COMPLEX'2009

# The First International Conference on Complex Sciences: Theory and Applications

Feb. 23-25, 2009 Shanghai, China

**Sponsored by**

**Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering (ICST)**

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**University of Shanghai for Science and Technology (USST)**

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COMPLEX'2009

**The First International Conference on Complex Sciences: Theory and Analysis**
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## Conference Programme

**Feb. 23, 2009 (Monday)**

| Chair-person | Time | Programme |
|---|---|---|
| | 0800-0820 | Opening Ceremony |
| Dr. Bing-Hong Wang | 0820-0900 | Opening Talk: "Applications of statistical physics to understanding complex systems", by Dr. H. Eugene Stanley, Boston University |
| Dr. Bing-Hong Wang | 0900-0940 | Keynote: "Synchronization and intervention of locally interacting multi-agent systems", by Dr. Lei Guo, Chinese Academy of Sciences |
| | 0940-1020 | Photo taking session and tea break |
| Dr. Seunghwan Kim | 1020-1100 | Keynote: "Spreading processes in complex techno-social networks", by Dr. Alessandro Vespignani, Indiana University |
| Dr. Seunghwan Kim | 1100-1130 | Plenary Talk: "A Schroedinger-like Equation for the PageRank", by Dr. Guido Caldarelli, University of Rome "Sapienza" |
| Dr. Seunghwan Kim | 1130-1200 | Plenary Talk: "Molecular models of the origin of life and biological evolution", by Dr. Chin-Kun Hu, Academia Sinica |
| | 1200-1330 | Lunch |
| Dr. Chin-Kun Hu | 1330-1400 | Plenary Talk: "Shortest path discovery of complex networks and the Internet: Some exact results", by Dr. Gábor Vattay, Eötvös University |
| Dr. Chin-Kun Hu | 1400-1430 | Plenary Talk: "Complexity in brain function", by Dr. Seunghwan (Swan) Kim, Pohang University of Science & Technology |
| Dr. Chin-Kun Hu | 1430-1500 | Plenary Talk: "Analyzing and modeling large scale social networks based on mobile phone data" by Dr. János Kertész, Budapest University of Technology and Economics |
| | 1500-1530 | Tea Break |
| | 1530-1730 | Poster Session I (Lobby, outside Postgraduate Lecture Theater) |
| | 1830 | Banquet at Golden Jade Sunshine Hotel Shanghai |

**Feb. 24, 2009 [Tuesday]**

| Chair-person | Time | Programme | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dr. Wenyuan Niu | 0820-0900 | Keynote: "Characterizing node activity and local effect in complex networks", by Dr. Deyi Li, National Natural Science Foundation of China | | | | | | |
| | 0900-0930 | Plenary Talk: "Percolation and immunization of complex networks", by Dr. Shlomo Havlin, Bar-llan University | | | | | | |
| | 0930-1000 | Plenary Talk: "Comparison of cellular networks by using dynamic-based measures", by Dr. Baowen Li, National University of Singapore | | | | | | |
| 1000-1030 | | Tea break | | | | | | |
| Dr. Shlomo Havlin | 1030-1100 | Plenary Talk: "Mechanisms of systemic risk: contagion, reinforcement, redistribution", by Dr. Frank Schweitzer, ETH Zurich | | | | | | |
| | 1100-1130 | Plenary Talk: "The social harmony equation based on social physics", by Dr. Wenyuan Niu, Institute of Policy and Management | | | | | | |
| | 1130-1200 | Plenary Talk: "Universal behavior of rank-ordered distributions in arts and sciences", by Dr. Gustavo Martínez-Mekler, National Autonomous University of Mexico | | | | | | |
| 1200-1330 | | Lunch | | | | | | |
| Dr. Baowen Li | 1330-1400 | Plenary Talk: " Experimental evidence for fragile to strong crossover in general glass forming liquids" by Dr. Francesco Mallamace, Università di Messina | | | | | | |
| | 1400-1430 | Plenary Talk: "Self-organization and finite size effects of the stylized facts in economics in a workable agent based model", by Dr. Luciano Pietronero, University of Rome "La Sapienza" | | | | | | |
| | 1430-1500 | Plenary Talk: "Evolution of complex networks studies during the past 10 years", by Dr. Byungnam Kahng, Seoul National University | | | | | | |
| 1500-1530 | | Tea Break | | | | | | |
| 1530-1750 | | Complex Network-I (D-101) | Complex Biological Systems-I (D-107) | Complex Social Systems-I (D-111) | Complex Engineering Systems-I (D-201) | Complex Economic Systems-I (D-106) | Complex System Methods-I (D-207) | Other Complex Systems (D-206) |
| 1900- | | Tour (to be finalized) | | | | | | |

**Feb. 25, 2009 [Wednesday]**

<table>
<tr><th>Chair-person</th><th>Time</th><th colspan="5">Programme</th></tr>
<tr><td rowspan="2">Dr. Yan Gao</td><td>0900-0930</td><td colspan="4">Plenary Talk: "Component detection in complex networks" by Dr. Choy Heng Lai, National University of Singapore</td><td rowspan="8"><u>WORKSHOPS</u><br>COART<br>ComplexCCS<br>ComplexEN<br>MANDYN<br>SPA<br>(for outline of schedules of all the workshops, please refer to the next page)</td></tr>
<tr><td>0930-1000</td><td colspan="4">Plenary Talk: "Statistical properties (entropy, freezing, organization) of single solution clusters for a random K-Satisfiability formula", by Dr. Haijun Zhou, Chinese Academy of Sciences</td></tr>
<tr><td colspan="2">1000-1030</td><td colspan="4">Tea break</td></tr>
<tr><td colspan="2">1030-1210</td><td>Complex Networks-II (D-101)</td><td>Complex Networks III (D-107)</td><td>Complex Social Systems-II (D-111)</td><td>Complex Economic Systems-II (D-106)</td></tr>
<tr><td colspan="2">1210-1330</td><td colspan="4">Lunch</td></tr>
<tr><td colspan="2">1330-1500</td><td colspan="4">Poster Session II (Lobby, outside Postgraduate Lecture Theater)</td></tr>
<tr><td colspan="2">1500-1530</td><td colspan="4">Tea Break</td></tr>
<tr><td colspan="2">1530-1730</td><td>Complex Networks-IV (D-101)</td><td>Complex Biological Systems-II (D-107)</td><td>Complex Engineering Systems-II (D-111)</td><td>Complex System Methods-II (D-106)</td></tr>
<tr><td>Dr. János Kertész</td><td>1735-1815</td><td colspan="5">Closing Talk: "The architecture of complexity: From the topology of the WWW to the structure of the cell", by Dr. Albert-László Barabási, Northeastern University and Harvard Medical School</td></tr>
</table>

**<u>Note: All the plenary talks will be given at the Conference Hall, New Complex Building of USST.</u>**

## Time Frame of Workshops

**Date: Feb. 25, 2009**

| Time | Complex Theory of Art and Music (COART) (D-102) | Causality in Complex Systems (ComplexCCS) (D-206) | Complex Engineering Networks (ComplexEN) (D-211) | Modelling and Analysis of Human Dynamics (MANDYN) (D-207) | Social Physics and Its Applications (SPA) (D-201) |
|---|---|---|---|---|---|
| 0830-0900 | | | Morning Session I | | |
| 0900-1000 | | | | | |
| 1000-1030 | Tea break | | | | |
| 1030-1200 | | Session I | Morning Session II | Session I | Session I-A |
| 1200-1300 | Lunch Break | | | | |
| 1300-1330 | | Session II | | Session II | |
| 1330-1500 | Session I | | Afternoon Session I | | Session I-B |
| 1500-1530 | Tea Break | | | | |
| 1530-1700 | Session II | Planning Meeting for Future Workshops (by Invitation) (D-202) | Afternoon Session II | Session III | Session II |
| 1700-1730 | | | | | |

# Oral Presentation Schedule

## Structure and Dynamics of Complex Networks

### Complex Networks-I — Feb. 24, 2009, 1530-1750

**Session Chair: Jin-Qing Fang** — **Room: D-101**

*Network Complexity Pyramid*
Jin-Qing Fang, Yong Li

*Generalized Farey Tree Network*
Jin-Qing Fang, Yong Li

*Community Identification in Directed Networks*
Youngdo Kim, Seung-Woo Son, Hawoong Jeong

*Impact of Local Events on Communities and Diseases*
Xin-Jian Xu, Li-Jie Zhang, Xun Zhang, Jie Lou

*An Emergence Principle for Complex Systems*
Michel Cotsaftis

*Phase Transitions of Active Rotators in Complex Networks*
Seung-Woo Son, Hawoong Jeong, Hyunsuk Hong

*Exploring and Understanding Scientific Metrics in Citation Networks*
Mikalai Krapivin, Maurizio Marchese, Fabio Casati

### Complex Networks-II — Feb. 25, 2009, 1030-1210

**Session Chair: Zonghua Liu** — **Room: D-101**

*Hypernetworks of Complex Systems*
Jeffrey Johnson

*Inefficiency in Networks with Multiple Sources and Sinks*
Hyejin Youn, Michael T. Gastner, Hawoong Jeong

*Adaptive Routing Approaches of Controlling Traffic Congestion in Internet*
Zonghua Liu, Ming Tang, P. M. Hui

*Evolution of the Internet AS-Level Ecosystem*
Srinivas Shakkottai, Marina Fomenkov, Ryan Koga, Dmitri Krioukov, Kimberley Claffy

*Using the Weighted Rich-Club Coefficient to Explore Traffic Organization in Mobility Networks*
Jos´e J. Ramasco, Vittoria Colizza, Pietro Panzarasa

