

商業智慧實務



Tamkang
University

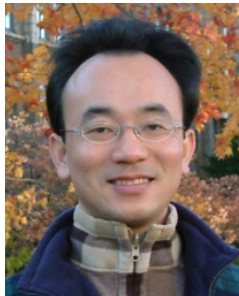
Practices of Business Intelligence

社會網路分析 (Social Network Analysis)

1022BI09

MI4

Wed, 9,10 (16:10-18:00) (B113)



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2014-05-14



課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
1	103/02/19	商業智慧導論 (Introduction to Business Intelligence)
2	103/02/26	管理決策支援系統與商業智慧 (Management Decision Support System and Business Intelligence)
3	103/03/05	企業績效管理 (Business Performance Management)
4	103/03/12	資料倉儲 (Data Warehousing)
5	103/03/19	商業智慧的資料探勘 (Data Mining for Business Intelligence)
6	103/03/26	商業智慧的資料探勘 (Data Mining for Business Intelligence)
7	103/04/02	教學行政觀摩日 (Off-campus study)
8	103/04/09	資料科學與巨量資料分析 (Data Science and Big Data Analytics)

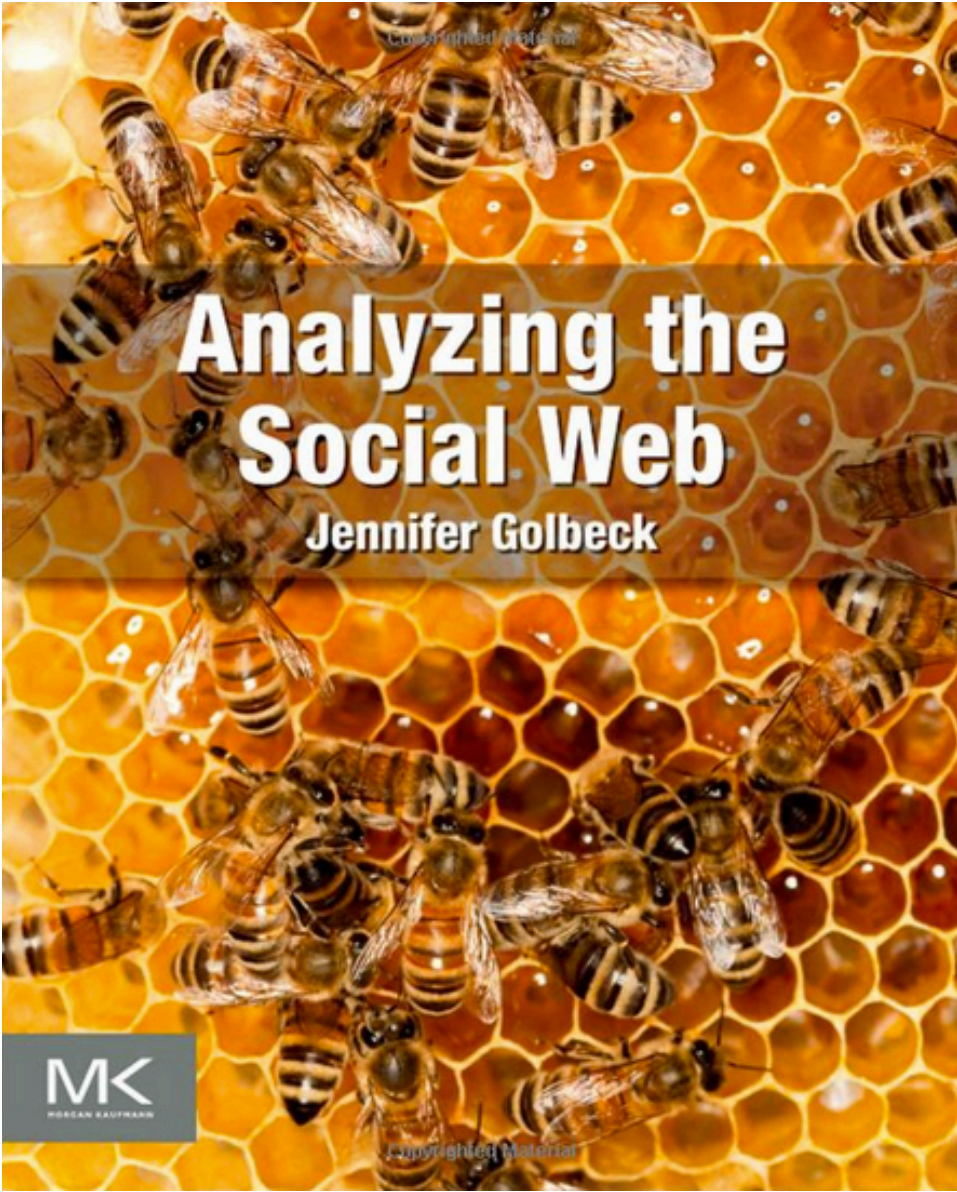
課程大綱 (Syllabus)

週次	日期	內容 (Subject/Topics)
9	103/04/16	期中報告 (Midterm Project Presentation)
10	103/04/23	期中考試週 (Midterm Exam)
11	103/04/30	文字探勘與網路探勘 (Text and Web Mining)
12	103/05/07	意見探勘與情感分析 (Opinion Mining and Sentiment Analysis)
13	103/05/14	社會網路分析 (Social Network Analysis)
14	103/05/21	期末報告 (Final Project Presentation)
15	103/05/28	畢業考試週 (Final Exam)

Outline

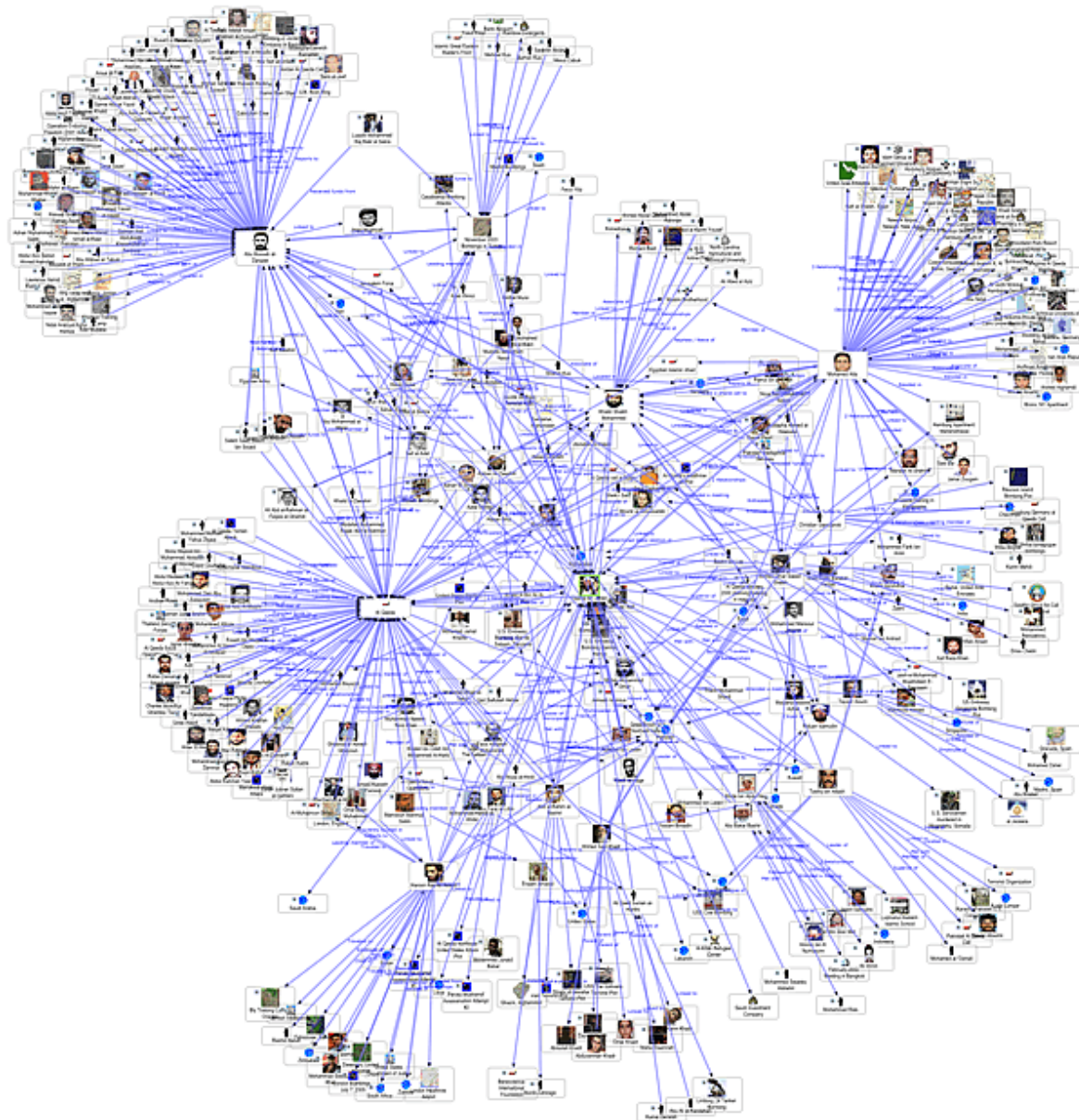
- Social Network Analysis (SNA)
 - Degree Centrality
 - Betweenness Centrality
 - Closeness Centrality
- Applications of SNA

Jennifer Golbeck (2013), *Analyzing the Social Web*, Morgan Kaufmann



Source: <http://www.amazon.com/Analyzing-Social-Web-Jennifer-Golbeck/dp/0124055311>

Social Network Analysis



Social Network Analysis

- A **social network** is a social structure of people, related (directly or indirectly) to each other through a common relation or interest
- **Social network analysis (SNA)** is the study of social networks to understand their structure and behavior

Social Network Analysis

- Using Social Network Analysis, you can get answers to questions like:
 - How highly connected is an entity within a network?
 - What is an entity's overall importance in a network?
 - How central is an entity within a network?
 - How does information flow within a network?

