
Society for Chaos Theory in Psychology & Life Sciences
Dedicated to the development of nonlinear science worldwide
since 1991
Abstracts to the 3rd International Nonlinear Science Conference, Tokyo, Japan
2008

Message from the SCTPLS President and the INSC Conference Chair

Welcome to the 3rd International Nonlinear Sciences Conference (INSC). The INSC tradition started in February 2003, in Vienna, Austria and continued in March of 2006 in Heraklion, Crete, Greece. This year, Tokyo, Japan serves as the venue for our 2008 conference.

The Society for Chaos Theory in Psychology & Life Sciences (SCTPLS), as the primary organizer, is fortunate to be in alliance with Chuo University, Faculty of Commerce and the Japan Association for Evolutionary Economics (JAFEE) to bring you the INSC-2008. Our mission, like in previous years, is to gather to celebrate a global scientific and scholarly community committed to the study of nonlinear dynamics.

The event reflects a commitment on the part of our organizations to facilitate international collaboration and to encourage the cultivation of scientific partnerships across the globe. We are able to offer you a rich and varied program, covering a wide range of scholarly disciplines including theoretical as well as applied approaches. It attests to the international character of our scholarly community that we have presenters from many countries to share their work in nonlinear dynamics, including scholars from the U.S., Eastern and Western Europe and Asia. We hope that this conference will become part of a long-standing tradition of international scholarly exchanges, which surely will strengthen our nonlinear dynamical systems community, and in the long run influence our work.

I want to thank the INSC committees for their excellent work and dedication in making this conference a success! To all participants, thank you for honoring us with your presence!
I hope you enjoy the scientific exchanges as much as the exquisite beauty our venue has to offer.

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Keynote Speakers and Featured Presentations

Mittag-Leffler Distributions, Power-laws and Non-Self Averaging in Macroeconomics
Dr. Masanao Aoki

Dr. Aoki is a Professor Emeritus of the Department of Economics at UCLA. Field: Applied Macroeconomics. His research is focused on a new approach to macroeconomic modeling by means of jump Markov processes by specifying transition rates appropriately in the backward Chapman-Kolmogorov (master equation); solutions of master equations to obtain aggregate dynamic equations, and fluctuations by solving the associated Fokker-Planck equations. Modeling and analysis of multi-agent models to investigate such things as herding behavior and return dynamics, i.e., power-laws in share or stock markets; Modeling and analysis of multiple country models by state space time series technique; aggregation of economy with heterogeneous agents by neural network methods; adaptive learning algorithms.

Non-linear Dynamics of Motor Learning
Dr. Gottfried Mayer-Kress

Dr. Mayer-Kress received his doctorate in theoretical physics from the University of Stuttgart, Germany in 1864. The thesis was “On the persistence of chaos and order in nonlinear dynamical systems” under his advisor Professor Hermann Haken. Since that time he worked on different aspects of stochastic and chaotic systems in a variety of applications. During his post-doctoral studies at the Center of Non-Linear Studies and the Santa Fe Institute he contributed to the dimensional analysis of chaotic time series as well as to modeling the impact of missile defense on the strategic arms race. He held visiting professor positions at UC Santa Cruz and UI Urbana Champaign where he was the first (with Peter Jung) to introduce spatio-temporal stochastic resonance in two-dimensional excitable systems. Presently he is a faculty member in the department of Kinesiology at Pennsylvania State University. For the past years he has worked (with Karl Newell and Yeou-Teh Liu) as Adjunct Associate Professor in the Department of Kinesiology on a non-linear dynamical systems theory of motor learning. He is the founding editor of *Complexity Digest* since 1999; served as one of the editors of Nonlinear in Physiological Time Series Analysis, Springer, 1998; member of the editorial board of Princeton Series in Complexity and of the *International Journal of Bifurcations and Chaos in Applied Sciences and Engineering*. Editor of Dimensions and Entropies in Chaotic Systems - Quantification of Complex Behavior, Springer Series in Synergetics, Vol 32, Springer Verlag, Berlin, 1986.

Emergence, Cognition, and Collective Intelligence
Dr. William Sulis

Dr. Sulis received a B.Sc. (Hon) in 1976 from Carleton University, Ottawa; M.D. in 1980; M.A. in 1984; a Ph.D in 1989 from the University of Western Ontario, London, and a FRCPC in Psychiatry in 1984, from The Royal College of Physicians and Surgeons of Canada, Ottawa. He is Director of the Collective Intelligence Laboratory, McMaster University and has a practice in Geriatric Psychiatry. He is an Associate Clinical Professor in the Department of Psychiatry and Associate Member, Department of Psychology, McMaster University. He is past President of the Society for Chaos Theory in Psychology and the Life Sciences and is on the Editorial Board of *Nonlinear Dynamics, Psychology, and Life Science*. He co-directed a NATO ASI and co-organized a NATO ARW. He is an alumnus of the Summer School of the Santa Fe Institute. He has published 3 books and over 30 articles in the field of complex systems theory, neural networks, artificial life, emergence, and collective intelligence. He discovered transient induced global response stabilization and saliency in complex systems. Dr. Sulis has studied a range of complex systems models including tempered neural networks, cocktail party automata, random graphical dynamical systems and is currently developing a theory of emergence called archetypal dynamics which is being applied to the foundations of quantum theory. Emergence, Cognition, and Collective Intelligence Collective intelligence, the study of the problem solving capabilities of collectives of lesser agents, serves as a prototypical model for emergence and for emergent cognition. The social insect colony has been the most intensively studied class of collective intelligence systems, both empirically and through formal modeling. In this talk I will describe various key mechanisms thought to underlie emergent processes generally and to apply these ideas to empirical data from the study of social insect colonies. Particular focus will be on the processes of aggregation, task allocation, nest building, and stigmergy as observed in natural colonies.

Hippocampus Generates Duality of Chaos and Fractal in Episodic context
Dr. Ichiro Tsuda

Dr. Tsuda is a Professor in the Research Institute of Electronic Science (RIES), and the graduate School of Mathematics, Hokkaido University, as well as visiting Professor at the Dept of Mechanical Engineering, Osaka University. He is a member of the Center of Excellence (COE) in the Dept of Mathematics, Hokkaido University. He is also an Advisory Board of Complex Systems Institute at Kalamazoo College. He has published widely in the field of dynamical processes and the brain. His research interest is mathematical modeling of the higher brain function including memory dynamics, thoughts and inference processes, and also numerical studies of chaotic dynamical systems. He constructed a one-dimensional map for sufficiently explaining chaos and bifurcation structure in the BZ reaction, and found noise-induced order in such a model. He also constructed neural network models for dynamic associative memory and also for episodic memory, based on physiological data on class I neurons and different types of synapses, where he found a new dynamical state named chaotic itinerancy, and proposed its dynamics interpretation in terms of Milnor attractor. He is also an editor of scientific journals of *Neural Networks*, *Chaos and Complexity Letters*, New Generation Computing, and the *Journal of Cognitive Neurodynamics*, and also and advisory board of Chaos.

Invited Speakers

Characterizing and Understanding Dynamics in Reactive Heterogeneous Multi-Agent Systems
Hussein A. Abbass

Professor, Dr. Hussein Abbass is the Chair of Information Technology at the School of Information Technology and Electrical Engineering, University of New South Wales, the Australian Defense Force Academy in Canberra, Australia. He is the Director of the University Defense and Security Applications Research Centre and the Director of the Artificial Life and Adaptive Robotics Laboratory. He is the Chair of the Australian Computer Society National Committee on Complex Systems, the IEEE task force on Artificial Life and Complex Adaptive Systems, and a Chief Investigator on the Australian Research Council (ARC) Centre for Complex Systems (ACCS). He holds an Advisory Professor at Vietnam National University, Ho-Chi Minh city, and held visiting positions at Imperial College London and University of Illinois. He published widely on evolutionary games, learning and optimization, ensemble learning, and multi-agent systems - with a particular emphasize on air-traffic management, combat and security applications.

Systems and interactions have been modeled successfully using mathematics, which enabled us to grasp the problem that is being modeled and understand how we arrived at the solutions. Recently, a wave of research emerged in modeling problems using agents. Agent-based distillation (ABD) is a branch of multi-agent systems where agents are simple entities that behave using simple attraction-repulsion equations. An agent in ABD has its own psychological and social factors as well as its physical capabilities such as its ability to run, carry a weapon, and shoot another agent. ABD attracted attention in defense as a simple tool that was claimed to overcome the limitations of Lanchester Equations [a series of differential equations used in combat to estimate casualty rates] and model combat at a higher level of fidelity than the aggregate behaviour of Lanchester Equations. Despite that simulation of ABD systems opened the door to answer questions that abstract mathematical models failed to answer, understanding the dynamics of ABD is a daunting task. Moreover, the field of ABD has been facing criticisms from mathematicians that the underpinning theoretical framework is lacking. This talk will bridge the gap between game theoretic models and ABD. I will present a number of ABD models that we developed for modeling combat, violence and evacuation. The work focused on tackling some of the challenges mentioned above and overcoming them by (1) using granger causality and multivariate time series analysis to understand the dynamics of the simulation; (2) developing mechanisms to mimic known game theoretic models and contrast the ABD environment with well-understood mathematics; (3) using social network analysis to detect different type of dynamics in traditional two-player games and generalizing the results to understand the dynamics of more complex mixed games. From topology to dynamics of complex networks.

From Topology to Dynamics of Complex Networks
Hawoong Jeong Korea Advanced Institute of Science and Technology

Complex systems as diverse as the Internet or the cell can be described by networks with complex topology. Traditionally it has been assumed that these networks are random. However, recent studies indicate that such complex systems emerge as a result of self-organizing processes governed by simple but generic laws, resulting in inhomogeneous scale-free topologies strikingly different from those predicted by random networks. Such studies also lead to a paradigm shift regarding our approach to complex systems, allowing us to view them as dynamical systems rather than static graphs. I will review historical development of complex network studies, and discuss the implications of these findings on the error and attack tolerance of the Internet and the robustness of the cells. Also recent research activities especially on dynamical aspect of complex network will be presented, including large-scale data analysis of social networking service (SNS), robustness of biological networks and price of anarchy of transportation networks.