### Complex Networks-III — Feb. 25, 2009, 1030-1210

**Session Chair: Xin-Jian Xu** — **Room: D-107**

*Modular Synchronization in Complex Network with a Gauge Kuramoto Model*
C. Choi, E. Oh, B. Kahng, D. Kim

*Slowdown in the Annihilation of Two Species Diffusion-Limited Reaction on Fractal Scale-Free Networks*
C-K. Yun, B. Kahng, D. Kim

*Funnelling Effect in Networks*
Parongama Sen

*Analysing Weighted Networks: An Approach via Maximum Flows*
Markus Brede, Fabio Boschetti

*Strong Dependence of Infection Profiles on Grouping Dynamics during Epidemiological Spreading*
Zhenyuan Zhao, Guannan Zhao, Chen Xu, Pak Ming Hui, Neil F. Johnson

**Complex Networks-IV** **Feb. 25, 2009, 1530-1730**

**Session Chair: Shiwei Yan** **Room: D-101**

*A Novel Measurement of Structure Properties in Complex Networks*
Yanni Han, Jun Hu, Shuqing Zhang, Deyi Li

*Immunization of Geographical Networks*
Bing Wang, Kazuyuki Aihara, Beom Jun Kim

*Community Division of Heterogeneous Networks*
Tsuyoshi Murata

*Evolving Model of Weighted Networks*
Xianmin Geng, Hongwei Zhou, Guanghui Wen

*A Preliminary Study on the Effects of Fear Factors in Disease Propagation*
Yubo Wang, Jie Hu, Gaoxi Xiao, Limsoon Wong, Stefan Ma, Tee Hiang Cheng

*A Statistical Study on Oscillatory Protein Expression*
Shiwei Yan

# Complex Biological Systems

**Complex Biological Systems-I** **Feb. 24, 2009, 1530-1750**

**Session Chair: Christine Nardini** **Room: D-107**

*Exponential Synchronization of General Complex Delayed Dynamical Networks via Adaptive Feedback Control*
Haifeng Zhang, Bing-Hong Wang

*An Approach to Enhance Convergence Efficiency of Self-Propelled Agent System*
Jian-Xi Gao, Zhuo Chen, Yun-Ze Cai, Xiao-Ming Xu

*Allometric Scaling of Weighted Food Webs*
Jiang Zhang

*MANIA: A Gene Network Reverse Algorithm for Compounds Mode-of-Action and Genes Interactions Inference*
Darong Lai, Hongtao Lu, Mario Lauria, Diego di Bernardo, Christine Nardini

*Modeling and Robustness Analysis of Biochemical Networks of Glycerol Metabolism by Klebsiella Pneumonia*
Jianxiong Ye, Enmin Feng, Lei Wang, Zhilong Xiu, Yaqin Sun

*A Max-Min Principle for Phyllotactic Patterns*
Wai-Ki Ching, Yang Cong, Nam-Kiu Tsing

*A Bipartite Graph Based Model of Protein Domain Networks*
J. C. Nacher, T. Ochiai M. Hayashida, T. Akutsu

**Complex Biological Systems-II** **Feb. 25, 2009, 1530-1730**

**Session Chair: Jae Woo Lee** **Room: D-107**

*Structure of Mutualistic Complex Networks*
Jun Kyung Hwang, Sung Eun Mang, Moon Young Cha, Jae Woo Lee

*Conservation of Edge Essentiality Profiles in Metabolic Networks across Species*
Tomasz Arodz

*Statistical Properties of Cell Topology and Geometry in a Tissue-Growth Model*
Patrik Sahlin, Henrik Jönsson

*New Statistics for Testing Differential Expression of a Pathway from Microarray Data*
Hoicheong Siu, Hua Dong, Li Jin, Momiao Xiong

*Spiral Waves Emergence in a Cyclic Predator-Prey Model*
Luo-Luo Jiang, Wen-Xu Wang, Xin Huang, Bing-Hong Wang

# Complex Economic Systems

## Complex Economic Systems-I — Feb. 24, 2009, 1530-1750

**Session Chair: Jürgen Mimkes** — **Room: D-106**

*An Adaptive Markov Chain Monte Carlo Method for GARCH Model*
Tetsuya Takaishi

*Morphological Similarities between DBM and An Economic Geography Model of City Growth*
Dominique Peeters, Pierre Frankhauser, Geoffrey Caruso, Jean Cavailhes, Isabelle Thomas, Gilles Vuidel

*Scaling Behavior of Cities Size Distribution in China*
Xiaowu Zhu, Aimin Xiong, Liangsheng Li, Maoxin Liu, X.S. Chen

*Cross-Correlations among Plate Indexes of Stock Market In China*
Xun Zhang, Huijie Yang

*Autonomous Co-operation and Control in Complex Adaptive Logistic Systems - Contributions and Limitations for the Innovation Capability of International Supply Networks*
Michael Hülsmann, Philip Cordes

*Dynamic Regimes of a Multi-Agent Stock Market Model*
Tongkui Yu, Honggang Li

*Differential Forms: A New Tool in Economic Systems*
Jürgen Mimkes

## Complex Economic Systems-II — Feb. 25, 2009, 1030-1210

**Session Chair: Da-Ren He** — **Room: D-106**

*Financially Constrained Fluctuations in an Evolving Network Economy*
Domenico Delli Gatti, Mauro Gallegati, Bruce Greenwald, Alberto Russo, Joseph Stiglitz

*Application of the Kelly Criterion to Ornstein-Uhlenbeck Processes*
Yingdong Lv, Bernhard K. Meister

*A Firm-Growing Model and the Study of Communication Patterns' Effect on the Structure of Firm's Social Network*
Liang Chen, Haigang Li, Zhong Chen, Li Li, Da-Ren He

*Optimal Service Capacities in a Competitive Multiple-Server Queuing Environment*
Wai-Ki Ching, Sin-Man Choi, Min Huang

*Evolving Specialization, Market and Productivity in an Agent-Based Cooperation Model*
Erbo Zhao, Guo Liu, Dan Luo, Xing'ang Xia, Zhangang Han

# Complex Social Systems

## Complex Social Systems-I — Feb. 24, 2009, 1530-1750

**Session Chair: Stanislaw Drozdz** — **Room: D-111**

*Linguistic Complexity*
Stanislaw Drozdz, Jaroslaw Kwapien, Adam Orczyk

*A Priority Queue Model of Human Dynamics with Bursty Input Tasks*
Jin Seop Kim, Naoki Masuda, Byungnam Kahng

*Multiple Phase Transitions in the Culture Dissemination*
Bing Wang, Yuexing Han, Luonan Chen, Kazuyuki Aihara

*Community Detection of Time-Varying Mobile Social Networks*
Shu-Yan Chan, Pan Hui, Kuang Xu

*Evolutionary Prisoner's Dilemma Game in Flocks*
Zhuo Chen, Jianxi Gao, Yunze Cai, Xiaoming Xu

*Recognition of Important Subgraphs in Collaboration Networks*
Chun-Hua Fu, Yue-Ping Zhou, Xiu-Lian Xu, Hui Chang, Ai-Xia Feng, Jian-Jun Shi, Da-Ren He

### Complex Social Systems-II — Feb. 25, 2009, 1030-1210

**Session Chair: Ning Zhang** — **Room: D-111**

*You Never Walk Alone: Recommending Academic Events Based on Social Network Analysis*
Ralf Klamma, Pham Manh Cuong, Yiwei Cao
*Organizational Adaptive Behavior: The Complex Perspective of Individual-Task Interactions*
Jiang Wu, Duoyong Sun, Bin Hu, Yu Zhang
*European Airlines' TFP and the 2001 Attack: Towards Safety in a Risk Society*
Panayotis Michaelides, Kostas Theologou, Angelos Vouldis
*Selection of Imitation Strategies in Populations (When to Learn or When to Replicate?)*
Juan G. Diaz Ochoa
*Inter-Profile Similarity (IPS): A Method for Semantic Analysis of Online Social Networks*
Matt Spear, Xiaoming Lu, Norman S. Matloff, S. Felix Wu

## Complex Engineering Systems

### Complex Engineering Systems-I — Feb. 24, 2009, 1530-1750

**Session Chair: Steve Uhlig** — **Room: D-201**

*Capturing Internet Traffic Dynamics Through Graph Distances*
Steve Uhlig, Bingjie Fu, Almerima Jamakovic
*Understanding the Spreading Patterns of Mobile Phone Viruses*
Zehui Qu, Pu Wang, Zhiguang Qin
*Spam Source Clustering by Constructing Spammer Network with Correlation Measure*
Jeongkyu Shin, Seunghwan Kim
*Detecting Gross Errors for Steady State Systems*
Congli Mei
*Identifying Social Communities in Complex Communications for Network Efficiency*
Pan Hui, Eiko Yoneki, Jon Crowcroft, Shu-Yan Chan
*Designing Capital-Intensive Systems with Architectural and Operational Flexibility Using a Screening Model*
Jijun Lin, Olivier de Weck, Richard de Neufville
*A Hybrid Ant-Colony Routing Algorithm for Mobile Ad-Hoc Networks*
Shahab Kamali, Jaroslav Opatrny

