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ENCYCLOPEDIA of COMPLEXITY and SYSTEMS SCIENCE

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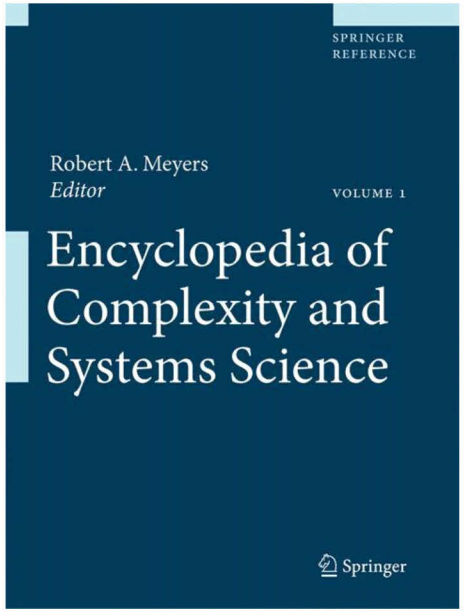
An authoritative single source for understanding and applying the concepts of complexity theory together with the tools and measures for analyzing complex systems in all fields of science and engineering



592 entries
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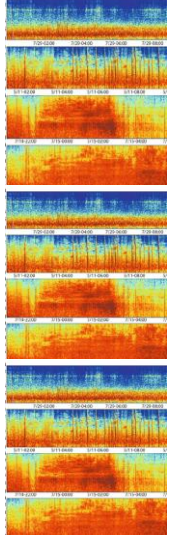
Objective



- To publish a multi-volume, multi-disciplinary print and web edition providing a complete and highly detailed presentation of the tools, applications, and accomplishments of complexity and systems science
- To reach a wider audience for complexity and systems science than has been possible up until now by assembling the concepts and tools for analyzing complex systems in a wide range of scientific and engineering fields

Why it's necessary

There is a recognized need to reframe modern science in terms of two extremes: The control over inherently complex, nano- or molecular-scale attributes of physical and biological systems on the one hand, and the complexity of large-scale earth and societal processes with multiple, interacting components on the other.

This realization has led to many new concepts and sophisticated mathematical and modeling tools for application to scientific, engineering, and societal issues that can be adequately described only in terms of complexity and dynamic systems. Relevant topics come from all areas of science and society, including topics as disparate as: **Climate change and human health, agent-based modeling in computer graphics and games, cognitive robots, graph structure of the world wide web, self-assembled materials, earthquake and tsunami forecasting, properties of carbon nanotubes, fractals and chaos, game theory and strategic complexity, celestial mechanics, social network analysis, soft computing, health care in the United States, biological complexity, freeway traffic management, and cities as complex systems.**

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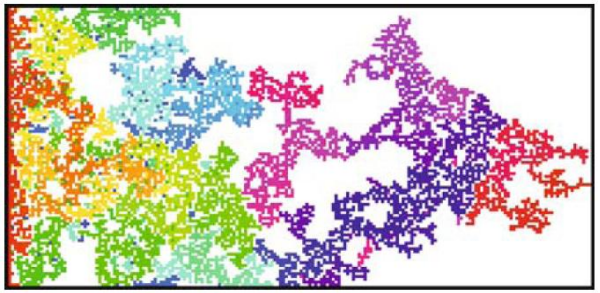

"The only word I can think of to describe your encyclopedia project is: Mind boggling. The importance of what you have accomplished cannot be exaggerated."

--**LOTFI ZADEH,** UC Berkeley,
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Biological Development and Evolution, Complexity and Self-organization in

STUART A. NEWMAN[1], GABOR FORGACS[2]
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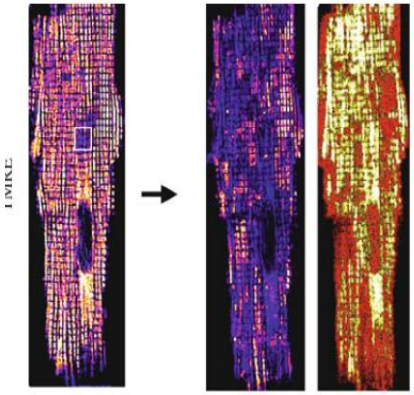
A Note from the Editor-in-Chief

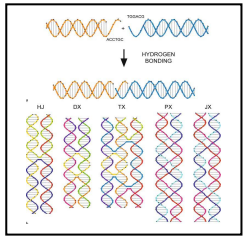
This Encyclopedia in total comprises 592 peer-reviewed, in-depth, 15–20 page articles presented alphabetically as prepared by more than 700 authors. The result is a carefully organized, accessible, and easily searchable 11,000-page reference work that places complexity and systems science at the center of modern scientific, engineering, and societal problems and potential solutions. A complete alphabetized listing of articles, extensive cross-references, glossaries of terms, and a detailed index are all included. We believe that there is no other treatment of this field with near the depth and authority of that prepared by our team of prize winning Board members, Section Editors and authors. This new publication will extend the influence of complexity and systems science to a much wider audience than has been possible up until now.

