UCLA
Human Complex Systems
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presents

The 4th
Lake Arrowhead
Conference
On Human Complex Systems

April 25 – 29, 2007
Lake Arrowhead, California
“Human complex systems” include: ethnic groups, societies, and other political, economic and cultural entities of all kinds. Within these systems, a large number of individuals (with varying personal attributes) interact in a variety of ways. From these interactions emerge large scale structures and processes that in turn affect the individuals within them.

Large-scale systems like cultures and societies are holistic, dynamic and self-referential. They are often difficult or impossible to predict – or even vaguely picture – if we just look at the individuals involved one-by-one or in a static framework. For example, individuals and their beliefs make a political movement, but we miss the whole if we only look at individuals, and we miss change if we view the movement as fixed. Human complex systems are dynamic: they change or develop over time as a result of influences from inside and outside the system. Also these systems are self-referential – individuals and organizations refer to, maintain and change themselves. And agents do not exist in a vacuum but use artifacts (technology) and move through a physical environment.

Social scientists have had a hard time explaining consumer trends, stock market crises, and the development of political and artistic movements, to name a few phenomena. Usually, the approach has been to determine the smaller, underlying causes of the larger phenomena. In the past, social scientists might approach these problems from an idealizing point of view, often talking about general characteristics of a group based on a broad observation of trends or actions supposedly definitive of that group. Or social scientists might shy away from such problems altogether.

Today, however, we social scientists have access to analytical tools and methodologies. These include specific use of computers and draw on developments in complexity theory. One example is multi-agent modeling and simulation. Social scientists are approaching their fields with new ways to think about their subjects. These new ways bridge the gap between individuals, their perceptions and thoughts, and the socio-cultural wholes to which they belong. We can even explore and analyze multiple levels of agency at the same time.

We are excited by the success of the Human Complex Systems interdepartmental degree program at UCLA. The program provides undergraduate students majoring in specific departments in the social sciences and humanities with an overview of these new tools and methods. Students in the biological and physical sciences are also welcome. Over thirty undergraduates will be graduating this spring from this program. The result enhances their major work and better prepares them for graduate school or entrance into the work place as tomorrow’s managers and leaders. Today, decision making and management are expressly requiring new skills to deal with increasing information flow and rapid socio-technological change.

Details on Human Complex Systems can be found at: http://www.hcs.ucla.edu/.

Among social scientists, we believe that computational, multi-agent approaches to analyzing connections between human beings, their environment and technology will help raise the level of scientific theory and practice in the social sciences. Only in the last half-century have we discovered the concept of “things that think.” On our desks we have the means to explore complex “what if” scenarios and experiment with counterfactuals and “life as it could be.” Our artificial worlds are fashioned by the same creative evolutionary power that created us.

We welcome you to Lake Arrowhead and thank you for taking part in what we hope will be a continuing journey of many enriching and inspiring meetings.

Signed, the Center for Human Complex Systems:
Phil Bonacich,
Nicholas Gessler,
Susanne Lohmann,
Bill McKelvey,
Dario Nardi,
Dwight Read, and
Francis Steen
PROGRAM

WEDNESDAY AFTERNOON 5:30 TO 6:15 PM

Pre-dinner Welcome and Introductory Remarks by BILL MCKELVEY mckelvey@anderson.ucla.edu

WEDNESDAY EVENING 8:00 TO 9:30 PM

“The Big Event” live group simulation, facilitated by DARIO NARDI darionardi@msn.com

WEDNESDAY EVENING 9:30 TO 11:00

SOCIAL TIME

THURSDAY MORNING 9:00 TO 12:00

1. WILLIAM B. ROUSE bill.rouse@ti.gatech.edu
   Complex Systems: Phenomena, Characteristics & Research Questions

   NETWORK DYNAMICS
   Chair: Susanne Lohmann

2. MENGXIAO ZHU, ALEYAHJA alexy@uiuc.edu, & NOSHIR CONTRACTO
   The Investigation and Design of Socially Realistic First Responder Networks and Plans

3. W. F. LAWLESS lawlessw@mail.paine.edu, JOSEPH WOOD, & HUI-LIEN TUNG
   Organizational Metrics with the Quantum Approach: Constructing an Organization of Quantum Agents

4. PHILIP BARRY pbarry@mitre.org & MATTHEW KOEHLER mklohler@mitre.org
   Pervasive Information in the Networked Enterprise

5. JIMING LIU jiming@uwindsor.ca
   Towards Network Autonomy: An Autonomy-Oriented Computing (AOC) Perspective

6. GEORGIOS C. CHASPARIS gchas@seas.ucla.edu & JEFF S. SHAMMA shamma@ucla.edu
   The Emergence of Efficient Social Networks by Dynamic Reinforcement

THURSDAY AFTERNOON 1:30 TO 3:30

INFORMATION PROCESSING
Chair: Dario Nardi

7. NICHOLAS GESSLER gessler@ucla.edu
   Intermediated Cultural Cognition: Putting Materiality Back into Simulations

8. MICHAEL FISCHER m.d.fischer@kent.ac.uk
   Agent Hyperadaptation: Culture, Technology and Tools
9. H. JOEL JEFFREY & JASON NADRO jeffrey@cs.niu.edu
Implementing the Community-Practice Model for Agent-based Simulation

10. DARIO NARDI darionardi@msn.com
Social Neuroscience: Lessons from Exploring Agents’ Minds

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**THURSDAY AFTERNOON 4:00 TO 6:00**

**CONCURRENT SESSION #1: **

**PINEVIEW**

**CHEATING, RESISTANCE & AGENTS WITH ATTITUDE**

*Chair: Stephen Guerin*

11. MICHAEL W. MACY _mwm14@cornell.edu_, ARNOUT VAN DE RIJT, & DAVID SIEGEL
Neighborhood Chance and Neighborhood Change

12. LASHON BOOKER, GARY STRONG, & BRIAN TIVNAN _btivnan@mitre.org_
Modeling Phase Change Behavior

13. SHAWN BARR _sbarr@clarku.edu_, ERIC CHARLES _echarles@clarku.edu_, OWEN DENSMORE _Owen@redfish.com_, STEVEN GUERIN _Steve@redfish.com_, & NICHOLAS S. THOMPSON _Nick@redfish.com_
Further Evidence that TIT FOR TAT is Not the Best Evolutionary Explanation of Social Reciprocation

14. JAMES GIRARD _jpgirard@thinkingmetal.com_
Building a High-Fidelity 3D Agent Based Crowd Environment Using COTS Software

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**CONCURRENT SESSION #2:**

**LIBRARY**

**ANALYZING SCHOOL AS COMPLEX SYSTEMS:**

**INSTITUTIONAL AND ORGANIZATIONAL PERSPECTIVES ON EDUCATIONAL CHANGE**

*Chair: William Penuel*

15. NORA SABELLI & JAY LEMKE _nora.sabelli@sri.com_
Analysis of Timescales for Educational Change (Line 1 of Research)

16. LIA DIBELLO _lia@wtri.com_
Workplace Goals and School Change

17. AASHA JOSHI _aasha.joshi@sri.com_ & WILLIAM R. PENUEL _william.penuel@sri.com_
The Role of Institutionalized Norms of Autonomy & Equality in Shaping Interactions of Teachers (Line 2 of Research)