### Complex Engineering Systems-II — Feb. 25, 2009, 1530-1730

**Session Chair: Wei Yan** — **Room D-111**

*Chaotic and Hyperchaotic attractors in Time-Delayed Neural Networks*
Dong Zhang, Jian Xu
*Modification Propagation in Complex Networks*
Mary Luz Mouronte, María Luisa Vargas, Luis Gregorio Moyano,
Francisco Javier García Algarra, Luis Salvador Del Pozo
*The Nonlinear Mechanism of Phase Transition in Computer Networks*
Li Yi-Peng, Huang Yi-Hua, Wang lei, Ren Yong
*Towards Automatic Discovery of Malware Signature for Anti-virus Cloud Computing*
Wei Yan, Erik Wu
*Entropy Based Detection of DDoS Attacks in Packet Switching Network Models*
Anna T. Lawniczak, Hao Wu, Bruno Di Stefano

# Complex Systems Methods

## Complex Systems Methods-I — Feb. 24, 2009, 1530-1750

**Session Chair: Jeffery Johnson** — **Room: D-207**

*Self-Organized Balanced Resources in Random Networks with Transportation Bandwidths*
C. H. Yeung, K. Y. Michael Wong

*Extremal Dependencies and Rank Correlations in Power Law Networks*
Yana Volkovich, Nelly Litvak, Bert Zwart

*An Adaptive Strategy for Resource Allocation with Changing Capacities*
Yingni She, Ho-fung Leung

*Policy, Design and Management: the in-vivo Laboratory for the Science of Complex Socio-Technical Systems*
Jeffrey Johnson

*Characters of Networks with Optimal Synchronizability*
Ming Zhao, Tao Zhou, Changsong Zhou, Bambi Hu, Bing-Hong Wang

*Antisynchronization of Two Complex Dynamical Networks*
Ioan Grosu , Ranjib Banerjee, Syamal K. Dana

*Synchronization Stability of Coupled Near-Identical Oscillator Network*
Jie Sun, Erik M. Bollt, Takashi Nishikawa

## Complex Systems Methods-II — Feb. 25, 2009, 1530-1730

**Session Chair: Parongama Sen** — **Room: D-106**

*Emergence and Simulation*
Alan Baker

*The Origin of Evolution in Physical Systems*
Jean-Claude Heudin

*Epidemic Self-Synchronization in Complex Networks*
Ingo Scholtes, Jean Botev, Markus Esch, Peter Sturm

*Scaling in Modulated Systems*
O. Portmann, A. Vindigni, D. Pescia

*SIRS Dynamics on Random Networks: Simulations and Analytical Models*
Ganna Rozhnova, Ana Nunes

*Optimization Using a New Bio-inspired Approach*
Xiang Feng, Francis C.M. Lau

# Other Complex Systems

## Other Complex Systems-I — Feb. 24, 2009, 1530-1750

**Session Chair: Chin-Kun Hu** — **Room: D-206**

*Complex Systems in Cosmology: "The Antennae" Case Study*
Jean-Claude Torrel, Claude Lattaud, Jean-Claude Heudin

*Mechanism of Morphological Transition in Hetero-Epitaxial Growth of Metal Films*
Cui-Lian Li, Chin-Kun Hu

*Temperature-Induced Domain Shrinking in Ising Ferromagnets Frustrated by Long-Range Interaction*
A. Vindigni, O. Portmann, N. Saratz, F. Cinti, P. Politi, D. Pescia

*On Distributed Multi-Point Concurrent Test System and Its Implementation*

Hao Luo, Huaxin Zeng

*Almost Periodicity and Distributional Chaos in Banach Space*

Lidong Wang, Shi Tang, Zhenyan Chu

*Complex Liquids and Glasses: the Jagla Model*

Limei Xu

# Poster Presentations Schedule

## Poster Session I — Feb. 23, 2009, 1530-1730

*P1 - Measuring the Efficiency of Network Designing*
Guoqiang Zhang, Guoqing Zhang

*P2 - A Comparative Analysis of Specific Spatial Network Topological Models*
Jun Wang, Gregory Provan

*P3 - Characterizing the Structural Complexity of Real-world Complex Networks*
Jun Wang, Gregory Provan

*P4 - Complex Networks with Different Types of Nodes*
Juan Zhang, Wenfeng Wu

*P5 - The Effects of Link and Node Capacity on Traffic Dynamics in Weighted Scale-free Networks*
M.B. Hu, R. Jiang, Y.H. Wu, Q.S. Wu

*P6 - Enhancement of Synchronizability of the Kuramoto Model with Assortative Degree-frequency Mixing*
Jin Fan, David J. Hill

*P7 - Analysis the Group Interest Network*
Ning Zhang

*P8 - A Bipartite Network Study of the Library Lending System*
Nan-Nan Li, Ning Zhang

*P9 - Stability of Non-diagonalizable Networks: Eigenvalue Analysis*
Linying Xiang, Zengqiang Chen, Jonathan J.H. Zhu

*P10 - Community Structure Detection in Complex Networks with Applications to Gas-liquid Two-phase Flow*
Zhongke Gao, Ningde Jin

*P11 - On General Laws of Complex Networks*
Wenjun Xiao, Behrooz Parhami

*P12 - Topological Analysis and Measurements of an Online Chinese Student Social Network*
Duoyong Sun, Jiang Wu, Shenghua Zheng, Bin Hu, Kathleen M.Carley

*P13 - Analysis and Modeling on the Government's Co-agglomeration in Industrial Clustering*
Ying-Chao Zhang, Chao Chen, Xin-Yi Huang, Yi-Lu Cai

*P14 - Frequency Domain Analysis of a Stochastic Biological Network Motif with Delay*
Qi Wang, Shiwei Yan, Shengjun Liu, Xian Li

*P15 - Modeling and Properties of Nonlinear Stochastic Dynamical System of Continuous Culture*
Lei Wang, Jianxiong Ye, Enmin Feng, Zhilong Xiu

*P16 - Organizational Structure of the Transcriptional Regulatory Network of Yeast: Periodic Genes*
Frank Emmert-Streib, Matthias Dehmer

*P17 - Invariance of the Hybrid System in Microbial Fermentation*
Caixia Gao, Enmin Feng

*P18 - Reconstructing Gene Networks from Microarray Time-Series Data via Granger Causality*
Qiang Luo, Xu Liu, Dongyun Yi

*P19 - The Complex Economic System of Supply Chain Financing*
Lili Zhang, Guangle Yan

*P20 - Collaborative Transportation Planning in Complex Adaptive Logistics Systems - A Complexity Science-based Analysis of Decision Making Problems of "Groupage Systems"*
Michael Hülsmann, Herbert Kopfer, Melanie Bloos, Philip Cordes

*P21 - An Agent-based Model of Retail Location Choice with Complementary Goods*
Arthur Huang, David Levinson

*P22 - Finding Sales Promotion and Making Decision for New Product Based on Group Analysis of Edge-enhanced Product Networks*

Jianbin Tan, Yi Huang, Bin Wu

*P23 - Stabilities of Stock States in Chinese Stock Markets*

Gyuchang Lim, Kyungho Seo, Soo Yong Kim, Kyungsik Kim

*P24 - Firm Size Distribution in Fortune Global 500*

Qinghua Chen, Liujun Chen, Kai liu

*P25 - Bifurcation Phenomena of Opinion Dynamics in Complex Networks*

L. Guo, X. Cai

*P26 - Ecologic Research the Voluntary Disclosure of Information of Listed Companies*

Hu Jing-Jing, Yan Guang-Le

*P27 - The Evolution of ICT Markets: An Agent-Based Model on Complex Networks*

Liangjie Zhao, Zhong Chen, Li Li

*P28 - A Research of Tacit Knowledge Transfer Based on the Complex Network Technology in Hierarchy Structure Organization*

Ting-Ting Cheng, Heng-Shan Wang, Lu-Bang Wang

*P29 - Scaling Law between Urban Electrical Consumption and Population in China*

Xiaowu Zhu, Aimin Xiong, Liangsheng Li, Maoxin Liu, X.S. Chen

*P30 - On the Approximation Solution of a Cellular Automaton Traffic Flow Model and its Relationship with Synchronized Flow*

R.Jiang, Y.M.Yuan, K.Nishinari

*P31 - An Effective Local Routing Strategy on the Complex Network*

Yu-Jian Li, Bing-hong Wang, Zheng-dong Xi, Chuan-yang Yin, Han-xin Yang, Duo Sun

*P32 - Development of Road Traffic CA Model of 4-Way Intersection to Study Travel Time*

Anna T. Lawniczak, Bruno N. Di Stefano

*P33 - Channel Estimation and ISI/ICI Cancellation for MIMO-OFDM Systems with Insufficient Cyclic Prefix*

Yi-Jen Chiu, Chien-Sheng Chen, Ting-Wei Chang

*P34 - Briefly Review of China High Technology Networks*

Yong Li, Jin-Qing Fang, Liu Qiang

*P35 - Towards Network Complexity*

Matthias Dehmer, Frank Emmert-Streib

*P36 - Packet-Level Traffic Allocation for Real-Time Streaming over Multipath Networks*

Yanfeng Zhang, Cuirong Wang, Yuan Gao

*P37 - Pollution Modeling and Simulation with Multi-Agent and Pretopology*

Murat Ahat, Sofiane Ben Amor, Marc Bui

*P38 - Enhancing Synchronization in Systems of Non-identical Oscillators*

Markus Brede

*P39 - Internal-Evolution Driven Growth in Creation-Annihilation Cyclic Games*

Xiao-Pu Han, Luo-Luo Jiang, Tao Zhou, Bing-Hong Wang

*P40 - Consensus Seeking and Controlling Over Directed Delayed Networks*

Jianquan Lu, Daniel W.C. Ho

*P41 - Non-Sufficient Memories that are Sufficient for Prediction*

Wolfgang Loehr, Nihat Ay

*P42 - An New Bio-inspired Approach to Traveling Salesman Problem*

Xiang Feng, Francis C.M. Lau

*P43 - Research on Web2.0 System Design base on CAS Theory*

Kai Chen, Hen-Shan Wang

*P44 - Complex Modelling of Open System Design for Sustainable Architecture*
Yan Gu, John Frazer