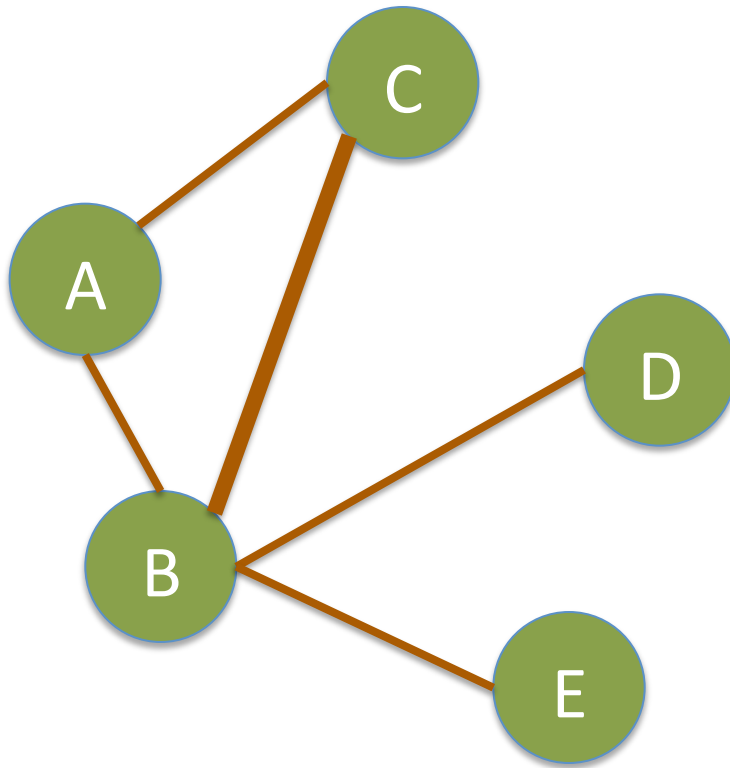
Social Network Analysis

- Social network is the study of social entities (people in an organization, called **actors**), and their **interactions and relationships**.
- The interactions and relationships can be represented with **a network or graph**,
 - each **vertex** (or **node**) represents an actor and
 - each link represents a relationship.
- From the network, we can study the properties of its structure, and **the role, position** and **prestige** of each social actor.
- We can also find various kinds of sub-graphs, e.g., **communities** formed by groups of actors.

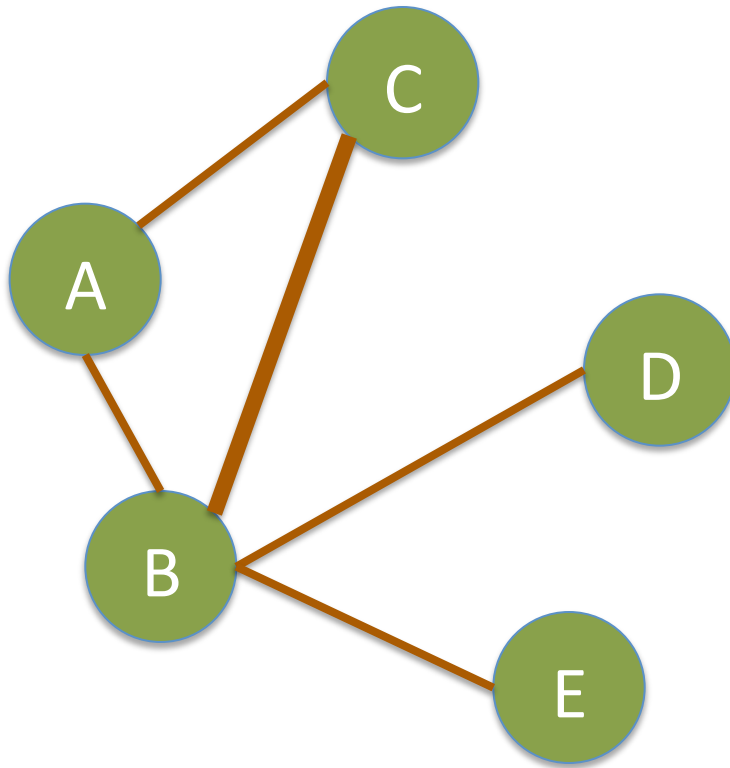
Social Network and the Web

- Social network analysis is useful for the Web because the Web is essentially a virtual society, and thus a virtual social network,
 - Each page: a social actor and
 - each hyperlink: a relationship.
- Many results from social network can be adapted and extended for use in the Web context.
- Two types of social network analysis,
 - **Centrality**
 - **Prestige**closely related to hyperlink analysis and search on the Web

