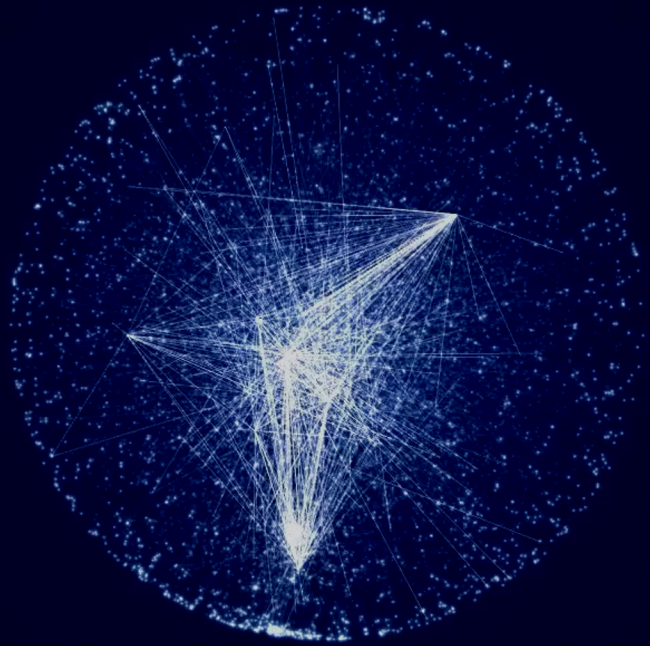
PARTIMOS EN BREVE

MUCHAS GRACIAS

El test comienza a las 11:55 en Canvas. Sección Evaluaciones

Network Science



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Video: Protein-Protein Interactions
Credit: Mauro Martino

Universidad del Desarrollo
Facultad de Ingeniería

Universidad del Desarrollo
Facultad de Gobierno

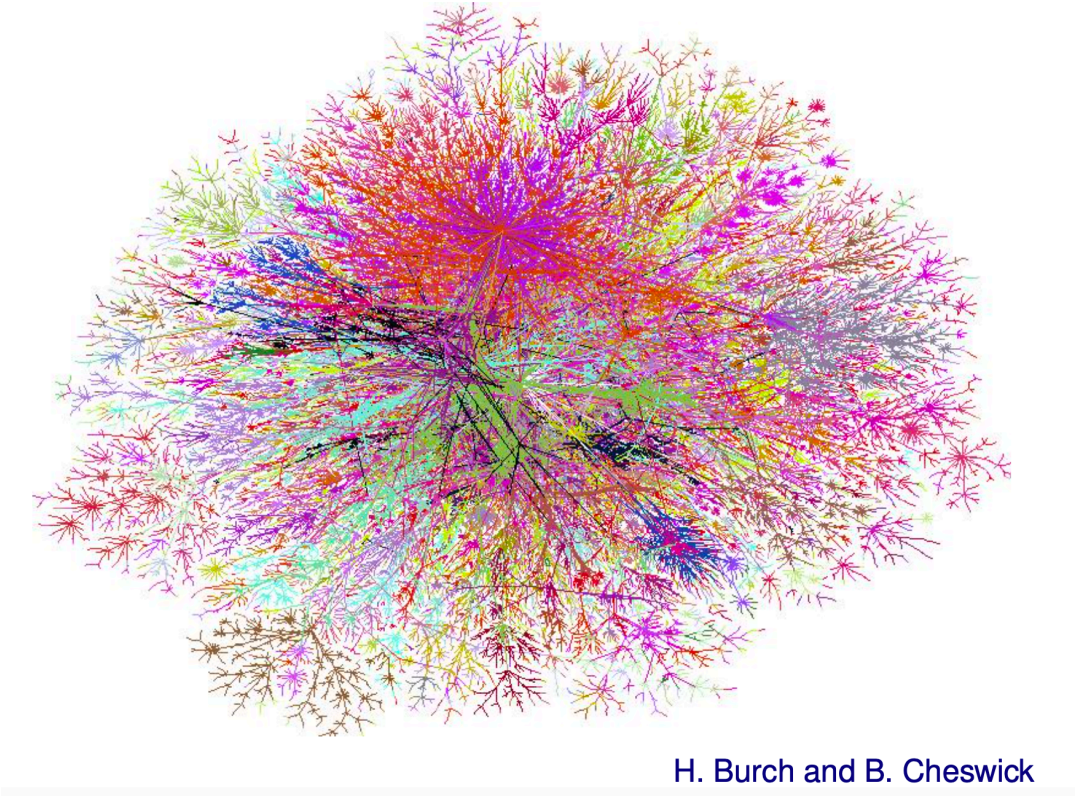
dataScience UDD

CICS UDD
CENTRO DE INVESTIGACIÓN EN COMPLEJIDAD SOCIAL

CRISSLAB
DECODING BEHAVIOR, ADVANCING SOCIETY

NICO NORTHWESTERN INSTITUTE ON COMPLEX SYSTEMS

Las redes son una representación matemática del mundo real



H. Burch and B. Cheswick

Simplificar la complejidad

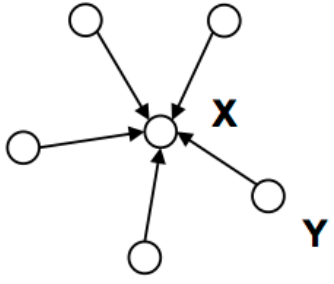
- **Patrones generales:** centralidad de grado, longitud de camino…
- **Patrones locales:** coeficiente de agrupamiento, transitividad…
- **Posición en la red:** comunidades, centralidad, influencia…

Medidas de centralidad

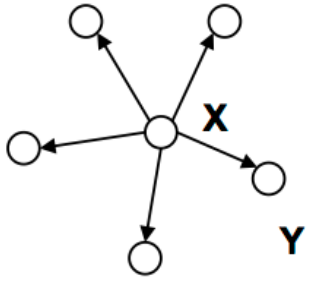
- **Posición en la red:** centralidad de grado, intermediación, cercanía
- **Influencia:** centralidad eigenvector, Katz, PageRank
- **Mecanismos:** in-degree, out-degree, flujo

