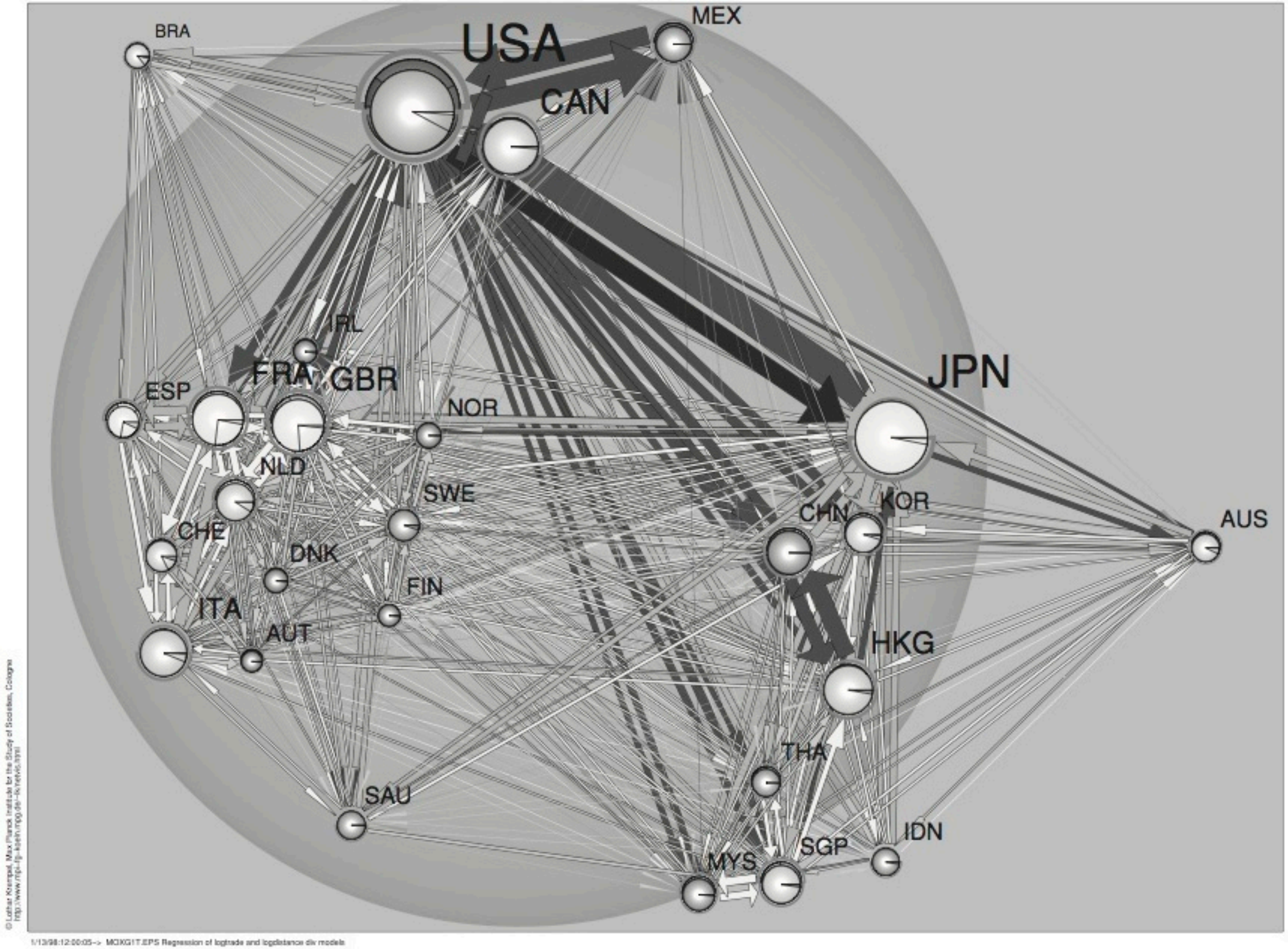


Figure 1.8. In a network representing international trade, one can look for countries that occupy powerful positions and derive economic benefits from these positions [262]. (Image from Carnegie Mellon University; http://www.cmu.edu/joss/content/articles/volume4/KrempelPlumper.html.)

Figure 1.9. In some settings, such as this map of medieval trade routes, physical networks constrain the patterns of interaction, giving certain participants an intrinsic economic advantage based on their individual network positions. (Image from http://upload.wikimedia.org/wikipedia/commons/e/e1/Late_Medieval_Trade_Routes.jpg.)

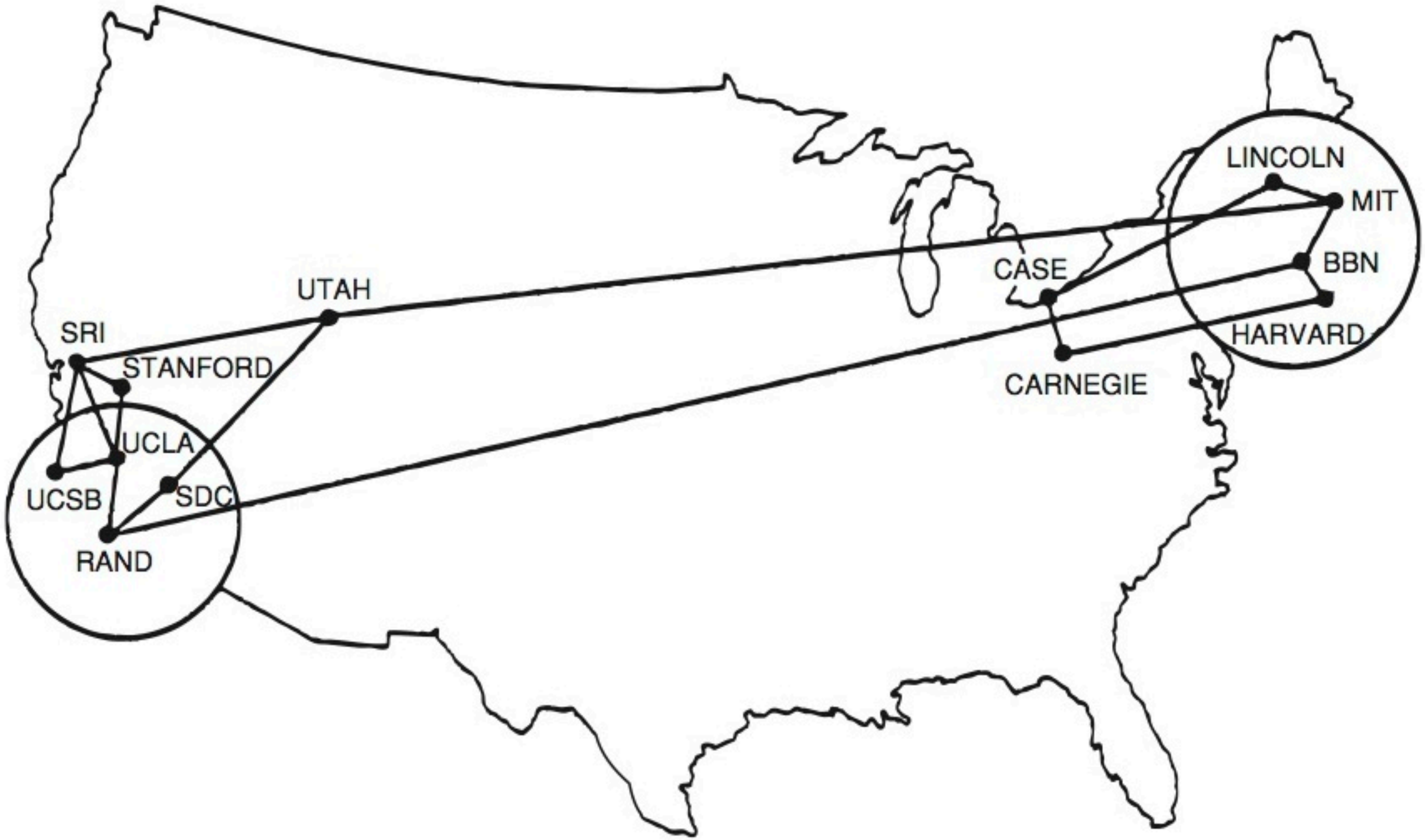


Figure 2.2. A network depicting the sites on the Internet, then known as the ARPANET, in December 1970. (Image from F. Heart, A. McKenzie, J. McQuillian, and D. Walden, [214]; available online at http://som.csudh.edu/cis/lpress/history/arpamaps/.)

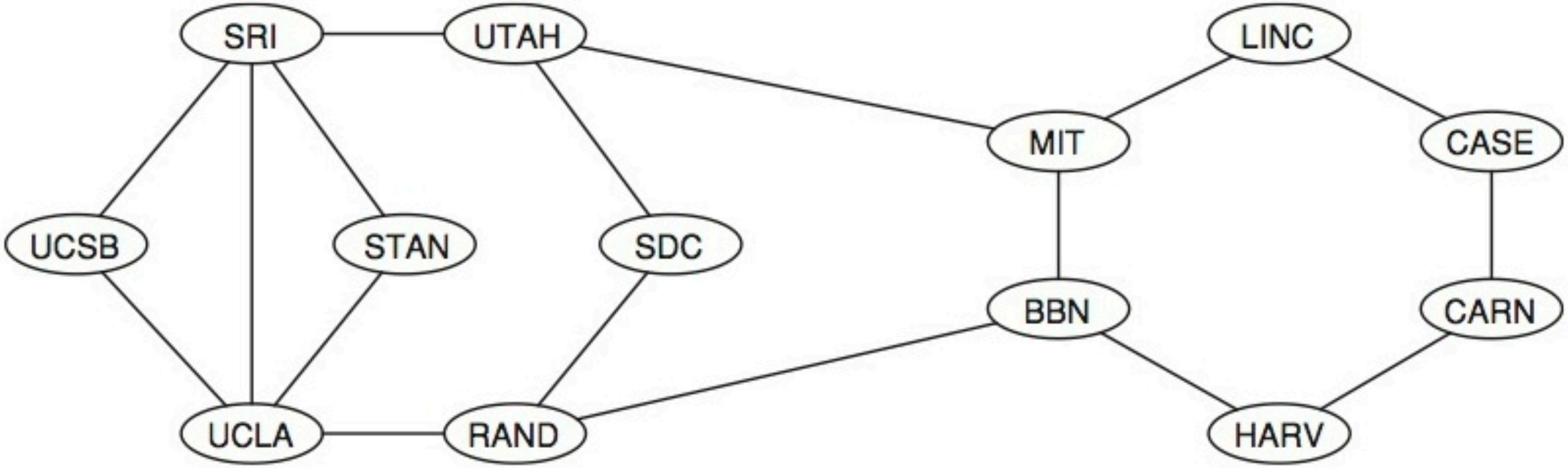


Figure 2.3. An alternate drawing of the thirteen-node Internet graph from December 1970.

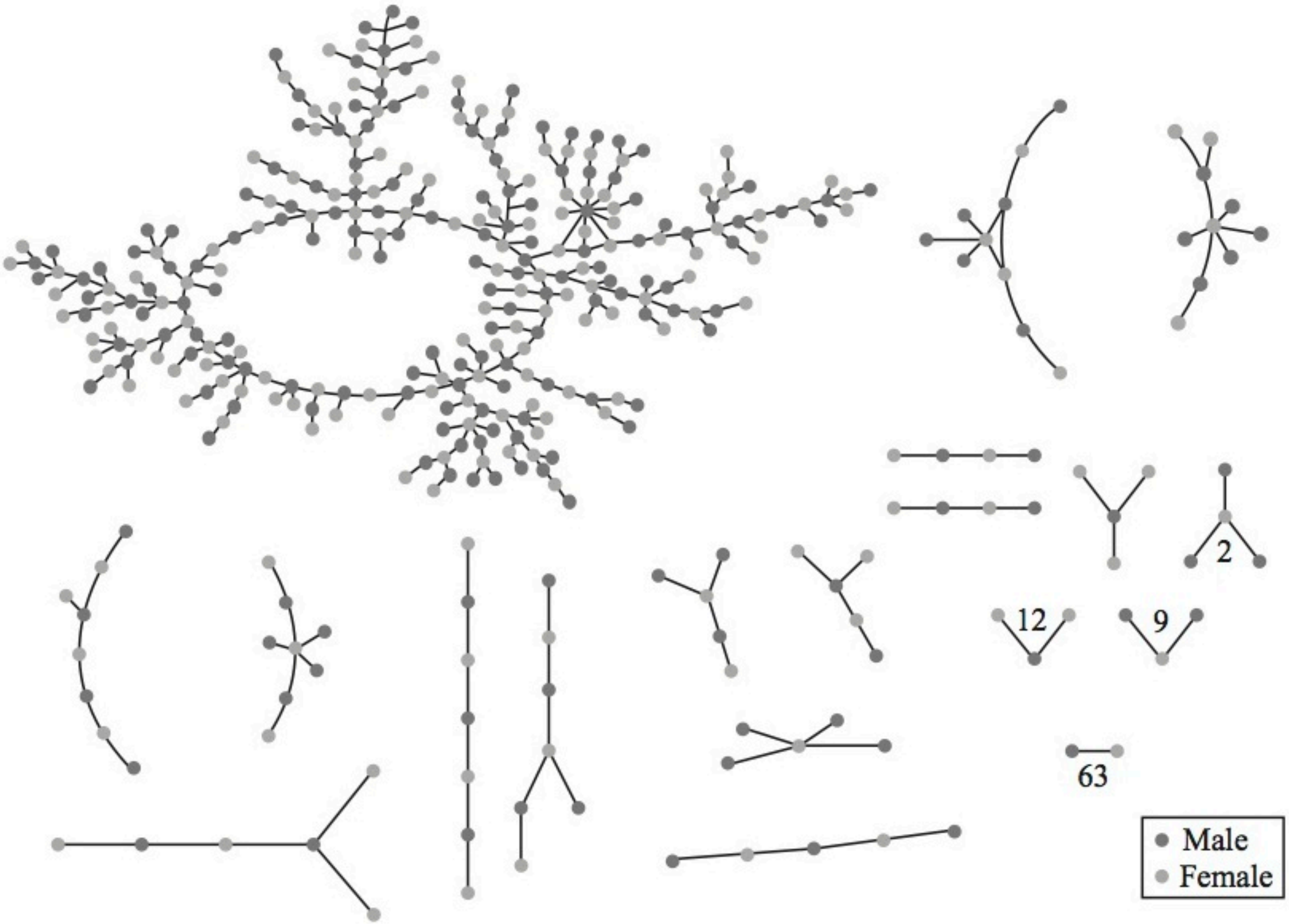


Figure 2.7. A network in which the nodes are students in a large American high school, and an edge joins any two who had a romantic relationship at some point during the 18-month period in which the study was conducted [49]. (Image from The University of Chicago Press.)