18. WILLIAM R. PENUEL _william.penuel@sri.com_, MARGARET RIEL _margaret.riel@sri.com_, KENNETH A. FRANK, & ANN KRAUSE
Teacher Networks and the Diffusion of Innovations (Line 3 of Research)
19. SUSANNE LOHMANN lohmann@ucla.edu
“Of Human Action, Not of Human Design: The Secret History of the University; or, Emergence, Evolution, and Dissemination of the Perfect Form”

THURSDAY EVENING 8:00 TO 9:30

SYMPOSIUM:
NEW DEVELOPMENTS IN CROWD DYNAMICS AND MASS EGRESS
DOUGLAS A. SAMUELSION samuelsondoug@yahoo.com, MATT PARKER matt.parker@anser.org, AUSTIN ZIMMERMAN austin.zimmerman@hsi.dhs.gov, LOREN MILLER, H. RIC BLACKSTEN, BRETT STEELE, STEPHEN GUERIN stephen.guerin@redfish.com, OWEN DENSMORE owen@backspaces.net, JOSHUA THORP jthorp@redfish.com

20. The Stadium Model (PNC Park, Pittsburgh)—“it was built in Processing, as other software was unable to deliver sufficiently fast display”

21. The Subway Model—“written in NetLogo, incorporates the new ‘Continuum Crowd’ representation”

22. “We will also present results of additional work on real-time movie-like rendering of the models’ output in both pure Java and Python/C++ implementations”

THURSDAY EVENING 9:30 TO 11:00

SOCIAL TIME

FRIDAY MORNING 8:45 TO 10:45

SOCIOCULTURAL DYNAMICS
Chair: Bridget Rosewell

23. KLAUS JAFFE Kjaffe@usb.ve
Sociodynamics: Towards a Fundamental Science of Social Dynamics

24. DAVID SALLACH sallach@anl.gov
Computational Dialects and Communities of Discourse

25. LARRY KUZNAR kuznar@ipfw.edu
Predicting Risky Behavior in Tribal Societies: Validating Decision Paradigms and Exploring Models

26. ANTONIO R. DIAZ ardi@uabc.mx, SUSAN JONES, LYNNE HALL, MANUEL P. CASTAÑÓN & DORA F. GUTIERREZ
An Approach to Simulating Mobility and Migratory Behavior in Tijuana
FRIDAY MORNING 11:00 TO 12:30
PINEVIEW

FROM HEAT BUGS TO SMART PARTS
Chair: Nick Gessler

27. JONATHAN OZIK jozik@anl.gov & DAVID L. SALLACH sallach@anl.gov
   Interpretive Heatbugs: Aggressive Acts and Voluntary Contributions

28. EUGENIO D. SUAREZ Eugenio.Suarez@Trinity.edu
   Shared Terminology in Social Science Fields Using Multi-agent Simulations

29. CHRISTINE WYCISK cwycisk@web.de & BILL MCKELVEY mckelvey@anderson.ucla.edu
   Smart Parts Logistics Systems as Complex Adaptive Systems: How to Design a Model to Manage an Artificial World?

FRIDAY AFTERNOON 1:30 TO 6:30

AFTERNOON FREE!!

FRIDAY EVENING 8:00 TO 10:00
PINEVIEW

SYMPOSIUM: ROBUSTNESS & VALIDITY: IMPLICATIONS FOR SOCIAL SCIENCE MODELLING OF LOW COGNITION, HETEROGENEOUS AGENTS
Chair: Paul Ormerod

30. GEORGE BACKUS, LAURA A. MCNAMARA lamcnam@santa.gov, & TIMOTHY G. TRUCANO
   Verification and Validation of Low Cognition Agent Models as Applied Epistemology

31. RICH COLBAUGH colbaugh@nmt.edu & KRISTIN GLASS
   Predictability and Prediction of Social Processes with Low Cognition Agents

32. PAUL ORMEROD pormerod@volterra.co.uk
   Cascades of Failure and Extinction in Evolving Complex Systems: Verification and Validation of Low Cognition Agent Models

33. BRIDGET ROSEWELL brosewell@volterra.co.uk
   Urban Growth: Emergent Stylized Facts from Zero Cognition Agent Models

FRIDAY EVENING 10:00 TO 11:00
LAKEVIEW

SOCIAL TIME
MARKET BEHAVIOR
Chair: Jessica Turnley

34. SHU-HENG CHEN chchen@nccu.edu.tw, CHUNG-CHIH LIAO, & PEI-JUNG CHOU
On the Plausibility of Sunspot Equilibrium: Simulations Based on Agent-based Artificial Stock Markets

35. HIROSHI TAKAHASHI htaka@e.okayama-u.ac.jp & TAKAO TERANO terano@dis.titech.ac.jp
Analyzing the Micro-Macro Structure in Financial Markets through Agent-based Modeling

36. JENNIFER WATKINS jhw@lanl.gov
Prediction Markets as an Aggregation Mechanism for Collective Intelligence

MODELING BEHAVIOR ON THE DARK SIDE
Chair: Bill McKelvey

37. NORMAN L. JOHNSON norman@santafe.edu & JENNIFER H. WATKINS jhw@lanl.gov
A Model of Emergent Leadership – For Communities, Organizations, and Defense

38. NICK MALLESON N.Malleson06@leeds.ac.uk
An Agent-based Model of Burglary in Leeds

39. ALLISON PINTO APinto@fmhi.usf.edu
Modeling Institutionalized Abuse to Prompt Responses from Parents, Professionals, and Policy Makers

METHODS, PART 1
Chair: Norman Johnson

40. STEPHEN GUERIN Stephen.guerin@redfish.com, JOSHUA THORP jthorp@redfish.com, & OWEN DENSMORE Owen@redfish.com,
Playing in the Sandbox: Participatory Agent-based Simulations with Tangible Interfaces

41. HOWARD T. WELSER htwiii@gmail.com & TOM LENTO, ERIC GLEAVE eric.gleave@gmail.com & MARC SMITH
Social Networks and Accumulated Interactions: New Directions for Generating Simulated Networks

42. CARL TOLLANDER carl@plektyx.com
A Garden of Models

43. IOANNIS D. KATERELOS iokat@panteion.gr
Chaos and Order in Social Systems: X-Model
SATURDAY AFTERNOON 4:00 TO 6:00

PINEVIEW

METHODS, PART 1
Chair: Norman Johnson

44. JAMES GIRARD jgirard@thinkingmetal.com
Using Observational Behavioral Analysis Techniques to Remove Hidden Variables and Parameter Dependencies in Agent Based Models

45. BRIAN F. TIVNAN btivnan@mitre.org
Docking Models in Organization Science: Comparison of March’s Organizational Code Model and Levinthal’s NK-Model of Rugged Landscapes

46. DANIEL KLAPPER, DINESH KUNCHAMWAR, ROBERT MARKS bobm@agsm.edu.au, & DAVID MIDGLEY
Minimalism & Model-building: An Assured Model of the Exchanges between Consumers, Retailers & Manufacturers

47. JESSICA GLICKENTURNLEY jgturnley@aol.com
An Approach to Validation of Computational Models of Social Phenomena

SATURDAY EVENING 8:00 TO 9:30

PINEVIEW

PANEL DISCUSSION: ISSUES IN PUBLISHING SIMULATION STUDIES
Lead by J. RICHARD HARRISON harrison@utdallas.edu,
with MICHAEL MACY mwm14@cornell.edu & BILL MCKELVEY mckelvey@anderson.ucla.edu

SATURDAY EVENING 9:30 TO 11:00

LAKEVIEW

SOCIAL TIME

ROOMS & MEALS

Check In: Check-in is 4:00 PM, Wednesday 25 April. The center cannot guarantee guest rooms prior to 4:00 pm.

