Information Society as a Complex System
http://discuss.santafe.edu/socialscaling/gems/">SFI
http://www.iscom.unimo.it/">Modena
DW home   http://eclectic.ss.uci.edu/~drwhite/index.html

Scaling Human Organizations

2003 Douglas R. White <u>A scale-free model for sequential hierarchy in human sociopolitical evolution</u>: Johnson's scalar stress and attentuation hypothesis reexamined. For submission to: *Journal of Archaeological Science*
http://eclectic.ss.uci.edu/~drwhite/pub/1982scalingDRW.pdf

Abstract: Following the logic of Johnson's (1982) model of scalar stress, understanding how networks are stacked at different levels to reduce information and energy load by substituting relationships among leaders of hierarchically ordered groups for relationships among members of larger groups at a lower level in the hierarchy is an important element in a theory of network scaling. It points to the possibility of scale-free modeling of the modularity of networks based on the relative constancy of the basic units at the individual level that give structure to these networks, the flexibility of how particular groups are organized, the fact that network hierarchies are population-filling with scale-free relationships to population size, and the bulking, organization and conservation of energy, information and material in ways that match the constraints on populations of individuals. These characteristics of scale-free modeling have been successful in biology, and social scaling may well follow the same principles.

Johnson, Gregory. 1982. Organizational Structure and Scalar Stress. In *Theory and Explanation in Archaeology: The Southampton Conference*, Colin Renfrew, Michael Rowlands and Barbara A. Segraves-Whallon, Editors pp. 397-421. Academic Press.
http://eclectic.ss.uci.edu/~drwhite/ISCOM/GAJ1-17.pdf

Two papers that cite Johnson:
paper by Tim Kohler   http://www.santafe.edu/sfi/publications/Working-Papers/99-05-033.pdf
Ecology, Group Formation and Group Size as factors of Coalitional Psychology Eric Schniter
http://www.uweb.ucsb.edu/~eschniter/manuscripts/GroupFormation.pdf

Networks and Ethnography

Introduction: Networks, Ethnography and Emergence. Chapter 1 of *Network Analysis and Ethnographic Problems*, with Ulla Johansen.
http://eclectic.ss.uci.edu/~drwhite/turks/1c.pdf

Glossary: EDIT Analytical Concepts for Networks and Ethnography (for the book)
http://eclectic.ss.uci.edu/~drwhite/turks/Networks_and_Ethnography.pdf

Bibliography EDIT - covers alot of the new literature on networks

http://eclectic.ss.uci.edu/~drwhite/turks/BibliogrWhiteJohansen.pdf

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Large-Scale Network of World Economy: Social scientists use the CRAY. 1988. Interview: Douglas R. White, David A. Smith. *Science at the San Diego Supercomputer Center 1987*: 27-28. http://eclectic.ss.uci.edu/~drwhite/WorldTrade/Cray.pdf

Structure and Dynamics of the Global Economy: Network Analysis of International Trade 1965-1980 David A. Smith, Douglas R. White *Social Forces*, Vol. 70, No. 4. (Jun., 1992), pp. 857-893. http://eclectic.ss.uci.edu/~drwhite/pw/GlobalEcon1992.pdf

Organizational Networks

Link to the movie and graphics: from Barabási web site for *Linked*!
http://www.nd.edu/~networks/linked/newfile18.htm
make sure to find the link to the images and follow them to newest graphics page
2003 Walter W. Powell, Douglas R. White, Kenneth W. Koput and Jason Owen-Smith.
Network Dynamics and Field Evolution: The Growth of Interorganizational Collaboration in the Life Sciences. Submitted to: *American Journal of Sociology*
http://eclectic.ss.uci.edu/~drwhite/SFI-WP2003d.pdf