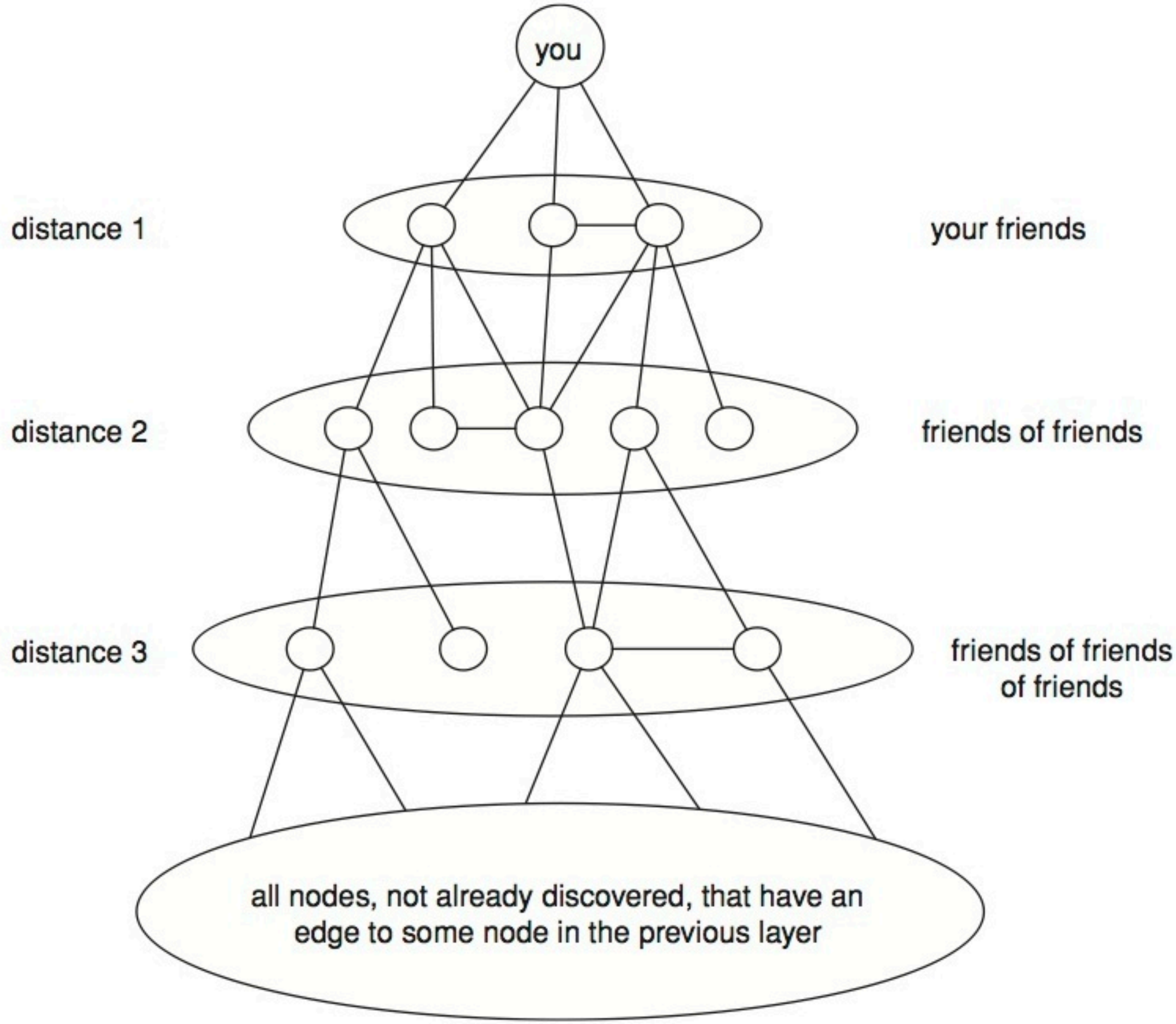


Figure 2.8. Breadth-first search discovers the distances to nodes one "layer" at a time; each layer is built of nodes that have an edge to at least one node in the previous layer.

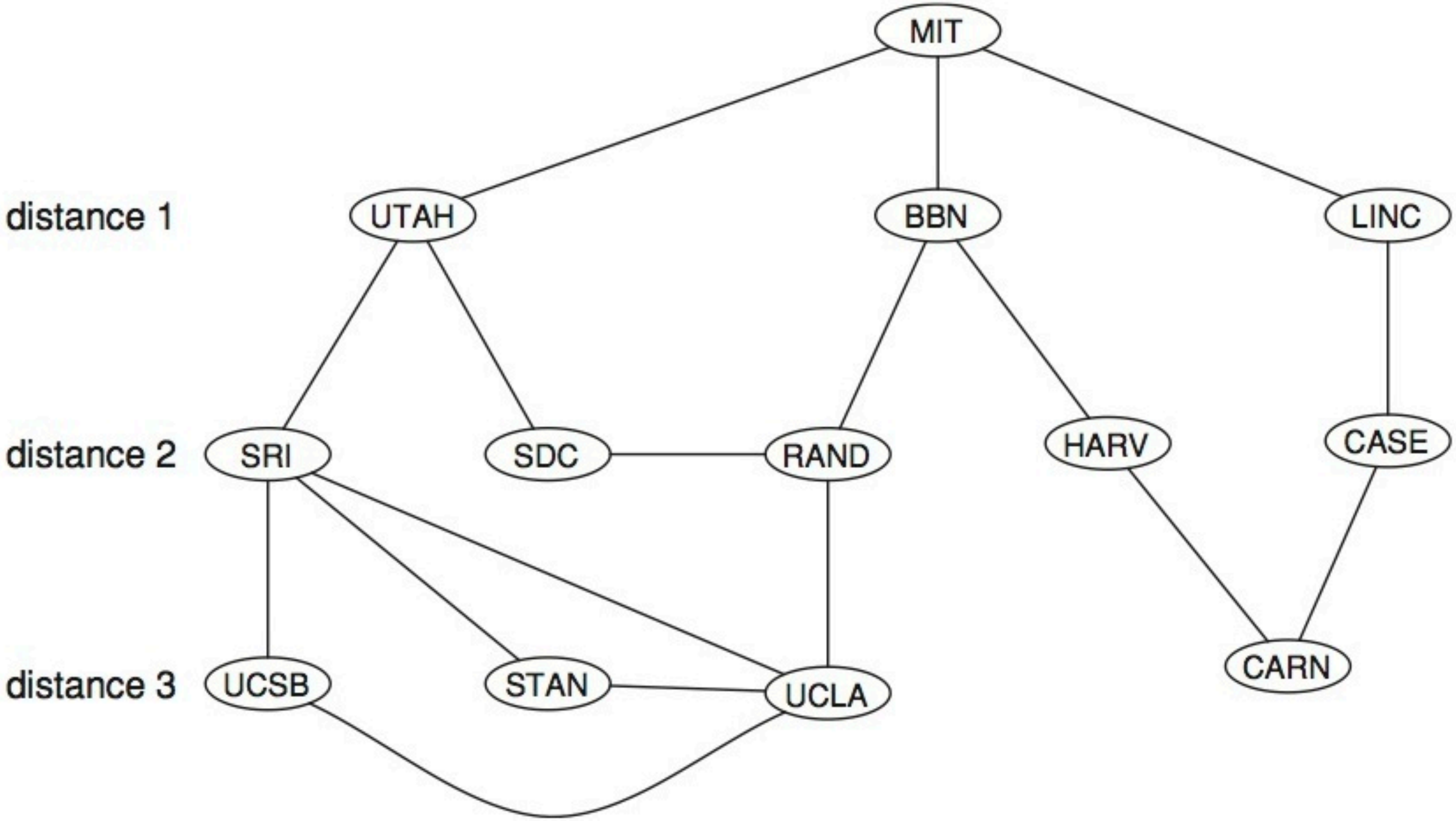


Figure 2.9. The layers arising from a breadth-first of the December 1970 ARPANET, starting at the node MIT.

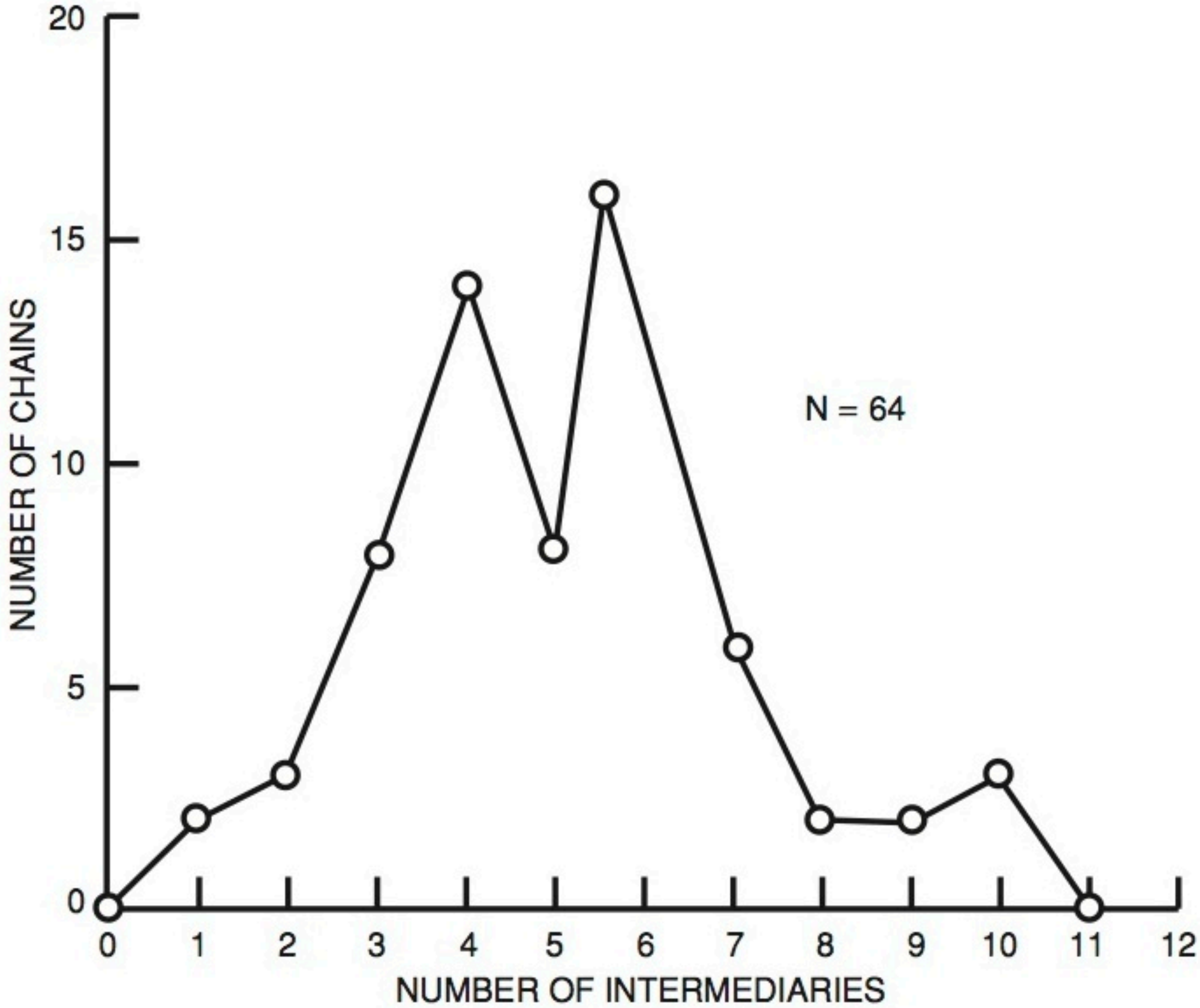


Figure 2.10. A histogram from Travers and Milgram's paper on their small-world experiment [391]. For each possible length (labeled "number of intermediaries" on the *x*-axis), the plot shows the number of successfully completed chains of that length. In total, sixty-four chains reached the target person, with a median chain length of six. (Image from the American Sociological Association.)