Coupling of Measurement Characteristics in Psychological Diversity
Irina Trofimova

Dr. Trofimova received and M.Sc. in 1988 from the Department of Psychology, Lomonosov Moscow State University, and a Ph.D in 1995 from the Institute of Psychology, Russian Academy of Science, Laboratory of differential psychology and psychophysiology. She was an Assistant Professor, in Moscow State Social University; Senior Scientific Researcher at Keldysh Institute of Applied Mathematics; Invited Lecturer at Moscow State University, Department of Psychology and Part-time Lecturer at Moscow Institute of Physics and Technologies. She was a founder and head of the Russian Synergetic Society, and an affiliate of the SCTPLS. At the Keldysh Institute she pioneered the modeling of Ensembles with Variable Structures (EVS) and she has studied models of functional diversity. In psychosemantic experiments, she discovered the phenomenon of projection through capacities. As part of her research in temperament she has developed a Compact version of the Structure of Temperament Questionnaire for use in organizational and educational settings. She has conducted 7 test-development projects. She co-organized a NATO ASI and a NATO ARW. She is Director of Psychological Services. Dr. Trofimova is the Administrator and Senior Researcher in the Collective Intelligence Laboratory, McMaster University. She has published 7 books and over 40 articles.

Workshop: Services, Sciences, Management and Engineering
Hidaka Kazuyoshi Tokyo Research Laboratory, IBM Japan, Ltd.

Services are playing an increasingly important role in the global economy, because of the growth of the service industry and the growth of service functions in the manufacturing

industry. In the past several years, by reflecting such economic trends, there has been the effort to establish new academic discipline called -Services Sciences, Management and Engineering (Services Sciences, in short). Major research issues in services sciences include service innovation management, technology to improve service efficiency, value proposition of the services, defining and measuring service productivity, testing services, risk management for service projects, operations research, computational organization theory, and methodologies and tools to improve service quality and efficiency.

Symposium 90: U-Mart Demo Session
Koyama Yuhsuke, Tokyo Institute of Technology, ***Taniguchi Kazuhisa*** Kinki University, ***Tadashi Yamada,*** Tokyo Institute of Technology,

U-Mart is an interdisciplinary research/ education project of a virtual futures market on computer for engineering and economics. Connecting the server and client via network, we can play the virtual futures market trading game (see http://www.u-mart.org/html/). We are going to show the demo of the U-Mart current system, which employs the Itayose method for the price determination and new system, which employs the Zaraba Method.

Symposium90: The Phenomenon of Synchrony in Psychotherapy Research
Tschacher Wolfgang
University of Bern, Switzerland, ***Nagaoka Chika*** Japan Society for the Promotion of Science, ***Ramseyer Fabian***, University of Bern, Switzerland

Synchronization phenomena are abundant in complex physical and social systems. Synchrony can be viewed as a universal concept in nonlinear systems science. These phenomena can be found on a variety of levels ranging from cell level (e.g. neuronal synchrony in the human brain) to mass phenomena (e.g. panic in a soccer stadium). This symposium focuses on cognitive and nonverbal synchrony in dyadic human systems and demonstrates novel approaches to the investigation of synchronization phenomena. W. Tschacher: Pattern formation is an important feature of self-organized systems. It was predicted to occur in dyadic therapy systems. This study evaluated the phenomenon and validity of increasing synchrony in psychotherapy courses. Assessments of synchrony were based on patients and therapists session reports. Factor-analytical measures and Landsberg's order measure were implemented (operationalized by increasing Landsberg order in initial versus final stages of psychotherapy courses). A sample of 30 therapy courses was recruited for the analyses. Significant increases of synchrony in therapy systems were found with all methods used. This synchrony effect was shown not to be attributable to response stereotypy of session report assessments or other trivial explanations. Synchrony was predominantly linked with interactional variables. C. Nagaoka: Body movement synchrony (i.e. rhythmic synchronization between the body movements of interacting partners) has been described qualitatively by the subjective impressions of skilled counselors, and has been considered to indicate the depth of the client-counselor relationship. A novel computer-based analysis was applied to evaluate body movement synchrony during psychological counseling. The intensity of the participants' body movement was measured using a video-based analysis with wavelet transformation. The time series change of the synchrony was analyzed using moving correlation of the intensity between the two time series. We analyzed four 50-minute psychotherapeutic counseling sessions and two ordinary advice sessions. The results revealed (1) the moving correlation coefficients were higher for the high evaluation group, (2) a consistent temporal pattern among the counseling cases, and (3) different temporal patterns for the counseling and advice sessions. F. Ramseyer: Previous studies of nonverbal behavior in social systems required a tremendous amount of manual coding, because nonverbal behavior has been traditionally investigated with observer rated categories. Objective quantitative approaches potentially provide new approaches to process measures of nonverbal behavior. Nonverbal behavior during psychotherapy was analyzed in terms of movement patterns from patients and therapists. Motion energy analysis (MEA) was carried out by an automated frame-by-frame examination of video sequences. This study investigated nonverbal synchrony between patient and therapist in video recordings of N=80 therapy sessions taken from separate dyads. A positive relationship between the amount of nonverbal coordination of patients and therapists with psychotherapy outcome was found. Discussion: The phenomenon of synchrony was found in diverse dyadic interactions. Different assessment methods showed a connection between favorable interpersonal effects and heightened synchrony. The empirical studies reported here demonstrate that predictions of complexity theory and nonlinear dynamical systems theory are relevant in the field of social interaction.

Symposium on Service Sciences,
Organizer Professor ***Namatame Akira***

Multidisciplinary works need to be done in managing complex service provision. After sharing some common knowledge to service-oriented systems, we discuss simulation and modeling for adaptive management of aggregated service provision on-demand in the Web/Grid environment and other service industries. It includes agent-based composition planning, service discovery, end-to-end quality-of-service monitoring. We will discuss with selected application scenarios in e-commerce trading, service contracting, applications on-demand, and supply network. In concluding remarks, we outline some open problems, further research and applicability of complex systems in different service oriented domains.

Hub Airport Location with Nonlinear Transportation Cost Function
Watanabe Daisuke, Tokyo University of Marine Science and Technology, ***Majima, Takahiro*** National Maritime Research Institute, ***Takadama Keiki,*** The University of Electro-Communications, ***Katuhara Mitujiro***, Hokkaido Intellect Tank, Japan

Recently, the transportation system has been greatly changed by competition because deregulation has been advanced all over the world. Especially, many of airlines adapt the hub-and-spokes system where economies of scale exist in the

transportation cost. In this paper, we analyze how the change of the transportation cost affects single hub airport location in the United States using the Weber problem which is to finds a location of a facility which minimizes the weighted sum of distances to a set of demand points. We formulate economies of scale using nonlinear cost function of distances and demands. We confirm economies of scale in both distances and demands from the parameters estimated by the actual transportation cost, and the elasticity of distances has decreased greatly while the elasticity of demands hardly changes. The location of hub airport will move to the east coast, which contains many large demand points as the economies of scale in distance become larger.

Toward Agent-Based Simulation on Marketing Behaviors for Service Science Studies

Terano Takao, Tokyo Institute of Technology, Yokohama, ***YamadaTakashi*** ,Tokyo Institute of Technology, ***Takahashi Masakazu***, GSSM Tsukuba, Inc., ***Nakao Toshiyuki***, Tokyo Institute of Technology ***Kishimoto Ariyuki***,Tokyo Institute of Technology ***Yokokawa Masaru,*** Institute of Technology

On the Service Science and Management Engineering context, we are developing a novel architecture to promote small long tail businesses using intelligent information recommendation systems. The main features of the architecture are 1) Dual-directed Recommendation system, 2) Portal site for three kinds of users: Producers, Retailers, and Consumers, which are considered to be Prosumers, and 3) gent-based implementation. Among them the paper focuses on the roles of agent-based simulation for marketing behaviors. Agent-based simulation (ABS) and/or agent-based modeling (ABM) are emerging technologies to uncover complex phenomena in the real world to bridge mathematical complex systems models and traditional descriptive models in the social sciences. In our ABS/ABM, marketing behavioral data gathered from Point-of-Sales (POS) information systems are integrated into marketing decision-making rules of individual persons. Then, we observe bottom-up phenomena emerging from agent-interactions and find new macro-level strategic decisions. Such a simulation model together with other techniques of complex adaptive systems will be new gears to promote SSME activities to real world problems.

User Social Interaction in Web BBS as Sandpile

Naruse Keitaro, The School of Computer Science and Engineering, University of Aizu, Japan
Kubo Masao, National Defense Academy

The objective of this paper is to investigate a social interaction mechanism among users in Internet, particularly in Web BBS. We often find long threads (a sequence of messages) and short ones, depending on subjects, even community members of BBS are almost same. In other words, we observe a different size of social phenomena (threads) yielded by local social communications (message interactions) in a same size of worlds (community members). It looks similar to self-organizing criticality (SOC), where a complex and nonlinear phenomena can be emerged from a cascade of simple local interactions. In this paper, we represent a social phenomenon in Web BBS taking the analogy to the sand pile mode: We associate a grain of sands as a motivation to post a message, and we interpret as a collapse of a sand pile at a cell as an actual message posting by a community member. Then, the size of cascading collapses corresponds to the length of a thread. For verifying the above analogy and modeling, we have evaluated how well the modeling can represent social phenomena in actual Web BBS logs. We have analyzed the relation between thread size, message distribution and modeling parameters, and the modeling results fit well to the actual logs significantly.

Searching for Better Layout of a Shop - Agent-based Approach Based on Video Analysis

Sato Hiroshi, National Defense Academy of Japan
Kubo Masao, National Defense Academy of Japan
Namatame Akira, National Defense Academy of Japan

Service Sciences is an attempt to introduce the knowledge of science and technology into the problems between consumers and providers. With the development of information technologies such as POS, RF-ID, and other monitoring system, providers can store tons of information of their consumers now. Video camera is the most popular tools among them and many stores already use it just for security. If we can extract useful information from the video data for marketing purpose, we can obtain strong marketing tool without additional equipments. In order to demonstrate the effectiveness of this approach, we build an agent-based simulator based on video-recorded customerβ s behavior in some store. By aggregation of the time spent at the front of specific products, we can estimate which properties of the products attract the customers. Random utility maximization model is adopted for modeling choice of the products. Random way point model is adopted for modeling moving around the store. Simulation results show that changing store layout can reduce the congestion and create a smooth flow in the store.

A Two-Sided Network-Effect Model for Service Innovation

Homma Koichi, Systems Development, Hitachi, Ltd.