We hope that this unique work will stimulate new career paths and new research into the complex problems facing science and society.



From "Chaotic Dynamics, Noise, and Fractal Space in Biochemistry," pages 524-548

Links among German corporations in 2000, from "Social Network Visualization, Methods of," pages 8345-8363



From "DNA-Templated Self-Assembly of Protein Arrays and Highly Conductive Nanowires," pages 2104-2113

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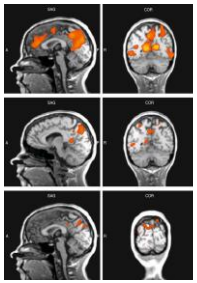
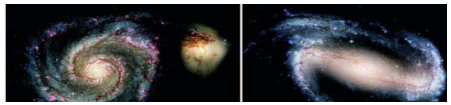
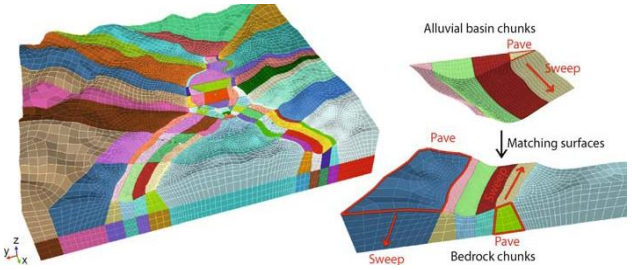


Brain activation patterns of a patient with OCD during psychotherapy, from "Self-organization in clinical psychology," pages 7991-8009



Normal spiral and barred spiral galaxies, from "Astrophysics: Dynamical Systems," pages 399-416



From "Simulation of seismic wave propagation in media with complex geometries," pages 7891-7914

FEATURES

- **Appeals to many disciplines:** Contains tools and measures for analyzing complex systems in science, engineering and in many areas of social, financial and business dynamics
- Written for **undergraduate and graduate students** as well as professionals
- Highly accessible: Each article includes a **glossary** of important terms and a concise **definition of the subject**, as well as an **extensive bibliography**
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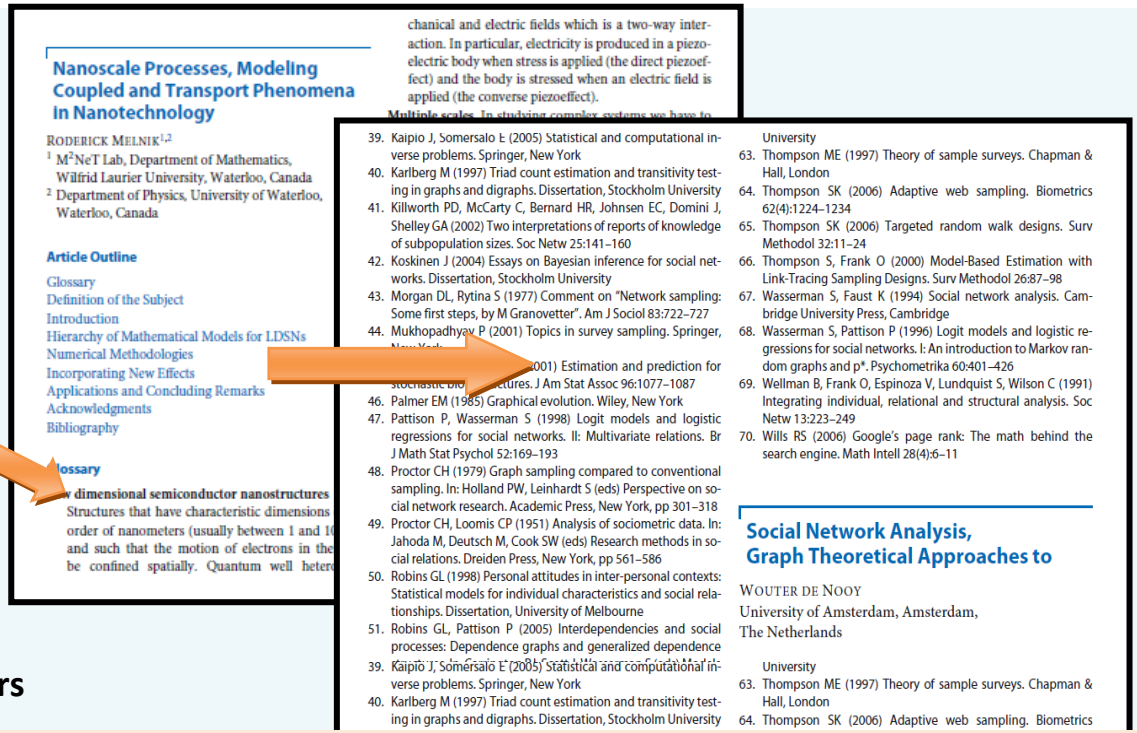