Degree

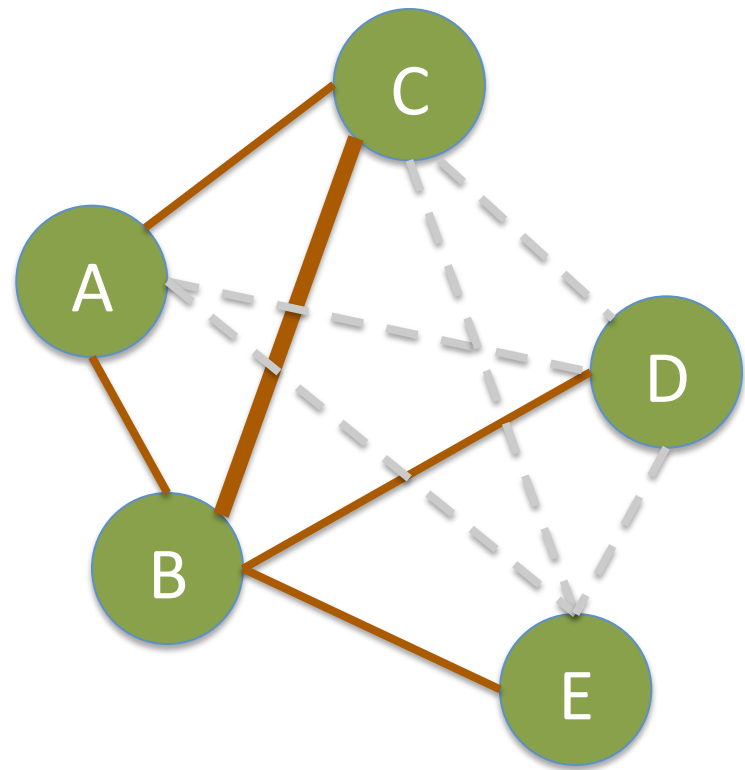


Degree



A: 2
B: 4
C: 2
D: 1
E: 1

Density

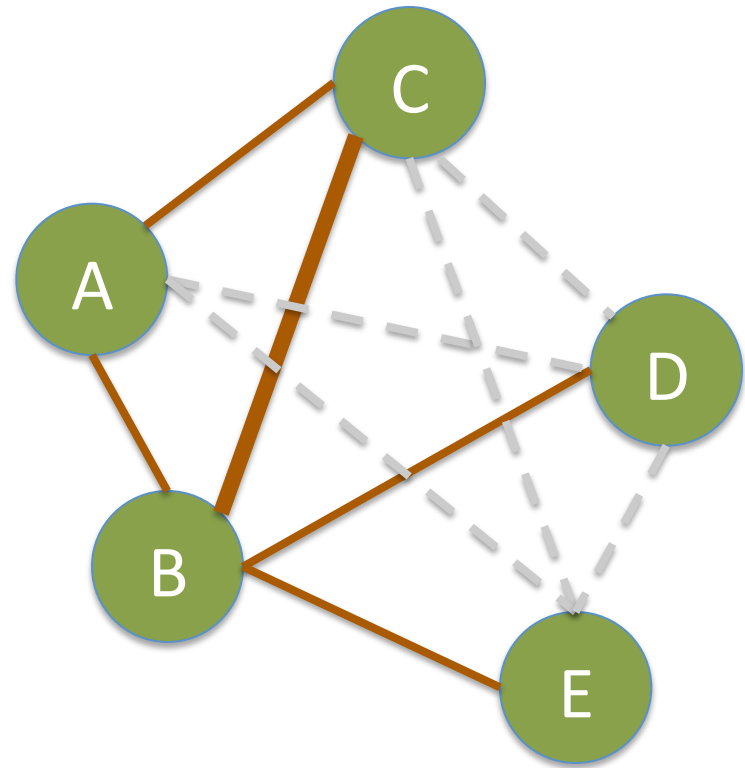


Density

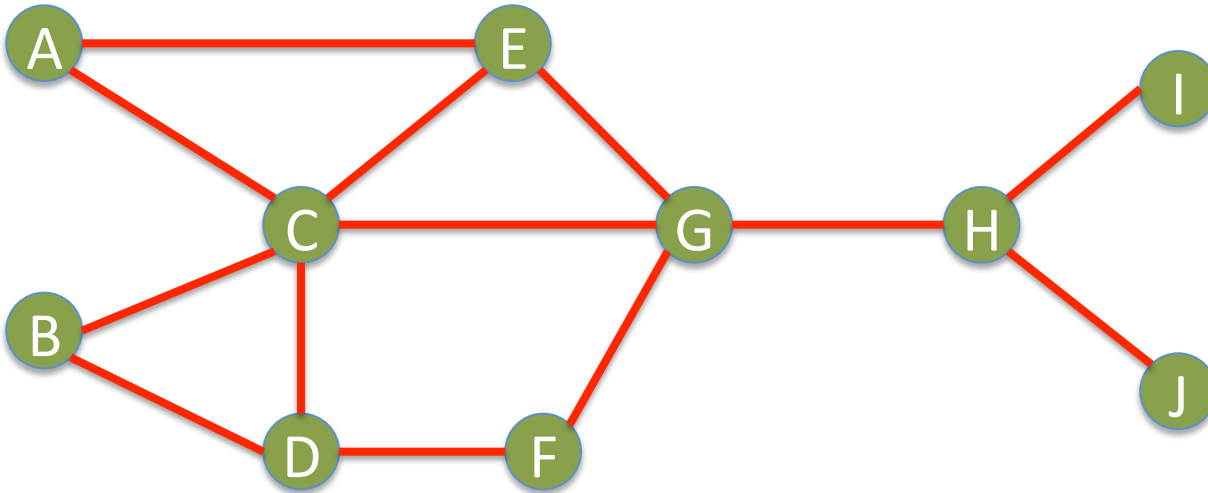
Edges (Links): 5

Total Possible Edges: 10

Density: $5/10 = 0.5$



Density



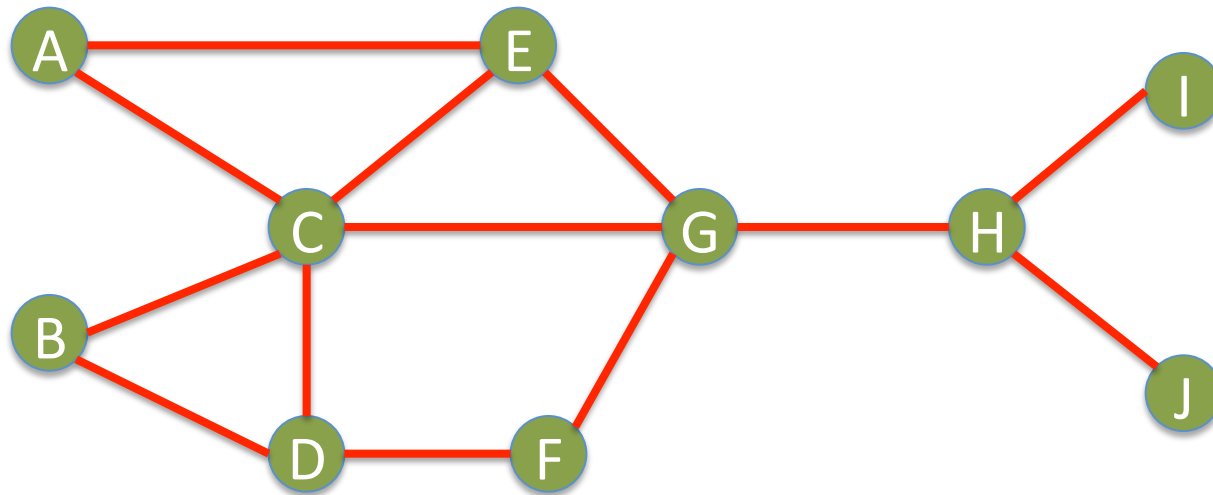
Nodes (n): 10

Edges (Links): 13

Total Possible Edges: $(n * (n-1)) / 2 = (10 * 9) / 2 = 45$

Density: $13/45 = 0.29$

Which Node is Most **Important**?



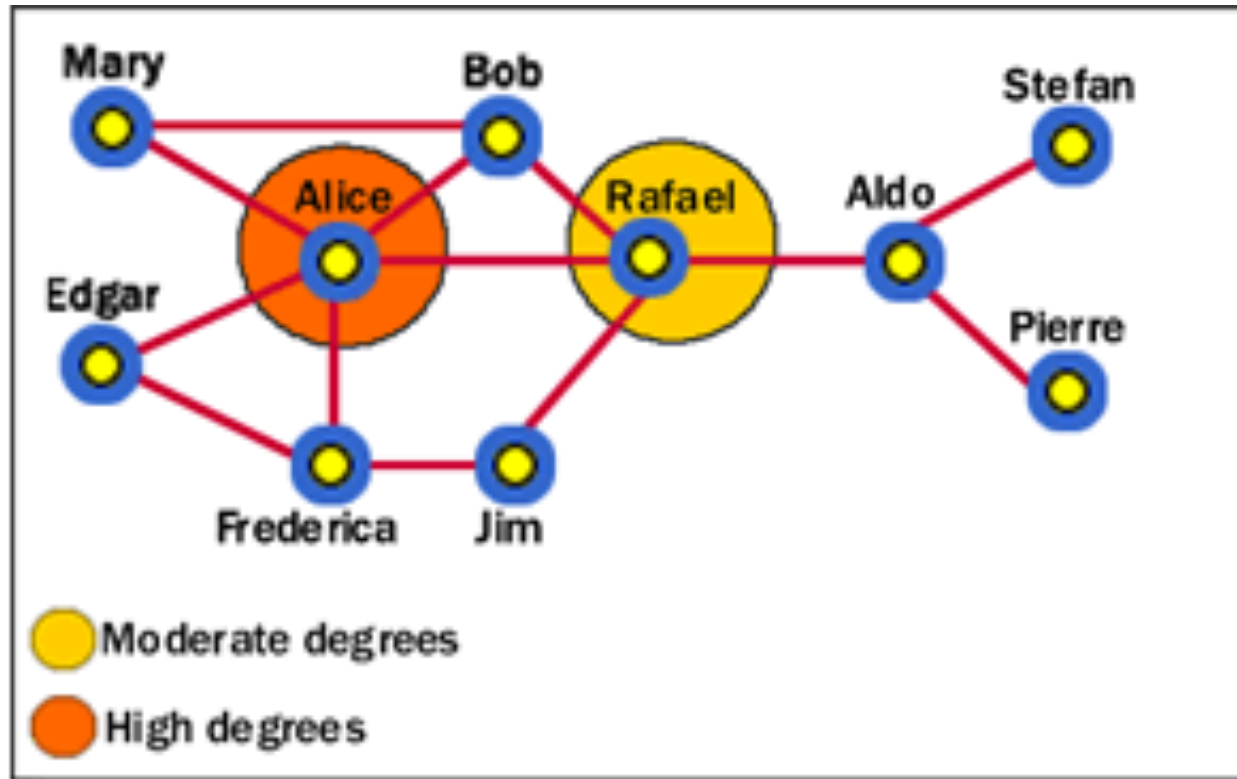
Centrality

- **Important or prominent actors** are those that are linked or involved with other actors extensively.
- A person with extensive contacts (links) or communications with many other people in the organization is considered more important than a person with relatively fewer contacts.
- The links can also be called **ties**.
A **central actor** is one involved in many ties.

Social Network Analysis (SNA)

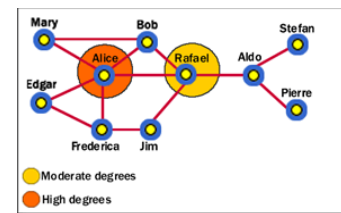
- Degree Centrality
- Betweenness Centrality
- Closeness Centrality

Social Network Analysis: Degree Centrality



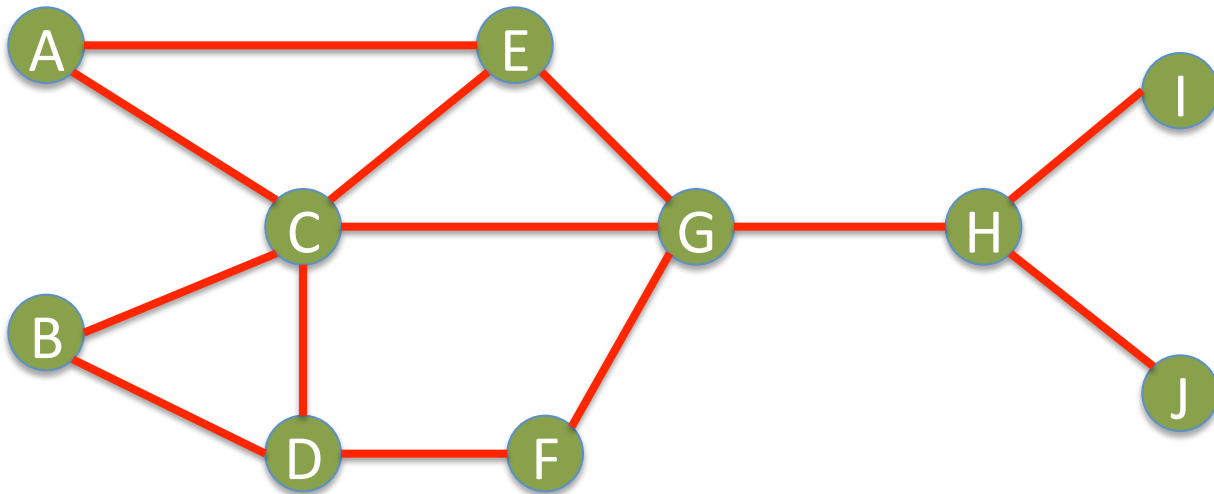
Alice has the highest degree centrality, which means that she is quite active in the network. However, she is not necessarily the most powerful person because she is only directly connected within one degree to people in her clique—she has to go through Rafael to get to other cliques.

Social Network Analysis: Degree Centrality

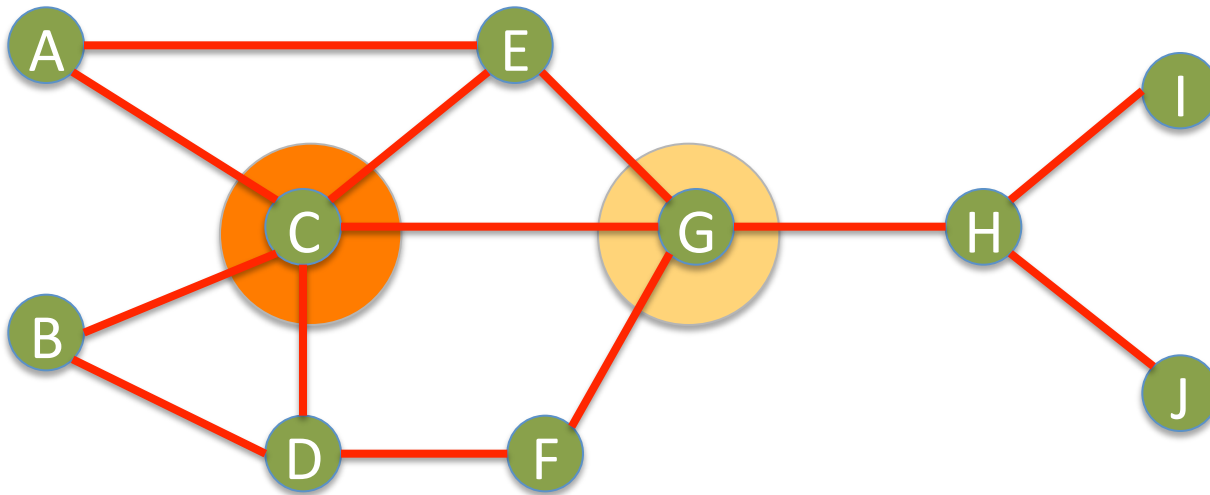


- Degree centrality is simply the number of direct relationships that an entity has.
- An entity with high degree centrality:
 - Is generally an active player in the network.
 - Is often a connector or hub in the network.
 - Is not necessarily the most connected entity in the network (an entity may have a large number of relationships, the majority of which point to low-level entities).
 - May be in an advantaged position in the network.
 - May have alternative avenues to satisfy organizational needs, and consequently may be less dependent on other individuals.
 - Can often be identified as third parties or deal makers.