Most complex systems, including biological systems and social systems, have a tendency to become more complex with time. Information and communication service systems are no exception. To stack a system layer is a typical way of the evolutional process of complex systems. Modeling the process of stacking a new system layer is an important approach to understand complex systems. In this paper, we discuss diffusion models for new information systems and services that are based on innovative technologies. In regard to such information systems and services, their diffusion is not a matter of course. There are so-called death valleys. Some invented technologies and services have become widespread, while others have not. Several mathematical models have been proposed to explain the bandwagon effect (or network effect) and the critical-mass mechanism. The most fundamental model of the network effect, Rohlf's model, interpreted the rapid and effortless growth of network products and services and their start-up problems. However, the model contains only one variable and insufficient for high-tech innovation these days. In this paper, we extend the Rohlf's model and introduce a potential field concept. The extended model has plural variables and explains two-sided network effect. As case studies, we apply the model to several innovative systems and

services. That is, electronic money systems, RFID tag systems, car-to-car communication systems, etc. We also discuss on the existing systems, such as the fax and bar-code systems.

International Comparison of Labor Productivity Distribution of Manufacturing and Non-Manufacturing Companies

Ikeda Yuichi, Hitachi Research Institute, ***Ishikawa Toshiko***, Hitachi Research Institute, ***Aoyama Hideaki,*** Kyoto University, ***Iyetomi Hiroshi*****,** Niigata University, ***Souma Wataru*** & ***Yoshi Fujiwara*** **NICT/ATR**

Considerable interest has been drawn for low productivity of Japanese non-manufacturing (service) sector, which was obtained based on macro economic study, among service science research society. In this paper, productivity distributions of firms are studied based on individual firms financial data for Japan, United state, United kingdom and China. First, labor productivity distributions of firms and sectors and the Pareto indexes are analyzed. Productivities of manufacturing and non-manufacturing sectors are estimated for the four countries and compared. Then, gross margin growth rate distributions of firms are analyzed. Correlation of growth rate of firms and macro economic quantities are clarified. Finally, Copula analysis of non-linear correlation of output and inputs of production function are analyzed. Contributions of total production factor, asset, and labor to the gross margin growth rate are estimated. This study will give basic understandings of productivity of non-manufacturing sector for service science research. Furthermore, Copula analysis of non-linear correlation will be important tool of service science research.

Symposium on Evolutionary Games and Complex Networks

Organizer: Professor ***Tanimoto Jun***

Evolutionary game on complex networks is one of the most interesting topics in various fields, such as nonlinear science, sociobiology, and other social sciences. As an archetype of the evolutionary games, arising cooperation and its maintenance might be the most important key. The emergence of cooperation in overcoming a dilemma has been explained by several theories. In terms of evolutionary game theory, Nowak classified five mechanisms that make cooperation © evolve instead of defection (D): kin selection, direct reciprocity, indirect reciprocity, network reciprocity, and group selection. Network reciprocity relies on two effects. The first is limiting the number of game opponents (depressing anonymity), which leads to a rise in mutual cooperation, and the second is a local adaptation mechanism, in which an agent copies a strategy from a neighbor linked by a network. These explain how C agents survive in a network game of Prisonerβ s Dilemma (PD), e.g., even though it requires agents to use only the simplest strategyβ either C or D. In the last few years, many studies have dealt with network reciprocity. Games on time constant networks including small-world, scale-free topologies have been discussed. Also, games on evolutionary networks (imply a co-evolution model for both strategy and network topology) attract much interest. Assortativity difference observed between human networks and bio-system networks is becoming a hot issue. Payoff matrix noise on a network game is observed to be much interesting and important, since the noise may enhance phase change from a defector dominant state to a cooperator dominant state, which occurs in a resonance-like fashion. In the proposed mini workshop, nominated six evolutionary game theorists respectively present the latest issues concerning the above-mentioned background, which can encourage fruitful discussion.

How to Set Payoff Matrices for Evolutionary Games on Heterogeneous Networks? (Invited speaker)

Masuda Naoki**,** The University of Tokyo

Interaction of social agents pretty often occur on complex networks that are not perfectly regular or random. This is true regardless of whether agents are spatially fixed or moving around in an arena, or whether the contact network is dynamic or not. On networks, the number of interaction in a unit time generally varies from agents to agents, representing heterogeneity in the contact rate, or equivalently, heterogeneity in the number of opponents. How cooperation could emerge in social dilemma games in such networks is a recent concern in interdisciplinary research communities. Until recently, standard evolutionary game theory mostly treated meanfield populations and regular networks and had not treated this problem. In this context, addition of a constant to each entry of a payoff matrix is irrelevant. Recently, it was shown that evolution of cooperation is promoted on heterogeneous networks such as scale-free networks. Hubs in a network earn more than non-hubs because they participate in the game more often than others. In this presentation, I show that addition of a constant to the payoff matrix considerably affects the dynamical consequences in this scenario. Particularly, when participating in the game is costly, non-hubs rather than hubs earn more and the prosper of cooperation through hubs breaks down.

Co-Evolution Model of Networks and Strategy in A 2 X 2 Game

Tanimoto Jun, Kyushu University, Fukuoka

A 2x2 game model implemented by co-evolution of both networks and strategies is established. Several numerical experiments considering various 2x2 game classes, including Prisoner's Dilemma (PD), Chicken, Leader, and Hero, reveal that the proposed co-evolution mechanism can solve dilemmas in the PD game class. The result of solving a dilemma is the development of mutual-cooperation reciprocity (R reciprocity), which arises through the emergence of several cooperative hub agents, which have many links in a heterogeneous and assortative social network. However, the co-evolution mechanism seems counterproductive in case of the Leader and Hero game classes, where alternating reciprocity (ST reciprocity) is more demanding. It is also suggested that the assortative and cluster coefficients of a network affect the emergence of cooperation for R reciprocity.

Cyclic Co-evolution of Cooperative Behaviors and Network Structures

Reiji Suzuki, Nagoya University, ***Masanori Kato***, NTT Communications Corporation, ***Takaya Arita***, Graduate School of Information Science, Nagoya University, Japan

There are many discussions on the evolution of cooperation on the complex network structures. Recently, the several studies clarified a strong impact, which the evolution of network structures has on the evolution of cooperation. Nevertheless, the clarification is based on the strong assumption that all agents adopt the same fixed rule for network modification. It must be recognized that each agent has its own strategy for modifying its neighboring network, and it evolves on the network. This paper aims at understanding co-evolutionary dynamics of cooperative behaviors and network structures of interactions. We constructed an evolutionary model in which each individual not only has a strategy for Prisoner's Dilemma to play with its neighbors on the network, but also has a strategy for changing its neighboring structure of the network. By conducting experiments with various settings of the payoff matrix, we found that the co-evolutionary cycles of cooperative behaviors and the network structures repeatedly occurred when both the temptation to defect and the cost for playing a game were moderate. The observed dynamics implies the dynamic aspect of the emergence and collapse of cooperative networks in a real world as follows: In the population of isolated individuals, the small clusters of the cooperators gradually grow and occupy the population. However, as they get matured in that individuals become highly connected, the network tends to be infested with free riders. The invasion by the free riders yields the mutually defecting population, and finally the whole network collapses.

Learning Games
Akiyama Eizo, Hanaki Nobuyuki & Ishikawa Ryuichiro, University of Tsukuba, Japan

This paper proposes a model of learning about a game. Players initially have little knowledge about the game. Through laying the identical game repeatedly, each player not only learns which action to choose but also constructs his personal view on the game. The model is studied using a hybrid payoff matrix of the prisoner's dilemma and coordination games. Results of computer simulations show when all the players are slow in learning the game, they have only a partial understanding of the game, but may enjoy higher payoffs than the cases with full or no understanding of the game; (2) when one of the players is quick in learning the game, he obtains a higher payoff than the others. However, all of them can receive lower payoffs than the case where all the players are slow learners.

Effect of Difference of Agent's Interaction on Collective Behavior
Iwanaga Saori, Japan Coast Guard Academy,
Namatame Akira, National Defense Academy, J

We deal with collective behavior, which is self-organized behavior as a whole in population, where each agent has own action rule and interacts each other. In our model, population is decentralized in that there is no central authority deciding which each agent acts. Agent is arranged on a lattice world and every agent acts, depending on its benefit function at the same time repeatedly. We clarify the relationship between collective behavior and (1) composition of population, (2) number of interaction and (3) structure of social network. At first, we show that collective behavior depends on the diversity of population. Secondly, we show that feature of collective behaviors are similar independent of number of interaction, and that collective behavior becomes unstable so that the number of interaction is large. At last, we show that collective behavior cannot estimate and collective behavior tends to be affected by choice and preference of hub agent.

Evolutionary Group Dynamics with Mutual Choice in Social Dilemmas
Yamashita Tomohisa, Information Technology Research Institute (ITRI)
Kurumatani Koichi, National Institute of Advanced Industrial Science and Technology (AIST)

In this research, we propose group dynamics that promotes cooperative behavior in the so-called Social Dilemmas and enhances the performance of systems. If cooperative behavior among self-interest individuals is established, effective distribution of resources and useful allocation of tasks based on coalition formation can be realized. In order to realize group dynamics, we extend the partner choice mechanisms for 2-IPD to that for N-person Dilemma game. Furthermore, we propose group split based on metanorm. As a result of simulations with an evolutionary approach, we confirm i) the establishment and maintain of cooperation, and ii) the enhancement of the performance of the systems consisting of self-interest players by group dynamics based on mutual choice in the Social Dilemmas.

Symposium60:
Direction of Coupling From Phases of Interacting oscillators: A Permutation Information Approach
Ghasemi Fatemeh, Bahraminasab Alireza, Stefanovska Aneta & McClintock Peter
Universitaet Muenster, Germany.

We introduce a directionality index for time series based on comparison of neighboring values. It can distinguish unidirectional from bi-directional coupling, as well as reveal and quantify asymmetry in bi-directional coupling. It is tested on a numerical model of coupled Van der Pol oscillators, and applied to cardio-respiratory data from healthy human subjects. There is no need for preprocessing and fine-tuning of parameters, which makes the method very simple computationally fast and robust.

Non-self Averaging of Avatamsaka Game with Different Forces

Aruka Yuji, Chuo University, **Eizo Akiyama,** Tsukuba University, Japan

In the Avatamsaka game Aruka(2001), selfishness would not be determined even if the agent selfishly adopts the strategy of defection. Individual selfishness could only be realized if the other agent cooperates. Any certain gain from defection can never be assured by defection alone. The sanction by defection as a reaction of the rival agent never implies the selfishness of the rival. Some attempt to analyze the memory effects to strategy deployment in an evolutionary game structure was shown in Akiyama and Aruka (2006). While Aruka (2002) applied a Polya Urn Process to this game to prove its convergence. In the latter attempt, we never took account of different forces (pay-off values) of defection or cooperation into analysis. We however have two type agents: D-type and T-type. But there may be a strong D-type and a feeble D-type; also a strong C-type and a feeble C-type. In the framework of indirect reciprocity, we have a variety of distribution of the same characteristics (types). The recent development of Urn Theory on stochastic process gives us a definite perspective on this issue. This view will be given by the idea of self-averaging. In this case, the absolute levels of pay-off of the game will affect the result of convergence. Aoki-Yoshikwa (2007) demonstrated when they criticized Lucas' representative method that Microsoft and small grocery store on the street face micro shocks drawn from the same unchanged probability distribution! In the light of Aoki-Yoshikawa (2007), we show the same argument in our Avatamsaka game with different forces.