Centralidad

- **Centralidad es una medida local de la red**
- Existen distintas medidas de centralidad, que se deben elegir en función de la mejor representación del sistema:
  - cuantas personas conoces?
  - con quien compartes -envias- tus recursos?
  - que tan popular eres?



indegree



outdegree

Going the Wrong Way on a One-Way Street: Centrality in Physics and Biology*

Linton C. Freeman, lin@aris.ss.uci.edu
University of California, Irvine

Abstract

When ideas and tools move from one field to another, the movement is generally from the natural to the social sciences. In recent years, however, there has been a major movement in the opposite direction. The idea of centrality and the tools for its measurement were originally developed in the social science field of social network analysis. But currently the concept and tools of centrality are being used widely in physics and biology. This paper examines how and why that—wrong way—movement developed, its extent and its consequences for the fields involved.

THE JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA VOLUME 22, NUMBER 6 NOVEMBER, 1950

Communication Patterns in Task-Oriented Groups

ALEX BAVELAS
Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts
(Received August 8, 1950)

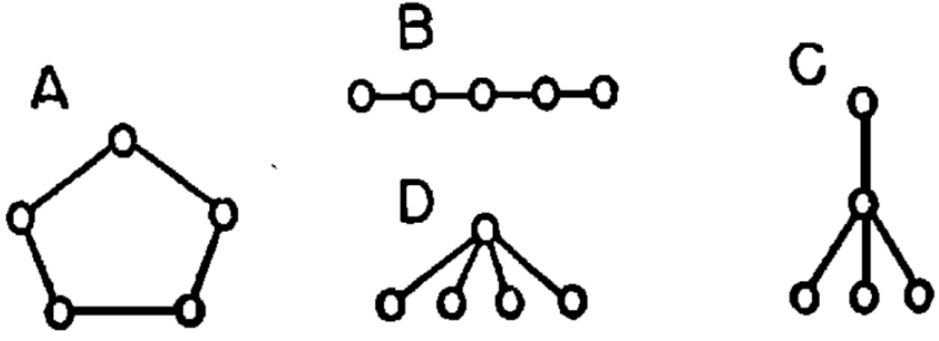


FIG. 1. Some illustrative communication patterns among five individuals.

Social Networks, 1 (1978/79) 215–239

Centrality in Social Networks Conceptual Clarification

Linton C. Freeman

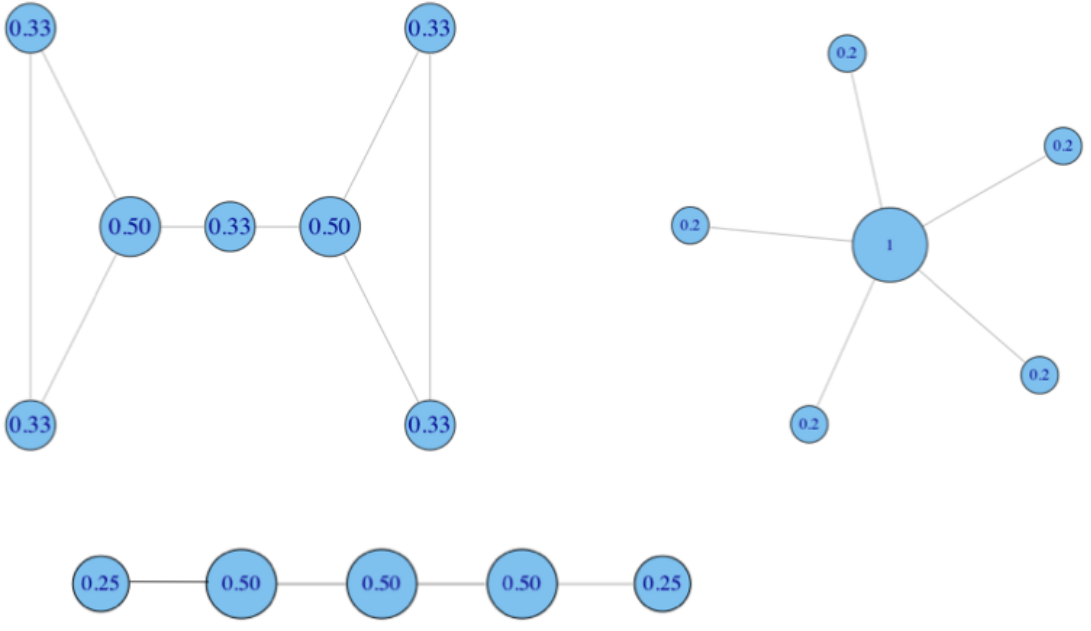
*Lehigh University**

The intuitive background for measures of structural centrality in social networks is reviewed and existing measures are evaluated in terms of their consistency with intuitions and their interpretability.

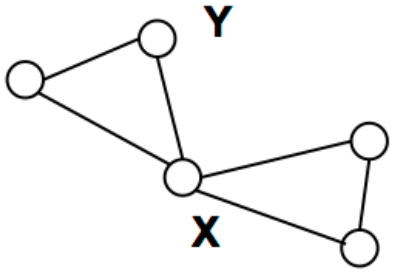
Three distinct intuitive conceptions of centrality are uncovered and existing measures are refined to embody these conceptions. Three measures are developed for each concept, one absolute and one relative measure of the centrality of positions in a network, and one reflecting the degree of centralization of the entire network. The implications of these measures for the experimental study of small groups is examined.