Nanoscale Processes, Modeling Coupled and Transport Phenomena in Nanotechnology

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Article Outline

Glossary
Definition of the Subject
Introduction
Hierarchy of Mathematical Models for LDSNs
Numerical Methodologies
Incorporating New Effects
Applications and Concluding Remarks
Acknowledgments
Bibliography

lossary

dimensional semiconductor nanostructures
Structures that have characteristic dimensions order of nanometers (usually between 1 and 10 and such that the motion of electrons in the be confined spatially. Quantum well heter

chanical and electric fields which is a two-way interaction. In particular, electricity is produced in a piezoelectric body when stress is applied (the direct piezoeffect) and the body is stressed when an electric field is applied (the converse piezoeffect).

Multiple scales. In studying complex systems we have to

39. Kaipio J, Somersalo E (2005) Statistical and computational inverse problems. Springer, New York
40. Karlberg M (1997) Triad count estimation and transitivity testing in graphs and digraphs. Dissertation, Stockholm University
41. Killworth PD, McCarty C, Bernard HR, Johnsen EC, Domini J, Shelley GA (2002) Two interpretations of reports of knowledge of subpopulation sizes. Soc Netw 25:141–160
42. Koskinen J (2004) Essays on Bayesian inference for social networks. Dissertation, Stockholm University
43. Morgan DL, Rytina S (1977) Comment on "Network sampling: Some first steps, by M Granovetter". Am J Sociol 83:722–727
44. Mukhopadhyay P (2001) Topics in survey sampling. Springer, New York

39. Kaipio J, Somersalo E (2005) Statistical and computational inverse problems. Springer, New York
40. Karlberg M (1997) Triad count estimation and transitivity testing in graphs and digraphs. Dissertation, Stockholm University

(2001) Estimation and prediction for stochastic bio structures. J Am Stat Assoc 96:1077–1087
46. Palmer EM (1985) Graphical evolution. Wiley, New York
47. Pattison P, Wasserman S (1998) Logit models and logistic regressions for social networks. II: Multivariate relations. Br J Math Stat Psychol 52:169–193
48. Proctor CH (1979) Graph sampling compared to conventional sampling. In: Holland PW, Leinhardt S (eds) Perspective on social network research. Academic Press, New York, pp 301–318
49. Proctor CH, Loomis CP (1951) Analysis of sociometric data. In: Jahoda M, Deutsch M, Cook SW (eds) Research methods in social relations. Dreiden Press, New York, pp 561–586
50. Robins GL (1998) Personal attitudes in inter-personal contexts: Statistical models for individual characteristics and social relationships. Dissertation, University of Melbourne
51. Robins GL, Pattison P (2005) Interdependencies and social processes: Dependence graphs and generalized dependence

39. Kaipio J, Somersalo E (2005) Statistical and computational inverse problems. Springer, New York
40. Karlberg M (1997) Triad count estimation and transitivity testing in graphs and digraphs. Dissertation, Stockholm University

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63. Thompson ME (1997) Theory of sample surveys. Chapman & Hall, London
64. Thompson SK (2006) Adaptive web sampling. Biometrics 62(4):1224–1234
65. Thompson SK (2006) Targeted random walk designs. Surv Methodol 32:11–24
66. Thompson S, Frank O (2000) Model-Based Estimation with Link-Tracing Sampling Designs. Surv Methodol 26:87–98
67. Wasserman S, Faust K (1994) Social network analysis. Cambridge University Press, Cambridge
68. Wasserman S, Pattison P (1996) Logit models and logistic regressions for social networks. I: An introduction to Markov random graphs and p*. Psychometrika 60:401–426
69. Wellman B, Frank O, Espinoza V, Lundquist S, Wilson C (1991) Integrating individual, relational and structural analysis. Soc Netw 13:223–249
70. Wills RS (2006) Google's page rank: The math behind the search engine. Math Intell 28(4):6–11

Social Network Analysis, Graph Theoretical Approaches to

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University
63. Thompson ME (1997) Theory of sample surveys. Chapman & Hall, London
64. Thompson SK (2006) Adaptive web sampling. Biometrics

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