The Fractal Organization of Transference, Defense, and Interpretation Understood as Temporal Metaphors

Borbely Antal**,** New York Psychoanalytic Institute

The main psychodynamic concepts in psychoanalysis are transference, defense, and interpretation. These have to be understood in their temporal function. Metaphor, a non-linear device and process, can be defined as understanding or seeing something located in one domain in terms of something else located in a different domain. Domains will here be defined not only semantically but also temporally. In psychoanalysis we understand the present experience in terms of past experience and
past experience in terms of the present one. Past and present are therefore metaphorically related to each other, irrespective of the expression of a linguistic metaphor. Such temporal metaphoricity constitutes, implicitly, the psychodynamic notions transference, defense, and interpretation. These temporal metaphors are shown to be fractally scaled. The ensemble of these temporal metaphors understood as temporal processes underlie the mind s functioning. Psychoanalysis, if reformulated from such a temporal metaphor point of view, is proposed as the basis for developing the still extant theory of the mind s complexity.

Reinforcement Learning in Auction Experiments

Chen Shu-Heng, National Chengchi University, Taiwan
Hsieh Yi Lin, National Chengchi University, Taiwan

In this paper, reinforcement learning (RL) is applied to model the learning behavior of human subjects observed in a series of auction experiments. The maximum likelihood estimator (MLE) is used to estimate a few different RL models, including a two-parameter one and a three-parameter one. In the two-parameter one, human agents' learning behavior is captured by the recency parameter and the attention parameter. In the three-parameter one, human agents' learning behavior is further captured by the intensity of choice. Our experiment designs with the estimated RL models provide us great opportunities to address two very fundamental questions in experimental economics. First, is learning behavior exogenous as naturally endowed or is it endogenous as determined or induced by the environment? Second, if it is exogenously given, does it matter? To address the exogeneity-or-endogeneity issue, we first examine the relation between market designs and the estimated learning behavior of individuals. We find that there is almost no evidence to support the effect of the market design on the observed learning behavior. Agents' learning behavior is not much affected by how the information is distributed among all agents. Neither is it much affected by how much information acquired by each agent. There is no significant difference across six different market designs and three agent designs. Given that learning behavior can be possibly exogenously determined, it does matter. We do find a significant pattern existing between the profit performance and agents' learning behavior. It is found that both recency effect and attention effect can contribute to the end result (accumulated profits). Agents with short-memory and focusing attention tend to earn higher profits than agents with long memory and diverse attention.

Can Agent-Based Financial Market Forecast? The Role of Agent Engineering

Chen Shu-Heng, National Chengchi University, Taipei,
Ying-Fang, National Chengchi University, Taiwan

It has been long asked whether agent-based model can be a useful tool for forecasting, instead of just replicate or grow the stylized facts. In other words, in addition to provide a bottom-up mechanism to explain the stylized fact as an emergent outcome, interests are further drawn to the prediction power of the same mechanism. The recent research trend seems to indicate that one can be cautiously optimistic about this possibility. This is particular so given the recent contribution by de Jong, Verschoor and Zwinkels (2006) and Manzan and Westerhoff (2007). In addition to that, we argue that there are at least two reasons to be optimistic. First, the bottom-up mechanism in the agent-based model behaves as a pool of many agents' forecasting, which is very similar to what known as the prediction markets or information markets. Second, the emergent behavior (the aggregate behavior) also behaves as a combination of different forecasts, which is, therefore, a kind of combined forecasts. In literature, evidences of the superiority of the prediction markets over the poll and other forecasts and evidences of the superiority of the combined forecast over simple forecasts already existed, while not necessary overwhelmingly. Therefore, it is anticipated that the agent-based model under a suitable construction process may lead

to some desirable outcomes. In this paper, we study the predictability of a kind of the agent-based financial models, namely, the n-type model. The n-type model is a generalization of the 2-type or 3-type models. There are n different types of agents. These agents may differ in various attributes. In this paper, we follow the essential spirit of the adaptive belief system proposed by Brock and Hommes (1997, 1998), and assume that these agents are differ in their beliefs or forecasts. A gradual approach is taken. We first start with a society of nave agents, which is frequently called zero-intelligent agents. Then the agent-based financial markets composing of these zero-intelligent agents will serve as a baseline model. The forecasting performance of this baseline model will then be compared with the agent-based financial market composed of various kinds of boundedly rational agents with incremental smartness or model sophistications, e.g., from linear models to non-linear models. In this way, we can address the question: the contribution of agent engineering to the forecasting performance of agent-based financial models.

Arts Skills, Development of Brain Engagement Structures, and Learning

Gardiner Martin, Brown University, USA

Learning and developing capability, for individual and social behavior, for verbal language, walking, mathematics, reading, writing, science, playing soccer, riding a bicycle, can require the learning of information, but always much more. The brain must develop structure for engaging with each area of skill, and must enlarge and continue to redevelop structure producing skill for capability to advance. This paper will discuss how the nature of capability implies that the associated brain structures must be complex and nonlinear to produce behavior not only beyond, but different from the sum of component contributions. It will be argued that capability can be and often is held back if students develop inadequate structures for engaging with skills they are trying to learn. How to aid the learning student to develop effective brain engagement structures is a critical problem for education at the present time. Experimental work to be reviewed shows that skill learning in music and other arts can interact valuably with broader academic and other skill learning. Such experimental observations can provide an important new general window on brain engagement structures and suggest important opportunity within education to help students develop advantageous brain engagement structures.

Leadership Emergence in Emergency Response Situations

Guastello Stephen, Marquette University
Doyle Meghan, Marquette University

It is well-known that leaders can emerge from leaderless groups. The process by which this phenomenon occurs requires NDS to explain, however. The interactions among group members eventually promote the self-organization of a social structure with primary and secondary leaders, and non-leaders. Previous research showed that the distribution of leaders is aptly described by the swallowtail catastrophe model, and that the control variables differ depending on the nature of the groups task, e.g. creative problem solving, production, or coordination-intensive tasks. The present study examined leadership emergence in a coordination-intensive task in an emergency response setting. Participants in the experiment were 225 undergraduates who were organized into groups of 4 to 12 participants; groups worked against an adversary using a board game, β The Creature the Ate Sheboygans Group size, group performance, and competitive behavior all contributed to the control parameters in the swallowtail model.

Plural Games Effect in Evolutionary Game Dynamics

Hashimoto Koh, **Aihara** Complexity Modelling Project, ***Aihara Kazuyuki***, The University of Tokyo

Evolutionary game theory is a basis of replicator systems and has applications ranging from animal behavior and human language to ecosystems and other hierarchical network systems. In evolutionary game dynamics, interactions among individuals are viewed as playing games and the frequency of players of each strategy increases and decreases according to their rewards. Its dynamics shows various kinds of behaviors and is used to describe evolutionary scenarios of many systems. Most studies in evolutionary game dynamics have focused on a single game. However, in many situations, we see that many games are played simultaneously. We construct a replicator equation with plural games by assuming that a reward of a player is a simple summation of the reward of each game. Even if the numbers of the strategies of the games are different, its dynamics can be described in one replicator equation. By investigating structures of invariant manifolds in the phase space of the replicator equation with plural games, we here show that when players play several games simultaneously, the fate of a single game cannot be determined without knowing the structures of the whole other games. As a result, studying by focusing on only a single game sometimes leads to incorrect consequence about the behavior of the game when players play other games. The most absorbing fact is that even if a single game has a ESS (evolutionary stable strategy), the frequencies of strategies in the game does not always converge to the ESS point when other games are played.

M &As Analogies to Collisions of Physical Objects

Harkiolakis Nicholas, Hellenic American University, Greece

An analogy will be presented between a physical phenomenon in the natural world and the phenomenon of mergers and acquisitions in the social world. A review of 30 major M & A projects of the last 15 years combined with current and past research indicates an easily identifiable pattern between them resembling plastic collisions in nature. Characteristics of the physical phenomenon involve the creation of a new object that by analogy corresponds to the merged organization, the release of energy that by analogy corresponds to the losses during the integration process, and a velocity vector that correspond to the direction and magnitude of growth of the business. The simplistic analogy is further analyzed with the breakdown of each organization in its constituent entities that among others include management, manufacturing and production, distribution channels, sales and marketing, human resources, information systems and organization culture. Success and failure of a M & A can be attributed to misalignment of the corresponding entities that during the β collision β process can easily contribute positively or

negatively on the final outcome. Selected cases for both successful and problematic M&As from the real world will be analyzed and presented.

Multimodal Modeling in Review

Horlacher Gary, University of Southern California

Nonlinear science extends scientific methods to deal with nonlinearities including variant rates of change, discontinuous change, multi-directional change, and reciprocal causality. Catastrophe theory focuses on discontinuities and involves bimodal and trimodal distributions. Cobb, Koppstein, & Chen (1983) illustrate how unimodal probability density families (e.g. normal, gamma, beta) are special cases of a broader range of multimodal density distributions. They suggest that multimodal density functions require fewer parameters and are often more appropriate than mixture of normals (or other unimodal) densities. Only a few scholars have followed the suggestion of Cobb, et al., whereas much has been done in extending and applying mixture models. Mixture densities are especially useful in searching for latent classes and are an important part of the exploding field of structural equation modeling (SEM) techniques. This is the first of a two-part presentation aimed at extending SEM to use multimodal probability density distributions. This presentation prepares the foundation for this extension. Applications using the mixture method to model bimodal and trimodal data are reviewed. The mixture approach is then compared with the multimodal distribution approach. This presentation illustrates the importance of the latter method.

Mathematical Model of Hit Phenomena and its Application to Movie Advertisement

Ishii Akira, Tottori University, ***Yoshida Narihiko***, The University of Digital Contents, ***Hayashi Takafumi***, Tottori University, ***Umemura Sanae***, Tottori University, ***Nakagawa Takeshi***, Dentsu Inc., Japan.