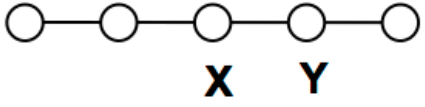
Centralidad de grado

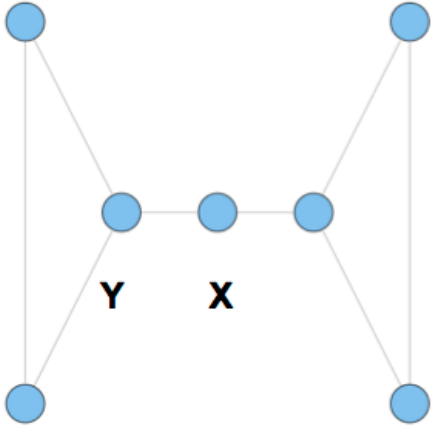
$$C^D(i) = \frac{k_i}{N-1}$$



Quien es mas importante, X o Y?







- Intermediacion entre grupos
- Probabilidad de que la información te llegue

Centralidad de intermediación

$$\tilde{C}^B(i) = \sum_{j<k} \frac{d_{jk}(i)}{d_{jk}}$$

d_{jk} Número de caminos mas cortos entre j y k

$d_{jk}(i)$ Número de caminos mas cortos entre j y k que pasan a traves de i

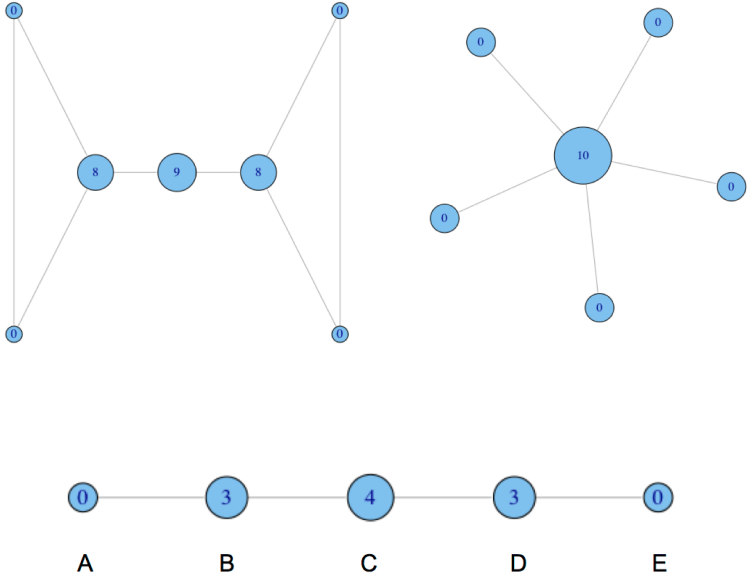
Centralidad de intermediación

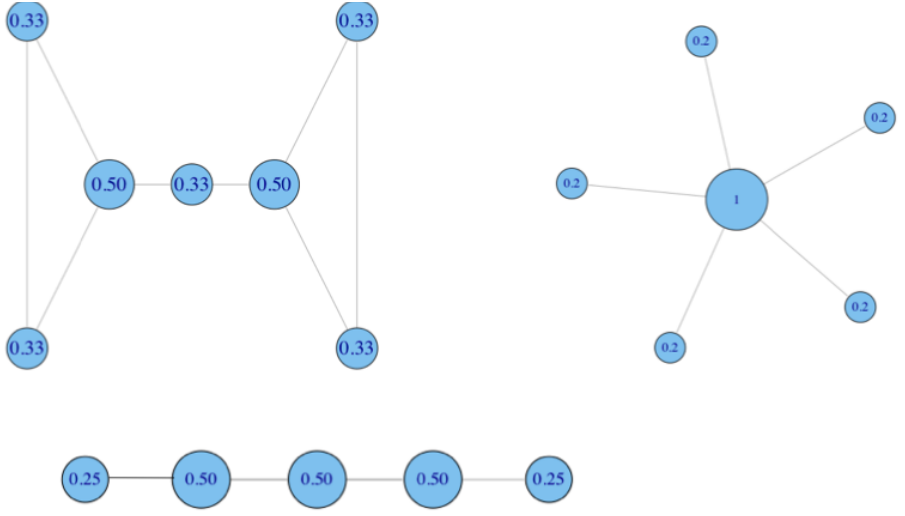
- Normalizacion:

$$C^B(i) = \frac{\tilde{C}^B}{(N-1)(N-2)/2}$$

- Denominador: numero de pares de vertices excluyendo *i*

Intermediacion vs. Grado





Centralidad de cercanía

$$\tilde{C}^C(i) = \left[\sum_{j=1}^{N} d(i,j)\right]^{-1} \qquad C^C(i) = \frac{\tilde{C}^C(i)}{N-1}$$

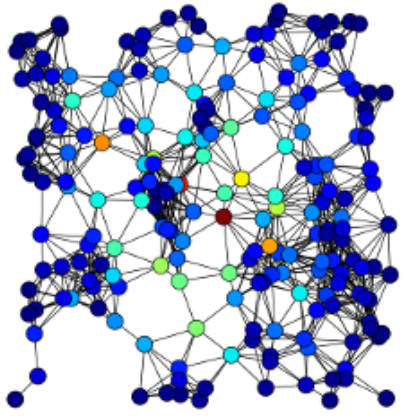
Centralidad eigenvector

Nota: un nodo es importunate si esta conectado a otros nodos importantes

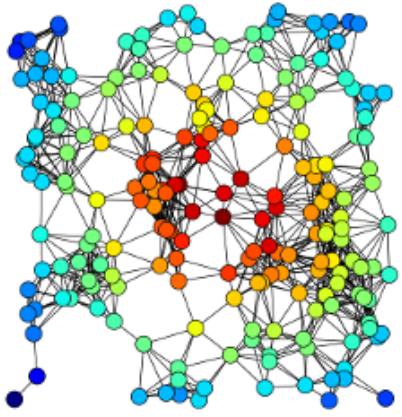
$$x_i = \frac{1}{\lambda} \sum_{j \in \Lambda(i)} x_j \qquad x_i = \frac{1}{\lambda} \sum_{j \in G} a_{ij} x_j$$

$$AX = \lambda X$$

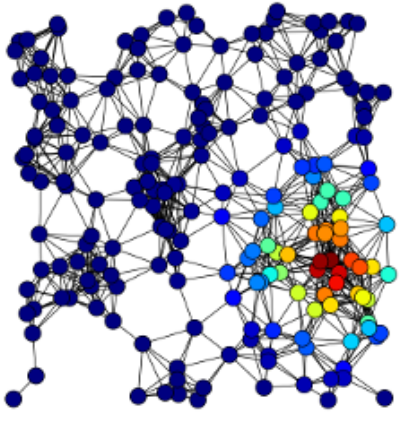
- Que hace a un nodo ser **importante**?
  - subjective → muchas definiciones y sujeto al contexto en que se estudia