2003 Douglas R. White, Walter W. Powell, Jason Owen-Smith and James MoodyNetwork Models and Organization Theory: from embeddedness to ridge structure. In preparation for *Computational and Mathematical Organization Theory* special issue on Mathematical Representations for the Analysis of Social Networks within and between Organizations, guest edited by Alessandro Lomi and Phillipa Pattison.
http://eclectic.ss.uci.edu/~drwhite/pub/cmot-3.pdf

2003 James Moody and Douglas R. White, Social Cohesion and Embeddedness: A Hierarchical Concept of Social Groups. *American Sociological Review* 68(1):1-25. http://eclectic.ss.uci.edu/~drwhite/soc_con17.pdf

> 2001 Douglas R. White and Frank Harary, The Cohesiveness of Blocks in Social Networks: Node Connectivity and Conditional Density. *Sociological Methodology 2001*, vol. 31, no. 1, pp. 305-359. Blackwell Publishers, Inc., Boston, USA and Oxford, UK. http://eclectic.ss.uci.edu/~drwhite/sm-w23.PDF
> http://www.santafe.edu/files/workshops/dynamics/sm-wh8a.pdf

Galois Lattices for Networks and Cohesive Groups

Using Galois Lattices to Represent Network Data. Linton C. Freeman, Douglas R. White *Sociological Methodology*, Vol. 23. (1993), pp. 127-146.
http://eclectic.ss.uci.edu/~drwhite/pw/Galois.pdf

Cliques, Galois Lattices, and the Structure of Human Social Groups. Linton C. Freeman
Social Networks, 18, 1996, 173-187. See: http://moreno.ss.uci.edu/groups.pdf

Lattices and dimensional representations: matrix decompositions and ordering structures
http://www.u.arizona.edu/~breiger/PEPRLBSN02.pdf

Scaling Papers

The Small-World of Human Language
http://complex.upf.es/~ricard/SWPRS.pdf

> Why social networks are different from other types of networks. M. E. J. Newman,
> Juyong Park. Condensed Matter, abstract cond-mat/0305612 From: Mark Newman
> May 2003 cond-mat/0305612   http://aps.arxiv.org/abs/cond-mat/0305612/

> DW: I think that clustering is a feature in common with biological networks, not
> distinct!

Scaling in Biological Networks
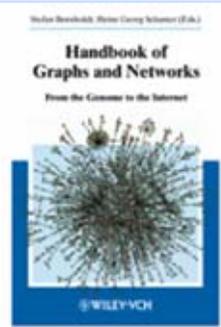http://eclectic.ss.uci.edu/~drwhite/pub/Scaling_and_Distribution_Networks.pdf
Growth dynamics of the World-Wide. LA Adamic and BA Huberman
http://www.hpl.hp.com/shl/papers/webgrowth/growthdynamics.pdf

html links are live on these pages

http://www.wiley-vch.de/publish/en/books/newTitles200211/3-527-40336-1/?sID=d05b

Bornholdt, Stefan / Schuster, Heinz Georg (eds.)
Handbook of Graphs and Networks
From the Genome to the Internet
Table of Contents
http://www.pro-physik.de/Phy/pdfs/Bornholdt_Inhaltsverz.pdf
Edition - November 2002
99.- Euro / 146.- SFR
2002. XVI, 401 Pages, Hardcover
ISBN 3-527-40336-1 - Wiley-VCH, Berlin

Short description
Defining the field of complex interacting networks in its infancy, this book presents
the dynamics of networks and their structure as a key concept across several
disciplines. The contributions present common underlying principles of network
dynamics and their theoretical descriptions, and are thus of interest to specialists as
well as to non-specialized readers looking for an introduction to this new and exciting
field.

From the contents:
Themes in biological networks: regulatory networks in the genome, neural networks,
ecological networks and food webs.
Further themes: Internet and the World-Wide Web, peer-to-peer networks, computer
viruses, traffic networks.
Methods: scale-free networks, small-world networks, generalized random graphs.