Check Out: Check-out time is 12:00 noon on Sunday 29 April.

Meals: are served in the main lodge during the following times:

Breakfast: 8:00 AM – 8:30 AM

Lunch: Begins service at 12:00 noon until 1:00 PM

Dinner: 6:30 - 8:00 PM

The main lodge and all center facilities close at midnight.
ABSTRACTS

AN AGENT-BASED MODEL OF BURGLARY IN LEEDS

Nick Malleson
University of Leeds

Occurrences of crime are complex phenomenon. They are the result of a vast number of inter-related factors which can include demographic and socioeconomic characteristics, cultural backgrounds, the presence of security measures, effects of the physical environment and relevant crime prevention techniques.

Traditionally, crime occurrences have been modeled using statistical techniques. Although these techniques have proven useful, they face difficulties with regards to providing predictive analyses. More recently, computer simulations of crime have been developed which provide the necessary predictive element, but these models face difficulties integrating behavioral information.

Agent-based modeling is a new modeling paradigm and has spurred a considerable amount of interest. An agent is an independent component of a system which can interact with other agents and its environment in order to achieve goals. In this manner, large systems of agents can be created to mimic real environments. Most importantly, the agents can incorporate behavioral information to determine how they should achieve their goals. An accurate agent-based model which incorporates human behavioral factors as well as detailed environmental components could have a number of uses with relevance to crime modeling. Not only could it be used to analyze offender travel but also provide ‘what if’ analyses, such as the effect that new environmental developments or crime reduction initiatives might have on a local area before their implementation. This will have a significant impact on local councils, town planners and the police.

Although simple, the agent-based model built for this project yields interesting results. It indicated that certain areas in Leeds have a much lower burglary rates than would be expected. It also demonstrates that agent-based modeling is an excellent tool for these types of analyses and should be extended further.

AGENT HYPERADAPTATION: CULTURE, TECHNOLOGY AND TOOLS

Michael Fischer
University of Kent at Canterbury, UK

Intelligent agents embedded in cultural processes demonstrate remarkable powers of creation, transformation, stability and regulation. Culture gives agents the power to hyper-adapt: not only can they achieve local minima and maxima, they modify or create the conditions for new adaptations. Culture transcends material and behavioral contexts. Cultural solutions are instantiated in material and behavioral terms, but are based in large part on ‘invented’ symbolic constructions of the interaction space and its elements. I will present an example of how a symbolic system ‘drives’ the material organization of human groups, and explore how symbolic systems act over material domains as a general case.

One of the properties of a cultural system is that it supports hyperadaptation. Hyperadaptation refers to a process of behaviorally modifying the local material context so that a range of new adaptations become possible. Hyperadaptation occurs in species other than humans but is the principle form of human adaptation. These often take the form of technologies, combinations of ideational and material adaptations. Tools are associated with many technologies, themselves probably the product of further adaptation to the original hyperadaptation. Tools are difficult to develop and replicate - only humans have done so with minor exceptions. Human hyperadaptivity appears to be unique both in its character and pervasiveness.

Ideational models are critical in human groups to support hyperadaptation. Hyperadaptive agents need a ‘story’ to go with the actions that replicate the conditions for hyperadaptation. The critical feature the story must have is that it is logically consistent, otherwise it is difficult to transmit with fidelity within a group. If the story can be reproduced with fidelity this helps to stabilize the associated knowledge of technique and translation (instantiation) necessary to produce behaviors from the story.
ANALYZING THE MICRO-MACRO STRUCTURE IN FINANCIAL MARKETS THROUGH AGENT-BASED MODELING
Hiroshi Takahashi (Okayama University)
Takao Terano (Tokyo Institute of Technology)

To investigate the risks of financial markets is one of the critical issues in risk management. This paper proposes an Agent-Based Model to clarify microscopic and macroscopic links between investor behaviors and price fluctuations in a financial market. The analysis presented in the paper focuses on the role that investors’ overconfidence plays in the financial market. From the simulation study of the agent-based virtual market, we have found that (1) overconfident investors emerge in a bottom-up fashion in the market, and (2) these overconfident investors have the ability to contribute to the market, in which the trading prices are coincide with theoretical fundamental values.

AN APPROACH TO SIMULATING MOBILITY AND MIGRATORY BEHAVIOR IN TIJUANA
Antonio R. Diaz, Susan Jones, Lynne Hall, Manuel P. Castañón and Dora F. Gutierrez

This paper discusses our attempts to further understand complex mobility and migratory behavior for the constantly changing and increasing population of Tijuana, Mexico. As with other frontier cities, the transient population of Tijuana is inevitably driven by socio-economic factors to move to locations with perceived benefits in terms of access to scarce resources, or increased stability. This has resulted in a highly diverse population, in terms of socio-economic status, culture and ethnicity, factors that inevitably result in disharmony, conflict and that potential leading to stress, ill health, poor life chances, social conflict and violent behavior.

In this paper, we will explore the underlying basis of the theoretical approach that we are taking to enable the simulation of population behaviors. This takes a recursive approach to the modeling of human action in context by using theoretical constructs from the theory of motivation, transactional analysis and psychology to understand population behavior at the level of the individual; and systems theory, in particular cybernetic modeling of human activity systems to place these individuals in a context. This approach is being used to develop a simulation through which the potential for human action can be simulated and extrapolated.

This paper will discuss our approach to modeling and simulating Tijuana’s population within a virtual environment. This environment is populated by intelligent agents representing the individuals, simulating interpersonal relationships between different profiles resembling the real population. We will outline the architecture, based on transactional analysis, that will be used for the agents’ minds and that will provide the modeling approach for individuals. We will discuss our use of constructs from systems modeling that are used to place individual behaviors in structural contexts. This is achieved using Stafford Beer’s Viable System Model to aggregate, interpret and represent the multi-ethnic, multi-cultural situation in Tijuana. Initial attempts to provide such information in a coherent, understandable visual medium will also be outlined.