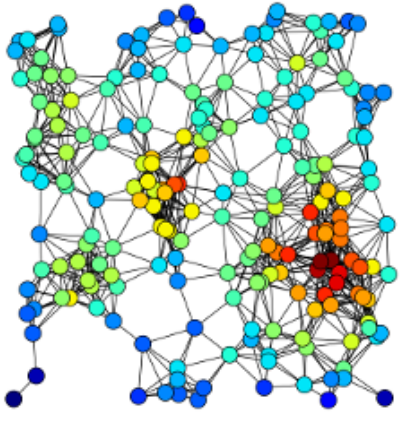
A Betweenness



B Closeness



C Eigenvector



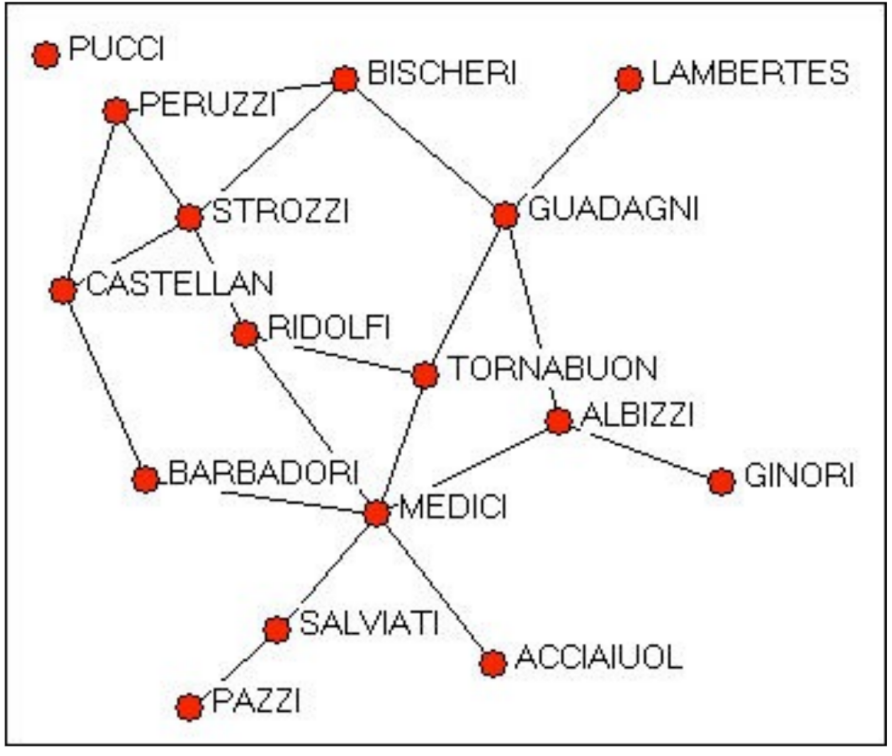
D Degree

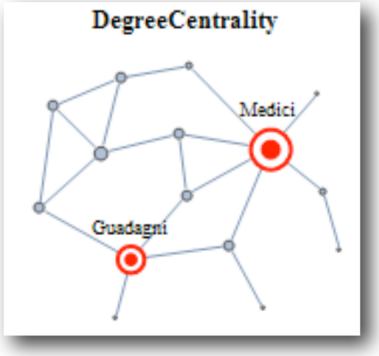
Robust Action and the Rise of the Medici, 1400–1434[1]

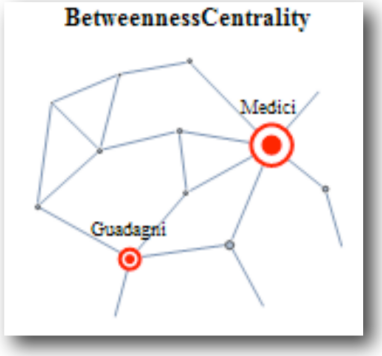
John F. Padgett and Christopher K. Ansell
University of Chicago

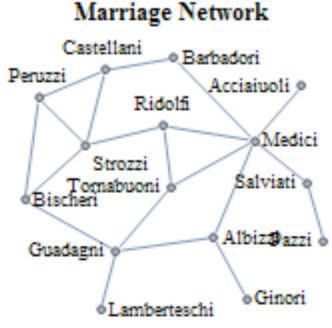
We analyze the centralization of political parties and elite networks that underlay the birth of the Renaissance state in Florence. Class revolt and fiscal crisis were the ultimate causes of elite consolidation, but Medicean political control was produced by means of network disjunctures within the elite, which the Medici alone spanned. Cosimo de' Medici's multivocal identity as sphinx harnessed the power available in these network holes and resolved the contradiction between judge and boss inherent in all organizations. Methodologically, we argue that to understand state formation one must penetrate beneath the veneer of formal institutions, groups, and goals down to the relational substrata of peoples' actual lives. Ambiguity and heterogeneity, not planning and self-interest, are the raw materials of which powerful states and persons are constructed.