From the contents
        Bela Bollobas and Oliver Riordan:
        1. Mathematical Results on Scale-free Random Graphs

Mark Newman:
2. Random Graphs as Models of Networks
http://www.santafe.edu/sfi/publications/Working-Papers/02-02-005.pdf

Albert-Lázló Barabási:
3. Emergence of Scaling in Complex Networks
http://www.pro-physik.de/Phy/pdfs/Bornholdt_K3_069_084.pdf

        R. Cohen, S. Havlin, and D. ben-Avraham:
        4. Structural Properties of Scale-Free Networks
        http://citeseer.nj.nec.com/cohen02structural.html

Lada A. Adamic, Rajan M. Lukose and Bernardo A. Huberman:
13. Local Search in Unstructured Networks
http://arxiv.org/abs/cond-mat/0204181
http://eclectic.ss.uci.edu/~drwhite/ISCOM/0204181.pdf

        S.N. Dorogovtsev and J.F.F. Mendes:
        14. Accelerated Growth of Networks
        http://arxiv.org/abs/cond-mat/0204102
        http://eclectic.ss.uci.edu/~drwhite/ISCOM/0204102.pdf

Sanjay Jain and Sandeep Krishna:
16. Graph Theory and the Evolution of Autocatalytic Networks
http://arxiv.org/abs/nlin.AO/0210070
http://eclectic.ss.uci.edu/~drwhite/ISCOM/0210070.pdf

http://eclectic.ss.uci.edu/~drwhite/pub/Handbook_of_Graphs_and_Networks.pdf

Corso di Laurea in Economia, Reti, Informazione

Rappresenta una offerta formativa innovativa che risponde alle esigenze di formare nuove figure professionali capaci di utilizzare e applicare le nuove tecnologie dell' informazione per la soluzione di problemi gestionali sia nell' area della Nuova Economia sia nell' area delle imprese tradizionali.

Si pone come obiettivo quello di creare quelle figure professionali, sempre più richieste dal mercato del lavoro, che siano in grado di interagire in maniera dinamica con in processi di trasformazione indotti dalle nuove tecnologie. Queste figure riguardano manager con forti competenze nel settore delle tecnologie dell' informazione e della comunicazione capaci, quindi, di comprendere in profondità le trasformazioni in atto nell' economia e nella gestione aziendale e di padroneggiare gli aspetti tecnici e tecnologici su cui tali trasformazioni si basano, di gestire e usare l' enorme flusso di informazione che le reti telematiche mettono a disposizione in tempi rapidissimi e di mantenere in continua evoluzione il proprio bagaglio di competenze. I laureati in tale corso di laurea saranno capaci di comunicare efficacemente in forma scritta e orale in lingua inglese e in un' altra lingua della Unione Europea, oltre l' italiano.

2002 Douglas R. White and Michael Houseman The Navigability of Strong Ties: Small Worlds, Tie Strength and Network Topology, in *Networks and Complexity Special Issue*, *Complexity* 8(1):72-81.
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http://eclectic.ss.uci.edu/~drwhite/T&S/BrudnerWhite1997Convert.pdf

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Dwight Read. Introduction by Murray Leaf
http://eclectic.ss.uci.edu/~drwhite/pub/White_EMCSR2a.pdf

2003 Douglas R. White, Ties, Weak and Strong. *Encyclopedia of Community* Vol. 4:1376-1379. Edited by Karen Christensen and David Levinson. Thousand Oaks, CA: Sage Reference. http://eclectic.ss.uci.edu/~drwhite/pw/EncyclopediaofCommunity.pdf