Social Network Analysis: Degree Centrality

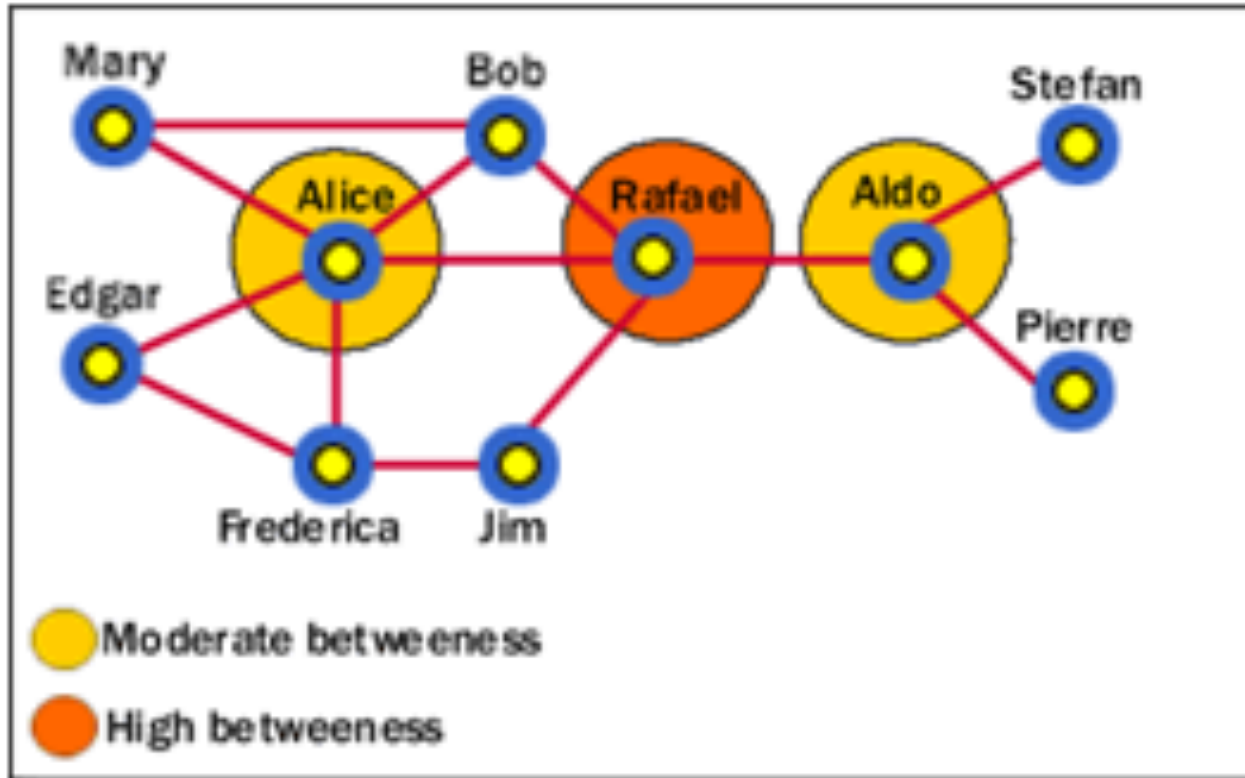


Social Network Analysis: Degree Centrality



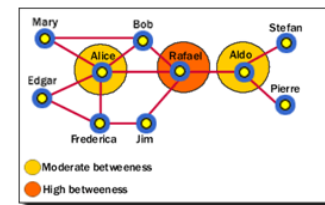
A: 2
B: 2
C: 5
D: 3
E: 3
F: 2
G: 4
H: 3
I: 1
J: 1

Social Network Analysis: Betweenness Centrality



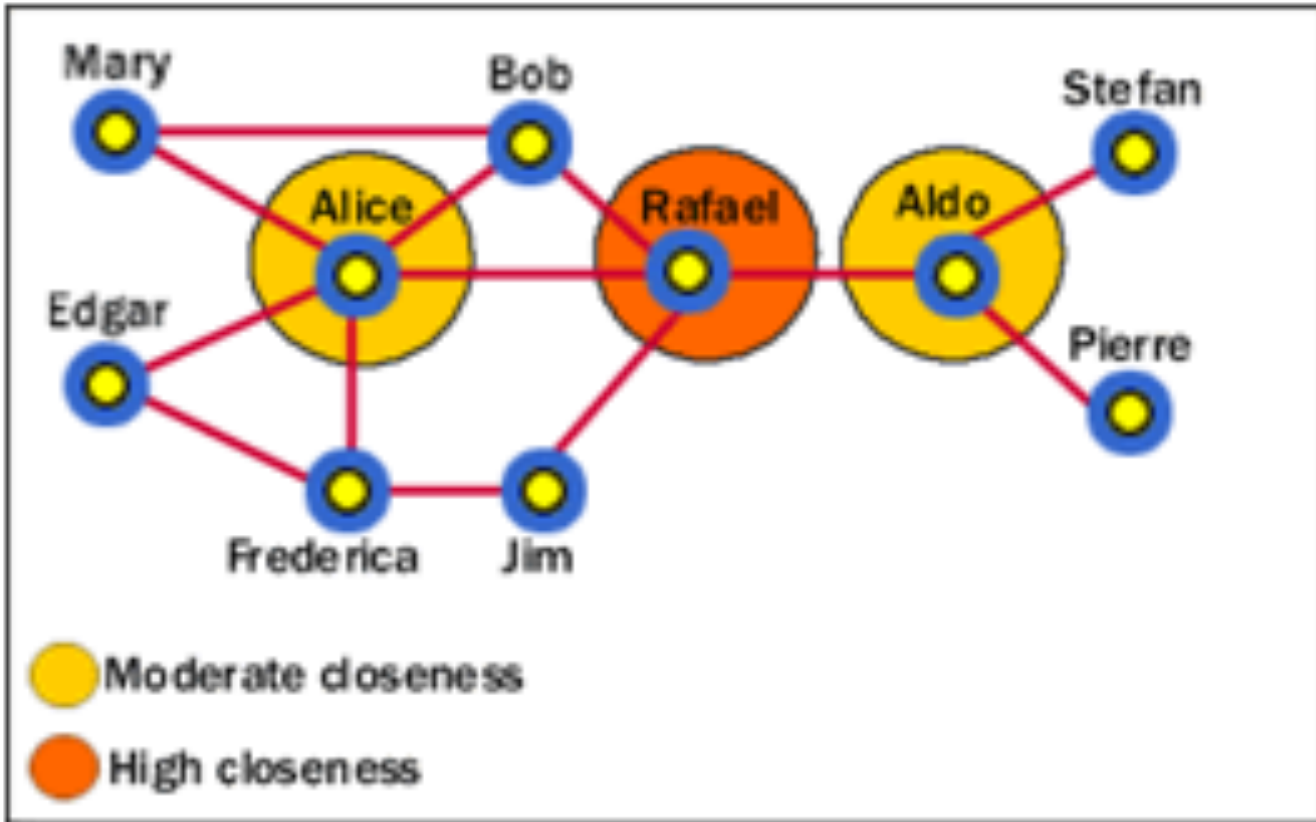
Rafael has the highest betweenness because he is between Alice and Aldo, who are between other entities. Alice and Aldo have a slightly lower betweenness because they are essentially only between their own cliques. Therefore, although Alice has a higher degree centrality, Rafael has more importance in the network in certain respects.

Social Network Analysis: Betweenness Centrality



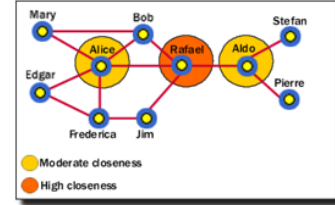
- Betweenness centrality identifies an entity's position within a network in terms of its ability to make connections to other pairs or groups in a network.
- An entity with a high betweenness centrality generally:
 - Holds a favored or powerful position in the network.
 - Represents a single point of failure—take the single betweenness spanner out of a network and you sever ties between cliques.
 - Has a greater amount of influence over what happens in a network.

Social Network Analysis: Closeness Centrality



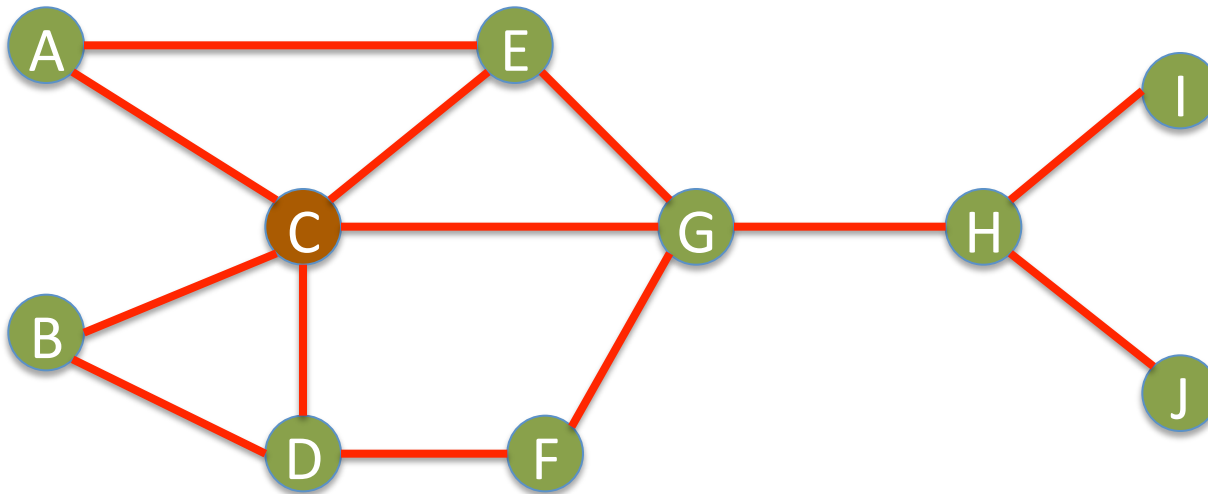
Rafael has the highest closeness centrality because he can reach more entities through shorter paths. As such, Rafael's placement allows him to connect to entities in his own clique, and to entities that span cliques.

Social Network Analysis: Closeness Centrality



- Closeness centrality measures how quickly an entity can access more entities in a network.
- An entity with a high closeness centrality generally:
 - Has quick access to other entities in a network.
 - Has a short path to other entities.
 - Is close to other entities.
 - Has high visibility as to what is happening in the network.