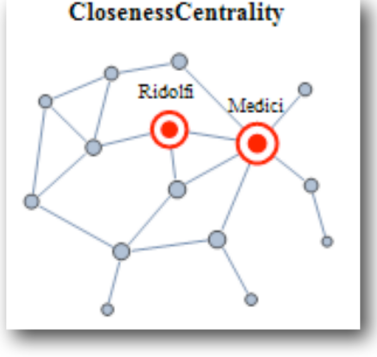
Familias florentinas




DegreeCentrality
Medici
Guadagni

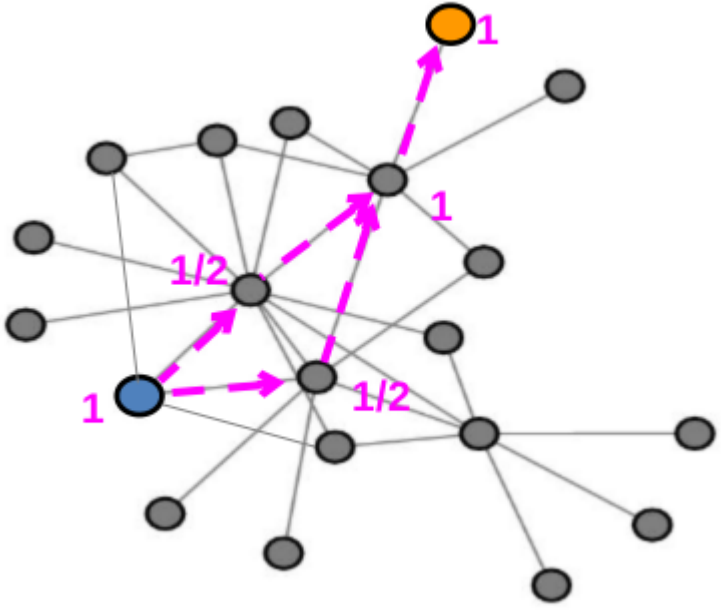

BetweennessCentrality
Medici
Guadagni


Marriage Network
Castellani
Barbadori
Peruzzi
Acciaiuoli
Ridolfi
Medici
Strozzi
Tornabuoni
Salviati
Bischeri
Albizzi
Guadagni
Ginori
Lamberteschi


ClosenessCentrality
Ridolfi
Medici


EigenvectorCentrality
Strozzi
Medici

De vuelta a centralidad de intermediación



- **Centralidad de carga (Load)**: el numero de paquetes que un nodo debe manejar durante el transporte basado en el camino más corto desde todos los nodos hacia todos los demás
- A que medida de centralidad se parece?

Centralidad en redes con peso

Por qué el peso es importante

The Strength of Weak Ties[1]

Mark S. Granovetter
Johns Hopkins University

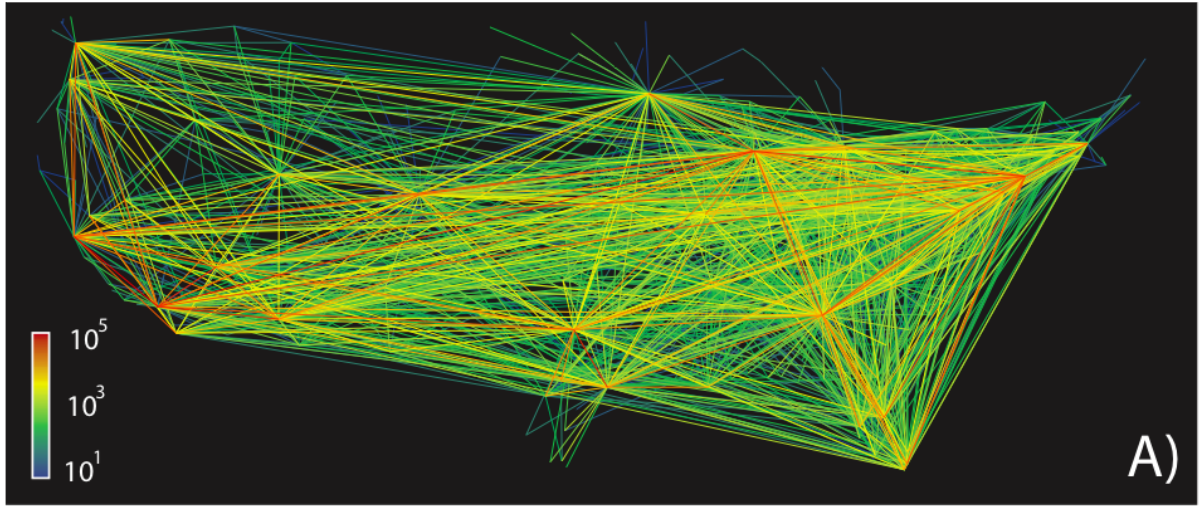
Analysis of social networks is suggested as a tool for linking micro and macro levels of sociological theory. The procedure is illustrated by elaboration of the macro implications of one aspect of small-scale interaction: the strength of dyadic ties. It is argued that the degree of overlap of two individuals' friendship networks varies directly with the strength of their tie to one another. The impact of this principle on diffusion of influence and information, mobility opportunity, and community organization is explored. Stress is laid on the cohesive power of weak ties. Most network models deal, implicitly, with strong ties, thus confining their applicability to small, well-defined groups. Emphasis on weak ties lends itself to discussion of relations *between* groups and to analysis of segments of social structure not easily defined in terms of primary groups.