The mathematical model for phenomena of hits of music, movies, books, TV drama and other similar entertainments are presented as non-equilibrium, dynamical and nonlinear phenomena. The model includes not only the direct communication but also the indirect human communication factor as non-linear effect. Using the mathematical model of hit phenomena with real data of the media advertisement in the daily TV program as advertisement factor, we can reproduce the number of daily audience and the number of daily blog comments for the real movie hits in 2007 at Japan.

Interdisciplinary Matrix in Economics

Jakimowicz Aleksander, Nicholas Copernicus University, ***Michalska Elzbieta***, Getin Bank, Poland

An integrated methodological position, which I have called the interdisciplinary matrix, allows us to bridge the gap between economic theory and reality. To coin the name for this new approach I drew on the Kuhnian language, which includes the notion of disciplinary matrix. There are three components of the matrix on which the existence of scientific communities hinges. These are symbolic generalizations, models and exemplars. In this context the term paradigm should refer to exemplars. The scientific developments have recently brought substantial changes in the structure of scientific communities. Scientists are no longer united only around the subject of their research, but also around the methodology they employ. The interdisciplinary matrix I have defined has four components: cybernetics, catastrophe theory, deterministic chaos and the theory of complexity. Since phenomena and processes which occur in various disciplines of science are isomorphic, the importance of interdisciplinary studies cannot be overestimated. Transferability of ideas and thoughts contributed to the creation of scientific communities, which unite representatives of various professions. Additionally, a new type of scientific journals emerged where papers from various scientific disciplines are published, for example Chaos, Solitons and Fractals or International Journal of Bifurcation and Chaos in Applied Sciences and Engineering. It is no longer surprising for anyone that a study on fractal theory in finance is published right next to a paper on black holes. When researching into certain phenomena we no longer need to develop theories for them as we can draw on the achievements in other disciplines. I take the view that current economic processes may not be fully explained unless reference is made to the 21st century developments in physics. The article pictures an example of an economic transformation model. When applied, most of the methods which have been proposed will add new value to and expand the knowledge of the economy.

A Foucauldian Perspective of Agency in Complex Human Systems: Implications for Management Practice

Jean Matthews, Glamorgan Business School, UK
Paul Thomas, Glamorgan Business School, UK

Complexity poses a challenge to the control-based paradigm of mainstream management practice promoting a micro-interactive perspective of the organization as a self-organizing complex adaptive system. The rationale behind this paper is to advance management thinking by gaining a better understanding of agency in complex adaptive systems and how agency engenders self-organization, emergence and co-evolution. The paper combines the discourses of Complexity with the post-structural school of thought, exploring the relativist conjectures of Michel Foucault whose portrayal of the social system as systems of circulating discourse emulates the characteristics of the complex adaptive system. Foucault's perspective of agency offers a relativist framework for complex adaptive systems, accepting that whilst agent subjectivity generates diverse concepts of reality rules emerge as a discursive construction, creating a negotiated and legitimized order. Discourse hence, is not fixed, but continually under the perturbation of agency, micro-level resistance and struggle that perpetuates a power differential within the system. The implication of Foucaultβ ³ work for management practice is that the power differential is essential to engender the adaptive tension that keeps the complex adaptive system operating at a far from equilibrium position, stimulating fractal patterns of self-organizing behaviour and thus maintaining system viability. The significance for management practice is that whilst a discursively constituted system continually competes it questions the belief that system equilibrium should or could ever be achieved through any control based discourse that seeks to repress this creative potential.

Simulation Capability of A Gene by Employing Chaos Having L=4

Jiguo Dong, The University of Electro Communications, ***Takako Yamada*** & ***Katsufusa Shono***, Kwansei Gakuin University, Tokyo

4 value (AGTC) combinations of a gene can be recognized as the time series of $Y_{t,1}$ that are a random combination of (0,1,2,3), obtained in the chaos having L=4. By synthesizing a logistic map, $x_{t+1}=4x_t(1-x_t)$, having Lyapunov exponent L=2 of $\lambda=\ln L$, chaos with L=4 was generated. The internal states x_t calculated by a fixed point calculation capability of 128 bit have a distorted distribution and by giving a nonlinear quantization into $[L^n]$, where L=4, n is a quantization resolution less than 32 and [ ] eliminates a small number, the integer time series $Y_{t,n}$ of 0~ $[L^n]$-1 were obtained. For the simulation of a gene, $Y_{t,1}$ of a random combination of (0,1,2,3) can determine a mapping function. The prediction capabilities were confirmed by comparing the backward calculation accepting $Y_{t,1}$ for determining the signs and the forward calculation producing $Y_{t,1}$ after the quantization of the synthesized logistic map. Convergence, divergence and bifurcation on the quantized time series $Y_{t,n}$ were uniform and the initial value sensitivities disappeared for the quantized observation of chaos having an integer L. The internal states x_t of 128 bit are compressed into $Y_{t,1}$ having 2 bit in each and the expansions are giving by the reverse calculation of the synthesized logistic map by selecting the signs given by $Y_{t,1}$.

Can Circuit Breakers Decrease Profit Disparity? Gini Coefficient Analysis of Artificial Market with Circuit Breakers

Kobayashi Shigeto & ***Hashimoto Takashi***, Japan Advanced Institute of Science and Technology

In various stock markets, there is a system called “circuit breakers” that interrupts trading of stocks for a certain period when stock price changes greatly. The purpose to introduce this system is to directly control rapid changes of stock prices and to evade a confusion of the market. Our previous work showed that circuit breakers reduce the volatility greatly when market liquidity is low. On the other hand, the circuit breakers have a small effect for market stabilization under high liquidity. In this paper, we study the influence of the circuit breakers on a stability of a market by operating the period of interruption and the ratios of random agent using an artificial market simulator “U-Mart” . For analysis, we observe the change of Gini coefficient, which indicates the degree of profit disparity among agents. We show that the Gini coefficient among agents decreases as the period of interruption increases. This result supports our finding that the circuit breakers prevent the maldistribution of profits and the destabilization of the settlement system under high liquidity. We also discuss the correlation between the time development of the Gini coefficient and the change of stock price in order to further to clarify how circuit breakers work in a stock market.

Computational Study on Joint Visual Attention How with Intentional Agency by Serial Architecture with Goals and Means

Konno Takeshi & ***Hashimoto Takashi***, Japan Advanced Institute of Science and Technology

Infants’ communicative eye gaze, particularly joint visual attention (JVA) which is defined as “looking where someone else is looking”, is noticeable behavior as the appearance of elementary ability of inferencing others’ intention. In the acquisition of JVA, it is pointed out that the inference ability develops based on intentional agency. If an infant acquires the intentional agency, the infant possesses own goals and selects means appropriately in order to attain the goals. In this paper, we study the acquisition of the intentional agency by constructing a computational model of JVA. We design a model of infant agent, which learns JVA through interactions with a caregiver based on visual orientation, which is a reflex behavior of gazing at an object. The learning is implemented with an association module, which accumulates relationships between caregiver’s eye directions and objects seen after the caregiver. We reveal that a serial connection of the association module with the visual orientation module enables JVA with the intentional agency. In the serial architecture, the agent can use the visual orientation as a means appropriately in order to attain the agent’s goal to gaze at an object that is an output from the association module. Through the analysis of the computational model, we confirm that the association module performs two functions in order to produce the agent’s goal. One function is to configure the predictive stimuli based on the regularities in the agent’s experiences to gaze at the caregiver’s eye directions followed by gazing at the objects. The other is to compare the output from the association module with the following three stimuli one bye one, the current visual stimulus, the current output from the association module, and the predictive stimuli.

Comparison of Search Strategies Based on Random Walk and Levy Flight

Koyama Hideaki, National Defense Academy of Japan
Namatame Akira, National Defense Academy of Japan

What is the best strategy for efficient search of randomly located targets? This question has been studied in many fields. Recently it is reported that Levy Flight search is more efficient than Random Walk search in sparsely target site. On the other hand, when target sites is not sparsely and it is dense, Random Walk search is more efficient. It has not also been argued that efficiency of searching when target is moving. In this study we have comparison study of Random Walk and Levy Flight. And we compare efficiency of searching of Random Walk and Levy Flight. At first, we experimented that influence of changing percentage of target sites in number of steps until which reaches target site. Secondly, we experiment that whether the change appears in detection efficiency when the target site is moving. As a result, regardless of stationary and moving, we are able to appear that the detection efficiency of Levy Flight far exceeds that of Random Walk under sparsely target site. However, when target sites are dense, the difference of the performance between Random Walk and Levy Flight become small.

Challenges in Prediction of Population Dynamics
Medvinsky Alexander, Institute for Theoretical & Experimental Biophysics, Russia

Complexity in ecological systems often prevents long-term predictions about changes in population size and properties of the population dynamics. Mathematical modeling of such complex system behaviors can provide a rough idea of scenarios of the population dynamics. I discuss the challenges in prediction of the dynamics. The case studies of the complex model dynamics of aquatic communities in a heterogeneous environment are given. The work was partially supported by RFBR.

How Social Structure Emerges by the Heterogeneous Agents about their Deductive Reasoning Ability
Ogawa Kazuhito, Osaka Sangyo University, ***Kawamura Tetsuya***, JSPS Research Fellow, ***Masumoto Gen***, Kyoto Sangyo University, ***Kobayashi Yohei***, & ***Yoshino Yusuke***, Kyoto University, Japan

This paper examines that how agents whose reasoning abilities are finite create an order in a society. Our motivation comes from two seminal studies. First is Hayek (1948), wherein he discussed that bounded ability agents' activities brought about an order spontaneously. Second is Aoki (2001) and his latest studies. According to Aoki, an institution comes into the world as a result that a person thinks that all the people follows a rule and other people do so. Although it is natural to assume that peopleβ s reasoning ability is finite, economists began to notice the reasoning ability only in late years. A lot of researchers have dealt with the relationship between the reasoning ability and economic consequence since Bernheim (1984). These studies investigate the relationships between human reasoning power and the characteristics of Nash equilibrium. However, because of modeling complexity, the investigation of the effect of agents' reasoning ability on the stability of social structure in the game with multiple equilibria or with no pure strategy equilibrium still remains. We model the situations wherein agents face with strategic complement or substitute environment. We suppose that agents are myopic, but that they have the reasoning ability about how the opponents behave. That is, agents guess each otherβ s choices and offer best response to their guess in each period. In modeling agents' bounded deductive reasoning power, we mainly utilize Camerer's cognitive hierarchy concept, which is affected by Haruvy and Stahl's series of studies. This concept assumes agents with high and low reasoning ability. The high ability agents can foresee how the low ability agents behave, although high ability agents cannot foresee how other high ability agents behave. Following is the simulation result. The increase in the proportion of agents whose reasoning ability is relatively higher than other agents means the increase in the proportion of agents who can foresee the opponents' behavior and the decrease in the number of low ability agents. Latter means the decrease in the number of agents whose behavior can be foreseen by high ability agents. Therefore, agents cannot offer best response to other agents' behavior and the social structure fluctuates. Although you may easily think that the increase in the number of clever agents stabilizes social structure, our result suggests the possibility of the inverse scenario.