Social Network Analysis: Closeness Centrality

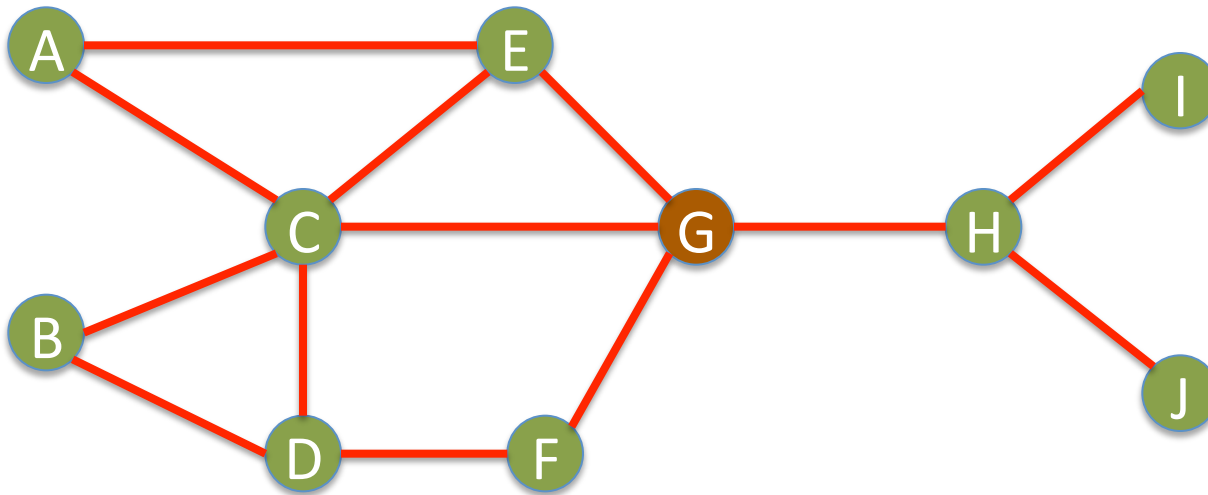


C→A: 1
C→B: 1
C→D: 1
C→E: 1
C→F: 2
C→G: 1
C→H: 2
C→I: 3
C→J: 3

Total=15

C: Closeness Centrality = $15/9 = 1.67$

Social Network Analysis: Closeness Centrality

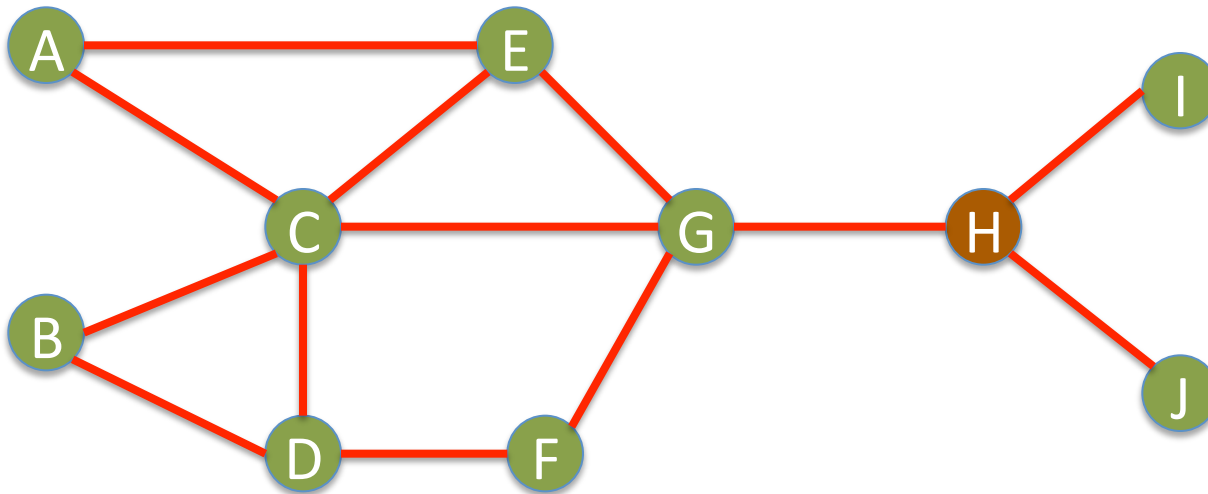


G→A: 2
G→B: 2
G→C: 1
G→D: 2
G→E: 1
G→F: 1
G→H: 1
G→I: 2
G→J: 2

Total=14

G: Closeness Centrality = $14/9 = 1.56$

Social Network Analysis: Closeness Centrality



H→A: 3

H→B: 3

H→C: 2

H→D: 2

H→E: 2

H→F: 2

H→G: 1

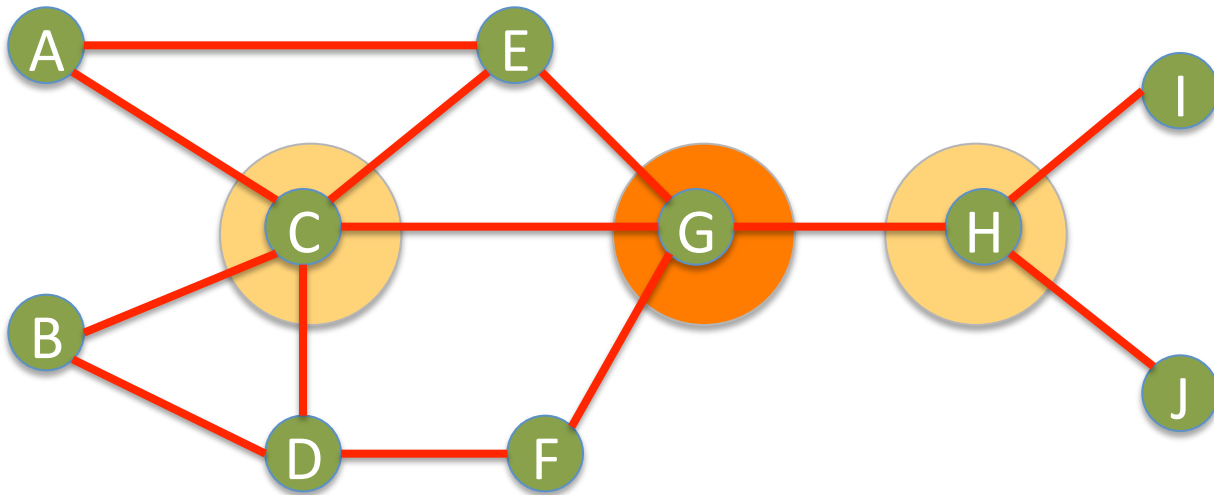
H→I: 1

H→J: 1

Total=17

H: Closeness Centrality = $17/9 = 1.89$

Social Network Analysis: Closeness Centrality

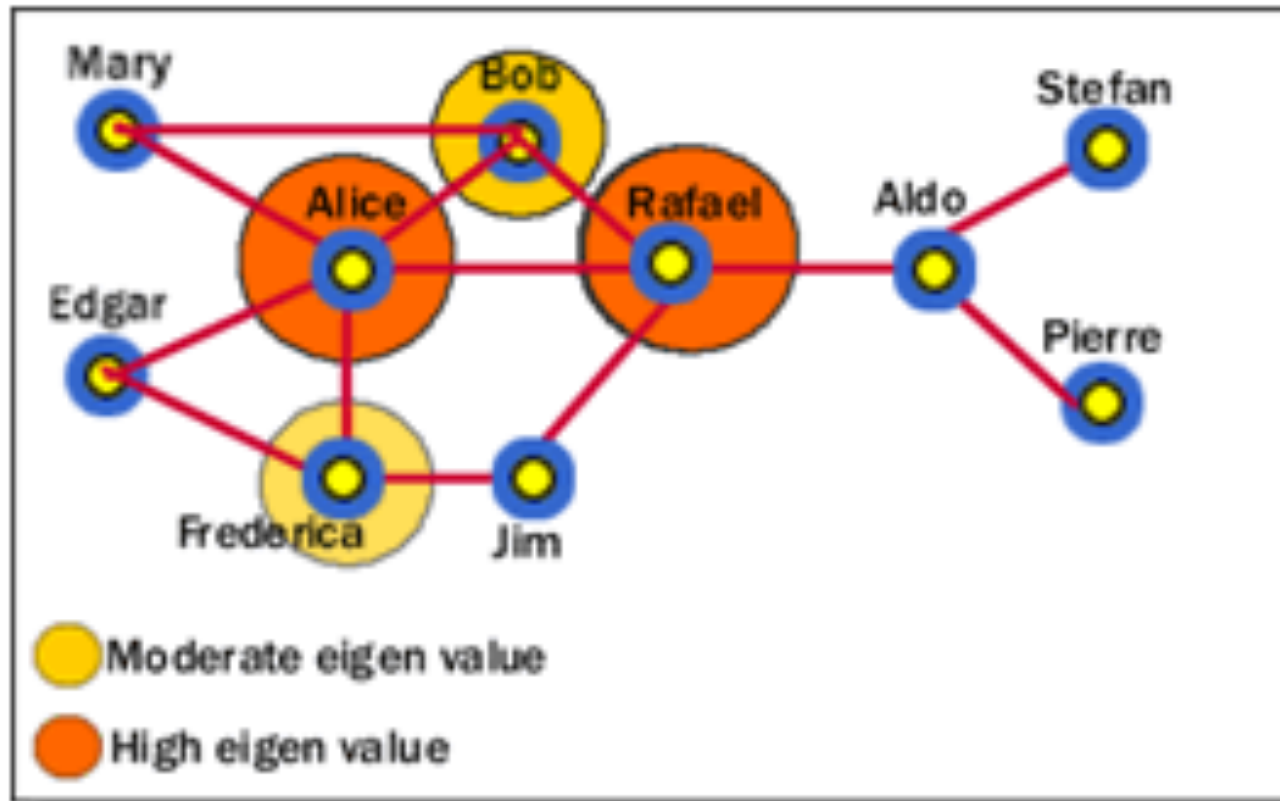


G: Closeness Centrality = $14/9 = 1.56$ 1

C: Closeness Centrality = $15/9 = 1.67$ 2

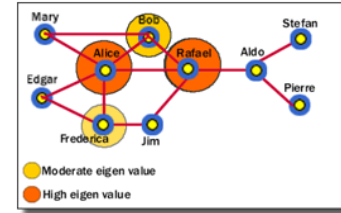
H: Closeness Centrality = $17/9 = 1.89$ 3