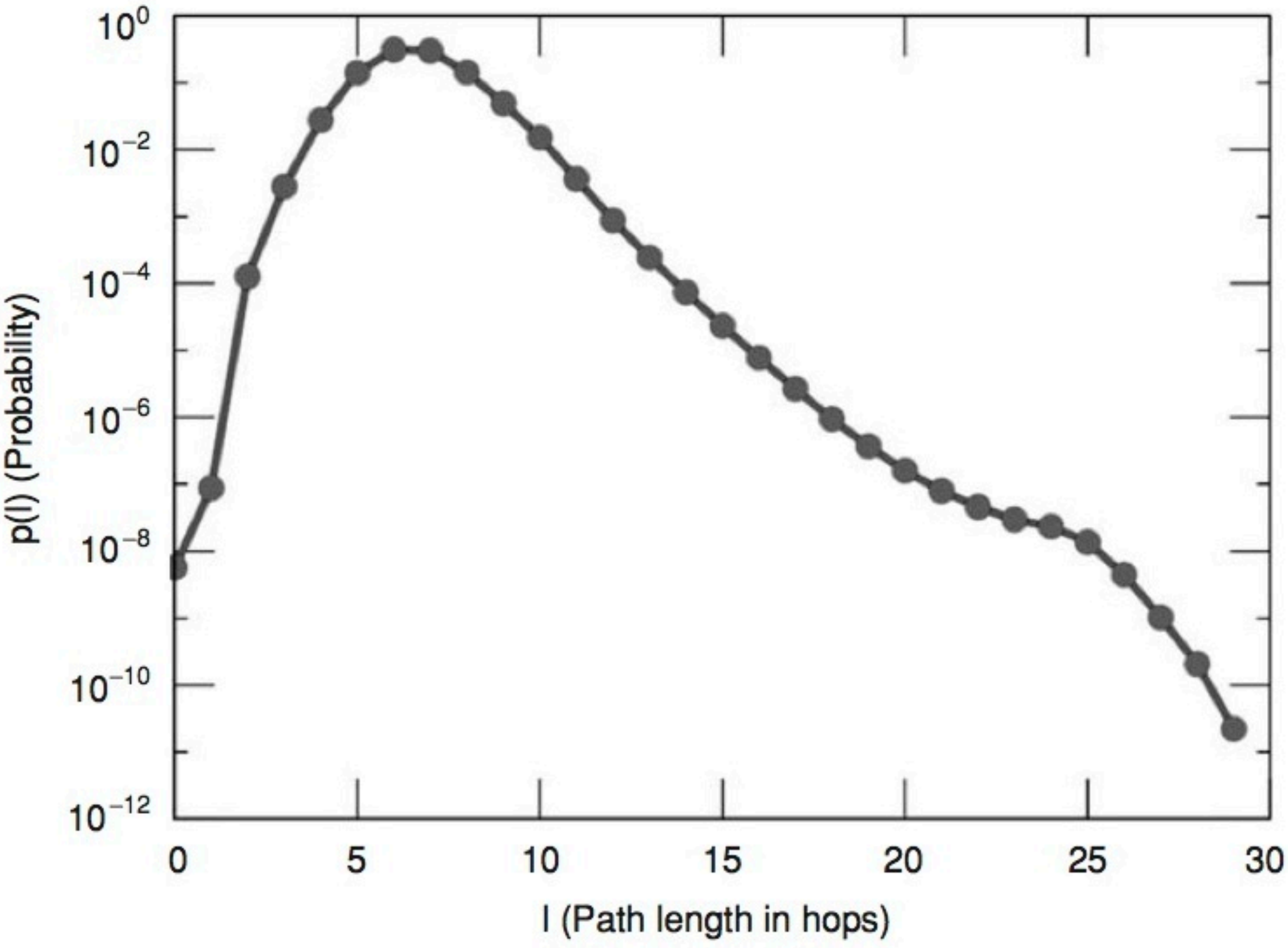


Figure 2.11. The distribution of distances in the graph of all active Microsoft Instant Messenger user accounts, in which an edge joins two users if they communicated at least once during a month-long observation period [273].

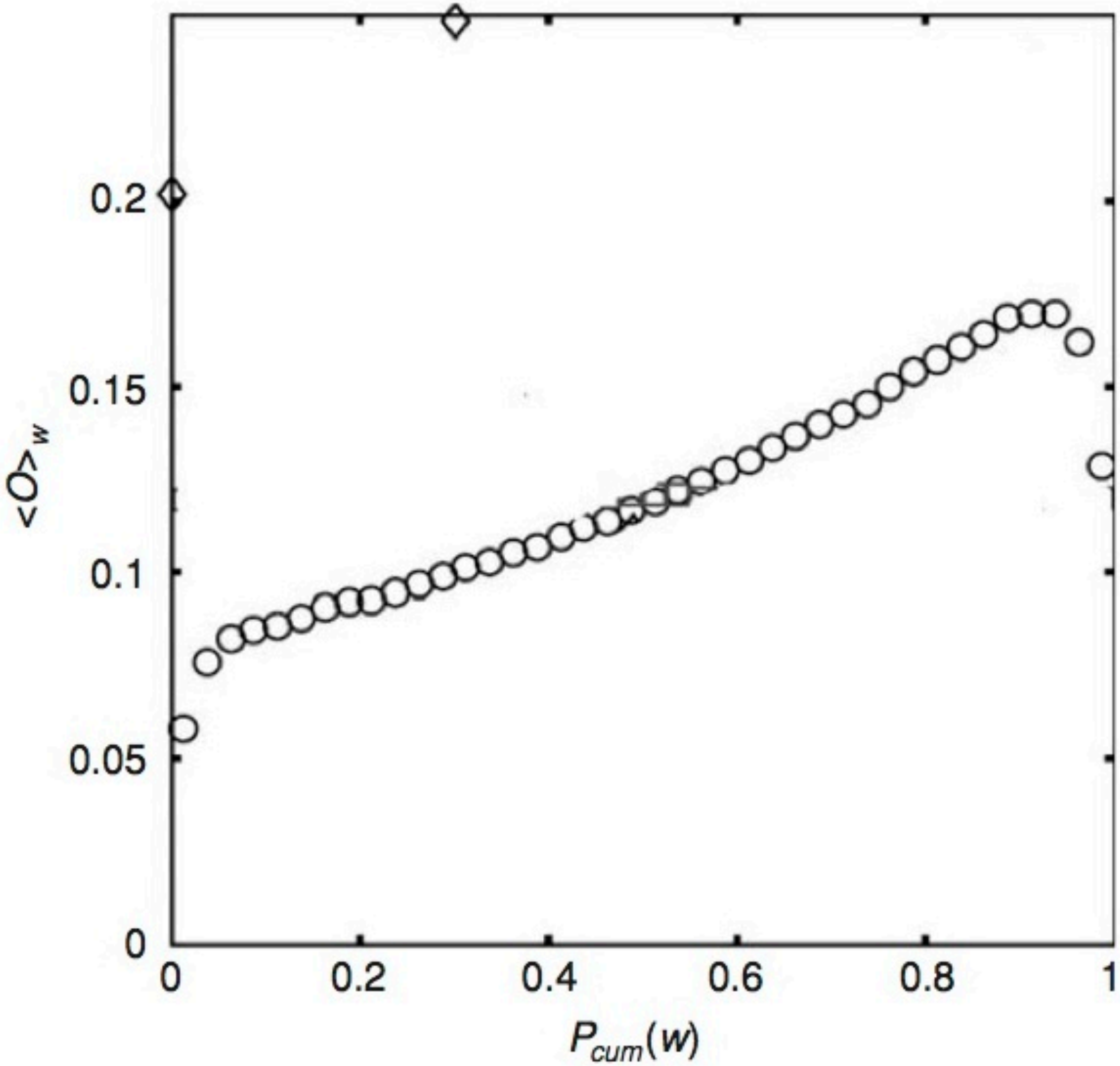


Figure 3.7. A plot of the neighborhood overlap of edges as a function of their percentile in the sorted order of all edges by tie strength. The fact that overlap increases with increasing tie strength is consistent with the theoretical predictions from Section 3.2 [334]. (Image from the National Academy of Sciences, USA.)

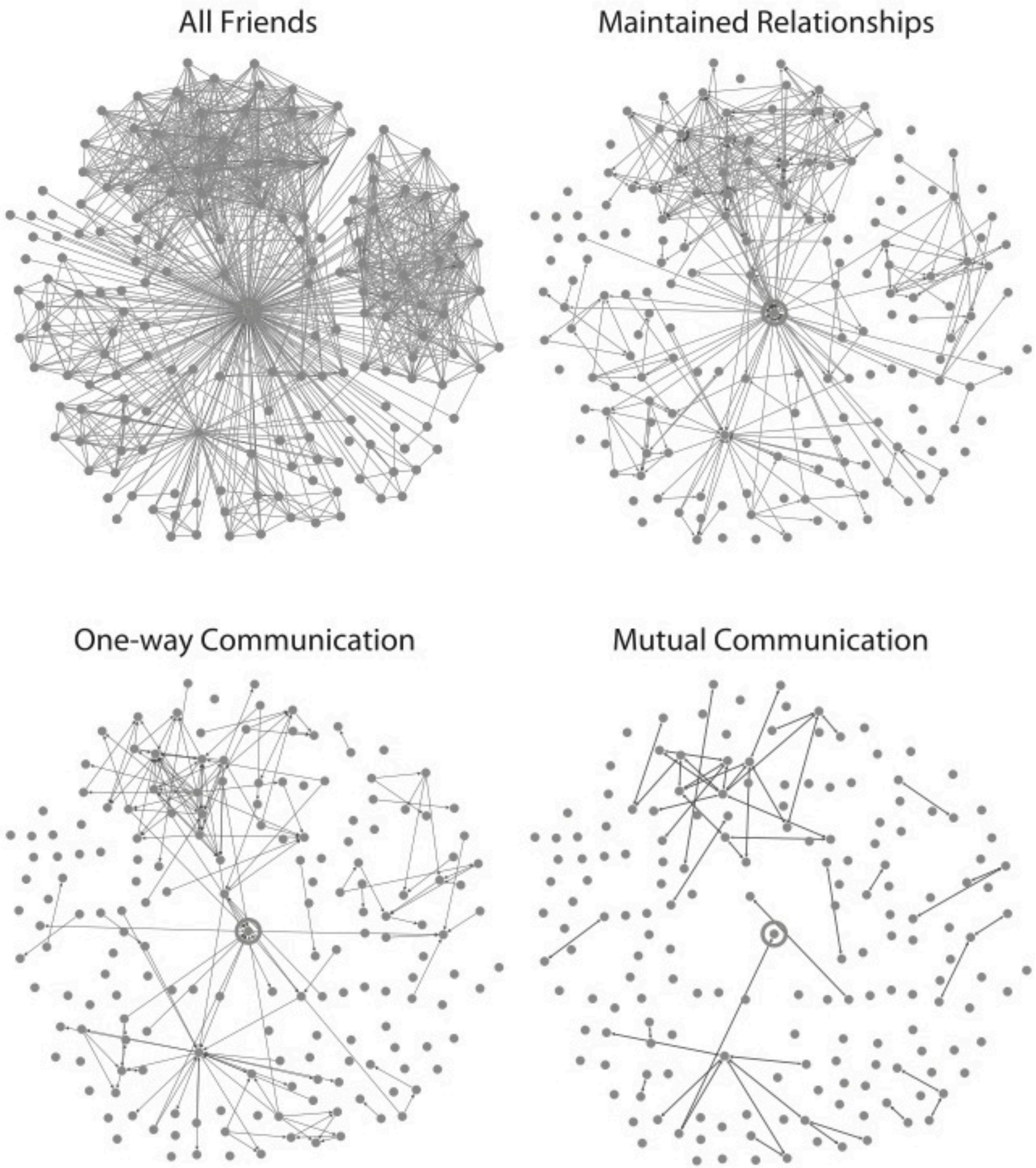


Figure 3.8. Four different views of a Facebook user's network neighborhood, showing the structure of links corresponding respectively to all declared friendships, maintained relationships, one-way communication, and reciprocal (i.e., mutual) communication, all over a one-month observation period. (Image from [286].)

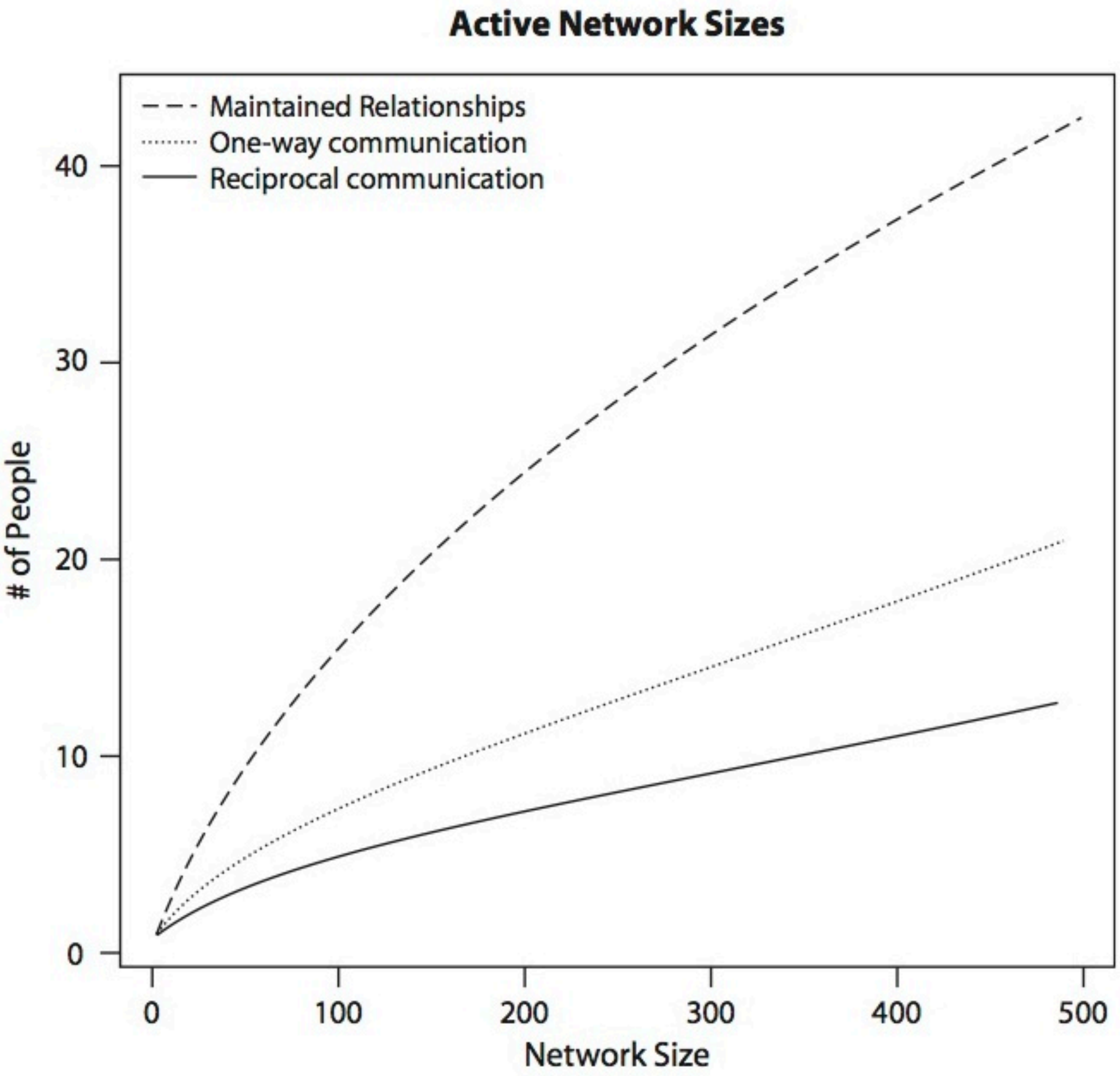


Figure 3.9. The number of links corresponding to maintained relationships, one-way communication, and reciprocal communication as a function of the total neighborhood size for users on Facebook. (Image from [286].)