Time-Scales of Stability and Variability in Coordination Learning: Effects of Concurrent and Terminal Feedback
Porter Jared & ***Hong S. Lee*****,** Louisiana State University
Magill Richard**,** New York University

Acquiring a novel coordination pattern is often viewed as the stabilization of an attractor, a process that is influenced by behavioral information. The experiment examined the practice and retention of a 90° relative phase bimanual pattern acquired with concurrent (during-trial) or terminal (post-trial) feedback. We examined the intra- and inter-trial variability of the coordination mode during practice and retention, distinguishing between learners and non-learners. Practice significantly reduced intra-trial variability of the coordination mode in all except the non-learners within the terminal feedback group. Inter-trial stability of the coordination mode increased with practice, but only in the learners within the terminal feedback group. During retention (no feedback provided), the terminal feedback group possessed higher inter-trial stability of the coordination mode that decreased significantly to a level equivalent to the concurrent feedback group when the movement frequency was raised from 1 Hz to 1.5 Hz. Intra-trial variability during retention was similar across the groups for the 1 Hz movement, but was significantly higher in the terminal feedback group at 1.5 Hz. Our findings show that terminal feedback affords greater stability to the coordination mode, though it does not become more resistant to an increased movement frequency. In sum, the stabilization of the coordination pattern with practice occurs primarily along the time-scale on which the behavioral information is provided.

Synchronization Between the Regulatory Processes in the Human Cardiovascular system
Prokhorov Mikhail, & ***Ponomarenko Vladimir*****,** Institute of Radio Engineering and Electronics, ***Gridnev Vladimir*** & ***Kiselev Anton*****,** Institute of Cardiology, Saratov

Complex rhythmic processes interacting with each other are typical in living organisms. As a result of nonlinear interaction these self-oscillating processes can become synchronized. The presence or absence of synchronization between the rhythms can reflect healthy dynamics. The aim of our research is to study synchronization between the processes of slow regulation of heart rate and blood pressure having in humans the fundamental frequency close to 0.1 Hz. We studied healthy subjects and patients after acute myocardial infarction. The electrocardiograms and blood pressure signals were simultaneously recorded in a horizontal position. For the patients the recordings were performed during the first three days and the third week after the infarction. To derive the 0.1 Hz rhythmic components of the signals we used band-pass filtration. Then we calculated the instantaneous phases of the signals using the Hilbert transform and analyzed their synchronization. We revealed that synchronization of 0.1 Hz rhythms is high for healthy subjects and is low for patients. The total duration of synchronization regions at the third week after infarction was in 1.5 times higher on the average than at the first week after infarction for the same patients. The overall value of the research is the reception of new information. We have shown that parameters of synchronization between the considered rhythms of the cardiovascular system can be used for diagnostics of its state and control of the efficiency of treatment.

Measuring Leadership Talent and Training Leadership Ability

Silfwerbrand Lykke, & ***Edvinsson Leif***, Lund University, ***Mattson Anders***, Crisis Management Support, Sweden

This paper is a part of a doctoral study named “Leadership in a crisis”. This paper proposes a way to a) measure the human talent leadership and b) training the ability for leadership, regarding individuals as well as leadership teams. The same simulation should be used for measuring and training. The simulation system uses intelligent agents based on HLA, IEEE 1516, for easy scaling, interoperability and reuse. The tool for measuring leadership is functional Magnetic Resonance Imaging, fMRI, which registers brain activity over time. Correctly stimulated the brain activity reflects the leadership talent. The system for stimulating leadership talent and the system for training of leadership ability should be the same tool, adapted to the demands for use with the fMRI tool. The system simulates small groups of people with group leaders. Each simulated individual, not just the subjectsB´ agent, is represented as an intelligent interface agent with fuzzy logic added. The agents are allowed to do mistakes but are intelligent enough to correct them over time. The fuzzy logic represent firstly, an incomplete and partly faulty picture of the leadership situation, which is common in real life, and secondly, the irrational actions that people sometimes have when stressed or confused and act emotionally. Several groups of simulations should easily be interconnected and the area of awareness per leader adapted to the purpose of the simulation. This tool can be a part of the Virtual Arena for crisis leadership training talent. The system for stimulating leadership talent and the system for training of leadership ability should be the same tool, adapted to the demands for use with the fMRI tool. The system simulates small groups of people with group leaders. Each simulated individual, not just the subjects-agent, is represented as an intelligent interface agent with fuzzy logic added. The agents are allowed to do mistakes but are intelligent enough to correct them over time. The fuzzy logic represent firstly, an incomplete and partly faulty picture of the leadership situation, which is common in real life, and secondly, the irrational actions that people sometimes have when stressed or confused and act emotionally. Several groups of simulations should easily be interconnected and the area of awareness per leader adapted to the purpose of the simulation. This tool can be a part of the Virtual Arena for crisis leadership training.

Visualizing Footprints of Chaos

Shimonishi Kazeto & Iba Takashi, Keio University

In this paper, we propose a new method for visualizing behaviors of a non-linear function. In this method, which we call the method “Footprint of Chaos”, the value generated by the function is converted into an angle. Therefore, the trajectory can be understood as a visual pattern on 2-dimentional plane. As results of simulation experiments, we can observe the obvious differences between the periodic area and the chaotic area. Moreover, the mixture of periodic and chaotic patterns are found in the edge of chaotic area. The proposed method is useful for understanding complex trajectory of nonlinear dynamics visually.

Testing Nonlinear Hypotheses in Neo-Piagetian Theories

Stamovlasis Dimitrios, Ministry of Education, Greece

In the current study is part of a research work which is working toward is made in building bridges between nonlinear dynamical system (NDS) theory and Neo-Piagetian framework. Cognitive variables provided by neo-Piagetian Theories, such as, *M*-capacity, logical thinking and field-dependence/ independence are tested as control variables in nonlinear models. Theory-driven hypotheses are tested with data from physics education problem solving and cusp catastrophe models are proposed which accounts for discontinuities in students’ performance. Data from students’ achievement scores in physics at high school level were measured at two points in time, and were analyzed using dynamic difference equations and statistical regression techniques. The cusp catastrophe model proved superior comparing to the pre-post linear counterpart. Besides the empirical evidence, theoretical analyses are provided, which attempt to build bridges between NDS-theory concepts and science education problem solving and to neo-Piagetian theories as well.

A Critical and Intermittent Finite Automaton in Mesoscopy

Takahashi Tatsuji, & Gunji Yukio-Pegio, Kobe University Japan

For a functional network, it is important to stay critical. If it is supercritical, it just produces synchronized states with no value, while a subcritical network prevents information propagation. We present a new self-organizing model with only one small finite automaton interacting just with itself, with no parameter. The interaction is mesoscopic, in between micro and macro, where parts and the whole are inseparable. The model shows intermittent and critical behavior, which has been heretofore realized by the collective dynamics between simple elements as in the models of self-organized criticality (SOC). The indivisibility of parts and the whole have been discussed everywhere in biology. In the SOC models, it is the consistency between parts and the whole, which atemporally holds, with global condition reflected in every local site. For example, in Bak-Sneppen model of co-evolution, only the least adapted species is eliminated. To realize this dynamics, every species needs to know if it is the least adapted or not. Each species looks over the whole collection of the species. In self-organizing map, winner-take-all dynamics assumes the same condition, which is hard to practice. SOC has removed the necessity of finely-tuned parameters to bring a system critical. Our model has got rid of the globality in SOC models, replacing the global consistency with a more actual assumption that every local element partially refers to the global information and so changes itself. We believe our work may have significance in engineering as well.

The Embedding of the Heartbeat of The Bullfrog Revealed an Extraordinary Low Dimensional Phase-Space Trajectory

Tanaka Katsunori, & ***Yazawa Toru***, Tokyo Metropolitan University, ***Katsuyama Tomoo***, Numazu National College of Technology,

The heart rate is always changing in response to the environment. The dynamical changes can be explained by physiological changes of the central nervous system (CNS). To study the dynamical system, we usually watch the behavior of nerve cells, which control the heart. We assume here, that the heart is an output from the CNS (the heart exhibits the Poincare section and the CNS is the large-scale dynamical system for example). Normally the degree of freedom for the heart rate is considered to be high. Therefore the Poincare section at a low dimension is not simple to see. However, we discovered that the Poincare section of the bullfrogβ s heart beat data was extraordinarily simple: Because the data was embedded by us into the phase space as low as three in dimension. Furthermore, we discovered that the attractor in the phase space did not change its configuration, when the environment temperature was altered. Life has a fundamentally temperature-independent bio-control mechanism.

Risk Assessment of Occupational Noise Exposure

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According to the European directive (2003/10/EC) in the risk assessment of noise the following points must be taken into account: 1. the level, type and duration of exposure, including any exposure to impulsive. 2. The effect of susceptibility. 3. The combined effects of noise and work-related ototoxic substances, and of noise and vibrations. All these points have are known at qualitative level, but no dose-response relationship has been established. The ototoxicity of all chemicals is not known. In animal studies indicate that there may be an interaction between smoking and exposure to ototoxic chemicals. Finally ageing has a strong effect to hearing. We studied the hearing loss among 255 male professional fiberglass reinforced plastic boat employees. For each worker the noise exposure, hearing thresholds, styrene exposure and individual susceptibility factors (blood pressure, smoking, use of painkillers and white finger disease) were collected. The hearing thresholds were adjusted to age using z-transform. The workers were divided into laminators, which were highly exposed to styrene and non-laminators, which had a lower styrene exposure. The analysis showed that both groups had a worsened hearing. For laminators the worsening was due to styrene exposure and for non-laminators prior exposure to noise were the major causes for worsened hearing. Preliminary analysis using decision tree techniques suggests that smoking workers are the most susceptible ones. The decision trees showed to be a useful tool to find relationships in small populations. However the major difficulty seems to be the preparation of raw data to analysis.