*P45 - Optimality Conditions of a Three-Dimension Non-Smooth Thermodynamic System of Sea Ice*
Wei Lv, Enmin Feng

*P46 - Frequency Distributions of Sand Pile Models*
Ruey-Tarng Liu

*P47 - Queueing Transition of Directed Polymer in Random Media with a Defect*
Jae Hwan Lee, Jin Min Kim

*P48 - Extinction and Coexistence in the Internet Market as Complex Networks*
Jiandong Zhao, Liping Fu, Rongfu Cheng

## Poster Session II — Feb. 25, 2009, 1330-1500

*P1 - Cache Allocation in CDN: An Evolutionary Game Generalized Particle Model*
Xiang Feng, Francis C.M. Lau

*P2 - A More Strict Definition of Stationary Degree Distribution*
Xiaojun Zhang, Zheng He

*P3 - Emergence of Scale-Free Networks with Seceding Mechanism*
Xian-Min Geng, Guang-Hui Wen, Shun-Chen Wan, Jie-Yu Xiong

*P4 - A Novel Software Evolving Model Based on Software Networks*
Weifeng Pan, Bing Li, Yutao Ma, Jing Liu

*P5 - Social Network as Double-edged Sword to Exchange: Frictions and the Emerging of Intellectual Intermediary Service*
Li Li, Bangtao Wu, Zhong Chen, Liangjie Zhao

*P6 - The Topological Characteristics and Community Structure in Consumer-Service Bipartite Graph*
Lin Li, Bao-Yan Gu, Li Chen

*P7 - The Stability of Growing Networks*
Zhenting Hou, Xiangxing Kong, Qinggui Zhao

*P8 - Gravity Model for Spatial and Weighted Network Based on Optimal Expected Traffic*
Jiang-Hai Qian, Ding-Ding Han

*P9 - Comparing Networks from a Data Analysis Perspective*
Wei Li, Jing-Yu Yang

*P10 - A Generating Method for Internet Topology with Multi-ASes and Multi-Tiers*
Jian-qiang Liu, Jiang-xing Wu, Xiao Huang, Dan Li

*P11 - A New Genetic Algorithm for Community Detection*
Chuan Shi, Yi Wang, Bin Wu

*P12 - Degree Distribution of a Two-Component Growing Network*
Jianhong Ke, Xiaoshuang Chen

*P13 - Fractal Fingerprint for Network Topologies*
Yuchun Guo, Changjia Chen, Shi Zhou

*P14 - Generalized Greedy Algorithm for Shortest Superstring*
Zhengjun Cao, Lihua Liu

*P15 - The Results on the Stability of Glycolytic Metabolic Networks in Different Cells*
Qinghua Zhou, Li Jin, Momiao Xiong

*P16 - On Scale-free Prior Distributions and Their Applicability in Large-scale Network Inference with Gaussian Graphical Models*
Paul Sheridan, Takeshi Kamimura, Hidetoshi Shimodaira

*P17 - Time Dependent Virus Replication in Cell Cultures*
J. G. Diaz Ochoa, A. Voigt, H. Briesen, K. Sundmacher

*P18 - Studies on Interpretive Structural Model for Forest Ecosystem Management Decision-making*
Suqing Liu, Yingshan Pu, YuanmanZhou, Yuequn Huang , Weidong Han, Linfeng Li, Jiping Li, Qunying Zen

*P19 - Moving Breather Collisions in the Peyrard-Bishop DNA Model*
A. Alvarez, FR Romero, J. Cuevas, JFR Archilla

*P20 - The Contrast of Parametric and Nonparametric Volatility Measurement Based on Chinese Stock Market*
Xinwu Zhang, Yan Wang, Handong Li

*P21 - An Application on Merton Model in the Non-Efficient Market*
Feng Ya-nan, Xiao Qing-xian

*P22 - Symmetry Breaking in the Evolution of World Economic Structure*
Hui Wang, Guangle Yan

*P23 - Research on Block & Comovement Effect of Stock Market in Financial Complex Network by Community Structure Analysis*
Chongwei Du

*P24 - Fuzzy Entropy Method for Quantifying Supply Chain Networks Complexity*
Jihui Zhang, Junqin Xu

*P25 - A Social Network Model Based on Topology Vision*
Ping-Nan Hsiao

*P26 - The System Dynamics Research on the Private Cars' Amount in Beijing*
Fan Jie, Yan Guang-le

*P27 - Dynamics of Research Team Formation in Complex Networks*
Caihong Sun, Yuzi Wan, Yu Chen

*P28 - Modelling of Population Migration to Reproduce Rank-Size Distribution of Cities in Japan*
Hiroto Kuninaka, Mitsugu Matsushita

*P29 - Tracking the Evolution in Social Network: Method and Results*
Shengqi Yang, Bin Wu, Bai Wang

*P30 - Self-Organized Collaboration Network Model Based on Module Emerging*
Yang Hongyong, Lu Lan, Zhang Siying

*P31 - Performance Analysis of Public Transport Systems in Nanjing Based on Network Topology*
Li Ping, Zhu Zhen-Tao, Zhou Jing, Ding Jin-Yuan, Wang Hong-Wei, Wei Shan-Sen

*P32 - The Probability Distribution of Inter-car Spacings*
Jin Guo Xian, Dong Han

*P33 - Correlation Properties and Self-Similarity of Renormalization Email Networks*
Lianming Zhang, Sundong Liu, Yuling Tang, Hualan Xu

*P34 - Constructing Searchable P2P Network with Randomly Selected Long-Distance Connections*
Jingbo Shen, Jinlong Li, Xufa Wang

*P35 - Measurement and Statistics of Application Business in Complex Internet*
Lei Wang, Weiji Su, Yong Ren, Shuhang Wu, Xiuming Shan, Shiji Song

*P36 - Joint Channel-Network Coding (JCNC) for Distributed Storage in Wireless Network*
Ning Wang, Gang Yang

*P37 - Average Consensus in Networks of Multi-agents with both Impulsive Effects and Time-delays*
QuanjunWu, Jin Zhou, Lan Xiang, Zengrong Liu

*P38 - The Control Based on Internal Average Kinetic Energy in Complex Environment for Multi-robot System*
Mao Yang, Yantao Tian, Xianghua Yin

*P39 - Adjustable Consensus of Mobile Agent Systems with Heterogeneous Delays*

Hong-yong Yang, Si-ying Zhang

*P40 - Sediment Transport Dynamics in River Networks: a Model*

Jie Huo, Xu-Ming Wang, Rui Hao, Jin-Feng Zhang

*P41 - Less Restrictive Synchronization Criteria in Complex Networks with Coupling Delays*

Yun Shang, Maoyin Chen

*P42 - Synchronization of Complex Networks with Time-varying Coupling Delay via Impulsive Control*

Yang Dai, Yunze Cai, Xiaoming Xu

*P43 - Global Synchronization of Generalized Complex Networks with Mixed Coupling Delays*

Yang Dai, Yunze Cai, Xiaoming Xu

*P44 - Evolutionary Game in a Single Hub Structure*

Xiaolan Qian, Junzhong Yang

*P45 - Design of Multilphase Sinusoidal Oscillator based on FTFN*

Yan Hui Xi, Qiao Liu, Li Liu

*P46 - Scaling Relations in Absorbing Phase Transitions with a Conserved Field in one Dimension*

Sang-Gui Lee, Sang B. Lee

Note: A-1 size portable boards will be provided for the authors to put on their posters. If one such board is not enough, a second board can be provided upon request. Authors are strongly encouraged to put on their posters as early as possible on the day with their respective poster session so that they could make use of tea break or lunch time to start their discussions earlier. Authors are gently reminded to remove their posters after their poster session. Local organizers will provide necessary tools for putting on posters. Student helpers will be around to provide help upon request. Thank you for your kind attention and enjoy your presentation.

## Workshop on "Complexity Theory of Art and Music" (COART)

### Brief Introduction

Recent studies have revealed in many artworks and pieces of music such features of complex systems as power law, small-world phenomenon and so on. It is clear that all features of artworks and music (at least what have passed check by time) should obey to the principles of the brain functioning, for instance, to the principles of patterns recognition. The aim of this satellite workshop is to investigate how ubiquitous and universal are complex properties in art and music and try to understand the relation of art and music features with the brain working.

**Conference Date: Feb. 25, 2009** **Room D-102**

### Program of Half-Day COART Workshop

| Time | Authors | Title |
|---|---|---|
| 1330-1400 | Yevin Igor | Complexity and Art: Review of Recent Publications |
| 1400-1430 | Beautement Patrick, Bronner Christine | Complex Phenomena in Orchestras: Metaphors for Leadership and Enterprise |
| 1430-1500 | Manuel Beltran del Rio, Germinal Cocho | Rank-Size Distribution of Notes in Harmonic Music. Shuffling of Distribution |
| 1500-1530 | Tea Break | |
| 1530-1600 | Xiaofan Liu, Chi K. Tse, Michael Small | Composing Music with Complex Networks |
| 1600-1630 | Grigolini Paolo, Adams David | Music, New Aesthetics and Complexity |
| 1630-1700 | Koblyakov Alexander | Complexity Approach to Musicology |

## Workshop on "Causality in Complex Systems" (ComplexCCS)

### Brief Introduction

One of the reasons people have difficulty in dealing with complex systems is that the linear causal chain way of thinking - A causes B causes C ... etc - breaks down in the presence of feedback and multiple interactions between causal and influence pathways. One could say that complex systems are characterised by networked rather than linear causal relationships. Moreover, the open-ended nature of complex adaptive systems implies that their structure, properties and behaviour can change dynamically as a result of interactions with the system's environment (e.g. through adaptation) and as a result of internal interactions (through self-organisation), so traditional notions of causality are even further stretched by these adaptive, self-organising and autopoietic behaviours. Nevertheless it is important to be able to reason about complex systems, make inferences about factors that contribute to current and alternative states of complex systems and explore their possible future trajectories, especially if we wish to influence them towards more favourable futures, and away from more dangerous possibilities.