Ejemplo 1: tráfico aéreo

Nodos: aeropuertos

Enlaces: vuelos directos

Peso: Numero de asientos

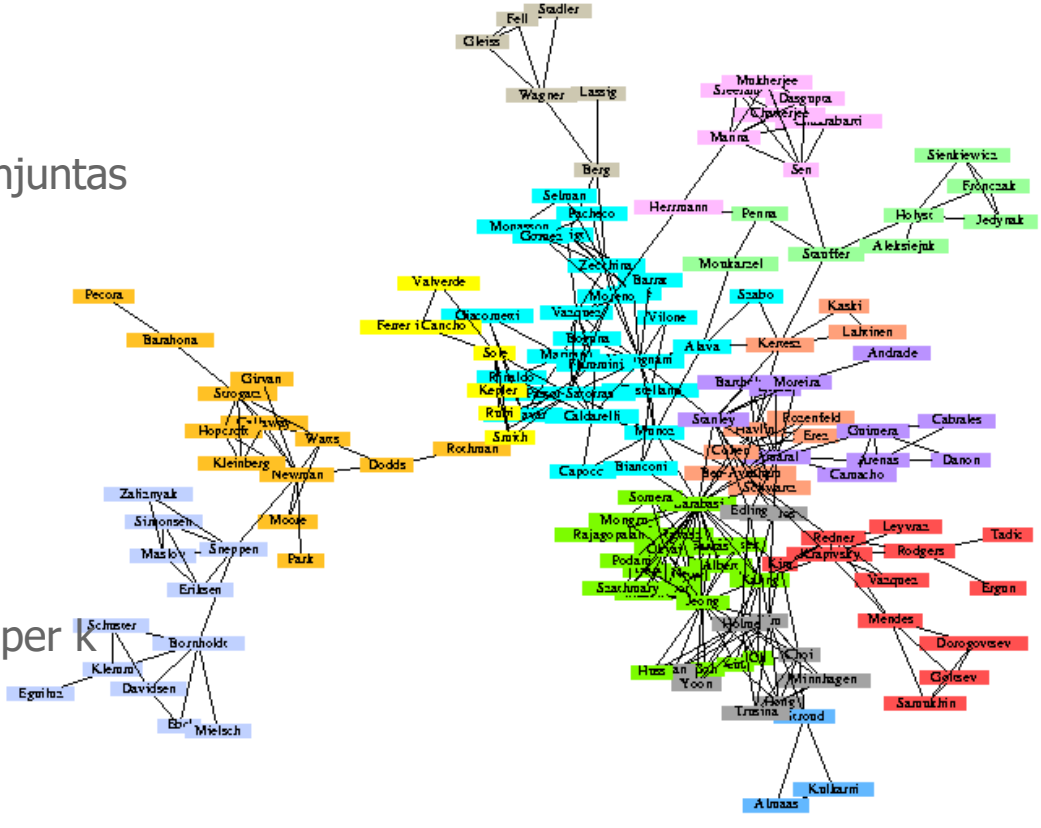


Ejemplo 2: Colaboraciones cientificas

- Nodos: científicos
- Enlces: publicaciones conjuntas
- Peso: numero de publicaciones conjuntas

$$w_{ij} = \Sigma_k \frac{\delta_i^k \delta_j^k}{n_k - 1}$$

- *i,j*: authors
- *k*: paper
- n_k numero de autores
- $\delta_{ik} = 1$ si el autor i contribuyo al paper k



The architecture of complex weighted networks

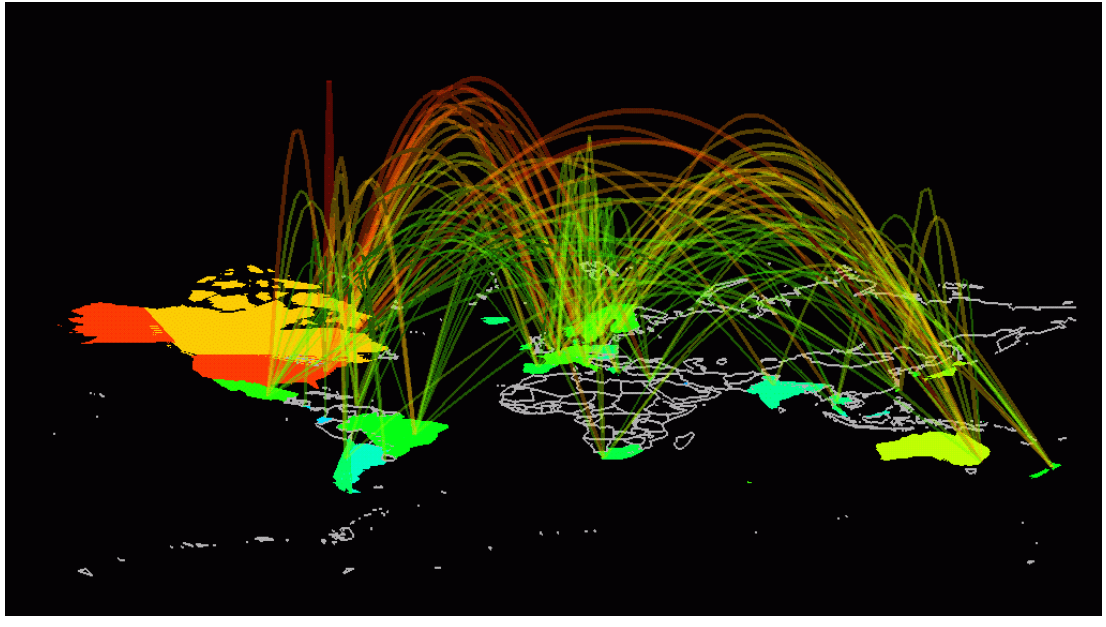
A. Barrat*, M. Barthélemy†, R. Pastor-Satorras‡, and A. Vespignani*§

*Laboratoire de Physique Théorique (Unité Mixte de Recherche du Centre National de la Recherche Scientifique 8627), Bâtiment 210, Université de Paris-Sud, 91405 Orsay Cedex, France; †Commissariat à l'Energie Atomique–Département de Physique Théorique et Appliquée, 91191 Bruyères-Le-Chatel, France; and ‡Departament de Física i Enginyeria Nuclear, Universitat Politècnica de Catalunya, Campus Nord, Mòdul B4, 08034 Barcelona, Spain

Communicated by Giorgio Parisi, University of Rome, Rome, Italy, January 8, 2004 (received for review October 29, 2003)