The Ecology of Education: Toward an Organic Paradigm

Torre Carlos A., Southern State University/Yale Univ.

The concept of ecology serves as a new organic paradigm for perceiving, studying, and explaining complex educational processes as well as for predicting possible courses of action and outcomes of these processes. Underlying this ecological approach is the assertion that human nature is amiss with life in schools because these are, often, artificial environments that run counter to our genetic make up. Findings in Anthropology, Biology, Psychology, Ecology; and other disciplines corroborate that our biological heritage is essentially that of pre-industrial, pre-agricultural humans who lived in small, interdependent, egalitarian bands/ clans. Consequently, we do poorly in large formal bureaucratic hierarchies with their one-way impersonal communication, lack of democratic process, and dehumanizing factory or business metaphors used so commonly to organize and manage schools, their curricula, and students. To be effective, pertinent, and efficient, schools need to develop ways of meeting biological needs once provided for by our natural environment. That is, schools must cultivate ways to re-create small, band-like collaborative groups that can fulfill our prerequisites for successful human development: a sense of belonging, recognition, respect; feeling competent, included, trusted, and dependable; feeling that others are reliable and that we influence our own learning process. I'll discuss how such nonlinear and human sciences as ecology, environmental psychology, complexity, fractal geometry, and anthropology can help us perceive education in ways that allow us to reclaim and understand our biological prerequisites for effective development as well as apply this understanding to the complex realities of our agricultural, industrial, and post industrial world.

The Heart Mind Connection: Physiology, Emotions, & the Readiness-to-Learn

Torre Carlos A. Southern State University/Yale Univ.

Through the use of Holter monitors and Recurrence Quantification Analysis (RQA)s, my research seeks to identify characteristic patterns, in the autonomic nervous system, associated with specific emotions. Emphasis is on the complex nature of thinking, problem-solving, teaching/learning, and the effects of language and culture on these processes. This experimental study examines how different educational processes and activities mediate the experience of emotions and how these emotions encourage or restrain children's ability to learn. Specifically, it explores the emotions that a combined group (n=12) of monolingual (English) (n=6) and bilingual (Spanish dominant) (n=6) kindergarteners experienced as they went through three different kinds of teaching methodologies - purposely conducted in English- while wearing Holter monitors to detect their individual heart-rate variability (HRV): 1) cognitive (learning numbers, colors, shapes, textures); 2) affective-perceptive (listening to a story and talking about their favorite parts); and 3) pragmatic (hands-on: illustrating their favorite part of the story by drawing, coloring, cutting and pasting). Recurrence Quantification Analysis (RQA) was used to examine the heart-rate variability (HRV) data. A recurrence point difference of approximately seven percent was found between monolinguals and bilinguals in cognitive activity and in affective-perceptive activity. However, virtually no difference existed between the two groups in pragmatic (hands-on)

activity. These findings demonstrate that advanced, nonlinear analytical methods can provide more comprehensive means of examination than standard techniques alone when applied to physiological data. It also serves as initial evidence of how different educational methodologies can affect physiological/emotional responses and, perhaps, students' ability to learn and develop.

1/f Noise and Movement Constraints in the Planning and Control of Aiming

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There is recent evidence of long-range correlation, or 1/f noise, in discrete aiming and that this correlation occurs primarily during the initial stage of the movement. 1/f noise indicates that variability at one point in time is positively correlated with variability at a later point, suggesting that behavior on early trials affects future behavior. The present study used 1/f noise to further examine how spatial, physical, and timing constraints affect planning and control processes in aiming. Participants moved objects of different mass to different distances at preferred speed (Experiment 1) and as quickly as possible (Experiment 2). Multiple fractal time series analyses were applied to the data to provide converging evidence of 1/f noise: power spectral density, standardized dispersion, rescaled range, and autoregressive fractionally integrated moving average. In Experiment 1, of those participants who showed 1/f noise, more showed 1/f noise at peak velocity, when planning and control would overlap through time to the greatest degree. In Experiment 2, where planning and control would have less time to overlap, of those participants who showed 1/f noise, fewer showed 1/f noise at peak velocity than in Experiment 1. 1/f-like noise has been produced by summing short-range processes at different time scales. As planning is a slower-moving process and control faster, this suggests that, with sufficient time for both planning and control, 1/f noise in aiming may arise from a similar summation of short-range processes.

Nonlinear Dynamics of Aging Gene/Protein Networks in Multiple Species - Implications for Humans

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In an ongoing research effort, we have developed and published a network systems biological strategy for predicting genes/proteins associated with aging/longevity. This method included the construction of a new type of network termed a Longevity Gene/Protein Network (LGPN). The nodes of the LGPN represent genes and corresponding proteins, and the different types of links included all known interactions between the nodes. Proceeding from a set of network topological criteria (node degree, closeness centrality, and betweenness centrality), the earlier C. elegans LGPN enabled us to predict 15 potential genes/proteins having a considerable likelihood of being associated with aging and/or longevity. Incorporating the most recent work on aging-related genes, we have expanded our network list of genes from 321 to 491. The updated LGPN network included 241 of these genes (vs. 202 in our early work), and the "longevity core" 129 of identified directly interacting genes/proteins has now been dramatically increased to 186, to include about 76 % of the new 241 gene list. This result may be considered to provide support for our hypothesis that aging/ longevity genes and proteins do not act individually but rather act as a complex system. The topological analysis of the expanded LGPN allowed us to expand our original list of predicted genes/proteins by adding eight more genes potentially related to aging and/or longevity: pqn-5, atn-1, 5D165, ima-3, pqn-54, gld-1, nhr-111, and vab-3, in addition to the previously predicted mpk-1, gei-4, csp-1, pal-1, mkk-4, 4O210, sem-5, gei-16, 1O814, 5M722, ife-3, ced-10, cdc-42, 10776OCo, and 1O690. In addition, we have completed similar work for the fly (D. melanogaster), rat (R. norwegicus) and yeast (S. cerevisiae). In this presentation, we will summarize our current data and then discuss the implication of these network results and their relationship to small world/power law dynamics and the implications for cross-species comparison and extrapolation to human aging. We will demonstrate how such networks, predicted by the author in 1982, can lead to survival curves typically seen in multispecies biodemography of survival.

Effect of the Delay on the Boundary of The Basin of Attraction in a Hopfield Neural Network System

Xu Jian, ***Shang Hui-lin***, & ***Huang Yu***, Tongji University, Shanghai, China,

The dynamics of neural networks may be affected by transmission delays and many studies have derived constraints on parameters such as connection weights, which ensure that the asymptotic dynamics of a network with delay remains similar to that of corresponding system without delay. However, even when the delay does not affect the dynamics of the system, it may affect other important features in the systemβ ³ dynamics such as the boundaries of the basins of attraction. In many neural network applications, such as associative memories, the network is designed so that stable equilibrium points represent stored information. In this framework, relevant information is retrieved by initializing the network at a point within the basin of attraction of the corresponding stable equilibrium point, and allowing the system to evolve to its stationary state. Motivated these facts, it is necessary for us to study the effects of the delay on controlling the boundary separating the basins of attraction of the stable equilibria. In this study, we choose a continuous-time Hopfield neural network system with delay as the dynamical model since the Hopfield neural networks have many potential applications in problems of signal processing, image processing, pattern recognition, associative memories and so on. It is assumed that the two neurons have the same neuronal output signal function. We aim to study the effect of the delay on the linear stability of equilibria and on the evolution of the boundary separating the basins of attraction of two locally stable equilibrium points in the system as the delay varies within the range that ensure the stability of the equilibrium points which are stable in the system without delay. We obtain some sufficient conditions for the stability of the stationary points by the theoretical approach. Then we are able to characterize theoretically and numerically the evolution of the boundary separating the basins of attraction of two locally stable equilibrium points as the delay varies. By using a linear approximation to predict the direction of the delay-induced changes, we obtain a theoretical characterization of the boundary separating the basins of attraction of two stable equilibria, which enable us to estimate the boundary. The validity of the theoretical results is verified by the numerical

ones obtained from the 4th-order Runge-Kutta approach. It follows from the theoretical and numerical results that the stabilities of the two equilibrium points are greatly affected by the delay, and the shape of the basin boundary was modified as the values of the delays were changed. Our investigations show that, even in this simple system, the boundary separating the basins of attraction of two stable equilibrium points depends on the value of the delays. Since the shapes of the basins of attraction of the equilibrium points in content addressable memories determines to which information a given initial condition is associated, the results provide the possibility to control the trajectory of the initial conditions that converge to content addressable information.

Alternans Heartbeat Lowers the Scaling Exponent in Animal Models and Humans

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Alternans is an arrhythmia exhibiting alternating amplitude/interval from heartbeat to heartbeat, and Traube first described it in 1872. However, it was only RECENTLY that alternans was recognized as the harbinger of a cardiac disease when an ischemic heart exhibited alternans. In animal models we artificially produced alternans at various experimental conditions, including the heart with an injury, the heart under emotional stress and the heart of a dying specimen. We have tested the detrended fluctuation analysis (DFA) on alternans and revealed that in both, animal models and humans, an alternans rhythm lowers the scaling exponent. We created our own program for the DFA. The DFA revealed that a normal heart exhibits the scaling exponent of 1.0 but an alternans heart exhibited that of about 0.6. We concluded that the scaling exponent can reflect a risk for the failing heart, especially when the low scaling exponent and alternans are concurrently present. The present research gives evidence that the specific fluctuation, so-called like the β 1/f noise, could be a key/baseline fluctuation for life. For diagnostic purpose the DFA is useful in biomedical fields as well as it is useful for the analysis in the field of statistical physics.

Attractor Network Model of Associative Memory and Art Perception

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The model of pattern recognition or attractor network model of associative memory, offered by J.Hopfield 1982, is the most known model in neuroscience. This paper aims to show, that such well-known laws of art perception as the Wundt law, perception of visual and semantic ambiguity in art, and also the model of perception of a musical tonalities, is nothing else than special cases of the basic Hopfield s model of pattern recognition. As is known, potential function of attractor network model represents alternation of maxima and minima in phase space. It easy to show that the Wundt curve, describing hedonic value of artworks as a function of its arousal potential and looking as the inverted U- shaped curve, is possible to receive if to approximate potential function in Hopfield model by potential function of elementary catastrophe "fold". Recently, it was shown that visual and semantic ambiguities are principal properties of artworks (Yevin I. Ambiguity in art, Complexus, 2006, N3). The model of perception of ambiguity can be received if to approximate potential function in Hopfield model by potential function of elementary catastrophe cusp. The following type of ambiguity in art will be considered: visual ambiguity in painting, semantic (meaning) ambiguity in literature, mixed (visual and semantic) ambiguity in acting and sculpture. At last, the model of perception of a major or minor tonalities in classical West-European music and in pentatonic can be received if to approximate Hopfield's potential function by potential function with three minima and four maxima (Yevin I. and Koblyakov A. Attractor Network Model of Music Tonality. Proceedings of International Workshop "Artificial Life Models for Musical Applications". Prague, September, 2001). It is reasonable to suggest that three stable steps of tonality: tonic, mediant, and dominant are keynotes of attractor network model. Others steps of tonality play the role of recognizable patterns, gravitating to some or other keynote.