This workshop seeks to review the state-of-the-art in thinking about Causality in Complex Systems, and to develop and discuss the key research questions the complex systems community most needs to address.

Furthermore, it aims to leverage relevant experience and knowledge by bringing together people who have expertise in particular domain-specific approaches to dealing with causal networks in different fields. We seek to stimulate cross-disciplinary synthesis and cooperation in methodological research.

### Program of Full-Day ComplexCCS Workshop

**Conference Date: Feb. 25, 2009** **Room: D-206**

| Time | Titles and Presenters |
|---|---|
| 1030-1040 | Anne-Marie Grisogono "Introduction to Workshop" |
| 1040-1110 | David Batten "Causality and Complexity in Adaptive Neural Systems" |
| 1110-1140 | Peter Goodison, Peter Johnson, Joanne Thoms "Establishing Causality in Complex Human Interactions: Identifying Breakdowns of Intentionality" |
| 1140-1210 | Patrick Beautement, Christine Broenner "Complex Multi-modal Multi-level Influence Networks - Affordable Housing Case Study" |
| 1210-1300 | Lunch Break |
| 1300-1330 | Qin Zhang "The Difference between Single-Valued and Multi-Valued Cases in the Compact Representation of CPD in Bayesian Networks" |
| 1330-1400 | Qiang Luo, Xu Liu, and Dongyun Yi "Reconstructing Gene Networks from Microarray Time-Series Data via Granger Causality" |
| 1400-1430 | Frank Emmert-Streib, Matthias Dehmer "Towards a Partitioning of the Input Space of Boolean Networks: Variable Selection using Bagging" |
| 1430-1500 | Discussions on the Papers Presented |
| 1500-1530 | Tea Break |
| 1530-1730 | Planning Meeting for Future Workshops (by Invitation) |

## Workshop on "Complex Engineering Networks" (ComplexEN)

### Scope

Complex network has been an active research field over the world after the great development over the last decade. This is the case not only in deeper and wider theoretical studies but also in many newly found real-world applications. This workshop aims at promoting the latest researches and applications on complex engineering networks, which serves as a representative collection and frontier exchange of this fast developing field.

### Program of Full-Day ComplexEN Workshop

**Conference Date: Feb. 25, 2009** **Room: D-211**

| Time | Activities | Chair Person |
|---|---|---|
| 0830-0835 | **Workshop Opening** | Guanrong Chen<br>City University of Hong Kong |
| 0835-1015 | **Morning Session 1**:<br>*Modelling and analysis of complex networks - I* | Xiaofan Wang<br>Shanghai Jiao Tong University |
| 1015-1040 | Tea Break | |
| 1040-1155 | **Morning Session 2**:<br>*Modelling and analysis of complex networks - II* | Zengqiang Chen<br>Nankai University |
| 1200-1345 | Lunch Time | |
| 1345-1500 | **Afternoon Session 1**:<br>*Epidemics and failure spreadings on complex networks* | Michael Z.Q. Chen<br>Leicester University |
| 1500-1530 | Tea Break | |
| 1530-1710 | **Afternoon Session 2**:<br>*Control and coordination of complex networking systems* | Xiang Li<br>Fudan University |
| 1710 | **Workshop Closing** | Guanrong Chen<br>City University of Hong Kong |

### Oral Presentation Schedule

**Morning Session 1: Modelling and analysis of complex networks - I**
Session Chair: Xiaofan Wang

08:35-09:00 Modeling and Dynamical Analysis of Molecular Networks
Ruiqi Wang, Zengrong Liu

09:00-09:25 Networks That Optimize a Trade-Off between Efficiency and Dynamical Resilience
Markus Brede, Bert de Vries

09:25-09:50 Power Law Modelling of Internet Topology
Shi Zhou

09:50-10:15 Collective Aggregation Pattern Dynamics Control via Attractive/ Repulsive Function
Michael Chen, Zhao Cheng, Hai-Tao Zhang, Tao Zhou, Ian Postlethwaite

**Morning Session 2: Modelling and analysis of complex networks –II**
Session Chair: Zengqiang Chen

10:40-11:05 Transforming Time Series into Complex Networks
Michael Small, Jie Zhang, Xiaoke Xu
11:05-11:30 Observing Stock Market Fluctuation in Networks of Stocks
Jing Liu, Chi Tse, Francis Lau, Keqing He
13:30-11:55 Visual Analysis of Complex Networks and Community Structure
Bin Wu

**Afternoon Session 1: Epidemics and failure spreadings on complex networks**
Session Chair: Michael Z.Q. Chen

13:45-14:10 Modeling Failure Propagation in Large-Scale Engineering Networks
Markus Schläpfer, Jonathan L. Shapiro
14:10-14:35 Modelling of Epidemics with a Generalized Nonlinear Incidence on Complex Networks
Maoxing Liu, Jiong Ruan
14:35-15:00 Model and Dynamic Behavior of Malware Propagation over Wireless Sensor Networks
Yu-Rong Song, Guo-Ping Jiang

**Afternoon Session 2: Control and coordination of complex networking systems**
Session Chair: Xiang Li

15:30-15:55 Eigenvalue Based Stability Analysis for Asymmetric Complex Dynamical Networks
Zengqiang Chen, Linying Xiang
15:55-16:20 Synchronization in Gradient Complex Networks
Xingang Wang
16:20-17:45 Collective Behavior Coordination and Aggregation with Low-Cost Communication
Hai-Tao Zhang, Michael Chen, Tao Zhou, Zhao Cheng, Pin-Ze Yu
16:45-17:10 Synchronization Stability of Coupled Near-Identical Oscillator Networks
Jie Sun, Erik M. Bollt, Takashi Nishikawa

**Note:** Each paper is offered 18 mins for presentation and 7 mins for free Q & A.

## Workshop on "Modelling And Analysis of Human Dynamics" (MANDYN)

### Brief Introduction

The activity of the recent years in the fields of computer science, sociology and statistical physics made possible to approach in a quantitative way the study of a variety of social systems. Network theory, agent-based modelling and simple cellular automata have been used to describe many systems related to human activity as: urban development, econophysics, traffic, analysis of queuing models. In all these cases the dynamics of these phenomena are driven by individual human actions. There is increasing evidence that the timing of many human activities, ranging from communication to entertainment and work patterns, follow non- Poisson statistics and more generally a universal behaviour. This inherent similarity in human patterns could impact all phenomena driven by human mobility, from epidemic prevention to emergency response, urban planning and agent-based modelling. This important conference is a perfect occasion to put together the scientists operating in the area of complex systems in such a way to produce a critical mass of competence and people necessary to boost the activity in the quantitative study of human dynamics.

### Program of Full-Day MANDYN Workshop

**Conference Date: Feb. 25, 2009** **Room: D-207**

| Time | Titles and Presenters |
|---|---|
| 1030-1100 | INVITED TALK: Registration to a Conference: How People react to a deadline (Tentative Topic) **L. Pietronero** |
| 1100-1120 | Interplay between Evolutionary Game and Network Structure: the Coevolution of Social Net, Cooperation and Wealth Distribution **Jie Ren** *et al.* |
| 1120-1140 | The Simulation Modeling of the Complex System Sustainable Development : Case of World Economy **Dmitry Chistilin** |
| 1140-1200 | Characterizing the Human Mobility Pattern in a Large Street Network **Bin Jiang** |
| 1200-1300 | Lunch |
| 1330-1330 | INVITED TALK: TBA **A-L. Barabási** |
| 1330-1350 | Modified Human Development Index ***Evgeny Borodkin, Andrei Vityazev*** |

| | |
|---|---|
| 1350-1410 | Weighted Networks and Community Detection: Planning Productive Districts in Sardinia<br>**Alessandro Chessa** |
| 1410-1430 | Dynamics of Priority-Queue Networks<br>**Kwang-Il Goh** |
| 1430-1450 | Generalized Thermodynamics Underlying the Laws of Zipf and Benford<br>**Carlo Altamirano, Alberto Robledo** |
| 1450-1530 | Tea Break |
| 1530-1550 | High Resolution Dynamical Mapping of Social Interactions with Active RFID<br>**Ciro Cattuto** *et al.* |
| 1550-1610 | Human Mobility Networks and Epidemic Invasion<br>**Vittoria Colizza***, et al.* |
| 1610-1630 | Towards the Characterization of Individual Users through Web Analytics<br>**Jose J Ramasco, Bruno Goncalves** |
| 1630-1650 | Human Dynamics<br>**Chaoming Song** |

## Workshop on " Social Physics and its Applications" (SPA)

### Brief Introduction

Social physics is to understand human society through using the reasoning and methodology of natural science, which seeks analogies from the world of physics to aggregate human behavior. When human organizes a society, it has its law of collective behaviors. Therefore social physics has two sides: material characteristic and mental attributes. Social physics as a scientific discipline has his own history of development. Around 1830 year Auguste Comte described sociology as 'social physics', but he only may find the simple analogies between physics and society. In 1950'-1980's there were appeared a lot of important scholars, such as Zipf, Garison, Haggett, Simon, Wilson and Prigogine etc. In China Niu had put the social combustion theory , Wang put artificial society and social computing and Gu put Wuli-Shili-Renli system approach to forward the social physics studies forward from different aspects

Society itself is a complex system, so we require some complex science theory, new system methodologies, complex system modeling, social network analysis etc to push the theoretical studies on social physics. The applied aspects in recent years the social stability, social harmony and anti-terrorism etc. put forward some crucial problems to be solved by us. We just wish organize this workshop to give a good chance to exchange the new research results in social physics and related topics. This workshop will be divided into two parts: 1. Social physics and its application to some real social problems in China; 2. Different useful system methodologies, expert mining, complex network, system modeling and cognitive theory for social problems. You are welcome to participate to our workshop.