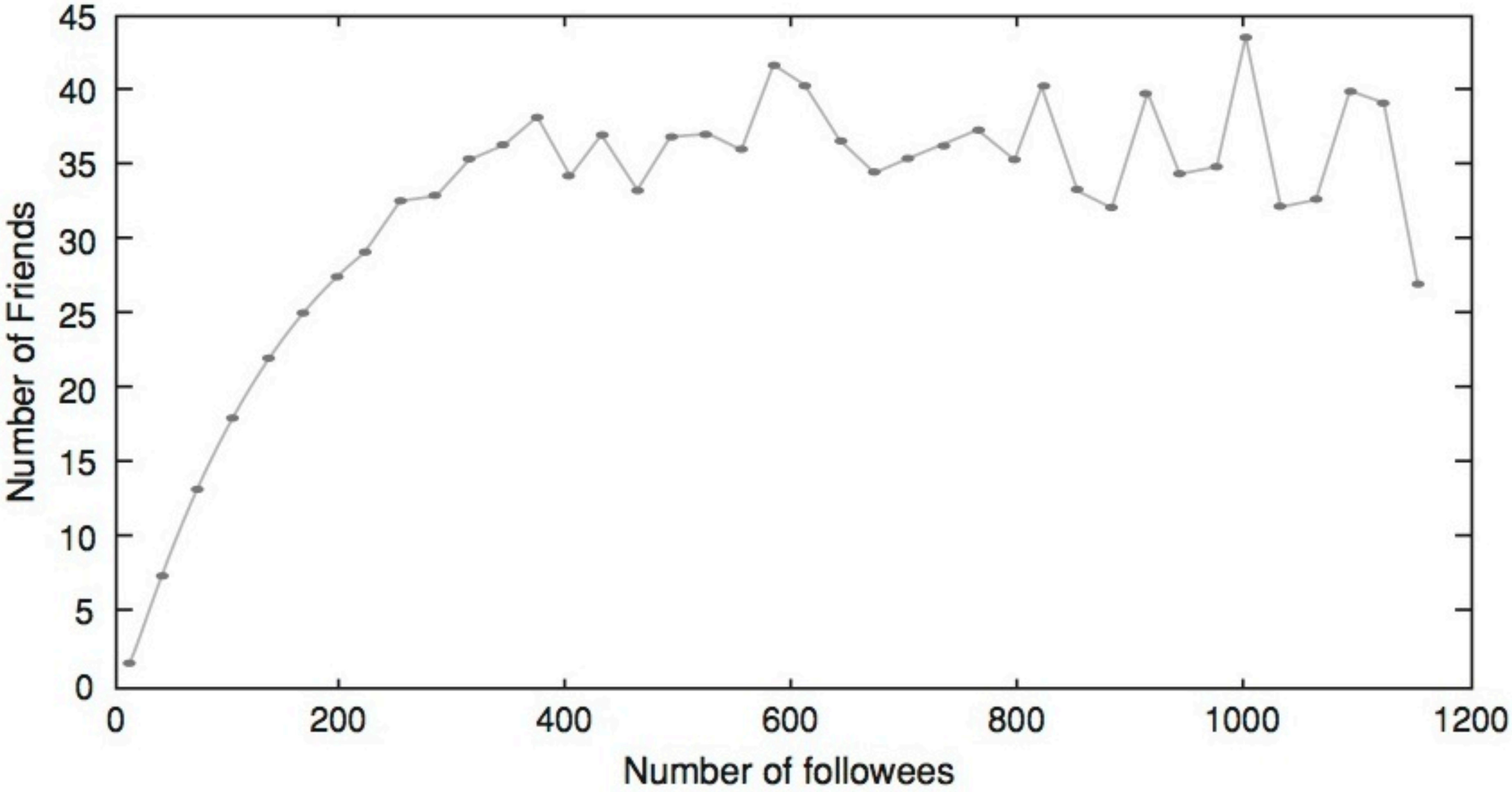


Figure 3.10. The total number of a user's strong ties (defined by multiple directed messages) as a function of the number of followees he or she has on Twitter. (Image from First Monday and [222].)

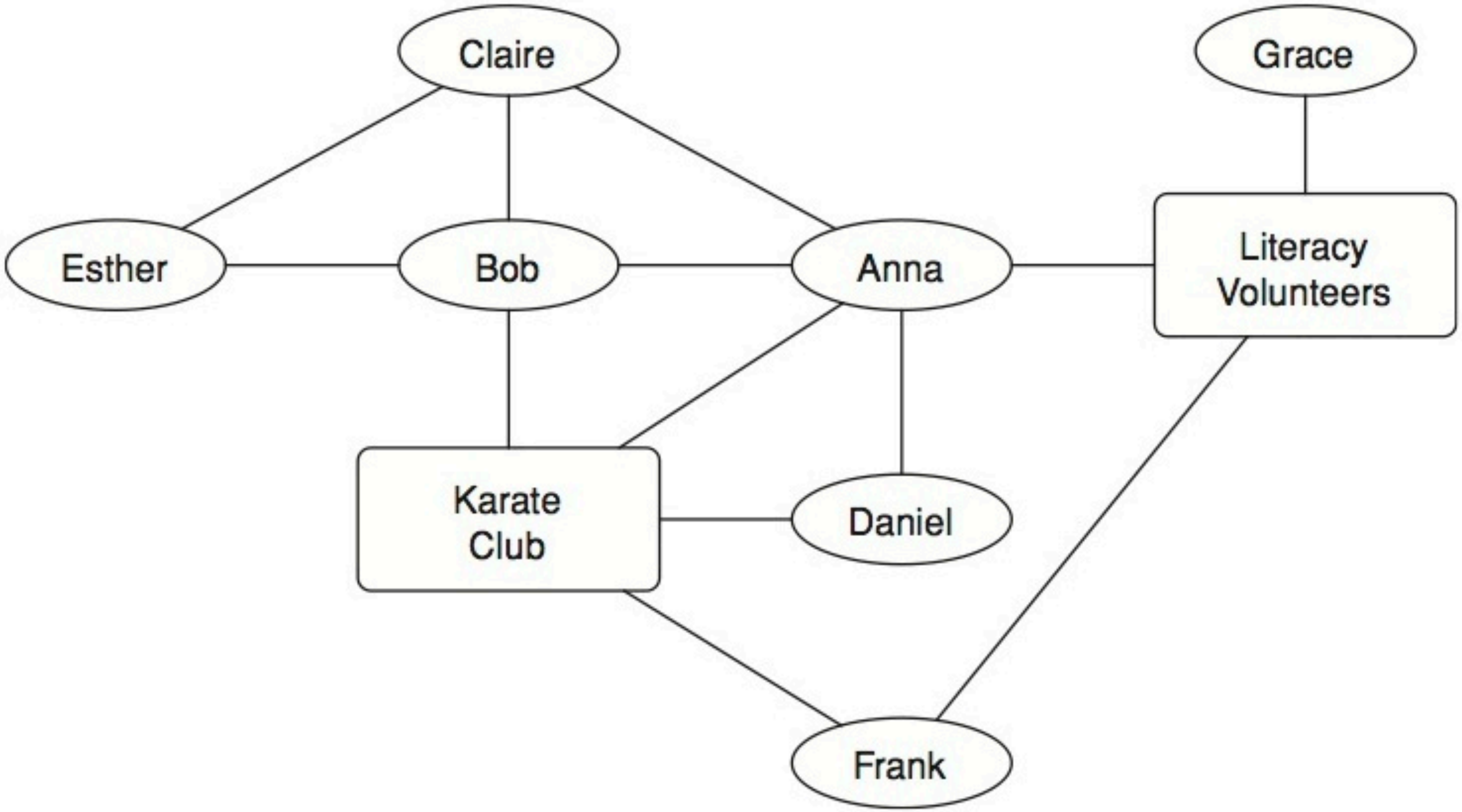


Figure 4.8. A larger network that contains the example from Figure 4.7. Pairs of people can have more than one friend (or more than one focus) in common. How does this increase the likelihood that an edge forms between them?

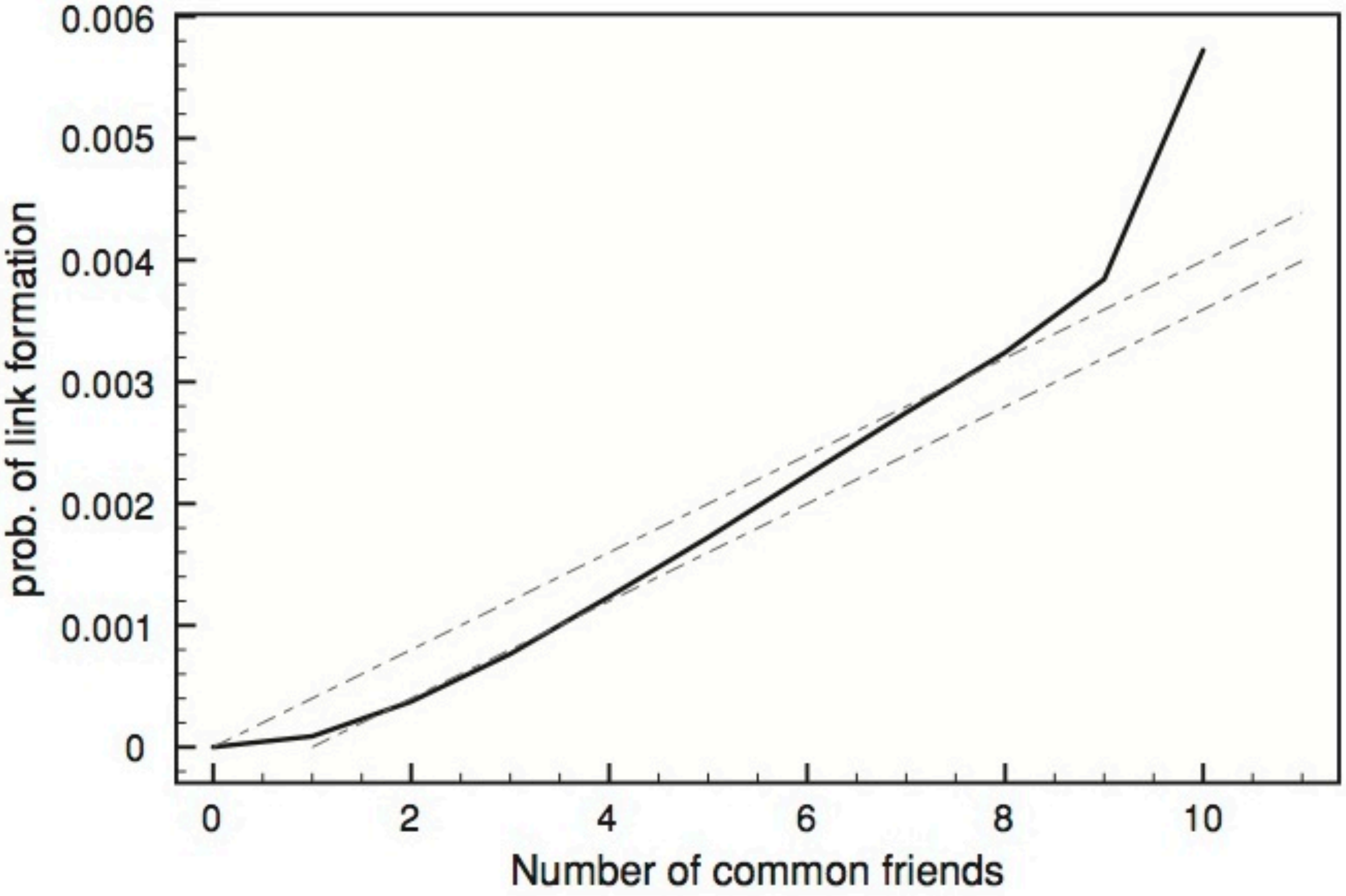


Figure 4.9. Quantifying the effects of triadic closure in an e-mail data set [259]. The curve determined from the data is shown in the solid black line; the dotted curves show a comparison to probabilities computed according to two simple baseline models in which common friends provide independent probabilities of link formation. (Image from the American Association for the Advancement of Science.)

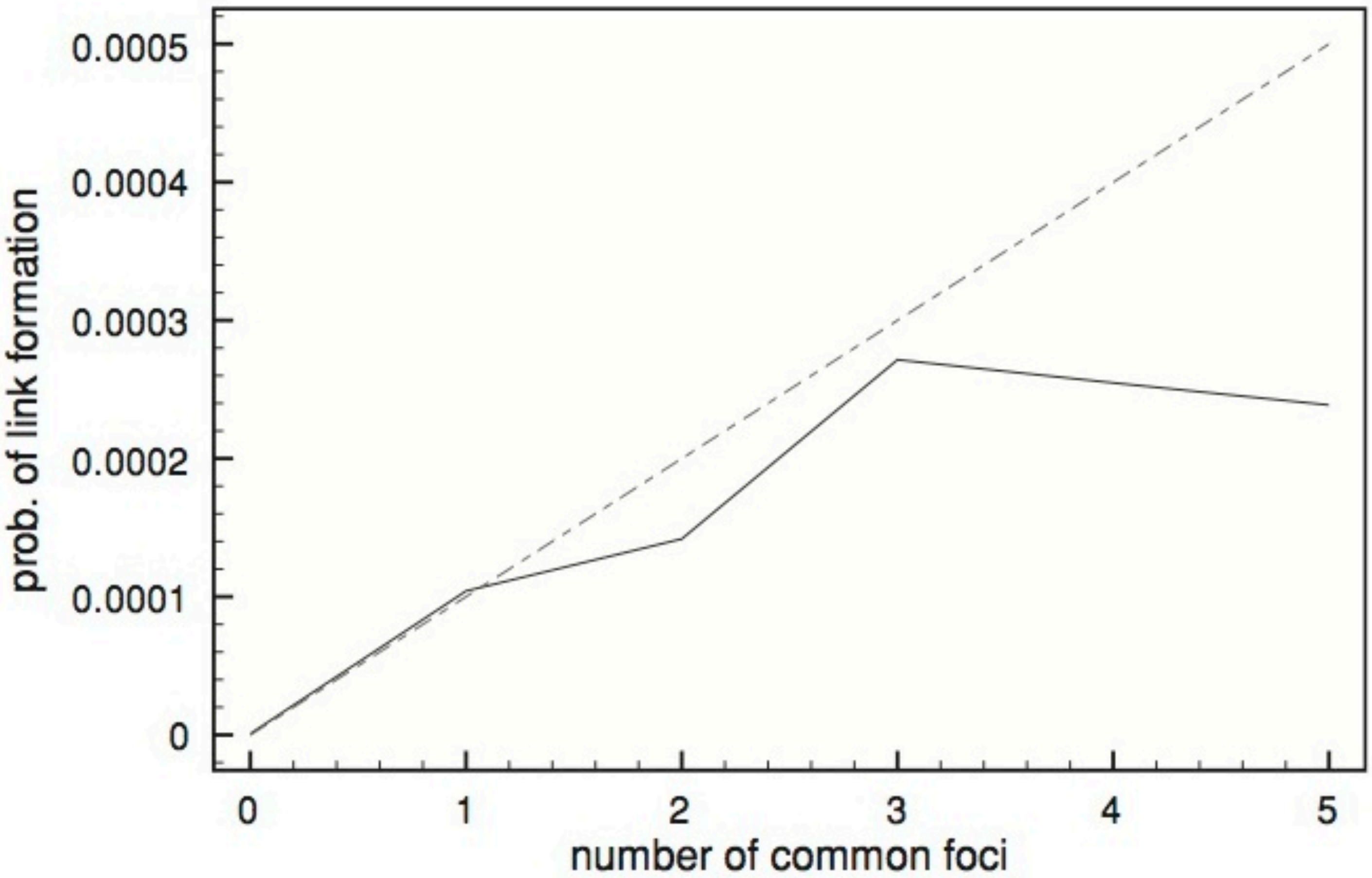


Figure 4.10. Quantifying the effects of focal closure in an e-mail data set [259]. Again, the curve determined from the data is shown as the solid black line, while the dotted curve provides a comparison to a simple baseline. (Image from the American Association for the Advancement of Science.)