AN APPROACH TO VALIDATION OF COMPUTATIONAL MODELS OF SOCIAL PHENOMENA
Jessica Glicken Turnley
Galisteo Consulting Group, Inc., www.galisteoconsulting.com

This discussion continues earlier work addressing (the absence of) methodologies for validating computational models of social phenomena. These types of models are being used with increasing frequency in a wide variety of arenas, with little or no formal means of assessing their goodness in any given application space. This discussion begins with a formal definition of validation and parses that in the light of three communities with histories of significant interaction with models of complex phenomena: nuclear weapons physics, systems ecology, and computational linguistics. The nuclear weapons physics community has developed very sophisticated models of weapons effects that cannot be tested against real world phenom-
ena because of various test ban treaties. This is analogous to the absence of true testbeds for social phenomena, which are precluded by ethical concerns. Systems ecologists work with complex models that incorporate several classes of phenomena of different types, each of which changes over time at different rates. This is similar to the complex environments in which human social activities are played out. Computational linguists must consider semantics and semiotics in their models non-observable phenomena comparable in many ways to cultural values and attitudes that affect and drive behavior. We gathered data from both interviews with practitioners in these different fields and a perusal of the literature. We combined these research findings with a look at the history of use of models in the national security arena, one of the growing fields of application for computational social models. We deconstruct what is meant by model in that arena, and the potential conceptual frames that implies. We combine the implications of those frames with what we have learned about the notion of validation to suggest a different approach to establish the goodness of computational models of social phenomena.

BUILDING A HIGH-FIDELITY 3D AGENT BASED CROWD ENVIRONMENT USING COTS (COMMERCIAL OFF-THE-SHELF) SOFTWARE

James Girard

We present a crowd simulation environment that integrates the AI implant, DI-guy and Vega Prime simulation products to produce a unified analysis tool for full 3D simulations of crowds. The three tools each provide key capabilities. Vega Prime provides a highly threaded, distributed simulation environment that can be scaled up to VR ‘caves’ if desired. DI-Guy provides an expandable library of human kinematics, including realistic transitions and blending of motions. AI-implant provides sense/react modeling, giving built-in goals for approach and flee as well as dynamic path finding and collision avoidance. Custom software has then been added to give a more seamless interface between the tools.

The tools are linked in a feedback loop. Desired actions determined by an agent’s brain are passed to the environment and kinematics library, which determines if the actual action is possible or what transitions need to take place ‘physically’. The current state of the agent and other agents is then passed back to the brain via the defined ‘senses’. The process of building high-fidelity environments forces the modeler to think in a more realistic way with regards to concepts of location, speed and senses. This also helps the final model to be more ‘approachable’ from a decision-maker’s point of view. The resulting agent based environment is very physically realistic. It can handle both realtime and non-realtime simulation modes, and has the ability to peer into any characters ‘brain’ while the application is running.

Please note: The author is unaffiliated with the companies selling any of the products mentioned here.

CHAOS AND ORDER IN SOCIAL SYSTEMS: X-MODEL

Ioannis D. Katerelos
Psychology Department, Panteion University, Athens, Greece

According to Katerelos & Koulouris (2004a, 2004b, 2004c), social behavior should be considered as the product of a multiple equilibria regulation process probably restrained by a communicational topology network. Based on simulations methodology (Gilbert & Troitzsch 2005), the authors claim unpredictability of the system’s outcome under certain circumstances: the system exhibits sensitivity to initial conditions (positive Lyapunov Exponents, see Sprott 2003) if the intra regulation factor $\Omega > 1$ (Transient Chaos). Under the value of 1, the system ends in a fixed point while, for $\Omega = 1$, the system equilibrates in a periodic motion.

In this paper, I shall present a model of opinion dynamics called X-Model, based on the MER Model; it takes under consideration both an agents’ internal (“intra-individual”) regulation structure among different opinions regarding the same social issue and a tendency for social equilibrium. In MER Model, the only parameter which is regulated is psi (adjusting the individual equilibrium force), in X-model, we also adjust the strive for social equilibrium (kappa). Then, we explore this nonlinear model by a series of computer simulations for a variety of parameter’ values. We examine under what conditions the model exhibits sensitive dependence on initial conditions and, finally, we calculate the Lyapunov Exponents. Our results show that for certain parameter’ values, the system exhibits final state sensitivity, thus it is chaotic (deterministic and unpredictable). The crucial question is to find out under what conditions the system stabilizes or destabilizes. Our results
show that, in certain locations of the parameter’s space (two-dimensional) the system becomes periodic whilst in others, the system presents a far-from-equilibrium behavior: the base of a new dynamic social theory of social facts.

**COMPUTATIONAL DIALECTS AND COMMUNITIES OF DISCOURSE**

*David L. Sallach, Argonne National Laboratory*

It has long been recognized that there is a rich interaction between culture and identity. Cultural and subcultural patterns help shape the identities of the human actors they envelop and, conversely, human identity helps to motivate cultural contributions. Yet, this relationship does not fully address the dynamics of the process. For example, few situated actors have the specific goal of modifying or shaping the culture within which they act. Moreover, while it seems evident that culture and identities reinforce each other, both are malleable and protean and, as a result, difficult to effectively model.

Social historian William Sewell (2005:168-172) provides an effective account of the complexity of contemporary culture by describing it as: 1) loosely integrated, 2) contradictory, 3) contested, 4) weakly bounded, and 4) thinly coherent. All such ‘weaknesses’, he writes, must necessarily be overcome, in interaction and in practice (Sewell 2005). Nonetheless, out of such diffuse cultural material strong collective identities are forged, frequently with dramatic consequences. The necessity for dynamic, transformative models of culture appears inescapable.

Parallel challenges are presented by the need to model social identities. The most compelling models of identity are situational, fine grain and highly dynamic (Garfinkel 2006; Smith-Lovin 2003). What appears to be needed is an interaction that maps one fluid process to another.

One process that has the potential to play a special role in binding culture and identity, and in shaping cultural upheavals, is the emergence and transformation of communities of discourse. Several authors show how such discourse processes have transformed wide areas over long durations (Blommaert 2005; Wuthnow 1989), and/or given rise intensely disruptive movements (Apter and Saich 1994). It appears to be a reasonable historical hypothesis that the dynamics of discourse actively contributes the processes by which the diffuse elements of culture are reshaped into transformative identities and movements.

Modeling cultural dynamics of this type can be facilitated by drawing upon the innovative Interpretive Agent research program (Mellarkod and Sallach 2004; Mellarkod and Sallach 2005; Ozik and Sallach 2006; Sallach 2003; Sallach 2006; Sallach and Mellarkod 2004a; Sallach and Mellarkod 2004b). At the same time, it is also likely to require a new generation of tools and techniques. Such techniques may well include the development of domain-specific languages (Hirschman 1986; Hobbs 1986) using programming languages that support layered dialects (Goldman and Blanton 2000). The present paper reports on the design and implementation issues of this research program.

**DOCKING MODELS IN ORGANIZATION SCIENCE:**

**COMPARISON OF MARCH’S ORGANIZATIONAL CODE MODEL AND LEVINTHAL’S NK-MODEL OF RUGGED LANDSCAPES**

*Brian F. Tivnan*

*The MITRE Corporation, McLean, VA*

Recognizing the inherent strengths of simulation-based research, James March proved to be one of the earliest pioneers of simulation as a methodological approach in organization science (e.g., Cyert and March’s (1963) Duopoly Model; Cohen, March and Olsen’s (1972) Garbage Can Model; and March’s (1991) Organizational Code Model). March appreciated that simulation provides the researcher a platform: (a) to explore the inherent complex dynamics of organizations (Simon, 1962), (b) to conduct experiments that would typically be impossible or impractical in the physical world (McKelvey, 1997b), and (c) to study sets of actors who possess an adaptive capacity (Axelrod, 1997) as an alternative to rational actor assumptions which overlook the boundedly rational limitations of their actors (Simon, 1976).