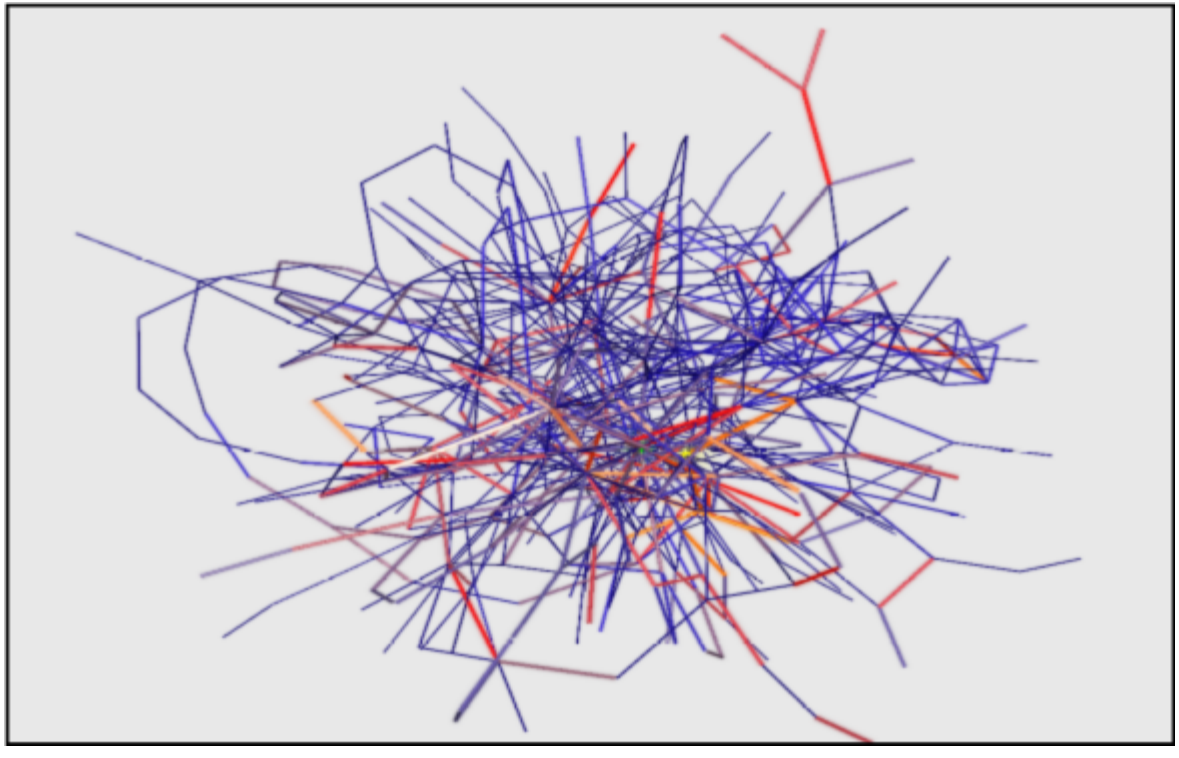
Ejemplo 3: Internet

- Nodos: routers
- Enlases: lineas físicas
- Peso: trafico



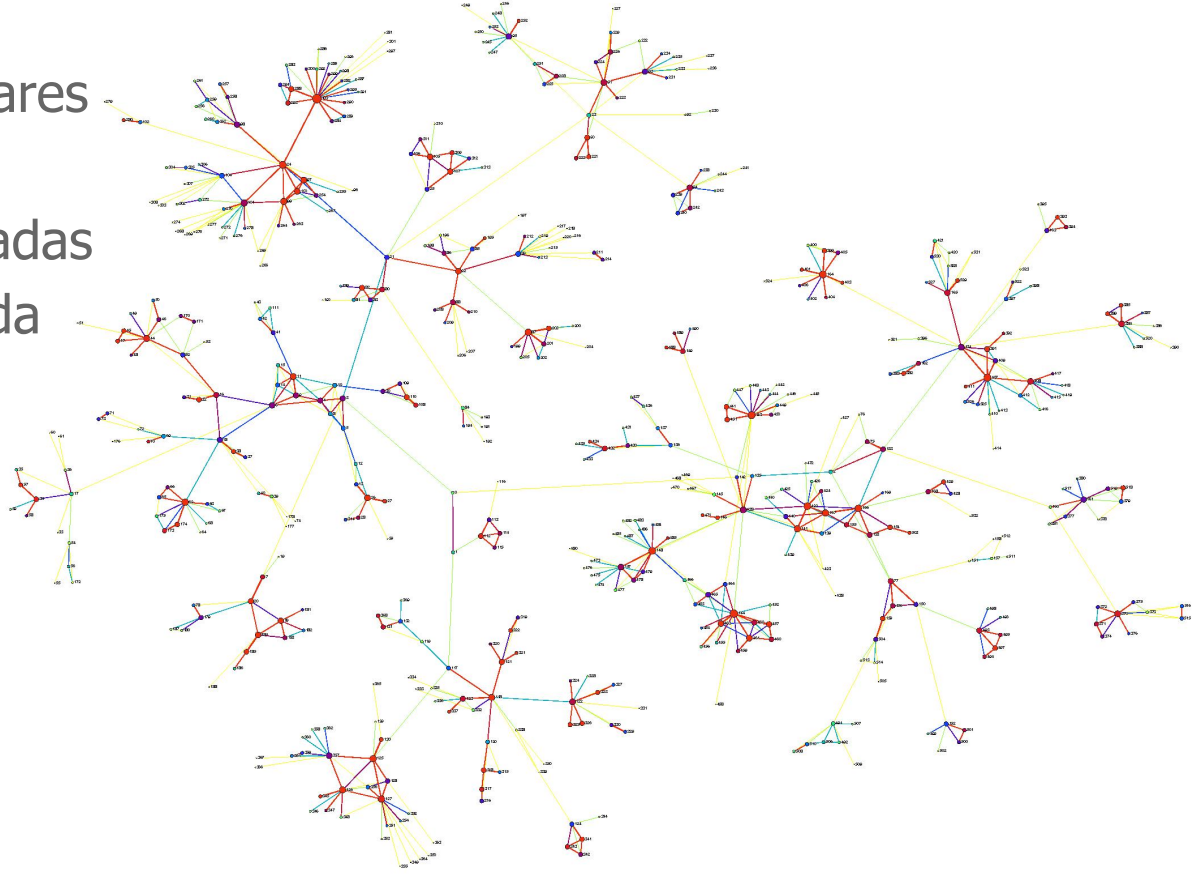
Ejemplo 4: Red metabólica

- Nodos: metabolitos
- Enlaces: reacciones
- Peso: flujo de reacción



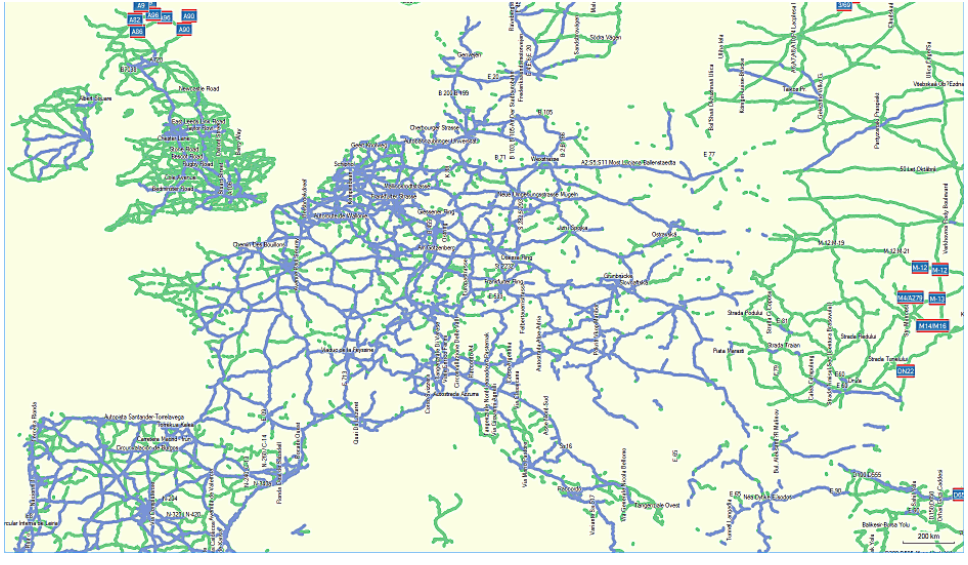
Ejemplo 5: Red de llamadas celulares

- Nodes: telefonos celulares
- Enlaces: llamadas
- Peso: numero de llamadas o duration de la llamada



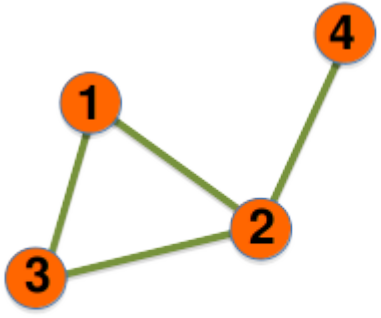
Qué significan los pesos?

- Es una decision critica de la moderación de la red
- Pueden significar:
  - distancia
  - costos
- O también:
  - mas conexiones
  - mayor correlación



En un caso, significa que el peso altos correspondie a longitudes de ruta largas, en el otro a longitudes de ruta cortas.

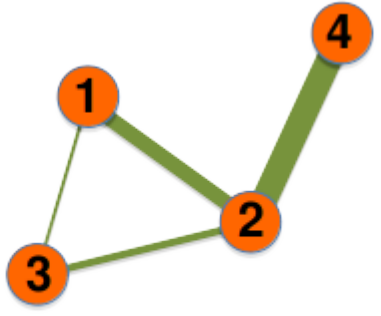
Grado con peso



$$A_{ij} = \begin{pmatrix} 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}$$

$$A_{ii} = 0 \qquad A_{ij} = A_{ji}$$