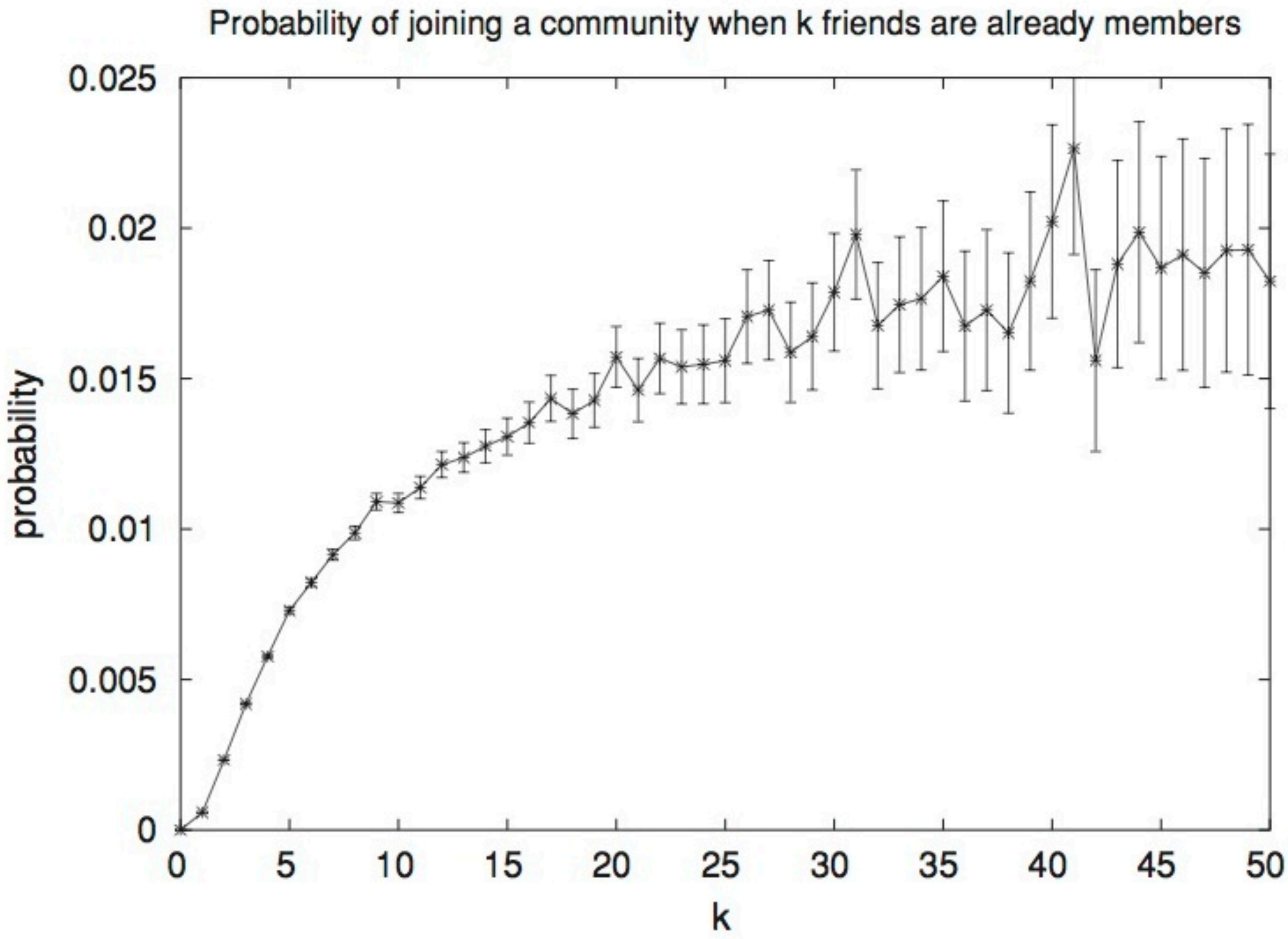


Figure 4.11. Quantifying the effects of membership closure in a large online data set: The plot shows the probability of joining a LiveJournal community as a function of the number of friends who are already members [32].

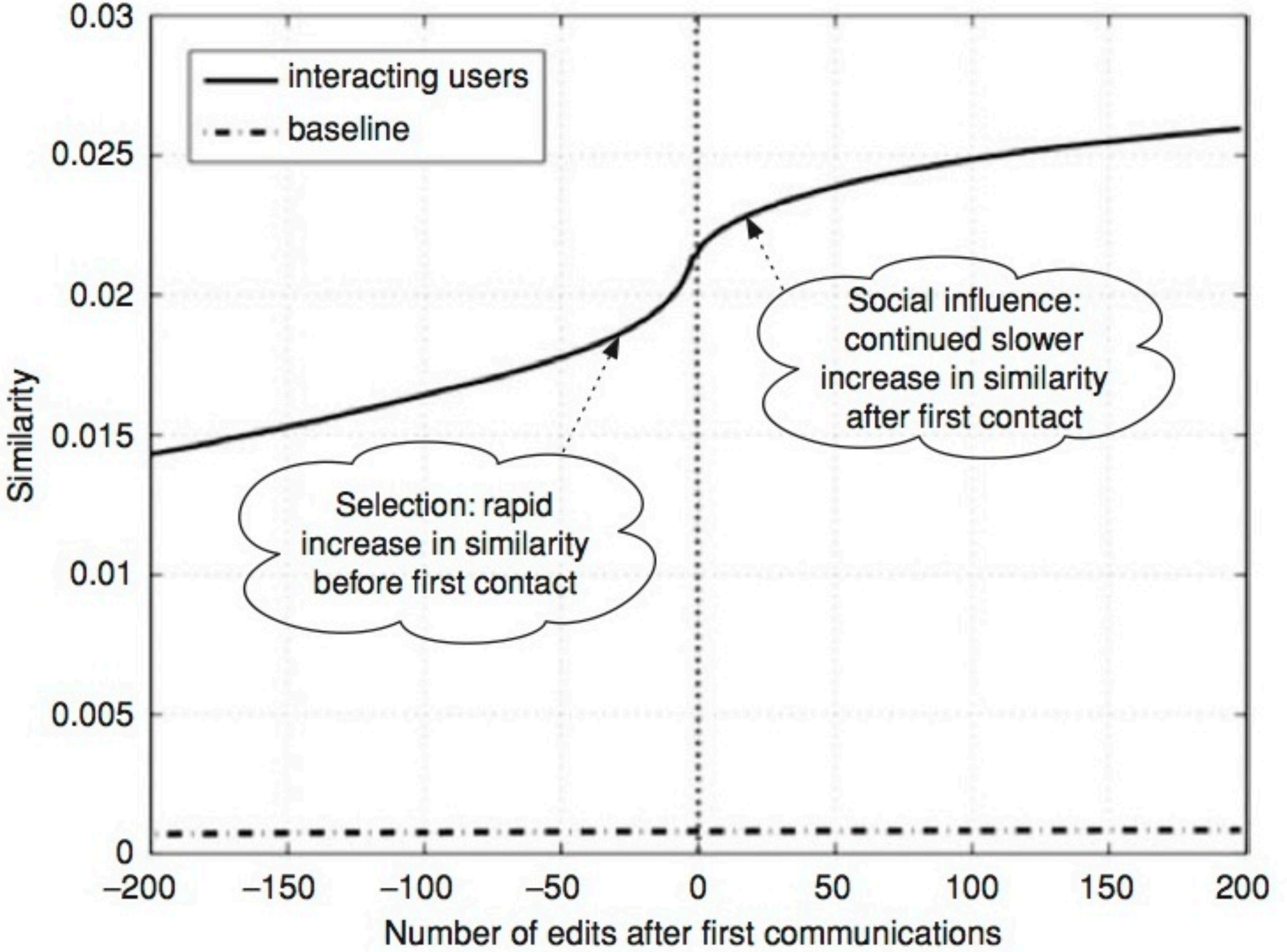


Figure 4.13. The average similarity of two editors on Wikipedia, relative to the time (0) at which they first communicated [122]. Time, on the x-axis, is measured in discrete units, where each unit corresponds to a single Wikipedia action taken by either of the two editors. The curve increases both before and after the first contact at time 0, indicating that both selection and social influence play a role; the increase in similarity is steepest just before time 0.

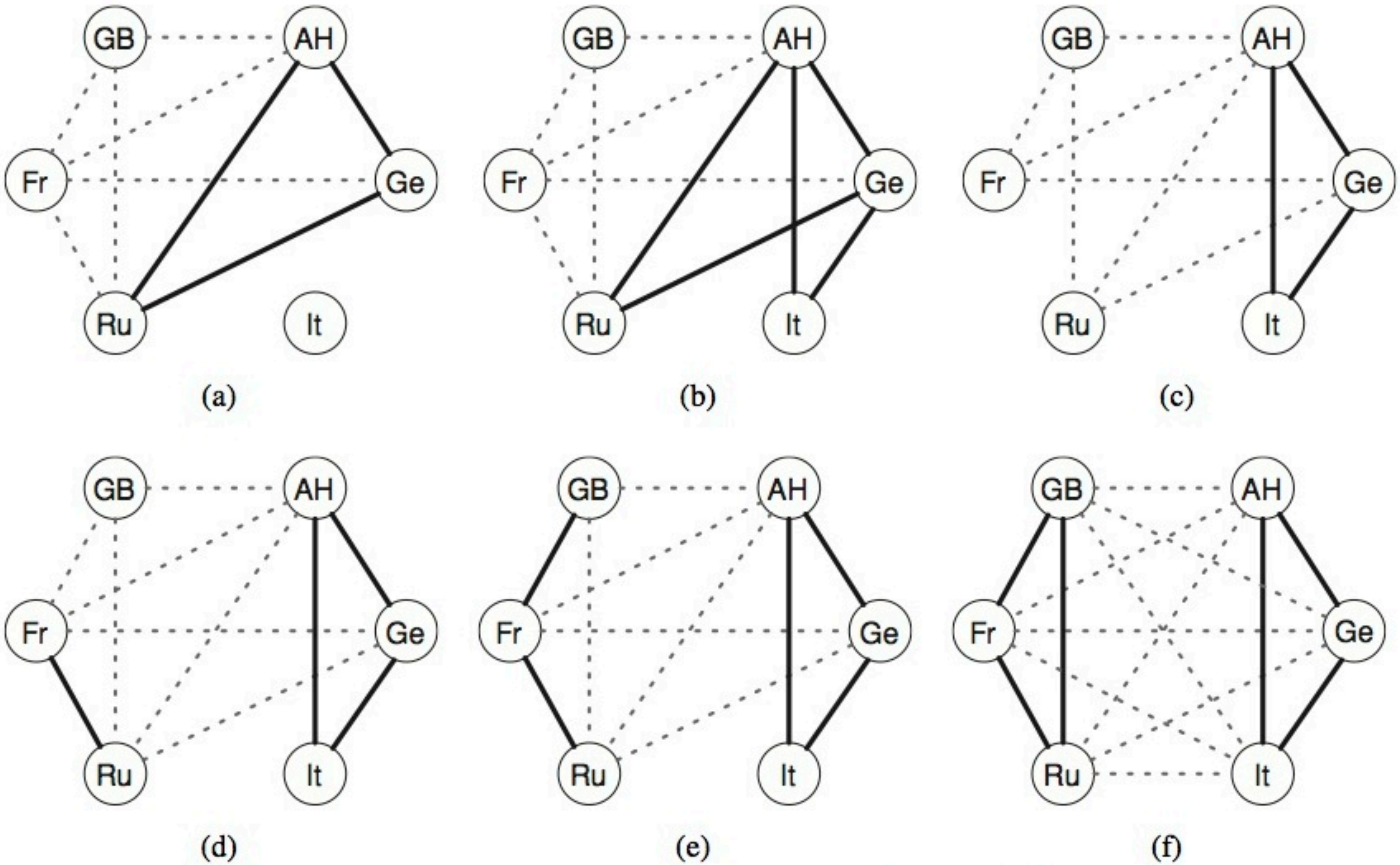


Figure 5.5. The evolution of alliances in Europe, 1872–1907 (the abbreviations GB, Fr, Ru, It, Ge, and AH stand for Great Britain, France, Russia, Italy, Germany, and Austria-Hungary, respectively): (a) Three Emperors' League, 1872–1881; (b) Triple Alliance, 1882; (c) German–Russian Lapse, 1890; (d) French–Russian Alliance, 1891–1994; (e) Entente Cordiale, 1904; (f) British Russian Alliance, 1907. Solid dark edges indicate friendship while dotted edges indicate enmity. Note how the network slides into a balanced labeling – and into World War I. (This figure and example are from Antal et al. [20] and Elsevier Science and Technology Journals.)