Levinthal (1991) began his investigation of the tension between adaptation and selection, continuing this research as the first to apply Kauffman’s (1993) NK model within the domain of Organization Science (Levinthal, 1997). Kauffman
introduced his NK model of adaptive landscapes as a modeling platform for the investigation of the evolutionary and coevolutionary choices of adaptive agents. Specifically, Levinthal’s (1997) model investigates the impact to organizational fitness from the interactions of elements within an organization.

Despite numerous concerns raised by McKelvey (1997a) regarding the applicability of Kauffman’s NK model to Organization Science, Levinthal’s initial study has been repeatedly extended (e.g., Levinthal and Warglien (1999), Rivkin (2000), Siggelkow and Rivkin (2005)). However, the application of Kauffman’s NK model in Docking Models in Organization Science 2 the Levinthal research has not been independently replicated. Subsequently, no model-to-model or docking comparisons (Axtell, Axelrod, Epstein, & Cohen, 1996) exist between the Levinthal research and other computational models of organizational theory. Building on Tivan’s (2005) research to replicate and extend March’s (1991) Organizational Code Model (OCM), this research describes the replication of Levinthal’s (1997) model and a docking comparison between it and the OCM.

THE EMERGENCE OF EFFICIENT SOCIAL NETWORKS
BY DYNAMIC REINFORCEMENT

Georgios C. Chasparis and Jeff S. Shamma
University of California, Los Angeles, Dept. of Mechanical Engineering

This paper presents an analysis of the emergence of efficient social networks. The network formation process is modeled as an evolutionary process, where individuals form and sever unidirectional links unilaterally. Each individual’s choices depend only on her own previous links and received net benefits. Furthermore, the selection process is subject to perturbations.

Individuals reinforce the establishment of a link if the link was beneficial in the past, and suppress the establishment of the link otherwise (i.e., “satisficing” behavior). This model has been used for human behavior by Arthur [1993] and social network formation based on reciprocity by Skyrms and Pemantle [2000] and Bonacich and Liggett [2003]. The model assumes that individuals have access only to local information, contrary to non-cooperative dynamic models such as the model of Bala and Goyal [2000] which assumes that the global configuration is known to all individuals.

Our reward function is similar to the one considered in the dynamic model of Bala and Goyal [2000]. In particular, the direction of a link determines the direction of both direct and indirect benefit flow, while benefit flow is assumed frictionless. Here we assume a slightly different cost function that not only depends on the number of currently established links (maintenance cost), but also on the “familiarity” of an individual with a link (establishment cost), which can be represented as a function of the current link selection strategies.

Under these assumptions, the invariant measure of the evolutionary process assigns positive probability to the emergence of multiple stable configurations (strict Nash networks). For example, in case of three players there are two stable configurations, the wheel network, which is Pareto efficient, and the star. Instead, if we assume zero establishment cost, then the only stable configuration is the wheel network, which agrees with Bala and Goyal [2000].

Finally, we show through analytical results and simulations that a single individual can reinforce the emergence of the efficient network through a simple dynamic processing of her own available information. In particular, when an individual’s decisions are also based on the rate of the reward changes then the efficient network can be the unique stable attractor.

FUNDAMENTAL CHANGE OF COMPLEX ORGANIZATIONAL SYSTEMS

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This paper reports on a synthesis emerging from a recent NSF-sponsored Workshop on Complex Engineered, Organizational, and Natural Systems. This synthesis is based on ideas and insights from the 50 workshop participants as well as 200 participants in seven subsequent presentations across the U.S. Participants represented a broad range of disciplines from behavioral, life, physical, and social sciences, as well as computing and engineering. Topics in this presentation will include
the characteristics of systems that cause them to be perceived as complex, phenomena of particular importance, and fundamental research issues implied by these characteristics and phenomena. The resulting framework in then mapped to two recent works on organizational change – Enterprise Transformation: Understanding and Enabling Fundamental Change (Wiley, 2006), and People and Organizations: Explorations of Human Behavior and Performance (Wiley, forthcoming in early 2007). This mapping provides insights into the complexity of organizational change as well as fundamental limits of our abilities to understand, anticipate, and facilitate change. Several broad hypotheses and grand challenge problems are suggested.

**FURTHER EVIDENCE THAT TIT FOR TAT IS NOT THE BEST EVOLUTIONARY EXPLANATION OF SOCIAL RECIPROCATION.**

*Nicholas Thompson, Shawn Barr and Eric Charles*

*Department of Psychology, Clark University*

*with*

*Owen Densmore, Steven Guerin, Nicholas S. Thompson,*

*Redfish Group, Santa Fe, New Mexico*

Of the three widely accepted solutions to the paradox of animal sociality, two, trait group selection and kin selection, are the result of positive assortment of altruists and non-altruists in the population. This positive assortment results in altruism falling disproportionately on other altruists. The third solution, Tit for Tat reciprocity, works on a different principle: in randomly assorted pairs, altruists should condition their cooperation on the cooperation of their partner. Hundreds, perhaps thousands of papers, have been written that employ TIT FOR TAT reciprocity to explain features human and animal social systems. But the model has always had a grievous fault: no mechanism has ever been proposed that would account for altruists remaining in association with individuals who will not cooperate with them. Joyce et al. (2005) have offered an alternative model, “MOTH”, which achieves reciprocal altruism through an assortment mechanism; MOTH altruists pair randomly and give their altruism unconditionally, but detach themselves from individuals that have responded selfishly. We claim that this model is both more naturalistic (animals tend to avoid unpleasant experiences) and more robust (no external mechanism to assort the individuals or to force them to remain in association is required) than TIT FOR TAT. Critics have challenged our conclusion on the ground that we failed to consider that selfish individuals would be paid to inflict a cost on altruists trying to break off a relationship. We now present a new version of the model that shows that MOTH is remarkably resilient in the face of costs imposed for leaving a relationship with a selfish individual. MOTH is thus still the preferred explanation for reciprocal relations amongst humans and animals.

**A GARDEN OF MODELS**

*Carl Tollander*  
*Plektyx*

Agent-Based Modeling practice faces a number of recurring methodological issues. Among these issues are authoring, composability, reusability, calibration, and ongoing connectivity to actual “live” data. Further, for many extended ABM projects, the issue of changing project narratives and object schemas can render the transformation from proof-of-concept models into decision-support models problematic.

One approach to these issues is to look for a closer integration between theory and model, where combinations of theories are active participants in the creation of models. Often, rather than looking for specific answers or optimum parameter configurations, what we want to find out is how multiple theories interact, that is, how they might co-evolve to find out what is salient about each other relative to some particular (possibly dynamic) data environment.