$$L = \frac{1}{2}\sum_{i,j=1}^{N} A_{ij} \qquad < k > = \frac{2L}{N}$$

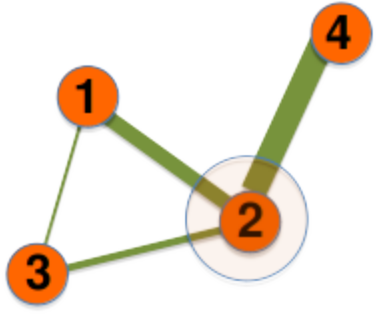


$$A_{ij} = \begin{pmatrix} 0 & 2 & 0.5 & 0 \\ 2 & 0 & 1 & 4 \\ 0.5 & 1 & 0 & 0 \\ 0 & 4 & 0 & 0 \end{pmatrix}$$

$$A_{ii} = 0 \qquad A_{ij} = A_{ji}$$

$$L = \frac{1}{2}\sum_{i,j=1}^{N} nonzero(A_{ij}) \qquad < k > = \frac{2L}{N}$$

a_{ij} y w_{ij}



Adjacency Matrix (A_{ij})

$$A_{ij} = \begin{pmatrix} 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}$$

Weights matrix (W_{ij})

$$W_{ij} = \begin{pmatrix} 0 & 2 & 0.5 & 0 \\ 2 & 0 & 1 & 4 \\ 0.5 & 1 & 0 & 0 \\ 0 & 4 & 0 & 0 \end{pmatrix}$$

Node Strength (*weighted degree*) s:

$$s_i = \sum_{j=1}^{N} a_{ij} w_{ij} = \sum_{j=1}^{N} w_{ij}$$

$$s_2 = \sum_{j=1}^{N} w_{2j} = w_{21} + w_{23} + w_{24}$$

P(s) y P(w) a menudo siguen una distribución de cola ancha

Strength distribution *P(s):*
probability that a randomly chosen node has strength *s*

Weight distribution ***P(w)*:**
probability that a randomly chosen link has weight ***w***