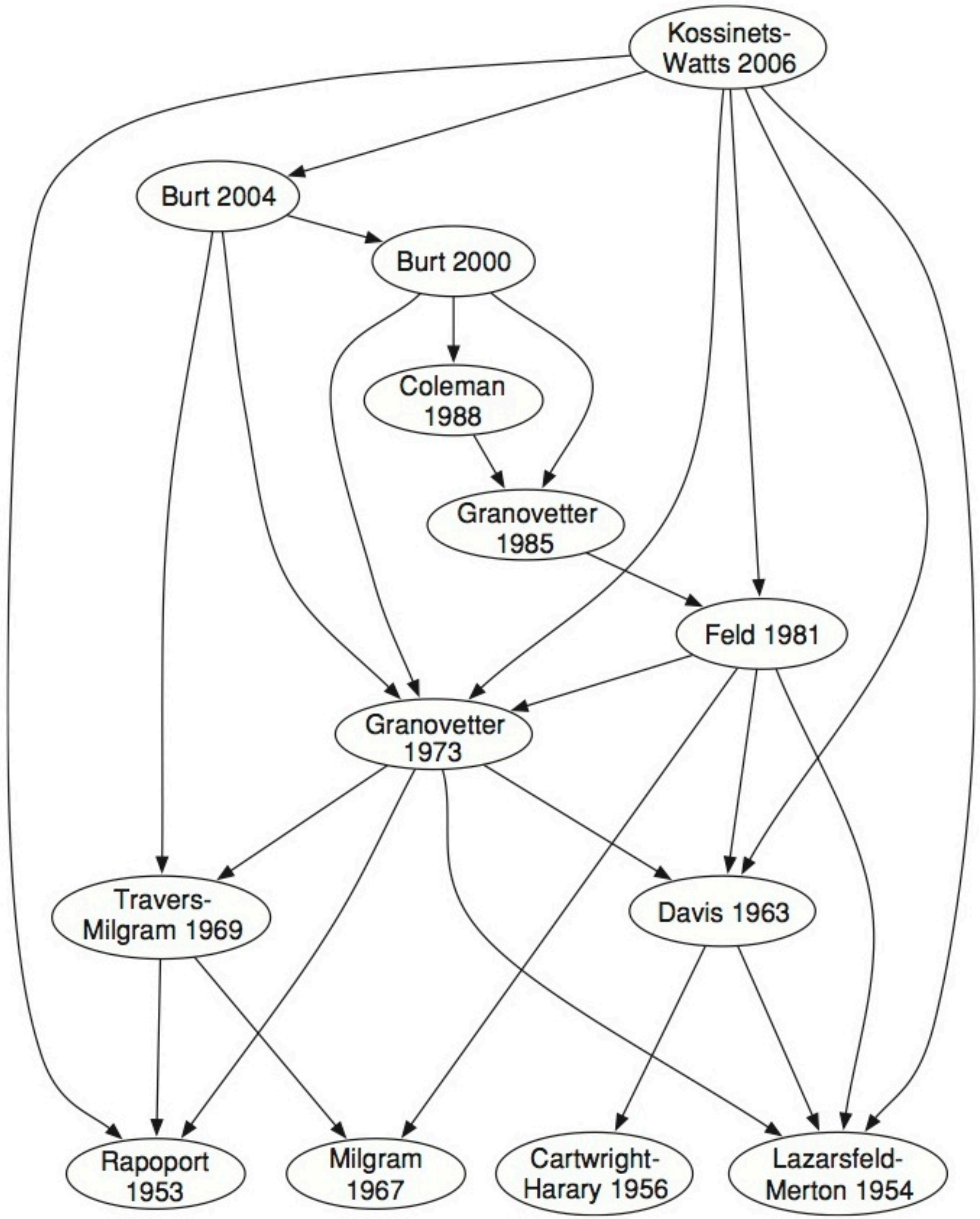


Figure 13.3. The network of citations among a set of research papers forms a directed graph that, like the Web, is a kind of information network. In contrast to the Web, however, the passage of time is much more evident in citation networks, since their links tend to point strictly backward in time.

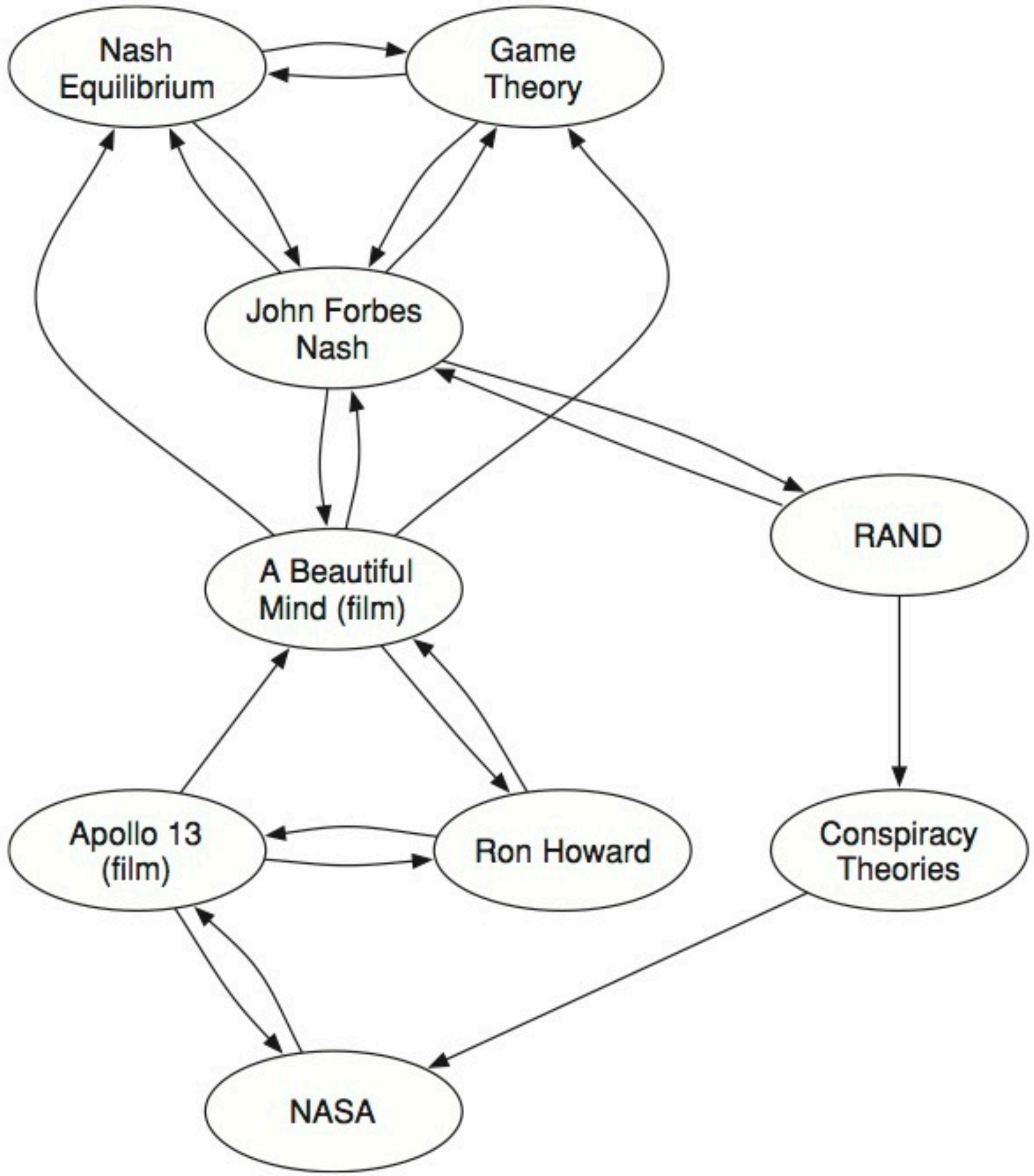


Figure 13.4. The cross-references among a set of articles in an encyclopedia form another kind of information network that can be represented as a directed graph. The figure shows the cross-references among a set of Wikipedia articles on topics in game theory and their connections to related topics, including popular culture and government agencies.

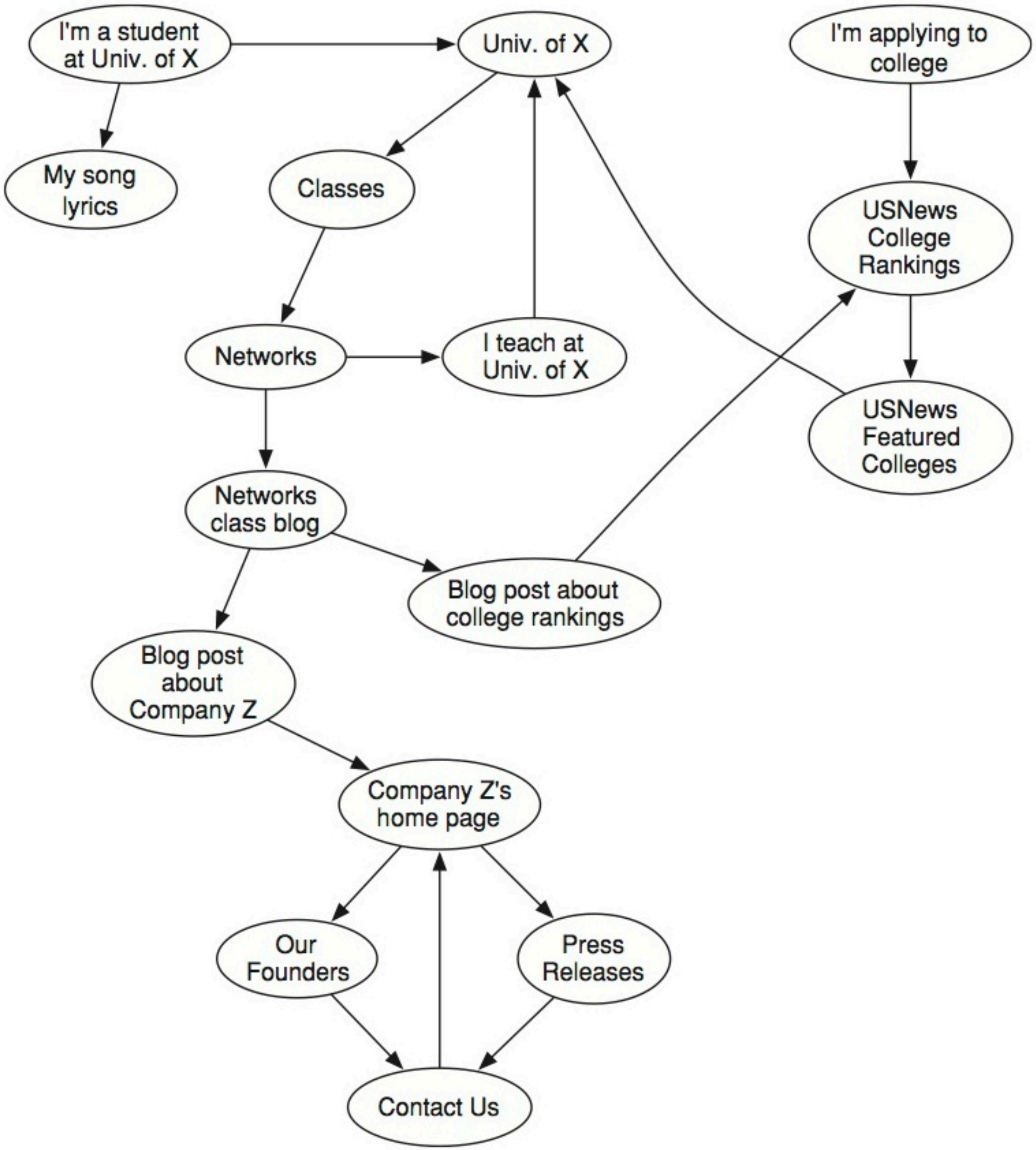


Figure 13.5. A directed graph formed by the links among a small set of Web pages.

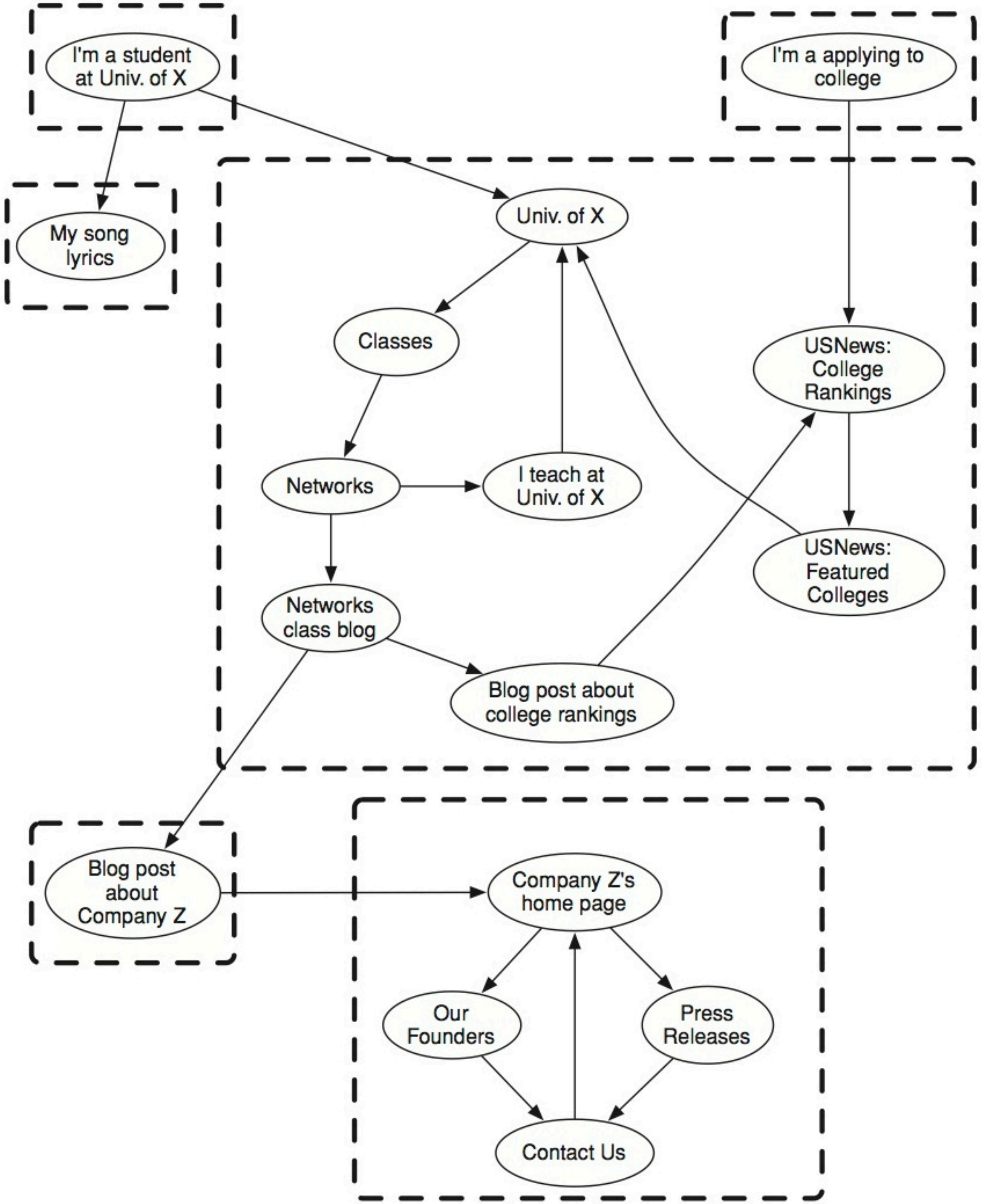


Figure 13.6. A directed graph with its strongly connected components identified.