Social Network Analysis: Eigenvalue



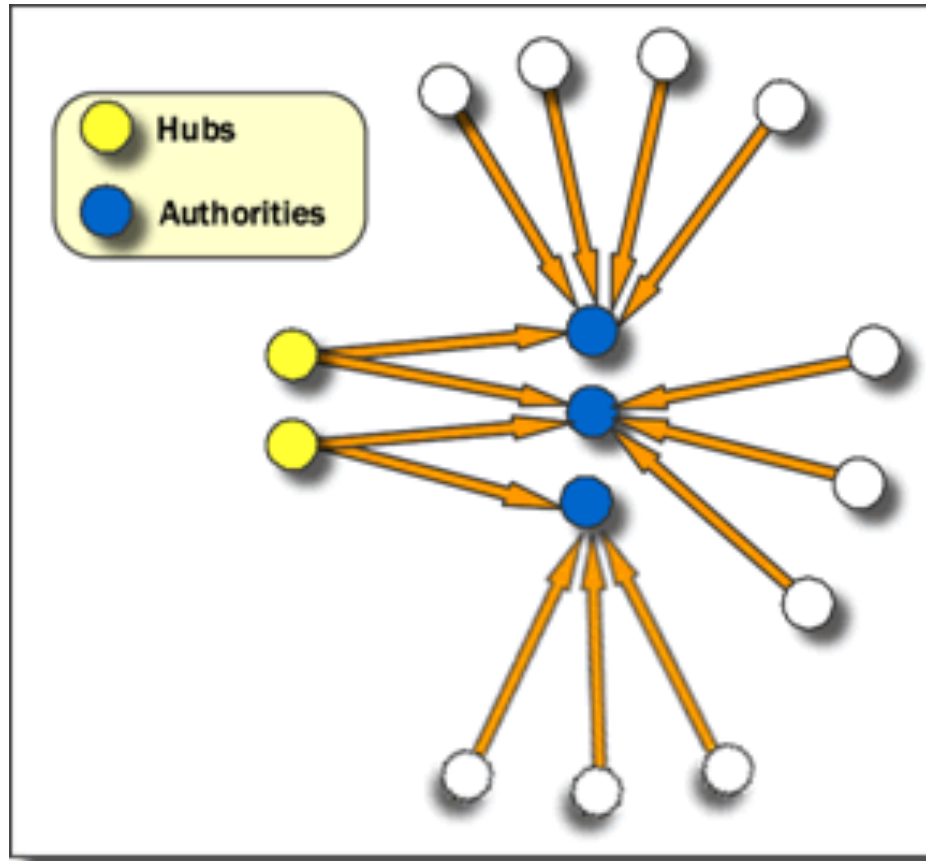
Alice and Rafael are closer to other highly close entities in the network. Bob and Frederica are also highly close, but to a lesser value.

Social Network Analysis: Eigenvalue



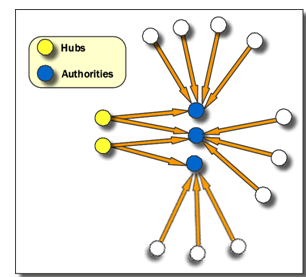
- Eigenvalue measures how close an entity is to other highly close entities within a network. In other words, Eigenvalue identifies the most central entities in terms of the global or overall makeup of the network.
- A high Eigenvalue generally:
 - Indicates an actor that is more central to the main pattern of distances among all entities.
 - Is a reasonable measure of one aspect of centrality in terms of positional advantage.

Social Network Analysis: Hub and Authority



Hubs are entities that point to a relatively large number of authorities. They are essentially the mutually reinforcing analogues to authorities. Authorities point to high hubs. Hubs point to high authorities. You cannot have one without the other.

Social Network Analysis: Hub and Authority



- Entities that many other entities point to are called Authorities. In Sentinel Visualizer, relationships are directional—they point from one entity to another.
- If an entity has a high number of relationships pointing to it, it has a high authority value, and generally:
 - Is a knowledge or organizational authority within a domain.
 - Acts as definitive source of information.

Social Network Analysis

Network Metrics

CardView TableView Group area [Expand groups](#) [Collapse groups](#)

Name	Type	Degree	Betweenness	Closeness	Eigenvalue	Hub	Authority
Osama bin Laden	Person	44	0.920492092358...	1	0.0271	0	0.011
Abdallah Al-Halabi	Person	2	0	0.654367256637...	0.0001	0	0
Abu Mussab al-Zarqawi	Person	84	0.934887847326...	0.869451697127...	0.7028	0.6572	0.1076
Al Qaeda	Terrorist Organiz..	85	1	0.962427745664...	0.0416	0.3941	0.0166
Ayman Al-Zawahiri	Person	14	0.045794908783...	0.716129032258...	0	0	0.0173
Ensam Arnaout	Person	4	0.031189325814...	0.656304733727...	0.0001	0	0
Imad Eddin Barsekat Yarbas	Person	11	0.065049589038...	0.704016913319...	0.0015	0	0.0025
Khalid Shaikh Mohammed	Person	32	0.339916464724...	0.866059817945...	0.002	0	0.1528
Mohamed Atta	Person	61	0.666268740074...	0.820197044334...	0.0015	0	0.6816

Application of SNA

Social Network Analysis

of

Research Collaboration

in

Information Reuse and Integration

Example of SNA Data Source


















dblp
computer science bibliography













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IRI 2010: Las Vegas, NV, USA

-    **Proceedings of the IEEE International Conference on Information Reuse and Integration, IRI 2010, 4-6 August 2010, Las Vegas, Nevada, USA.** IEEE Systems, Man, and Cybernetics Society 2010
-    Reda Alhajj, James B. D. Joshi, Mei-Ling Shyu: **Message from Program Co-Chairs.** 1
-    Stuart Harvey Rubin, Shu-Ching Chen: **Forward.** 1
-    Lotfi A. Zadeh: **Precisiation of meaning - toward computation with natural language.** 1-4
-    Reda Alhajj, Shu-Ching Chen, Gongzhu Hu, James B. D. Joshi, Gordon K. Lee, Stuart Harvey Rubin, Mei-Ling Shyu, Lotfi A. Zadeh: **Panel title: Critical need for funding of basic and applied research in large-scale computing.** 1

Automation, Integration and Reuse across Various Apps

-    László István Etesi, André Csillaghy, Lin-Ching Chang: **A message-based interoperability framework with application to astrophysics.** 1-6
-    Awny Alnusair, Tian Zhao, Eric Bodden: **Effective API navigation and reuse.** 7-12
-    Manabu Ohta, Ryohei Inoue, Atsuhiko Takasu: **Empirical evaluation of active sampling for CRF-based analysis of pages.** 13-18
-    Qunzhi Zhou, Viktor K. Prasanna: **Workflow management of simulation based computation processes in transportation domain.** 19-24

Source: <http://www.informatik.uni-trier.de/~ley/db/conf/iri/iri2010.html>

Research Question

- RQ1: What are the scientific **collaboration patterns** in the IRI research community?
- RQ2: Who are the **prominent researchers** in the IRI community?

Methodology

- Developed a simple **web focused crawler** program to download literature information about all IRI papers published between **2003 and 2010** from **IEEE Xplore** and **DBLP**.
 - **767** paper
 - **1599** distinct author
- Developed a program to convert the list of coauthors into the **format of a network file** which can be readable by social network analysis software.
- **UCINet** and **Pajek** were used in this study for the social network analysis.

Top10 prolific authors (IRI 2003-2010)

1. Stuart Harvey Rubin
2. Taghi M. Khoshgoftaar
3. Shu-Ching Chen
4. Mei-Ling Shyu
5. Mohamed E. Fayad
6. Reda Alhajj
7. Du Zhang
8. Wen-Lian Hsu
9. Jason Van Hulse
10. Min-Yuh Day

Data Analysis and Discussion

- **Closeness Centrality**
 - Collaborated widely
- **Betweenness Centrality**
 - Collaborated diversely
- **Degree Centrality**
 - Collaborated frequently
- **Visualization of Social Network Analysis**
 - Insight into the structural characteristics of research collaboration networks

Top 20 authors with the highest **closeness** scores

Rank	ID	Closeness	Author
1	3	0.024675	Shu-Ching Chen
2	1	0.022830	Stuart Harvey Rubin
3	4	0.022207	Mei-Ling Shyu
4	6	0.020013	Reda Alhajj
5	61	0.019700	Na Zhao
6	260	0.018936	Min Chen
7	151	0.018230	Gordon K. Lee
8	19	0.017962	Chengcui Zhang
9	1043	0.017962	Isai Michel Lombera
10	1027	0.017962	Michael Armella
11	443	0.017448	James B. Law
12	157	0.017082	Keqi Zhang
13	253	0.016731	Shahid Hamid
14	1038	0.016618	Walter Z. Tang
15	959	0.016285	Chengjun Zhan
16	957	0.016285	Lin Luo
17	956	0.016285	Guo Chen
18	955	0.016285	Xin Huang
19	943	0.016285	Sneh Gulati
20	960	0.016071	Sheng-Tun Li