To explore this approach, we will introduce a programming framework under development inspired by insights from Category Theory and Developmental Biology called ‘Resartus’. This framework represents theories as different agent ‘identities’ and enables a collection of such agents to employ those identities in local data environments to create and navigate new model structure.
This “gardening” approach to complexity modeling opens up new design possibilities for exploring and illuminating the theories and narratives under scientific and journalistic discussion. In addition, calibration and verification efforts can be more easily understood in terms of how the identity-grown model structure emerges. Recombination of models and model components is enabled by growing them together in situ.

We will illustrate the application of this approach and programming framework in a ‘Public Policy Workbench’ effort in progress.

**GRAPH GENERATORS FOR SOCIAL NETWORKS:**
**COMPARING FEATURES OF SIMULATED GRAPHS TO THOSE OF LARGE SCALE SOCIAL NETWORKS IN COMPUTER MEDIATED INTERACTION**

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*Eric Gleave, Marc Smith*

_Microsoft Research_

The explosion in popularity of systems for computer mediated interaction (CMI) such as online discussion groups, e-mail lists, blogs, resource sharing systems, and online games has resulted in a similar explosion in the availability of large scale, longitudinal social network data. The new CMI datasets provide an ideal range of benchmarks for evaluating the veracity of network generation algorithms, refining our understanding of large social networks, and investigating how network features develop through the dynamic accumulation of social interactions. Our project proposes to compare features of networks derived from four novel CMI datasets (Wikipedia, Wallop, Usenet, and a large e-mail corpus) to features of simulated networks from a range of graph generators. For each graph we document measures of degree distribution, clustering, diameter and document the relative frequency of basic motifs. These features are compared to the same measures found for simulated graphs generated from the Random graphs (Erdos and Renyi 1960, Aiello et al. 2000); Preferential Attachment models (de Solla Price 1976, Barabasi and Albert 1999); and Forest Fire models (Leskovec et al. 2005). Because social networks result from the accumulation of ties, it is crucial to consider how network features may depend upon the temporal sampling framework. We investigate the degree to which that measured features depend on whether cross-sectional or cumulative sampling structures are employed. We suspect that greater consideration should be put into how data collection assumptions affect graph features and researchers should actively justify their sampling structure in light of the interactive process that generates the ties.

**IMPLEMENTING THE COMMUNITY-PRACTICE MODEL**
**FOR AGENT-BASED SIMULATION**

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The community - practice model is a formal theoretical framework that allows formal description of very wide range of factors involving human action in communities. “Community” is a broadly applicable, formal, concept, encompassing any group with recognizable structure: families, businesses, ethnic groups, nations, work teams, and cultures. The model includes community-specific values that affect choice of action; hierarchical descriptions of the full range of human behavior, including intrinsic or expressive behavior as well as behavior motivated by self-interest; specification of the statuses or positions of a formal model of identity as the set of statuses occupied by an agent in all communities of which it is a member; and the impact of community choice principles on individual agent choice of action. Each agent chooses an action (a practice) intrinsic to at least one status/identity facet, and engages in a version of that practice, recursively carrying out the stages, sub-stages, etc., that comprise the selected version of the action.

The concepts (status, practice, identity, cultural values, etc.) included in the community-practice model are well
known in anthropology and sociology. What is distinctive about the community-practice model is that it is comprehensive, systematically incorporating all the aspects in one framework and, most important for the purposes of agent-based simulation, that it a formal framework, yielding formal descriptions, not only a conceptual one.

We report on results of implementing two prototype community simulations. The first, deliberately chosen to be a minimum deviation from a standard biological model, simulates the behaviors of a community of predators, prey, and pacifists. Prey graze and mate; predators prey and mate; and pacifists mate and convert predators to pacifists. An agent that is converted acquires the new status of pacifist. In one version, a converted agent retains the status of predator while acquiring the new status of pacifist, thus modeling the case in which an individual has conflicting reasons for choosing different actions based on having conflicting statuses. Predator-prey-pacificist has clear implications for modeling terrorism and suicide bomber recruitment. The second is a model of a simple human community, with statuses including husband, wife, mother, father, child, farmer, hunter, and doctor; and practices including finding mates, raising crops, hunting, raising children, and treating the sick.

**INTERMEDIATED CULTURAL COGNITION: PUTTING MATERIALITY BACK INTO SIMULATIONS**

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Among the many attractions of simulation is the ability to control the materiality of the subject under study. The space, time and matter-energy may be conveniently altered to focus on the informational patterns of the problem. But information is always instantiated on a marker, and the materiality of that marker changes the character of the information it conveys. Each marker, information carrier, or medium, has a life of its own: its own audience and capacity, its own costs of inscription, maintenance and presentation. Each has its own vagueness and ambiguity, its own accuracy, precision and repeatability, and finally its own robustness, durability, failure and decay. The world is re-presented in the medium of mind as concepts and ideas, re-presented as speech or written text, and embodied in a myriad of material contrivances, signs, symbols and suggestions of behavior, in a world of technological artifacts and ways of doing things - a material cultural environment that is, in many ways, more immersive and compelling than the ideas themselves. It is these artifacts of technology which constitute distributed material cultural cognition, the processes which mediate our daily lives. INTERMEDIATION, how information is conveyed and negotiated among these media, may provide a necessary insight into the emergence of emergence, the capture of the global patterns of behavior of a system which serve as the local primitives for yet higher levels of emergence. This quest, at the center of evolutionary computation, has been the focus of recent workshops on “Dynamical Hierarchies,” “Dynamic Ontology” and “Computational Synthesis.” At the upcoming meeting on “Levels of Reality” it is identified as “possibly the single most relevant and unresolved problem in science and philosophy.”

**INTERPRETIVE HEATBUGS: AGGRESSIVE ACTS AND VOLUNTARY CONTRIBUTIONS**

*Jonathan Ozik and David L. Sallach*

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The purpose of the Interpretive Agent (IA) research program is to incorporate endogenous meaning attribution as a means of orienting agent communication and action selection into agent-based modeling. Interpretive Heatbugs (IHB) is an IA reference application in which interpretive mechanisms (prototype reasoning, situation definition and orientation accounting are developed, illustrated and made available to other researchers. Similar to its widely known generic heatbug predecessor, it is designed to provide a simple introduction to the paradigm, in this case, interpretive agency. IHB uses the familiar heatbugs environment, where heat emitting bugs require temperate zones and flee from settings that are uncomfortably hot or cold. Because each bug emits a small amount of heat, congregations of bugs initially create the needed warmth, while overcrowding creates excessive heat. These competing influences give rise to the often observed complex churning
patterns. To this dynamic of temperature fluctuations driving the bug movements, IHB adds the capability of bugs to ignore, assist or undercut each other, as well as ethnic and religious identities that mediate the decisions to help or hinder.

The IHB application has previously explored the role of interpretation in the use of force as a means of improving bug circumstances. These decisions draw upon the projection of a bug’s comfort levels on others, as well as the prototype categorization of all the bugs accessible for interaction. IHB has since been extended to include bug decisions to request gifts of energy (a placeholder for health and/or wealth) and bug decisions to convey all, part or none of the energy requested. Both asker and prospective donor take into account the (actual or projected) comfort level of the prospective recipient. The present paper draws the various bug mechanisms together and presents preliminary results, with particular emphasis on the emergence of endogenous evaluative classification in bug orientation and action.