### Program of Full-Day SPA Workshop

**Conference Date: Feb. 25, 2009** **Room: D-201**

**Part I** **Chair: Prof. NIU Wenyuan**

| Time | Titles and Authors |
|---|---|
| 1030-1100 | **Gu J.F.*, Song W.Q., Zhu Z.X., Liu Y.J.,** "Expert mining for Solving Social Harmony Problems" |
| 1100-1130 | **Yang J.M.*, Wang W.J., Chen G.R..,** "A Two-Level Complex Network Model and Its Application" |
| 1130-1200 | **Tang X.J.*,** "Qualitative Meta-Synthesis Techniques for Analysis of Public Opinions for In-Depth Study" |
| 1200-1330 | Lunch |
| 1330-1400 | **Zheng R.*, Shi K., Li S.,** "The Influence Factors and Mechanism of Societal Risk Perception" |
| 1400-1430 | **Fan Z.M.*, Niu W.Y., Gu J.F.,** "Control Mode of Public Emergency Response" |
| 1430-1500 | **Liu Y.J.*,** "Opinion Modeling Based on Meta-synthesis Approach" |

**Part II** **Chair: Prof. GU Jifa**

| Time | Titles and Authors |
|---|---|
| 1530-1550 | **Li D.*, Wang Y.L., Fu Y.,** "Social Physics and the Flow of Migrant Peasant Workers" |
| 1550-1610 | **Ma Y.H.*, Niu W.Y., Li Q.Q.,** "Research on Early Warning of Chinese Food Safety Based on Social |

| | |
|---|---|
| | physics” |
| 1610-1630 | **Ning M.*, Gu J.F.,** “Research on Social Stability Mechanisms Based on Activation Energy and Gradual Activation Reaction Theory” |
| 1630-1650 | **Wang Y.L.*, Li D.,** “Social Physics and China’s Population Migration” |
| 1650-1710 | **Fu Y.*,** “Two-dimensional Coupling Model on Social Deprivation and its Application” |
| 1710-1730 | **Chen M.Y.*, Liu Y.J.,** “Research on the Best Time to Intervene into Network Public Opinion for Managers——Based on "Nankai Buick Affair"” |

**Note:** The authors with * will give talks.

# Invited Plenary Talks

## Applications of statistical physics to understanding complex systems (Opening Talk)

H. Eugene Stanley,
Departments of Physics, Chemistry, Physiology, and Biomedical Engineering
Boston University USA

**Abstract**

We will address some significant open questions where statistical physics concepts and methods may be helpful.

(1) The Anomalies of a Complex Fluid, Liquid Water
(2) The Behavior of Complex Economic Systems
(3) Threat Networks and Threatened Networks
(4) Biological Physics: "THE FIRST THREE MINUTES OF ALZHEIMER DISEASE"

Additional concepts in complex systems will also be briefly discussed:

(5) Applications of statistical physics to genomics (addressing questions such as why 97 percent of the human genome is called ``junk DNA'' since a traditional belief is that it has no known purpose).
(6) Using statistical physics concepts to detect physiological abnormalities before they become life threatening

## The architecture of complexity: From the topology of the WWW to the structure of the cell (Keynote and Closing Talk)

Dr. Albert-László Barabási
Center for Complex Network Research at Northeastern University
and Department of Medicine, Harvard Medical School, USA

**Abstract**

Systems as diverse as the world wide web, Internet or the cell are described by highly interconnected networks with amazingly complex topology. Recent studies indicate that these networks are the result of self-organizing processes governed by simple but generic laws, resulting in architectural features that makes them much more similar to each other than one would have expected by chance. I will discuss the amazing order characterizing our interconnected world and its implications to network robustness, social networks and potentially human diseases.

## Synchronization and intervention of locally interacting multi-agent systems (Keynote)

Dr. Lei Guo
Academy of Mathematics and Systems Science
Chinese Academy of Sciences, China

**Abstract**

Multi-agent systems (MAS) arise from diverse fields in natural and artificial systems, e.g., schools of fish, flocking of birds, swarm intelligence and the coordination of autonomous mobile robots, *etc*. Generally speaking, MAS are composed of many agents which interact with each other by either local or global rules, or both. Even with only local interactions, the whole system may still emerge some kinds of collective behaviors, such as, consensus, synchronization, clustering, whirlpool, *etc*., which are

macroscopic properties of the MAS. The understanding of the emergence phenomena from local to global (or from micro to macro), is a basic problem in the study of complex systems.

In this paper, we will work with a basic class of MAS, where each agent has the tendency to behave as other agents do in its neighborhood. This is a typical phenomenon in many MAS, especially in biological systems, and such a property is well captured by the so called Vicsek model. This model possesses some key features of the MAS, such as dynamic behavior, local interactions, and changing neighbor graphs. The simulations done by Vicsek and his coauthors tell us that all agents will eventually move in the same direction (synchronization) when the density is large and the noise is small. This model looks simple, but the nonlinear coupling relationship between the positions and headings makes the theoretical analysis quite involved. In fact, almost all of the existing studies have to resort to a certain kind of connectivity assumptions, which are difficult and troublesome issues in themselves.

In the first part of this talk, we will present some recent progress in the synchronization analysis of the above mentioned Vicsek model. We will give a complete theoretical analysis of this model without imposing any connectivity conditions. The main technical results are the following: a) For any given and fixed model parameters concerning with both the interaction radius $r$ and the agents' moving velocity $v$, the overall system will synchronize as long as the population size $n$ is large enough, which is consistent with the simulations given by Vicsek *et al*; b) If both $r$ and $v$ decrease as the population size $n$ increases, but satisfy a certain decaying rates, then again, the overall system will synchronize for large $n$.

In the second part, we will address the problem of intervention of MAS. In many real applications, it is difficult or impossible to change the local rules of the agents, such as, the human customized behavior, the moving strategies of animals. Then what is the feasible way to intervene such kinds of MAS? To answer this question, we will propose a new notion called "soft control", which is different from the traditional approach of distributed control. To demonstrate the feasibility, we will consider two ways to intervene such MAS in this talk. The first one is to use a small portion of "information" agents, and the second one is to design one or more "intelligent" agent(s). In the first case, we will show that the proportion of the information agents needed will tends to zero as the population size increases to infinity. In the second case, we will give some examples to show how to design one or a few "intelligent" agents.

Finally, we will present some interesting problems for future investigation.

## Characterizing node activity and local effect in complex networks (Keynote)

Dr. Deyi Li
National Natural Science Foundation of China, China

**Abstract**

Node activity, local effect, asymmetric topology and preferential attachment are basic characteristics of realistic networks focused in network science. Each active node is an independent acting agent, having different energy and uncertainty. Local effect of nodes is the result of node activity interaction, that is, each node affects its neighboring nodes, and at the same time, its neighboring nodes also affect itself. Moreover, this effectiveness will gradually decrease with the increase of distance, without any centralized control upon it. Furthermore, complex networks have other typical properties, such as asymmetric topology which presents as clustering nodes, and preferential attachment in network growing which is different from random attachment.

The nonlinear interactions between different parts of complex networks cause the emergent properties of whole network. As we know now, the emergent mechanism from the simple local interactions to the global collective behaviors is the core issue of network science research. The known common measures, such as degree distribution, betweenness distribution, clustering coefficient and average path length, etc., are used to characterize general statistical regulations. However, all the above measures are hard to characterize the inherent rules behind the emergent properties. For example, degree may be used to measure the connection ability of a node, while betweenness characterizing the ability of flow bridging, and clustering coefficient characterizing the phenomena of structural clustering, etc. Different measurement ways may get different results, and it is difficult to mix and measure the node ability of interaction, connection and localization.

From the classic concept of field introduced by M. Faraday in 1837, the field as an interpretation of non-contact interaction between particles in every different granularity, from atom to universe, had attained huge success. In a potential field, potential means the work done to move a unit object, such as a mass point or a charge point, from some position to the reference point. Data field introduced in 1999 by our group, as the main method in cognitive physics, reflects field model into the data space. It is a virtual field, describing the relationship among data point in coordinates, could be used to dig out data characteristics.

The locality of a node in network reflects its position potential, named as topological potential, which characterizes its ability of affecting other nodes, and the result of other nodes interaction effect overlapping. Topological potential and its distribution focus on the structural localization conduced by node activity. Considering a node in network as a potential source, it can affect others along with paths connecting each other. Hence all of nodes in a network affect each other by their potential fields overlapping. The potential field in networks does not like other classic field owning Euclidean distance, so we replace Euclidean distance by jumps between two nodes.