Douglas R. White, **Born**: 13 Mar 1942 Minneapolis, MN, USA, Professor of Social Sciences, UC Irvine, is Graduate Director of Social Networks, member of the Mathematical Behavioral Sciences Institute, Humboldt senior scientist (Cologne), external faculty at Ecole des Hautes Etudes (Paris), and member of several working groups at the Santa Fe Institute. An NSF and NIMH predoctoral fellow, his PhD at Minnesota (1969) involved work at Michigan (1965-66) and Columbia (1966-67) in mathematical sociology, mathematical psychology and anthropology. He publishes in fields of social structure, networks, modeling social systems and network dynamics. He co-edited *The Anthropology of Urban Environments (*1972*), Research Methods in Social Network Analysis* (1991) and *Kinship, Networks and Exchange* (1998). Current work models the network dynamics of changing institutional configurations such as the biotechnical industry and longitudinal network and demographic studies of human populations. A recent contribution to network analysis, in *Sociological Methodology 2001*, provides a means of blocking of socially cohesive sets in large networks, with applications to commodity flows, social class, elite formation, corporate interlocks, communities, factionalism, and forms of social organization that can be identified in terms of hierarchies and intersections of organizations with cohesive groups or flow-cohesive structures.

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Selected Articles

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1977 Entailment Theory and Method: A Cross-Cultural Analysis of the Sexual Division of Labor (drw, M.Burton, L.Brudner) **Behavior Science Research** 12:1-24

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1992 Representing and Analyzing Kinship: A Network Approach (drw, P.Jorion) **Current Anthropology** 33:454-462.

1993 Using Galois lattices to represent network data (L.Freeman, drw) **Sociological Methodology 1993**, 127-146.

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2001a The Cohesiveness of Blocks in Social Networks: Node Connectivity and Conditional Density. Douglas R. White and Frank Harary, **Sociological Methodology 2001** (vol.31):305-359. Blackwell Publishers, Inc., Boston, USA and Oxford, UK.

2001b Fast Approximation Algorithms for Finding Node-Independent Paths in Networks (drw and and M. E. J. Newman) **Santa Fe Institute Working Paper** http://www.santafe.edu/sfi/publications/wpabstract/200107035

Proposal for the research project to be carried out while visiting Modena (work in progress)
"Society as a Complex System: Network Dynamics."
Key words: Urban scaling, dynamics of socioeconomic networks and flows, centralities, crosscutting organization, cohesion, community and class.

Context In calendar year 2003 I am working on Workpackage (WP) 13 of the EU project "Society as a Complex System," with S.E. van der Leeuw and Leona Sanders, who are among the Participant co-PIs. Our team is experienced with the application of the complex systems approach to the long-term evolution of social structures in relation to their environment, and we are responsible for managing the component on urban systems scaling laws, WP 13-17 and WP 6 in the innovation subproject. Our component will be realised in five workpackages: one on data and metrology (WP 13), two on case studies (WP 14 and 15), one on conceptualisation (WP 16) and one on modelling (WP 17). The bulk of the literature on scaling in urban systems, based on 'top-down' modelling (looking at the whole set of interacting cities simultaneously, deriving generalisations from the observation of their spatial structure and their long-term dynamics, and interpreting these dynamics), demonstrates that top-down approaches alone do not lead to conclusive results: A complementary 'bottom-up' approach is needed. Ultimately, observed patterns are the result of the interaction between large numbers of different individuals, groups, institutions and other entities. In a 'top-down' approach, the description of the full range of such entities is reduced to averages, so that the asymmetries in the interactions between different entities are discounted. Viewed from the perspective of 'complexity theory', these asymmetries actually drive the dynamics, and are responsible for the patterns generated. We will combine the study of these lower-level dynamics with that of the patterns they generate in order to understand the scaling phenomena concerned.