Consistent with the concept of a reference application, the interpretive mechanisms that support the acts of aggression, requests and voluntary contributions are designed to support comparable decisions in a variety of complex social applications (e.g., models of cultural conflicts such as genocide and ethnic cleansing, as well as diversifying markets, and a range of extended cultural processes).

THE INVESTIGATION AND DESIGN OF SOCIAL REALISTIC FIRST RESPONDER NETWORKS AND PLANS
Mengxiao Zhu, Alex Yahja, and Noshir Contractor

Events that lead up to and follow natural disasters such as Hurricane Katrina demonstrate that communication and coordinating knowledge among first responders is critical. It is clear that traditional incident command strategies tend to be idealistic and excessively reliant on hierarchical modes of coordination for people and technologies. There is an increasing recognition of exploring more peer-to-peer forms of coordinating first-responders and technologies.

This paper seeks to advance recent research in this area by utilizing Monge & Contractor’s (2003) Multi-Theoretical Multilevel (MTML) mechanisms to understand how first responders form, maintain, and dissolve communication and knowledge networks. This study uses the MTML mechanisms to model the dynamics and evolution of peer-to-peer (P2P) first responder networks. The goal of this modeling effort is to help design a robust socio-technical infrastructure to enable future first responders.

The modeling of dynamic communication and social networks is done using multi-agent simulation model and the validation is done using rule-based and ontological inference of simulation experiments against empirical knowledge and data. The simulation is run for many trials to test the effects of various theories and levels and their combinations of the MTML model on the performance of the responder networks. This includes testing the effectiveness of various communication technologies within the context of networks.

Early results indicate the utility of theories of social exchange and structural holes in understanding and designing effective first responder P2P networks. This study also assesses the effectiveness of the semantic and cognitive theory of social networks to understand and design first responder networks. Because of its theoretical foundations, the agent simulation model is closer to “reality” in a social, cognitive, spatial, and ontological sense, and thereby more amenable to validation against real world data. The agent simulation is run on Tungsten, a 2,500-node 15-teraflap supercomputer.

MINIMALISM AND MODEL-BUILDING: AN ASSURED MODEL OF THE EXCHANGES BETWEEN CONSUMERS, RETAILERS AND MANUFACTURERS
Daniel Klapper (University of Frankfurt), Dinesh Kunchamwar (Barclays Capital), Robert Marks (Australian Graduate School of Management) & David Midgley (INSEAD)

At a previous Lake Arrowhead conference we presented an agent-based model (ABM) of the exchanges between consumers, retailers and manufacturers. More recently we published a procedure for ‘assuring’ ABMs in general, using this model as an illustration. (Midgley, Marks and Kunchamwar, “The Building and Assurance of Agent-Based Models: An Example and Challenge to the Field,” Journal of Business Research, forthcoming.) Model assurance combines ideas from software
proof, destructive testing and empirical validation. In that paper we raise the philosophical issue of whether social scientists should take a traditional scientific approach to building ABMs or whether they should prefer a minimalist approach. Taking our own advice we developed a second, minimalist version of our model—Supermarket ABM 2.0. In this paper we present the results of assuring Supermarket ABM 2.0. The specific steps taken to assure the model include:

Verification: Two external experts have inspected the RePast code to discover whether it follows the model specification correctly. We use the Genetic Algorithm as an optimizer to test the bounds of the model by seeking implausible results.

Validation: A real supermarket chain has provided two databases which we use to validate the model. Here we follow a hybrid approach where we use one database to calibrate consumer agents at the micro-level and then we fit the retailer and manufacturer models to the other database at the macro-level, again using the Genetic Algorithm.

We report the results of this model assurance exercise and use it to define ‘minimalism’ more tightly, arguing that it is more restrictive than ‘parsimony.’ We also extend this debate by discussing the practical barriers that currently prevent ABMs reaching their full potential in the social sciences. These include the costs of software proof and the lack of data to validate many aspects of the agents.

A MODEL OF EMERGENT LEADERSHIP – FOR COMMUNITIES, ORGANIZATIONS AND DEFENSE

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The traditional view of leadership assumes a pre-existing social hierarchy – leaders ascend to existing positions of leadership. But what happens in newly formed groups where prior leadership has not been present? Or in more dynamic approaches to group problem solving in communities, organizations and terrorism that are self-organizing and bottom-up, particularly on the Internet? We present a model of emergent leadership where leaders arise out of the behavioral dynamics within and between groups, without the need of a pre-existing leadership position. The basis of the model of emergent leadership is a comprehensive representation of group identity formation and dynamics – developed by the authors and Dr. Merle Lefkoff, starting from the underlying approach in the CONSUMAT model. This research has far-reaching implications from understanding terrorist groups to market dominance to the organizational dynamics of government and business. It provides optimization guidelines for the management of emergent leadership and the avoidance of the failure modes of leadership in self-organizing systems.

MODELING INSTITUTIONALIZED ABUSE TO PROMPT RESPONSES FROM PARENTS, PROFESSIONALS AND POLICY MAKERS

Allison Pinto

Over the past 15 years, an alarming phenomenon of nouveau institutionalization has emerged: thousands of American parents are now sending their adolescents, often referred to as “troubled teens,” to residential facilities that self-identify as “therapeutic boarding schools,” “emotional growth academies,” and “residential behavior modification facilities.” While these programs market themselves as a more enriching, less pathologizing alternative to traditional residential psychiatric facilities, reports from former participants indicate that in many of these programs, youth are receiving substandard care and are suffering egregious human rights abuses. It is not an overstatement to say that many youth are experiencing mistreatment that fits the internationally acknowledged definition of torture.

Despite increased media attention, the phenomenon continues, as parents still send their children to facilities with records of abuse, child-serving professionals remain relatively silent about the mistreatment, and policy makers and legislators remain relatively unresponsive to calls for increased protections.

What will it take to prompt a societal phase transition, such that the United States expresses collective outrage about the mistreatment of American youth in these facilities, and responds in ways that protect adolescents and put an end to the
mistreatment that is occurring? Agent based modeling has the potential to increase understanding regarding the many factors and conditions that together are affecting the choices and actions of parents, program operators / staff and policy makers / legislators that contribute to the institutionalized abuse of youth. This paper will present preliminary agent-based models developed to illustrate the processes of initial program selection and institutionalized abuse, and then will detail the process involved in presenting these models to parents, child-serving (mental health, educational, and legal) professionals, and policy-makers / legislators in order to prompt changes in attitudes, choices and actions to ensure the protection and well-being of youth. As such, agent-based modeling will be presented as a tool for “macrosystemic intervention.”

**MODELING PHASE CHANGE BEHAVIOR**  
*Gary W. Strong; Lashon B. Booker, and Brian F. Tivnan*

We hypothesize that the social group is an external representation of a subset of human behavior that serves to simplify human decision-making by reliance on group influences. This research aims to better understand the dynamics of groups such as "leaderless resistance groups," which are not organizations as much as ideologies that depend on external communications such as the Internet.