We will further discuss the choice of potential functions and the optimal effect factor, which is used to characterize the mathematical law of nodes interaction. In order to uncover the physical measures behind nodes potential interactions, we compared the common measure ways, such as degree, betweenness, closeness centrality and each of their distribution. It should be especially pointed out that topological potential along with paths between nodes cannot be measured simply by those common measure ways. Topological potential emphasizes nodes connection pattern, local activity, which leads to the emergent patterns of different connections, and is also helpful to understand the dynamics of networks.

In real world, each node has many reality attributes, reflecting different node activity. Topological potential regards these attributes as a source of the node ability, named as mass of node, affecting other nodes. The emergence and evolution of complex networks are the interaction result of nodes localizing with different reality attributes.

As an illustration and application of topological potential, we have carefully analyzed nodes ranking, community detecting, bridging nodes detecting, kernel membership of community discovering and so on, took Krebs' political books online-selling network as the main demonstration. In the demonstration network, nodes represent real time best seller (books) about US politics sold by the online bookseller Amazon, and edges represent frequent co-purchasing of books by the same buyers, as indicated by the "customers who bought this book also bought these other books" feature on Amazon. We conclude that the partial order ranking, as the form of top N is useful to some actual problems, comparing the ranking result with other well-known algorithms, such as PageRank and HITS. We also conclude that nodes cluster by topological potential effect, forming different communities. Some nodes are kernel to a community for they localize in the topology attracting kernel. Some other nodes bridge among different communities for they are affected equally by these communities.

## Spreading processes in complex techno-social networks (Keynote)

Dr. Alessandro Vespignani
Indiana University, USA

**Abstract**

In different contexts we are challenged by multi-scale networks where infrastructures composed by different technological layers are interoperating with the social component that drives their use and development. Examples are provided by the Internet, the social Web, the new WiFi communication technologies and transportation and mobility infrastructures. The multi-scale nature and complexity of these techno-social networks are crucial features in the understanding of these systems and the dynamical processes occurring on top of them.

We will discuss the central statistical features of these networks and their impact on epidemic, contagion and spreading processes in both the biological world and the ITC domain. We will present the development of realistic computational models based on the network paradigm and the reaction-diffusion processes framework that allows their theoretical understanding. Finally we will analyze the central role of complex networks thinking in the definition of predictive large scale computational approaches for the modeling of emergent disease spreading.

## A Schroedinger-like equation for the PageRank

Dr. Guido Caldarelli
University of Rome "Sapienza", Italy

**Abstract**

Computation of PageRank is usually made iteratively with a large use of computational time. In this paper we show that the PageRank can be expressed in terms of a wave function obeying a Schroedinger-like equation. In particular the topological disorder given by the unbalance of outgoing and ingoing links between pages, induces wave function and potential structuring. This allows to directly localize the pages with the largest score. Based on this analysis we also propose a model of growth of the WWW based on PageRank evaluation.

## Percolation and immunization of complex networks

Dr. Shlomo Havlin
Bar-llan University, Israel

**Abstract**

Statistical physics approaches are developed and applied successfully in recent years to understand the topology, robustness and function of complex networks. We will show how ideas and tools from percolation theory lead to novel results on the robustness, immunization strategies, optimal paths and minimum spanning trees. These results are relevant to many real world systems ranging from the Internet to social systems and climate. A novel percolation process which is characterized by

fragmenting the network by removing a minimal number of nodes will be also discussed. This result is useful for efficient immunization strategies. We will also discuss how one can synthesize novel materials in which light can be localized by modifying the network topology.

## Molecular models of the origin of life and biological evolution

Chin-Kun Hu
Institute of Physics, Academia Sinica, Taiwan

**Abstract**

In the talk, I first introduce molecular models of the origin of life and biological evolution with connected mutation-selection scheme proposed by Eigen [1] and the solution of a paradox about the origin of life with lethal mutants and truncated selection [2]. I then introduce Crow-Kimura model with parallel mutation-selection scheme [3]. Baake *et al.* mapped equations of the parallel model into a quantum spin model in a transverse magnetic field [4]. Recently, David B. Saakian and I did the similar mapping for the Eigen model [5]. Using Suzuki-Trottere formalism, we have studied statics and dynamics of the Eigen model and the Crow-Kimura model with the single-peak fitness function and found that the relaxation in the parallel model is faster than that in the connected model [5]. We have also studied both models with rather general fitness functions [5] and obtained error thresholds for various cases. For the Eigen model with nonzero degradation rate, we find a new phase which can represent virus quasi-species under attack by the immune system [6]. We also study the Eigen model with multiple peaks which can represent virus or cancer cells attached by drug or the immune systems [7]. Finally, we calculate the phase diagrams of a diploid biological evolution model and find new phases in which the final steady states depend on initial sequence distributions [8].

**References**

[1] M. Eigen, Naturwissenschaften 58, 465 (1971); M. Eigen, J. McCaskill, and P. Schuster, Adv. Chem. Phys. 75, 149 (1989).
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## Evolution of complex networks studies during the past 10 years.

Dr. Byungnam Kahng
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**Abstract**

During the past 10 years since the publication of pioneering papers on small-world and scale-free networks, explosive number of papers have been published in multidisciplinary fields. In my talks, I present how researches on complex networks have evolved during the past 10 years through the introduction of a growing co-authorship network in network science. Fractality is found to be distinct feature of the co-authorship network in the early stage of the evolution, which is hidden in the later stage. However, we find that it is still underneath the network structure as a skeleton when we remove inactive links. Dynamics on fractal scale-free networks is introduced, which proceeds slowly compared with the one on non-fractal scale-free networks.

## Analysis and modeling of large scale social networks based on mobile phone data

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**Abstract**

Recent development in information and communication technology has enabled to study networks of social interactions of unprecedented size. Such systems include email or phone networks and e-communities. In contrast to the traditional, questionnaire-based investigations, in these cases a natural quantitative measure of the strength of the interactions is present (like the frequency or duration of calls) leading to weighted network representations. One important observation is that this strength of the interactions varies over many orders of magnitude. A natural conclusion is that the weights play important roles both in the evolution of the network topology and in the dynamics of the processes on the networks. Based on simple rules borrowed from sociology we construct a model [1], where the emergence of the community structure is a consequence of the interplay between topology and weights. We show that the model reflects well the observations made on a huge call network [2, 3].

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## Complexity in brain function

Dr. Seunghwan (Swan) Kim
Pohang University of Science & Technology, Korea.

**Abstract**

TBA

## Component detection in complex networks

Choy Heng Lai
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**Abstract**

We study how to detect, in complex networks, groups or components each of which consists of nodes sharing a similar connection pattern. Based on the mixture models and exploratory analysis set up by Newman and Leicht, we develop an algorithm that is applicable to a network with any degree

distribution. The partitioning of a network suggested by this algorithm also applies to its complementary network. In general, groups of similar components are not necessarily identical with the communities in a community network: thus partitioning a network into groups of similar components provides additional information of the network structure. The proposed algorithm can also be used for community detection when the groups and communities overlap. By introducing a tunable parameter that controls the involved effects of heterogeneity, we can also investigate conveniently how the group structure can be coupled with the heterogeneity characteristics. In particular, an interesting example shows that a group partition can evolve into a community partition in some situations where the involved heterogeneity effects are tuned. The extension of this algorithm to weighted networks is discussed as well.

## Comparison of cellular networks by using dynamic-based measures

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**Abstract**

Cellular networks describe the relations between genes, proteins, metabolites and so on. The relations are physical, chemical or functional interactions. Comparison of cellular networks is one of the essential topics in systems biology, for example, one can gain deep insights into evolution by comparing networks of different species, or find cure solutions to diseases by comparing the diseased networks to healthy ones.

Structures and functions of cellular networks are bridged by dynamical processes occurring from micro- to macro- scales. To reach a reliable comparison we should compare simultaneously the patterns at different scales in a quantitative way. What is more, because we can not explore completely a cellular network, the resulting data are just some samples of the entire network. This incomplete exploration may also introduce noise to the resulting network, namely, artificial edges and losing edges and nodes.

Structures of networks determine the dynamical processes. The structures of complex networks can induce nontrivial properties to the physical processes occurring on them. The physical processes in turn can be used as probes to capture the structure properties. Well studied dynamical processes, such as the random walks and the Boolean dynamics, can be good candidates as probes.

In this talk we review briefly some of our recent works on this topic. The localization properties of electrons walking on networks are used to detect the structural characteristics of cellular networks. Totally eight protein-protein interaction networks are considered. It is found that the real world networks share some characteristics significantly different from some modeling networks.

## Experimental evidence for fragile to strong crossover in general glass forming liquids

Francesco Mallamace,
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**Abstract**

It is becoming common practice to partition glass-forming liquids into two classes, based on the behavior of an Arrhenius plot, log(η) vs 1/T where η is the shear viscosity. Strong liquids correspond to linear behavior while fragile liquids to have up word-curvature. Here we analyze the existing experimental data of the transport parameters (the shear viscosity, the self-diffusion coefficients and the density-density time relaxations) of 76 glass forming liquids. We show the data are consistent with the onset of an Arrhenius behavior for T below a crossover temperature Tcross, where η ~ 10^3 Poise, well above the glass transition temperature TG where η is of the order of 10^13 Poise for all liquids we study. We also show that below Tcross the Stokes-Einstein relation (SE) D/T ~ η-1 is replaced by a fractional SE D/T ~ η^(-0.65). We also note that ηcross ~ 10^3 Poise is far below the glass transition ηcross ~ 10^13 Poise. An important goal of our study is that the fractional SE (the variation with respect to temperature of the transport properties of all these glass forming liquids) gives clear evidence of a remarkable degree of universality.