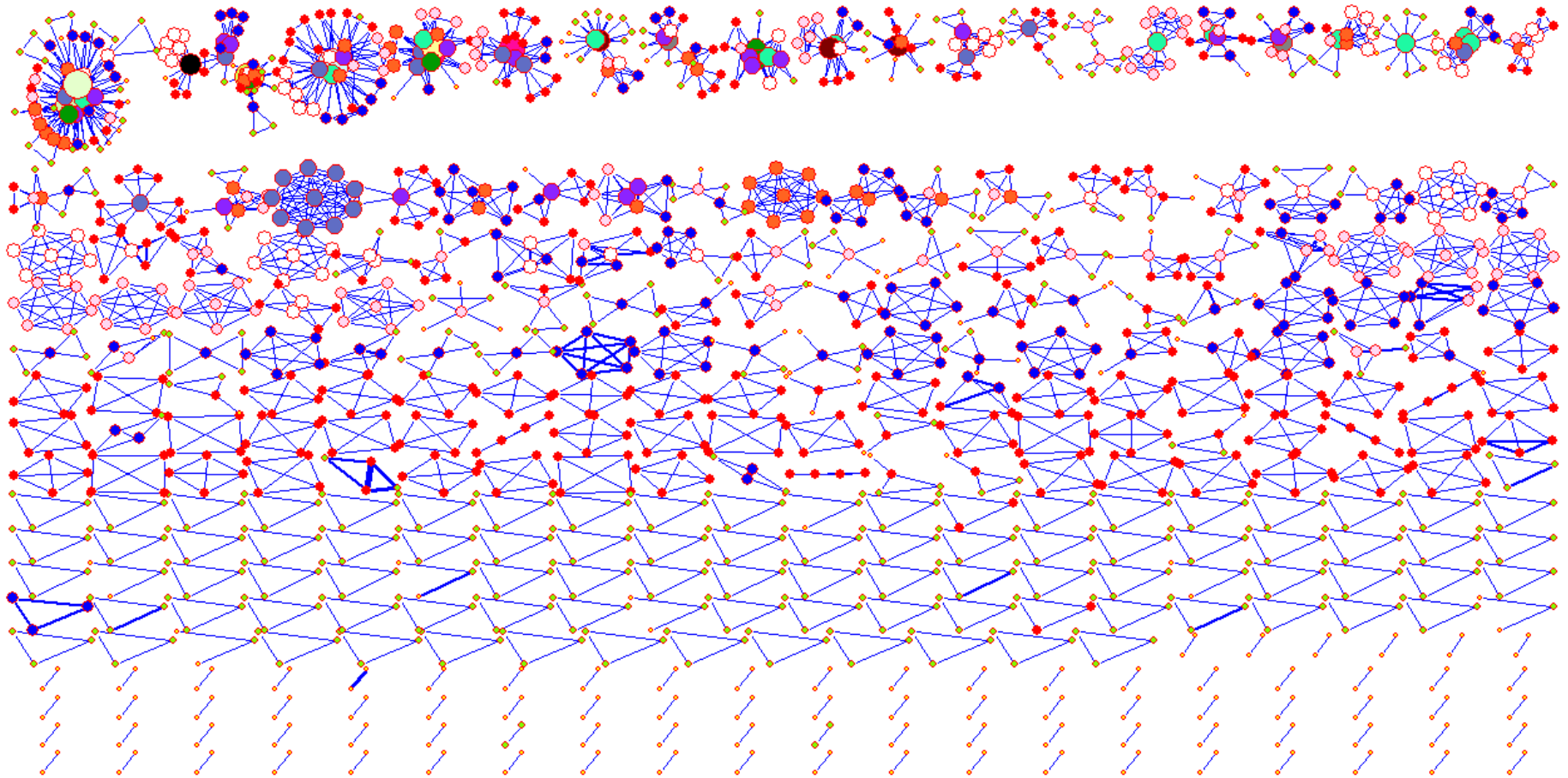
Top 20 authors with the highest **betweenness** scores

Rank	ID	Betweenness	Author
1	1	0.000752	Stuart Harvey Rubin
2	3	0.000741	Shu-Ching Chen
3	2	0.000406	Taghi M. Khoshgoftaar
4	66	0.000385	Xingquan Zhu
5	4	0.000376	Mei-Ling Shyu
6	6	0.000296	Reda Alhajj
7	65	0.000256	Xindong Wu
8	19	0.000194	Chengcui Zhang
9	39	0.000185	Wei Dai
10	15	0.000107	Narayan C. Debnath
11	31	0.000094	Qianhui Althea Liang
12	151	0.000094	Gordon K. Lee
13	7	0.000085	Du Zhang
14	30	0.000072	Baowen Xu
15	41	0.000067	Hongji Yang
16	270	0.000060	Zhiwei Xu
17	5	0.000043	Mohamed E. Fayad
18	110	0.000042	Abhijit S. Pandya
19	106	0.000042	Sam Hsu
20	8	0.000042	Wen-Lian Hsu

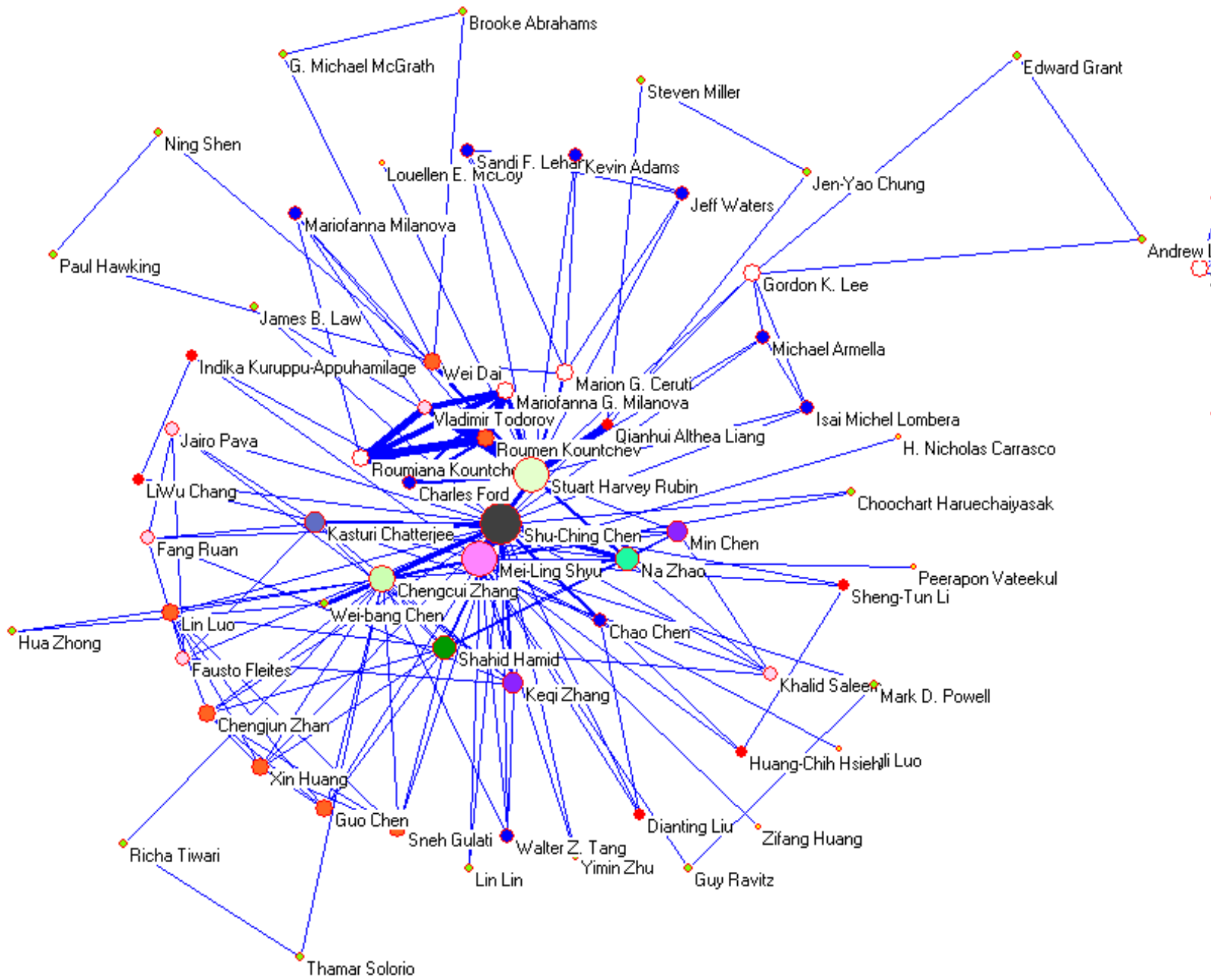
Top 20 authors with the highest **degree** scores

Rank	ID	Degree	Author
1	3	0.035044	Shu-Ching Chen
2	1	0.034418	Stuart Harvey Rubin
3	2	0.030663	Taghi M. Khoshgoftaar
4	6	0.028786	Reda Alhajj
5	8	0.028786	Wen-Lian Hsu
6	10	0.024406	Min-Yuh Day
7	4	0.022528	Mei-Ling Shyu
8	17	0.021277	Richard Tzong-Han Tsai
9	14	0.017522	Eduardo Santana de Almeida
10	16	0.017522	Roumen Kountchev
11	40	0.016896	Hong-Jie Dai
12	15	0.015645	Narayan C. Debnath
13	9	0.015019	Jason Van Hulse
14	25	0.013767	Roumiana Kountcheva
15	28	0.013141	Silvio Romero de Lemos Meira
16	24	0.013141	Vladimir Todorov
17	23	0.013141	Mariofanna G. Milanova
18	5	0.013141	Mohamed E. Fayad
19	19	0.012516	Chengcui Zhang
20	18	0.011890	Waleed W. Smari

Visualization of IRI (IEEE IRI 2003-2010) co-authorship network (global view)