Robust Bagging Algorithm in Small Sample Classification

Zaman Faisal, & ***Hirose Hideo***, Kyushu Institute of Technology, Japan

In discriminant analysis one often has to face the small observed sample size problem. This problem arises when the data feature space dimensionality is large compared with the number of available observed samples. The inversion of the covariance matrix is principally impossible when the data dimensionality exceeds the number of observed samples as the sample estimate of the covariance matrix may become close to a singular matrix in this case. As a consequence the statistical parameters estimated on such small sample have a tendency to be biased and may have a larger variance. Thus classifiers based on small training sets are unstable and weak i.e., having a high classification error. In this study we try to overcome this difficulty in small sample classification through a completely new theory, "Classifier Combination". In accordance with this theory we used an ensemble learning method, named "agging". In the method, we produce a large number of bootstrap samples from the training sample, construct linear classifiers on these bootstrap samples, combine these classifiers, and apply these combined classifiers on the test set. We have used a variant of bagging algorithm and proposed a new bagging algorithm, " Robust Bagging Algorithm". The results showed that the bagging algorithm reduced the misclassification error considerably and the robust bagging algorithm performed slightly better than the bagging because it filtered out the extreme results.

Psychology May Connect Daily Stock Market Dynamics and Brokers Blood Pressure

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In recent works we described applications of chaos theory for optimal blood pressure determination. The aim of this work was to investigate how could physiological parameters

correlate with some quantitative factors of economical information. We examined dynamics of stock markets (SM) as Dow, S&P (US) and RTS (RUS) indices daily moving and blood pressure (BP) of brokers at middle age in Saint-Petersburg during NY stock sessions in October of Elliot waves were used for stock market analysis and ZhGS formulas (presented in Orange) were used for BP dynamics. Data show that stock market dynamics was chaotic and may be imaged in some graphical attractors. We could figure out that bigger part of brokers cohort had same graphical attractors for BP dynamics and named it Zhirkov's phenomenon. Correlation of BP and SM dynamics was rather strong. Theory of psychological factors influences on stock markets is widely discussed. Interaction between SM and BP dynamics seems mysterious but only at the first look. It was shown that psychological factors may determinate professional decisions and the same mechanisms are well known in BP regulation. Elliot waves and ZhGS formulas based on golden ratio, private decision of Mandelbrot equation, may help for SM and BP relation analysis. Our data showed that psychological effects on SM and BP could be described by mathematical terms of harmony and chaos. They may be interested for stock market research and brokers health analysis.

Poster Presentations

Visualizing Footprints of Chaos
Iba Takashi, Systems Theorist, Keio University, Japan, ***Shimonishi Kazeto***, Keio University, Japan

In this poster presentation, we explore the patterns on our proposed method for visualizing behaviors of a non-linear function. In this method, which we call the method "Footsprint of Chaos", the value generated by the function is converted into an angle. Therefore, the trajectory can be understood as a visual pattern on 2-dimentional plane. As results of simulation experiments, we can observe the obvious differences between the periodic area and the chaotic area. Moreover, the mixture of periodic and chaotic patterns are found in the edge of chaotic area, The proposed method is useful for understanding complex trajectory of nonlinear dynamics visually.

Temporal Order Driven by Global and Local Structures in Biological Model Networks
Oosawa Chikoo, Kyushu Institute of Technology, Japan

Complex networks of interacting many elements arise in biological, sociological, and physical area and have revealed at least two statistical properties: power-law connectivity distributions having a small number of highly connected nodes, called as hubs; highly clustered connections among adjacent nodes. The last local structures are called motif or sub-graph and consist of a few nodes and edges among the nodes, which are found to be statistically significant, and can be regarded as functional modules in biomolecular and neuronal networks. In general, although the accumulated data of complex networks underlie the evidence of statistical properties, it is unclear why the both hubs (global) and certain sub-graphs (local) are favored in dynamical biological networks. To examine the effects of having the hubs or the sub-graphs on dynamical networks we constructed many Boolean networks, which is one of the discrete dynamical models for transcriptional regulatory networks and embedded two different power-law rank out degree distributions or varying numbers of independent sub-graphs. The amount of mutual information (degree of temporal order) and size of entropy (randomness) were determined from the finite length of periodic states, known as an attractor. After comparing dynamical behaviors from the networks we found that both hubs and sub-graphs have a potential ability of providing higher temporal order in gene expressions. Since the higher degree of temporal order contribute to processes in survival, maintenance, and self-organization, these results may indicate that reason why the both global and local structures are favored in biological complex networks.

On the Relationship between Chaotic and Tunnel Ionizations in Strong Laser Fields
Onishi Takaaki, & ***Shudo Akira***, Tokyo Metropolitan University, Japan

We will discuss the relationship between chaotic ionization and tunnel ionization of atomic or molecular gas in strong laser fields, for which investigations have been developed respectively in nonlinear dynamics and in atomic physics. It has been known that underlying classical dynamics is chaotic in both ionizations, and classical chaos manifests itself in quantum mechanics of chaotic ionization. However, it has not been known what is the quantum-mechanical manifestation of chaos in tunnel ionization, and tight connection has not been made in the investigations of the two ionizations in both areas of physics. The main reason will be because of the considerable difference in the methods and conditions for experimental schemes, and in the theoretical interests in both disciplines. Our aim is to understand the two ionizations and the relationship between them on the same theoretical footing. The outcomes of our study are as follows. First we have made a clear difference between both ionizations in a parameter space, and suggested the possibility to observe the crossover between them in experiments. Second we have formulated a semi-classical S-matrix for photoelectron ejected from a model atom or molecule under the irradiation of strong laser fields. The S-matrix has a characteristic that it includes amplitudes associated with two types of trajectories, which correspond to classical diffusion in chaotic phase space and adiabatic tunneling through energy barrier, respectively. This implies that the two ionizations can be described by a single S-matrix and can be understood on the same theoretical footing.

A Phase Transition of Multi-Peak of Information Spreading on Communities' Structure
***Satoh Keisuke*, & *Hayashi Yukio*,** Japan Advanced Institute of Science and Technology

On a BBS (Bulletin Board Systems) of online communities generate the network that the nodes are the contributors, the links are the contributing relations, link weights represent the number of contributions, and bridge nodes connect many communities that nodes are dense contacts. We demonstrate information spreading by this model that information is easy spreading through high weight links. The result comes to the multi-peak phenomenon. This phenomenon is the oscillation phenomenon that the spreading peaks occur in the communities because these spread easy and spreading peaks do not occur between the communities because these spread

difficult through the bridge nodes. We suggest that our confirmation of this multi-peak phenomenon on the online communities network that has weight links and many communities, and we consider to the phase diagram that the information spreading modelβ s parameter of the information spread easy and the frequency distribution of link weights, the phase of multi-peak is between the phase of global spreading information that all nodes have spread it to the phase of local spreading it that some nodes have spread it.

Chaos Characteristics of Different Types of Dendrochronological Time-Series

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Tree-rings are widely used as a proxy source of information on climate changes in the past for few thousands years. To reconstruct past climate changes the initial time-series of ring width for individual trees are de-trended and then averaged. The method is intended to reveal the climate signal in the time-series. I aimed to determine the influence of such treatments and number of individual trees used for averaging on chaos characteristics of dendrochronological time-series for coniferous trees from the south of USA and north-east of Russia (Yakutia). Correlation dimensions for different types of time-series: initial individual, individual de-trended, standard averaged and residual were calculated by the Grassberger-Procaccia and Scargle's algorithms. The fractal dimensions were estimated by the Hurst coefficient. The initial individual time-series of ring-width had less correlation dimensions (5-6) than averaged standard and residual ones (7-9). De-trending itself with no averaging did not yield increase in correlation dimensions while the averaging increased the correlation dimensions of both standard and residual time-series. However the correlation dimension growth reached the plateau when tree number in the group was more than 10-15. Dendrochronological time-series of trees from Russia have less correlation dimensions than trees from the USA. The Hurst coefficient indicates that the residual times-series having almost zero autocorrelation coefficients are characterized non-persistent chaotic behavior. The possible reasons of the phenomena are changes in contributions of biological and climatic components in times-series of different types.

Analysis of Electrotaxis Based on Spontaneous Motility in Dictyostelium Cells

Takagi Hiroaki, Nara Medical University, ***Sato Masayuki J***., ***Yanagida Toshio***, & ***Ueda Masahiro***, Osaka University, Japan

Cells can show not only spontaneous movement but also tactic responses to environmental signals. Since the former can be regarded as the basis to realize the latter, it is important to investigate spontaneous cell movement and its fluctuations quantitatively, and identify its control mechanism. As the first step towards the purpose, we took a series of spontaneous movement of Dictyostelium cells experimentally and characterized these trajectories through statistical analysis. We found that cells show complex dynamical behaviors with anomalous super diffusion, several timescale dynamics, and power-law velocity statistics. Then we applied a generalized Langevin model to reproduce its velocity dynamics successfully with non-linear velocity decay rate, velocity fluctuation, and memory. Based on the results, as the second step, we analyzed tactic movement. We also took a series of electrotactic movement of Dictyostelium cells under various field strengths experimentally. By statistical analysis of these trajectories, we applied the proposed Langevin model and estimated the degree of produced bias in the tactic movement and characterized various dynamical properties. Finally we discuss about the possible molecular mechanism and the consistent relationships between spontaneous movement and tactic response.

Nonlinear Dynamics, Psychology, and Life Sciences

Nonlinear Dynamics, Psychology, and Life Sciences publishes original papers that augment the fundamental ways we understand, describe, model and predict nonlinear phenomena in psychology, the life and social sciences. Nonlinear concepts include attractors, bifurcations, chaos, fractals, solitons, catastrophes, self-organization, cellular automata, genetic algorithms and related evolutionary processes, and neural networks. The broad mixture of the disciplines represented here indicates that many bodies of knowledge share common principles.

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