## Universal behavior of rank-ordered distributions in arts and sciences

Gustavo Martínez-Mekler
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**Abstract**

During the past decade or so, a considerable amount of research has been devoted to power law behaviors, particularly with regard to complex networks. However, when real data is analyzed, in most of the cases the power law trend holds only for an intermediate range of values; there is a power law breakdown in the distribution tails. Both the breakdown point and the tail functional form are of interest. Several explanations leading to various power law correction schemes have been provided for this phenomenon, such as finite size effects, network dilution, network growth constraints and different underlying dynamical regimes. Here we uncover a universal behavior of the way in which elements of a system are distributed according to their importance with respect to a given property, valid for the full range of values, regardless of whether or not a power law has previously been suggested [1]. The two parameter function we propose for these rank-ordered distributions is a generalization of the beta distribution and gives excellent fits to an impressive amount of very diverse phenomena, coming from the arts, social and natural sciences. The parameters have the potential of providing a criterion for rough classifications.

Based on our phenomenological observations we have studied several models that generate data following our distribution. In some cases, under appropriate limiting conditions, we obtain the generalized beta functional form as a stationary solution. From the modeling and data analysis we have identified relevant features such as conflicting dynamics and convergence of multiple heterogeneous processes. The ubiquity of this functional universality suggests that there must be a general underlying explanation, most probably of a statistical nature. Some progress has been attained in this respect.

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## The social harmony equation based on social physics

Wenyuan Niu
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**Abstract**

Social Harmony Equation (SHE) leads the social system to the evolution direction of social entropy increase by accumulation of "social combustion substances", i.e., the accumulation of microcosmic "basic particles" (individual) in social system from assimilate "basic social energy" to dissimilated one; meanwhile, the catalysis of "social combustion promoter" (social excitation energy) has enhanced the "social temperature" of disordering process of social system and completed the energy accumulation of social entropy increase that can generate the transition. Finally, ignited by the "social trigger threshold", the social system has completed the abrupt change from orderliness to disorderliness. The continuous variation of the above-mentioned three basic nonlinear processes has jointly composed the whole contents of social combustion theory. Under the restriction of such conditions of different time ($t$), different space ($\alpha$) and different scale ($\beta$), it is finally explained as a comprehensive dynamics of social system deterioration.

## Self-organization and finite size effects of the stylized facts in economics in a workable agent based model

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and Institute of Complex Systems CNR, Roma, Italy

**Abstract**

The deviation from a Random Walk behavior in financial time series have been identified as Stylized Facts (SF) and are common to all markets. The main ones are that the fluctuations are much lager than those predicted from the standard economic theory (gaussian fluctuations), the clustering of volatility and a substantial nonstationarity of all properties. Many Agent Based Models have been proposed to explain these phenomena and many are indeed able to reproduce some of them. However the situation is still rather problematic becaus these models are typically rather complicated and with various ad hoc assumptions. This has prevented a systhematic study of these effects. We have tried therefore to define a workable Agent based Model (1), which would contain the essential elements, but in a mathematically simple and well defined framework. In addition we have considered some new important elements like the nonstationarity of the process with respect to the number of agents and the question of the self-organization. Namely why all markets evolve spontaneously towards the situation corresponding to the SF, considering that in all models this is restricted to a narrow range of parameters.

The SF are shown to correspond to finite size effects (with respect to time and to the number of agents N) which, however, can be active at different time scales. This implies that universality cannot be expected in describing these properties in terms of effecive critical exponents. The introduction of a threshold in the agents' action (small price movements lead to no action) triggers the self-organization towards the intermittent state corresponding to the SF. From these studies the herding phenomenon seems to be a crucial one beyond the standard theory as a triggering element of bubbles and crashs which develop spontaneously without a cause-effect relation. The model can also be used backwards to derive the strategies of the agents from the price time series. Other applications are under consideration like the problem of finite liquidity and the possibility that the reference fundamental price is subject to large fluctuations if one cnsiders that all markets are linked into a large network (2).

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## Mechanisms of systemic risk: contagion, reinforcement, redistribution

Frank Schweitzer
Chair of Systems Design, ETH Zurich, Switzerland

**Abstract**

The term 'systemic risk' commonly denotes the risk that a whole system consisting of many interacting agents fails. It is a macroscopic property which emerges from the nonlinear interactions of agents. In fact, 'systemic risk' already implies that the failure of the system cannot be fully explained by the failure of a single agent. Instead, one has to understand how such singular failures are able to spread through the whole system, affecting other agents. Here, in addition to network topology, dynamic mechanisms such as contagion (similar to epidemic processes or herding behavior), reinforcement (of prevailing trends), and redistribution (e.g. of load, stress, or debt) play a considerable role. The talk aims at categorizing some of the existing models in a common framework, first, and discussing a specific model of financial networks, afterwards, to elucidate the critical conditions for the breakdown of a system.

## Shortest path discovery of complex networks and the Internet: Some exact results

Gábor Vattay
Eötvös University, Hungary.

**Abstract**

Exploring the topology of large complex networks is a considerable research challenge. The main difficulty of mapping these networks is related to their dynamically changing structure and self-organized growth. The physical structure of the Internet is one of the best examples demonstrating the complexity of this problem. In the absence of accurate Internet maps, the complex systems and networking research communities started new efforts (see for example www.netdimes.org) to map the topology in a distributed fashion. These use methods based on local views of the network from several points and merge these views in order to get an accurate global map. Local views are obtained by evaluating a certain number of paths to different destinations by using specific tools such as traceroute. In a typical traceroute study, a set of active sources deployed in the network run traceroute probes to a set of destination nodes. Each probe collects information on all the nodes and edges traversed along the path connecting the source to the destination, allowing the discovery of the network. To a first approximation the route obtained by traceroute-like probes is the shortest path between the two nodes.

In this talk we present new results for the link and node discovery probability and for the number of links and nodes discovered by traceroute-like shortest path based methods in complex networks. Our most important finding is that the link discovery probability in real networks is several order of magnitude lower than it is predicted by the mean-field approximation. As a consequence, the number of discovered nodes grows much slower than expected. We demonstrate this in simulated growing complex networks, real Internet data provided by DIMES and in traceroute measurements done in the PlanetLab infrastructure. The result can also be applied for Peer-to-Peer overlay networks where the average number of Internet routers affected by the P2P can be estimated.

First we formulate the link discovery probability for randomly placed source and destination pairs in generic complex networks. In this case we recover exactly the mean-field approximation introduced by Dall'Asta, Alvarez-Hamelin, Barrat, V´azquez, and Vespignani. In the mean-field approximation the discovery probability $\pi_i=1-\exp(-\varrho_T\varrho_Sb_i)$ depends on the product of density of traceroute sources $ \varrho_S$ and targets $\varrho_T$ and the betweenness $b_i$ of the link. We show that the number of discovered links $N_d$ scales with the product of numbers of source $N_S$ and target $N_T$ nodes $N_d\sim N_TN_S$.

Then we consider various types of growing complex networks. In case of {\em tree networks} we give an exact closed expression for the link discovery probability and for the number of discovered links. We show that neither the discovery probability nor the number of discovered links follows the predictions of the mean-field approximation. Instead, the discovery probabilty depends on the sum of densities of sources and targets $ \varrho_S+\varrho_T$ and the number of discovered nodes is proportional with the sum of target and source nodes $N_d\sim N_T+N_S$. In case the number of probes is small compared to the number of nodes in the network $N_S,N_T\ll N$ the relations are linear with logarithmic corrections.

In case of a broad range of non-tree like growing complex networks we carry out large scale numerical simulations. Both the real number of discovered nodes and the mean-field estimates are calculated and averaged for many realizations. A linear scaling in the number of discovered nodes is observed similar to the tree case. Some deviations are observed and explained for low number of probes.

A similar study is carried out for the DIMES router data available at www.netdimes.org. The results are very similar to those observed in growing networks with similar degree distribution and mean degree.

Finally traceroute data measured in PlanetLab is analyzed. Both classical and Paris traceroute studies are carried out among about 300 PlanetLab sites. The number of discovered IP addresses and number of discovered links is averaged for randomly selected subsets of the nodes. The results confirm again the new type of scaling. This study can be considered as a prototype model of P2P networks where the number of discovered links and nodes can be interpreted as links and routers involved in forming the overlay network.

## Cavity Approach to the NP-complete Vertex-Cover Problem on a Random Graph: Ground-State Energy and Entropy

Haijun Zhou
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**Abstract**

The vertex-cover problem is a well-known nondeterministic polynomial complete (NP-complete) combinatorial optimization problem in theoretical computer science. Given a graph of vertices and edges, a vertex-cover consists of a subset U of vertices of the graph such that for each edge of the graph, at least one of its end vertices is in this subset U. The optimization version of the vertex-cover problem aims at constructing a vertex-cover of minimal size (one of the ground states). In this work, the vertex-cover problem on a completely random graph of mean vertex degree c is studied using the cavity method of statistical physics [1, 2, 3, 4]. We demonstrate that when the mean vertex degree c is larger than a critical value 2.718283, long-range correlations among the vertices of the random graph build up

and they make a simple warning-propagation algorithm fail to converge [2]. In the parameter range of c>2.718283, the ground-state energy and entropy densities of the random vertex-cover problem are estimated by the zero-temperature first-step replica-symmetry-breaking (1RSB) cavity method [1,3,4]. An efficient survey-propagation algorithm is also implemented to construct optimal or near-optimal vertex-covers for single random graphs [3].

Many other NP-complete combinatorial optimization problems can also be studied by the same cavity method. This work also presents a physical interpretation on why the random vertex-cover problem becomes computationally difficult when c>2.718283.

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