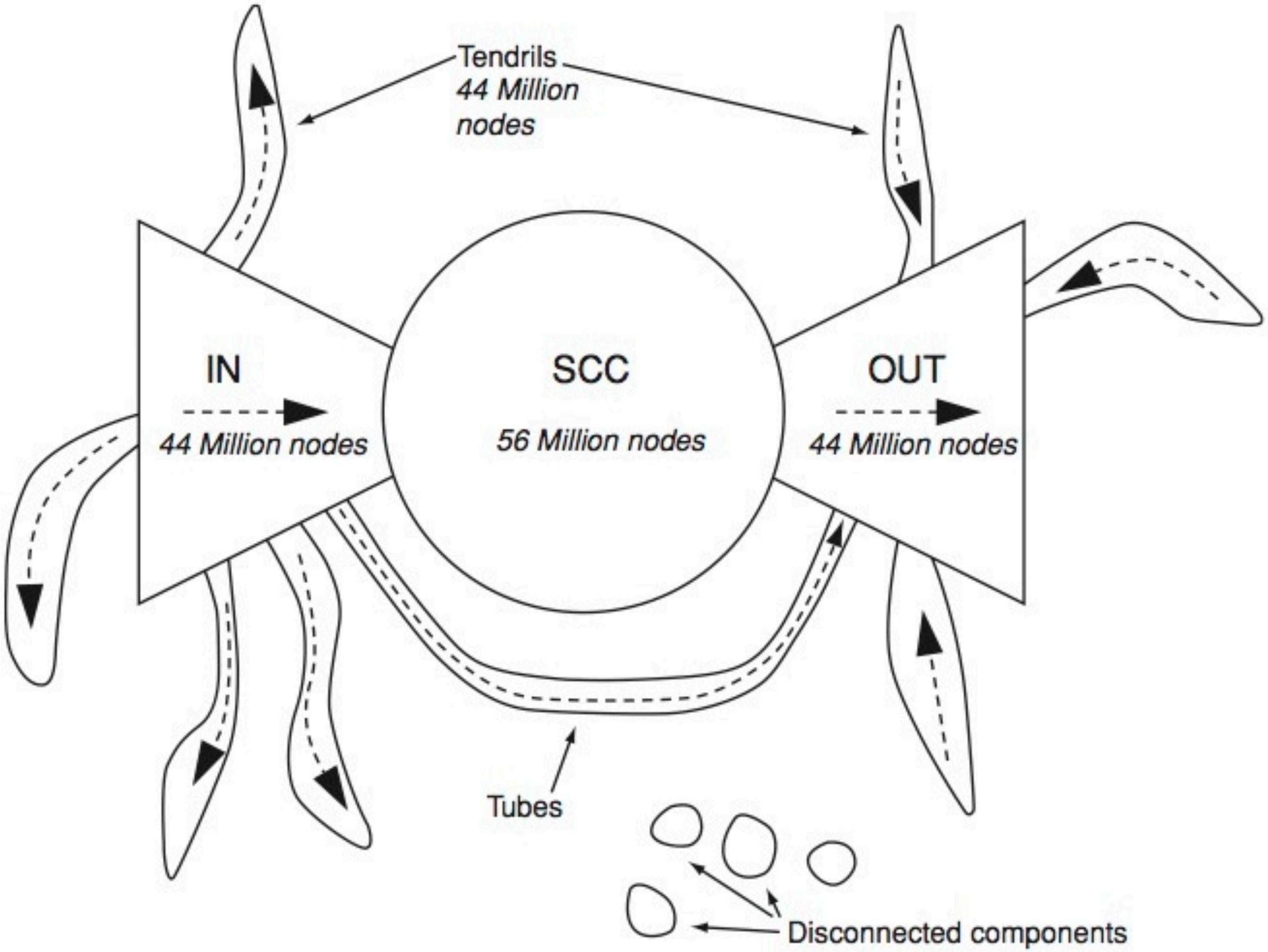


Figure 13.7. A schematic picture of the bow-tie structure of the Web (image from Broder et al., [80]). Although the numbers are now outdated, the structure has persisted.

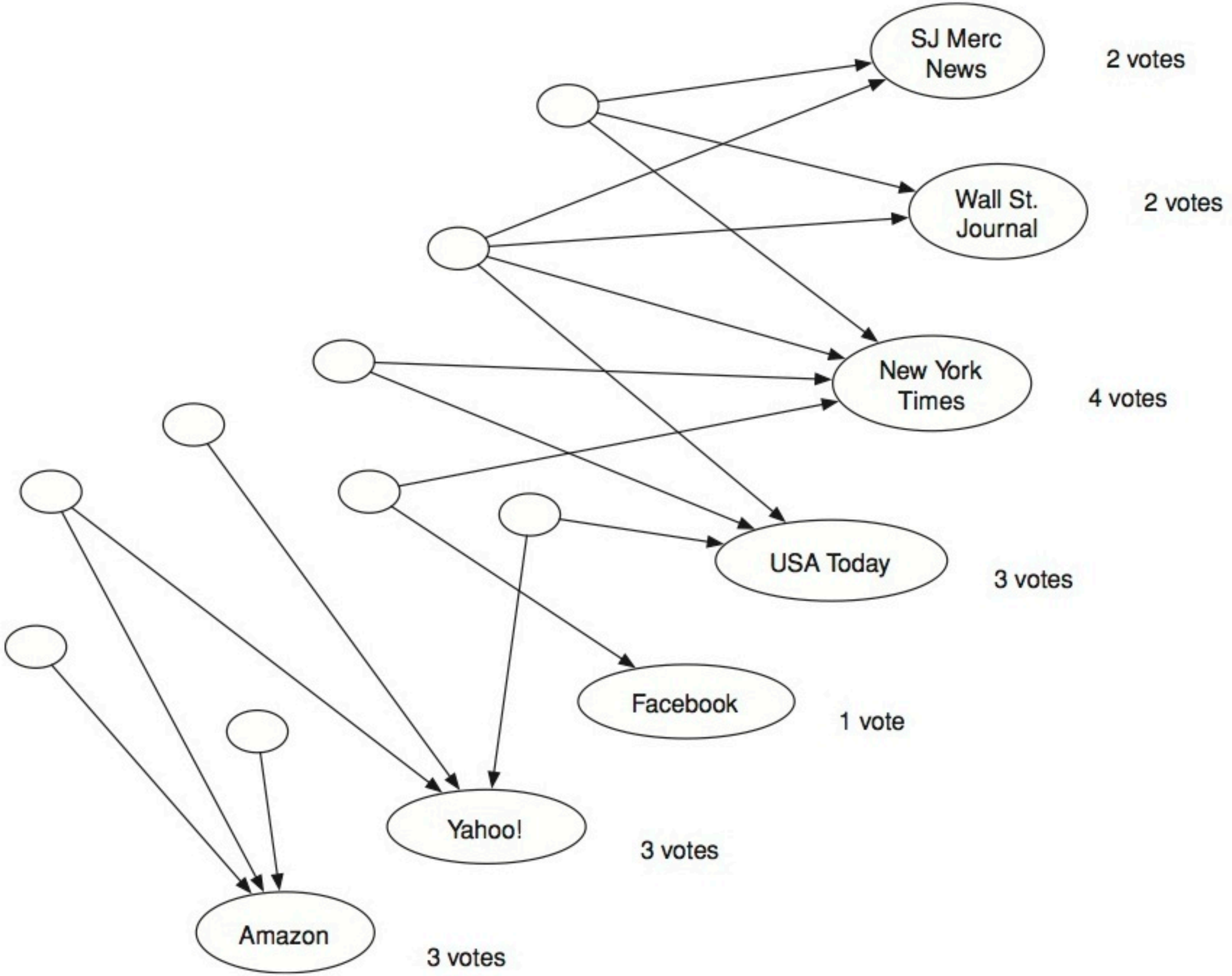


Figure 14.1. Counting in-links to pages for the query "newspapers."

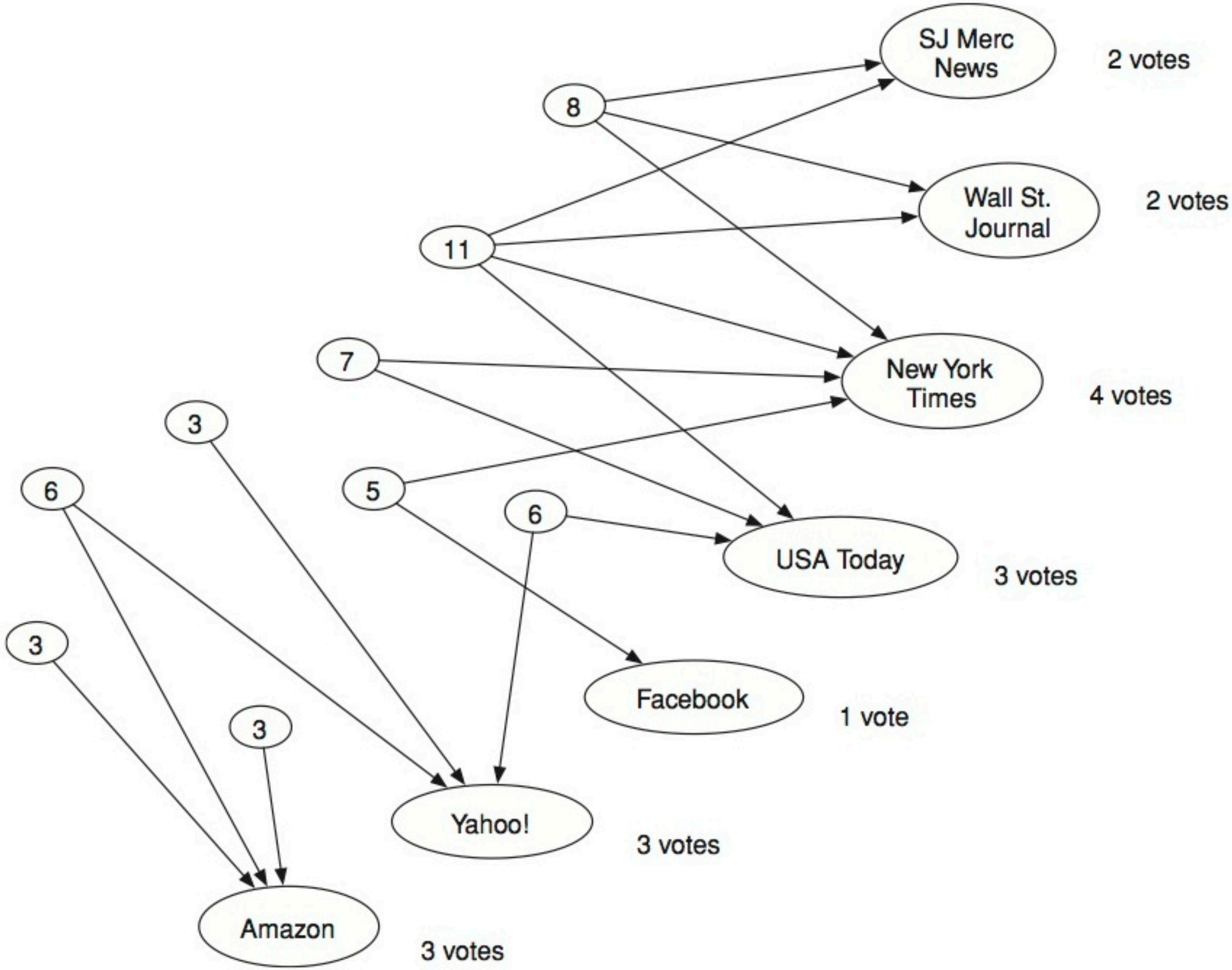


Figure 14.2. Finding good lists for the query "newspapers": each page's value as a list is written as a number inside it.