Data and measurement methods (metrology) My expertise is in network measurement (e.g., cohesion, position, centralities) and dynamics, using both controlled simulation and statistical methods that fall outside the general linear model to deal with complex forms of interaction. My workpackage (WP 13) begins with an in-depth investigation into the nature of the urban scaling relationships that have been brought to light in the extant literature. The objectives are to provide optimal descriptions of urban scaling phenomena, and to identify the best indicators to use in further work. The first part of the investigation has the double aim of (1) completing our inventory the full range of stable scaling relationships observable in urban phenomena, and of (2) identifying the full range of extant theories about the underlying dynamics, the flow patterns that sustain them. The second step in this workpackage is to look closely at the nature and role of the different kinds of crosscutting networks that are manifest in urban systems, and the conditions under which they may be observed. As it is through these networks that matter, energy and information are transmitted, they constrain, and are constrained by, the direct needs of the individual entities that together constitute the system, as well as by the structure of the system and its dynamics. To try to determine the best possible data on the networks and flows to be used, and what measures to apply to them, we will experiment with two or three 'mini' case-studies. In the third step I will describe these examples of cross-cutting networks in graph-theoretical terms so as to provide an independent and powerful descriptive 'language' that facilitates the application of very effective analytical and modeling tools (e.g., White et al. 1974,83,88,91,92,94,96,97,98,99[a],99b,00a,00b, Freeman and White 1991, Smith and White 1992, Brudner and White 1997, Moody and White 2000, Powell, White, Koput and Owen-Smith 2002). With these networks modelled in graph-theory terms, although the content areas will differ, their dynamics can be studied in the same conceptual framework as WP 6 [innovation dynamics]. Such mapping should yield an abstract description of the networks and their interconnections in terms that are easily transposed from one case to another, while also capturing the essential phenomena from our point of view: the flows of the principal commodities through the system.

Case studies The case studies of multiple networks that I propose to develop, along with appropriate graph-theoretical models for each—work to be carried out in Modena if this proposal is approved—are these:

(1) Southern Rhône Basin: Analysis of structural dynamics in a 2200-year history/prehistory of settlement growth in relation to changes in transport network configurations (cohesive blocks, flow-cohesive structures, flow-centralities, communities defined by removal of edges with high edge-betweenness). This study, conducted with S.E. van der Leeuw, asks: Can we predict exchange, viability and growth of urban and peri-urban units from network dynamics? The data are from van der Leeuw's Southern Rhône Basin project within the EU ARCHAEOMEDES PROGRAMME. See

http://www.cranfield.ac.uk/sims/ecotech/projects/arch/archlinks.htm and
http://www.ucl.ac.uk/archaeology/research/profiles/mcglade/glde9.htm.

My first study will tie in with the case study in **WP 14** that initiates, in parallel, a 'top-down' and a 'bottom-up' on a data set that has already been collected, for 5500 communes in Southern France. Here, my results will combine with the study of how the interaction between the dynamics between settlements of different sizes, from the smallest to the largest in the region, has led to the scaling phenomena observed. The essential contribution of this case study is that it will allow us to view the dynamics concerned in their spatial, functional and resource contexts. Indeed, the interaction between a set of villages and the town that is their focus will be very different if that town is one among several in the area concerned, or the only one. It will also vary with the relative sizes of the towns concerned, and with their distances. Moreover, while settlement size is in part related to the number of functions that a settlement fulfils in the dynamics of the whole system, it is also related to the specific functions, to the resources on which they depend, and to the connectivity between a settlement and others. These parameters will therefore also have to be taken into account.

(2) Nord-pas-de-Calais: Analysis of structural dynamics in a 200-year genealogical/spatial history of the bourgeoisie of the northern industrial region of France and the adjacent region of Belgium. This study, conducted with demographer Hervé Le Bras (LDH, EHESS Paris), asks: Do large-scale cohesive kinship and marriage networks form a basis for identifying social class formations? Are the parameters of patterns exhibited, including varieties of fractally-cohesive scaling pattern in their spatial-linkage patterning, indicative of concomitant changes in socioeconomic indicators? I brought to this study a 100,000-person computerized genealogical dataset of the bourgeoisie of the region, and we integrated Le Bras's database of French parish codes and coordinates to pinpoint spatial locations and thereby establish the spatiality of marriage and migration patterns over time. Kinship and marriage constitute one of our crosscutting networks.