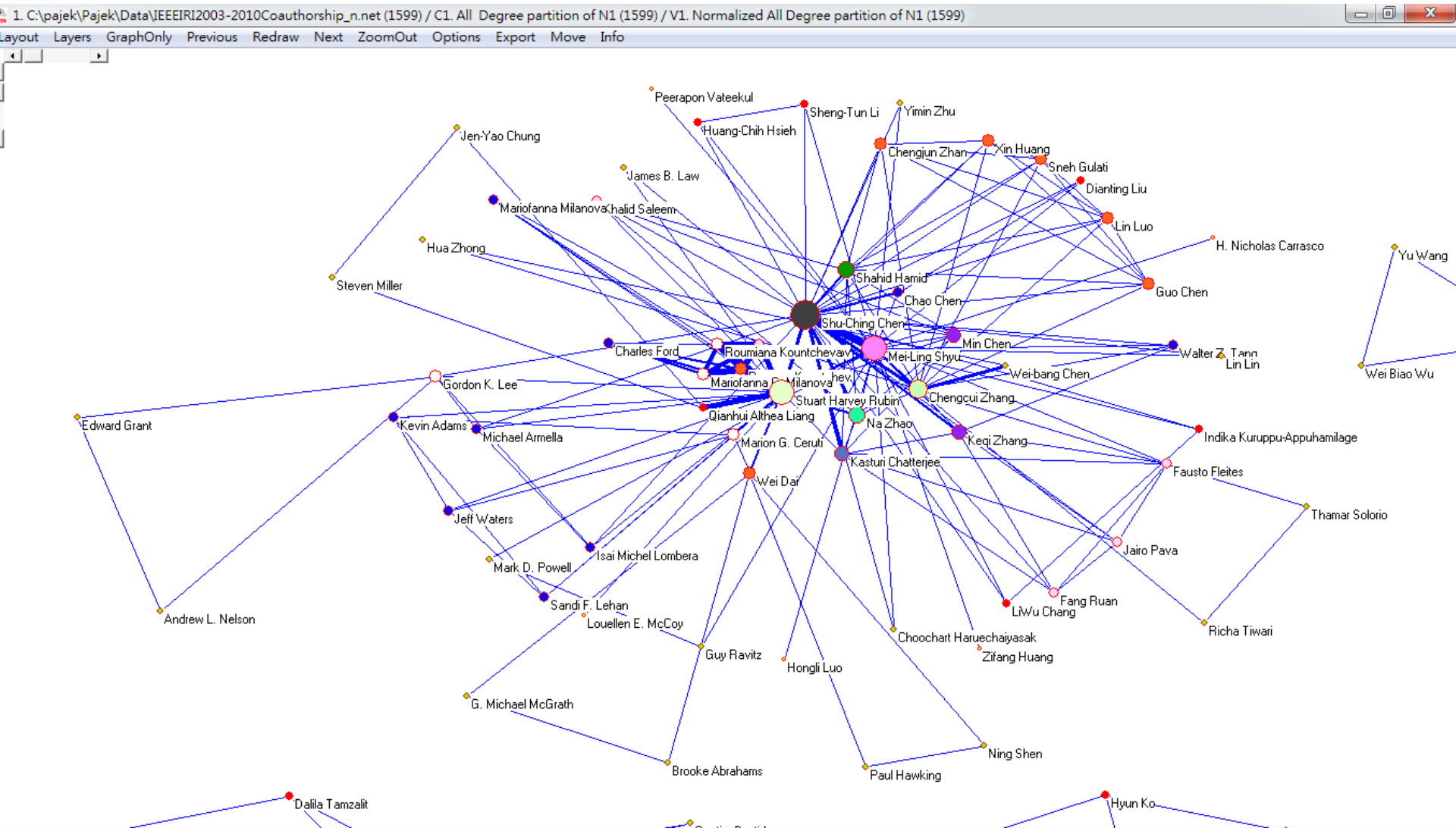


Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"



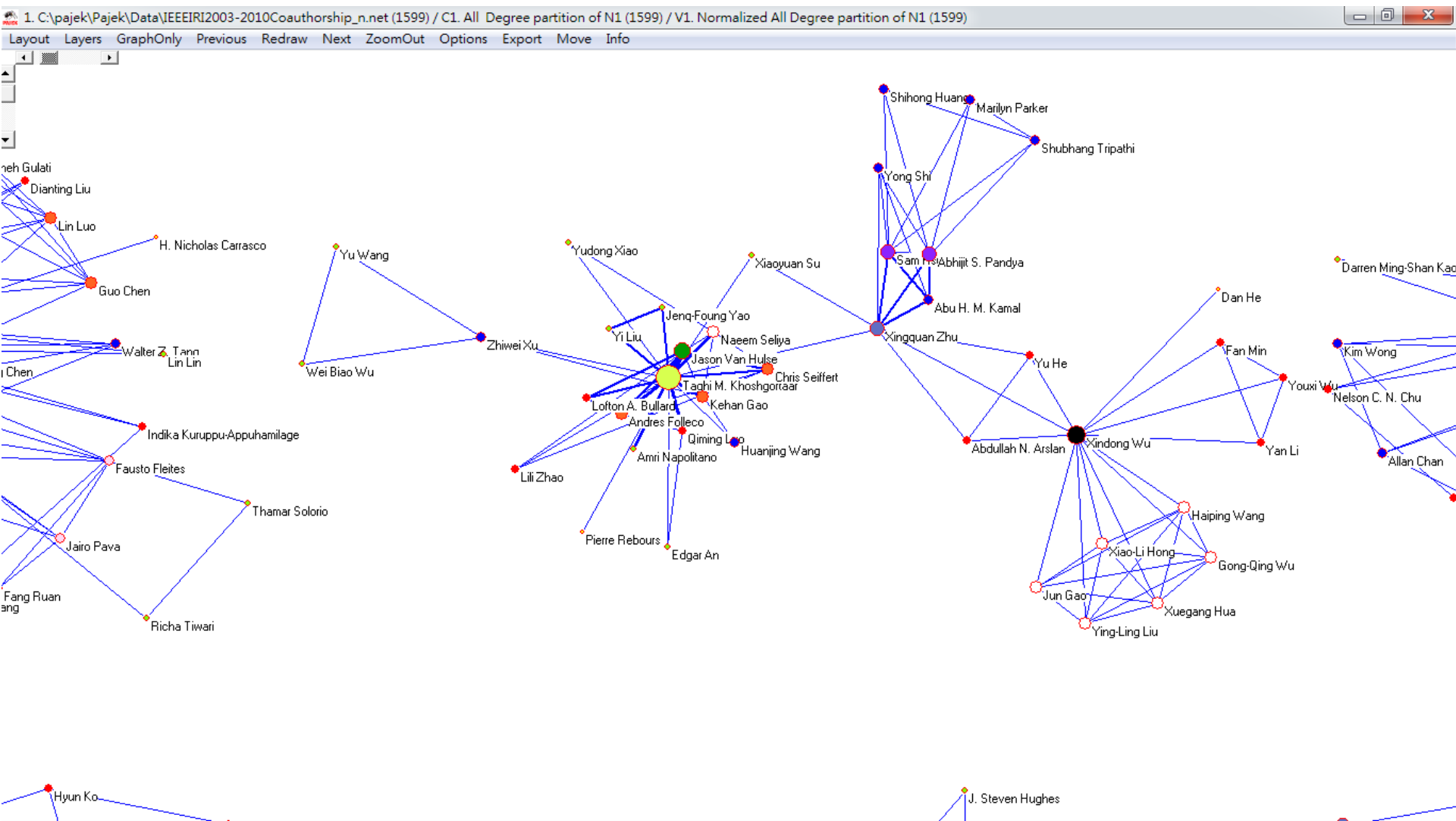
Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
 "Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Visualization of Social Network Analysis



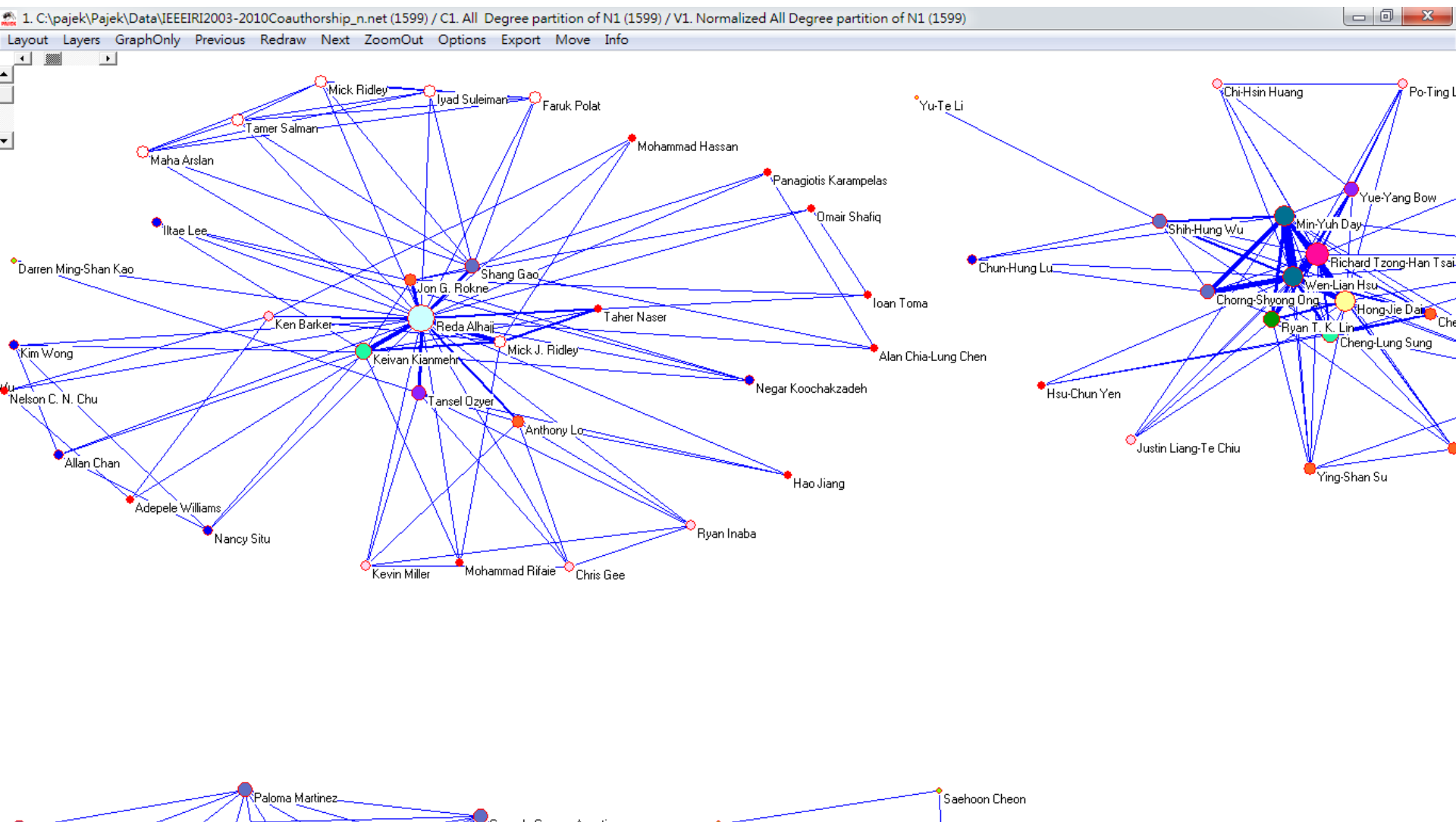
Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Visualization of Social Network Analysis



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"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Summary

- Social Network Analysis (SNA)
 - Degree Centrality
 - Betweenness Centrality
 - Closeness Centrality
- Applications of SNA

References

- Bing Liu (2011) , “Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data,” 2nd Edition, Springer.
<http://www.cs.uic.edu/~liub/WebMiningBook.html>
- Jennifer Golbeck (2013), Analyzing the Social Web, Morgan Kaufmann.
<http://analyzingthesocialweb.com/course-materials.shtml>
- Sentinel Visualizer, <http://www.fmsasg.com/SocialNetworkAnalysis/>
- Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011), "Social Network Analysis of Research Collaboration in Information Reuse and Integration," The First International Workshop on Issues and Challenges in Social Computing (WICSOC 2011), August 2, 2011, in Proceedings of the IEEE International Conference on Information Reuse and Integration (IEEE IRI 2011), Las Vegas, Nevada, USA, August 3-5, 2011, pp. 551-556.