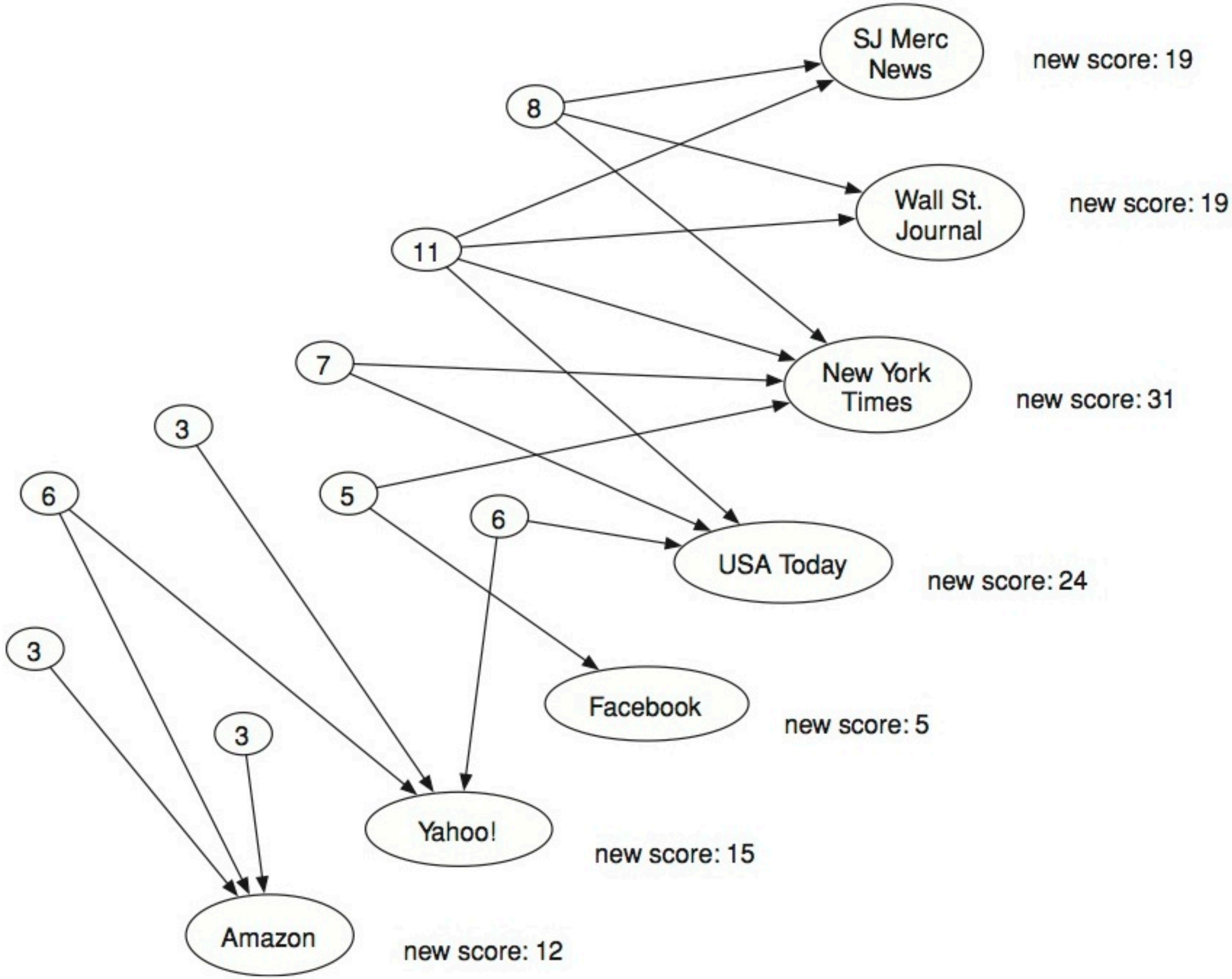


Figure 14.3. Reweighting votes for the query "newspapers": each labeled page's new score is equal to the sum of the values of all lists that point to it.

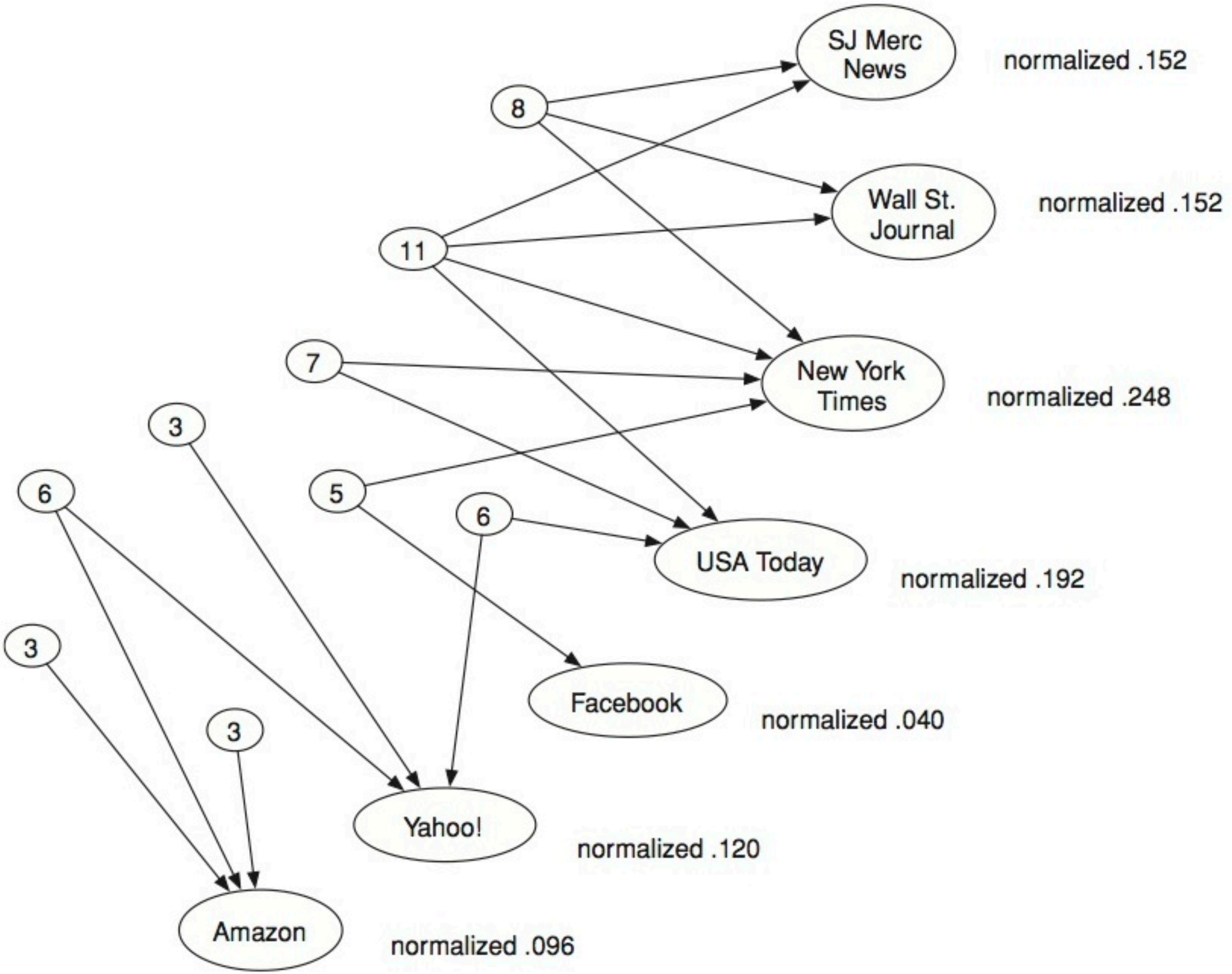


Figure 14.4. Reweighting votes after normalizing for the query "newspapers."

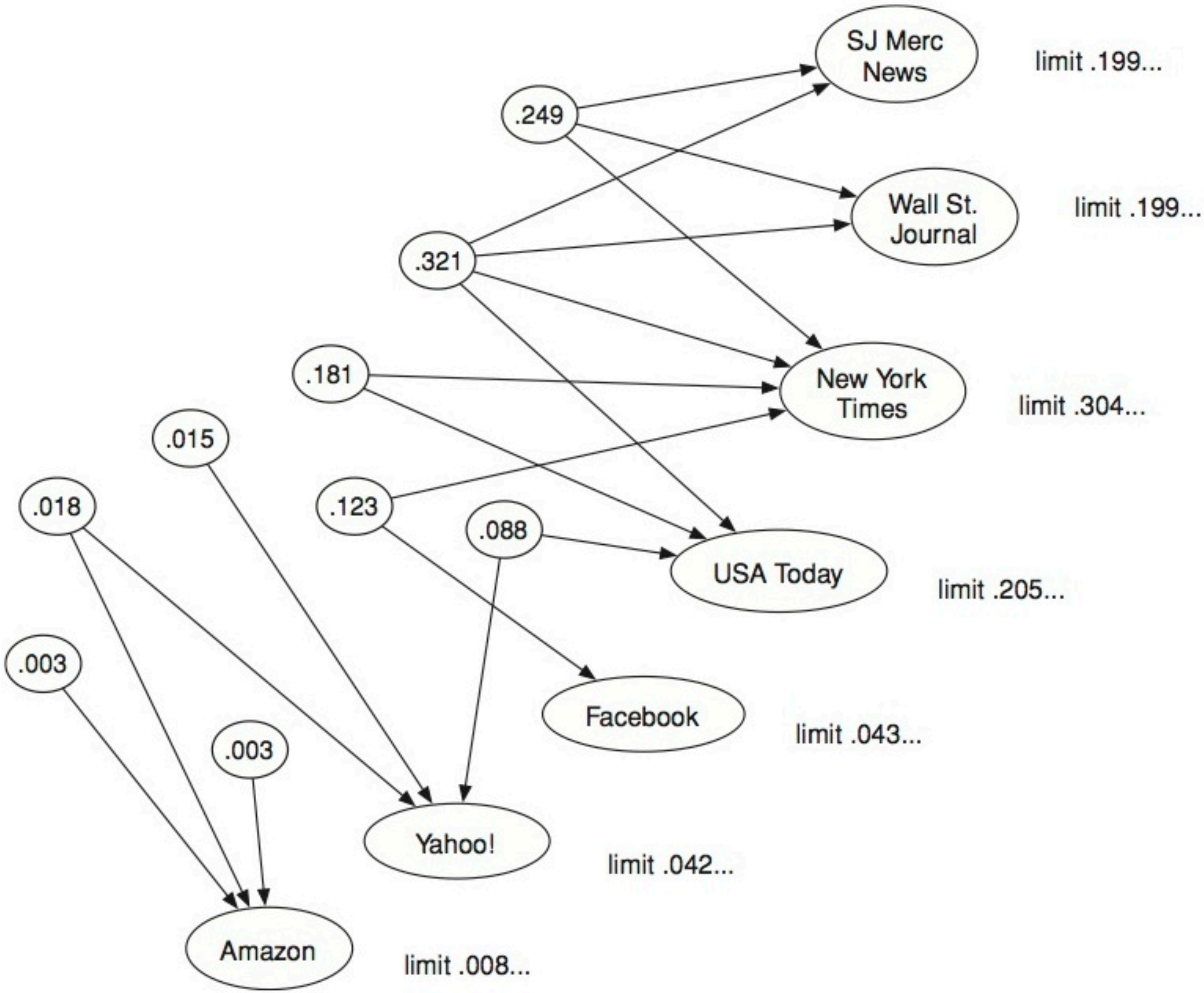
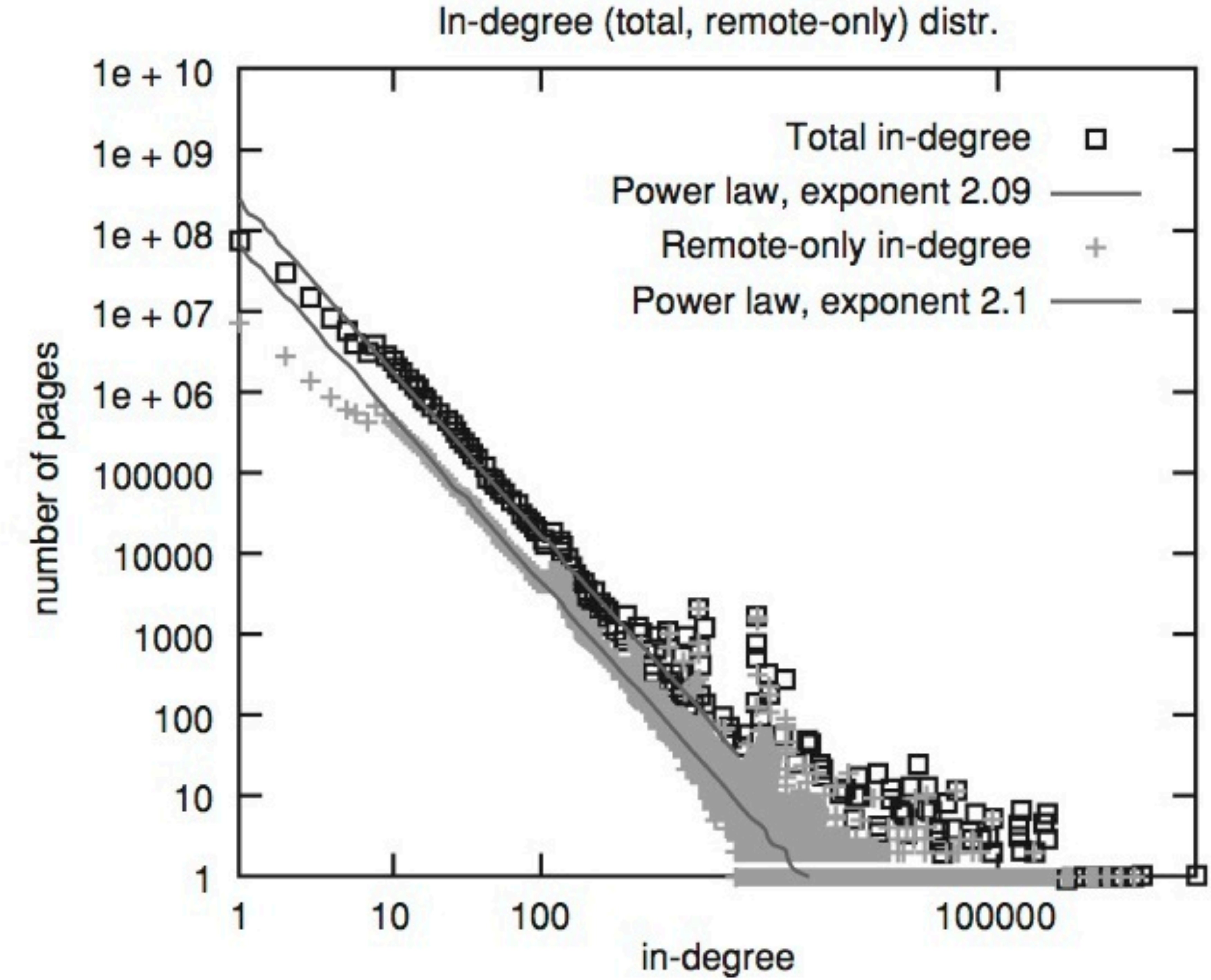


Figure 14.5. Limiting hub and authority values for the query "newspapers."


In-degree (total, remote-only) distr.
Total in-degree
Power law, exponent 2.09
Remote-only in-degree
Power law, exponent 2.1
number of pages
in-degree
1e + 10
1e + 09
1e + 08
1e + 07
1e + 06
100000
10000
1000
100
10
1
1
10
100
100000