(3) Biotech Industry, worldwide: Analysis of structural dynamics in a 14-year (168 month) time series consisting of organizational and financial attributes and ties of biotechnology firms, of pharmaceuticals, universities, research institutes, government agencies, financial groups (including venture capital) in short term contracts with those 400+ biotechs engaged in development of biotechnology applications to humans. This study, conducted with Walter W. Powell, Kenneth Koput and Jason Owen-Smith, asks: (1) What are the regional differences (e.g., Europe, U.S. and Canada, Asia) in development of biotech industry that lead to different types of network dynamics? (2) What is the relation between the dynamics of collaborative tie-formation, the emergence of macro-structure (topologies of cohesive blocks, hubs, central positions) in the collaborative network that are significant in terms of altering the paths, interaction rules, and roles of biotech actants in subsequent development of the industry. See:

http://eclectic.ss.uci.edu/~drwhite/Movie/index.html
http://www.unige.ch/ses/socio/socio01/francais/plenieres/pleniere.htm

Conceptualisation of expected results. My workpackage 13 along with 14 and 15 (further case studies by other team members) should provide our team with enough data and ideas to initiate WP 16: the construction of a conceptual model of the relationship between settlement dynamics that takes the different flows, the different levels of interaction, and the spatio-temporal dimensions of these into account, as well as the interaction between the 'bottom-up' and the 'top-down,' processes in the system. Although it is at present, of course, impossible to detail what this conceptual model will look like, we wish to express it in terms of 'flow structures': self-organising networks that channel the flows of energy, matter and information through the society. By doing so, we ensure that this part of the project is directly linked into WP 6 (constructing a model of innovation dynamics in terms of meta-stable flow structures). I will deliver several of the project reports **(D17- D19)**, critically reviewing the contribution of the extant literature against the background of 'complex systems theory', outlining the relationship between self-structuring flows and dynamic networks, and describing the measures used to monitor the flow dynamics and the networks that result from them.

Together, **WP's 13** and **14** should allow our team to decide what the best measures are to monitor both the structure and the dynamics of the interacting flows in such a way that the scaling dynamics can be

linked to them. Once these measures have been identified, it is time to upscale our field of study to the whole of Europe, as all towns and cities on the continent are increasingly part of one single system. Collecting the data to do that is the role of **WP 15**. We are aware of the fact that collecting appropriate data on this scale may be difficult in view of the difficulties to compare statistics collected under different regimes, on different spatial and temporal scales, etc. However, we feel that sufficient data are available to allow us to come up with some good proxy measures, provided we do not attempt to go into as much detail as in the case of Southern France. Not only would collecting such detail encounter major scheduling problems, as such a task is vast, but the data would not be comparable due to the differences in administrative organisation between European nations. We will compensate for this lack of detail by adding a level at the top: that of the whole of the European settlement system.

Costs

Travel
      San Diego-Modena-San Diego $1800
      Modena-Paris-Modena (3 collaborations with Le Bras, L.Sanders,
            and other team members) $900 (3 trips)

Equipment
      Laptop with large screen, $\geq$700 mhertz, 20gig drive, CD,
            zipdrive, highspeed internet connector $2600
      Brother MFC4800 or equivalent
            5-in-1 fax, laser printer (b/w) , copier,, scanner, OCR $800

Assistance
      Research Assistant, fluent in computer usage
      (data analysis packages, graphics) $4000

Total $10,100

(I can always make do on less, but these are my actual needs)

Any two of the following three network experts could evaluate the research proposal. They are all members of Department of Sociology, Columbia University, 413 Fayerweather Hall, 1180 Amsterdam Avenue, Mail Code 2571,New York, New York 10027
      Peter Bearman   **psb17@cunix.cc.columbia.edu**
      Duncan Watts   **djw24@columbia.edu**
      Harrison White   **hcw2@columbia.edu**