We have begun development of a framework for modeling social group formation, recruitment, adaptation of belief upon recruitment, group competition, and group utilization of communications technology to further group objectives. Testing of this framework began with a potentially simple domain, the formation of an “invisible college” in scientific publication patterns and will expand to resistance group recruitment. The initial domain is similar to group recruitment, but much simpler in terms of data collection and extraction.

Progress to date includes the examination of agent-level and group-level processes in the proposed framework, technical approaches for modeling those processes, and integration of real data into the modeling framework. Two parallel efforts to model aspects of group behavior have been implemented: the transmission of fanatic behaviors -- based on a mathematical model by Castillo-Chavez and Song (2003); and, team assembly mechanisms -- based on a model by Guimera et al (2005). We created a modeling framework in which social identity groups offer pre-tested solutions to common problems. Individuals adopt a group’s solutions due to the reduced decision-making cost compared with case-by-case decision-making. Identity groups compete, and individuals “express” only a small number of available groups. We believe this is a general biological strategy for evaluating adaptations.

**NEIGHBORHOOD CHANCE AND NEIGHBORHOOD CHANGE**  
*Micahel W. Macy, Arnout van de Rijt, & David Siegel*  
*Cornell University*

Schelling showed how residential segregation arises even in a population that is tolerant of diversity. In a recent paper (AJS, 2006) Bruch and Mare challenge this conclusion, claiming that it depends on threshold functions that are not empirically plausible. They replace Schelling’s threshold with a linear preference for as many co-ethnic neighbors as possible – and segregation largely disappears. This result is puzzling, given that Schelling’s population is indifferent to ethnic composition so long as they are not in the minority. In contrast, Bruch and Mare’s population strictly prefers co-ethnic neighbors. Yet Schelling’s population segregates while Bruch and Mare’s does not. In replicating their results, we discovered the reason for this apparent paradox: color blindness, due to very high noise levels that precipitate error cascades when combined with sensitivity to small changes in ethnic composition. When we decreased noise sufficiently for linear preferences to directly shape behavior, we obtained the same levels of segregation as observed with the threshold functions that Schelling assumed.
“OF HUMAN ACTION, NOT OF HUMAN DESIGN:” THE SECRET HISTORY OF THE UNIVERSITY; OR, THE EMERGENCE, EVOLUTION, AND DISSEMINATION OF THE PERFECT FORM

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Eight hundred years after the first universities emerged in Bologna and Paris, in the late 12th and early 13th centuries, the idea of a university has achieved near-global spread. At the turn of the 21st century, the planet supports on the order of 1,000 research universities (out of about 10,000 institutions of higher education in existence today). About one quarter of the countries in the world sport at least one research university; those that do not are mostly very small or very poor—or majority Muslim.

University, universiteti, université, universitat, universidade, universidad, universität, universiteit, univerzitet, univerzita, universitas, università, universitas, universiteit, universität, univerza, universyte, universiteto: the Latin root, universitas, stands for the One, the totality, or the whole wide world, and it comes with the connotation of combining parts to form a whole. Latin was the universal language of medieval Europe where universitas stood for society, corporation, or guild, which comes with the connotation of internal self-governance and autonomy vis-à-vis the outside world. These two meanings of universitas—both of which can be traced back to the origins of the university in the European Middle Ages—summarize the essence of the university very nicely. The history of university design since then is but a series of footnotes to the medieval structure, of which two are noteworthy: the German research university and American land-grant university, both of them products of the 19th century.

This paper spells out the initial emergence and the evolution over time of the forms and norms that define the research university, as well as the factors shaping its geographical dissemination. It includes false starts that were missing critical pieces of structure (Athens, Alexandria, Constantinople, and Baghdad); models that can be highly functional under certain conditions but are unreplicable (Oxford and Cambridge; Harvard, Yale, and Princeton); blueprints that multiplied furiously, even though they were highly dysfunctional, only to collapse eventually (the Spanish universities of the 15th through 17th centuries); and bad designs that resulted from wrong inferences about the causes of rotten university systems (the French universities of the late 18th and early 19th centuries). It concludes with a critical discussion of the “ideas of a university” that are bandied about in the world-class universities movement today.

ON THE PLAUSIBILITY OF SUNSPOT EQUILIBRIA: SIMULATIONS BASED ON AGENT-BASED ARTIFICIAL STOCK MARKETS

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This study examines the plausibility of the emergence of sunspot equilibria in an agent-based artificial stock market. Using the agent-based model, we make the sunspots explicit so that we can test, e.g., by Granger causality test, whether purely extrinsic uncertainty can influence price dynamics. Also, through agent-based simulation, the coordination process, mainly driven by genetic programming, becomes observable, which makes us be able to analyze what agents perceive and whether they believe in sunspots. The two together enable us to test the possibility of growing sunspots from bottom up. By manipulating different control variables, three series of experiments are conducted. Generally speaking, the chance of observing “sunspot equilibria” in this agent-based artificial stock market is small; numerically, our simulation shows a probability only around 10%. However, the sunspot believers can never been driven out of the market. Nevertheless, they are always outnumbered by fundamental believers, which evidences that the market as collective behavior is rational and can distinguish the fundamentals from sunspots. We also find that the time horizon by which agents’ performance is evaluated plays a crucial role. Lengthening the time horizon will cause sunspots believers difficult to survive.
Conant and Ashby (1970) proposed that “Every good regulator of a system must be a model of that system”. Yet the evidence for traditional models of organizations fails to meet that criteria: The correspondence presumed between reality and observations aggregated from individual members has been unable to reconstruct an organization’s actual status (Levine & Moreland, 1998). The result clearly indicates that the traditional model cannot be used to control organizations (Weick & Quinn, 1999). This failure has lead Pfeffer & Fong (2005) to propose that belief illusions are a critical missing ingredient. We agree, and have constructed a bistable model of reality interdependent between physical reality and observations. The observations can be modeled with complex functions where only the real part corresponds with reality while the imaginary part does not (i.e., “illusions”). If the imaginary part is interdependent with social influences (e.g., culture, roles) and physical location, two stories of social reality always exist (Wendt, 2005). The immediate implication is that observational information alone is insufficient to model or control organizations.

Organisms live under uncertainty partly dispelled by social interaction (Carley, 2002). To survive, they form organizations as centers of cooperation (Ambrose, 2001) that marginalize opposing beliefs among members in exchange for a share of resources, a tradeoff between the loss of information from consensus-seeking and adaptability to change. The loss for organizations constituted of bistable agents means that information must be generated from perturbations (Lewin, 1951; Lawless & Grayson, 2004). Conant and Ashby (1970) have further posited that good regulation occurs when the available control variance is greater that the perturbation variance.

We have applied our model to a web-based metric for Marine Corps weather forecasters (Lawless et al., 2006a); to reorganize a Management Information System at a University in the European Union (Lawless et al., 2006b); to measure the performance of a military medical department of clinical research (Lawless et al., 2006c); and, in an ongoing application, to measure the performance of a university’s graduate school of business (Lawless et al., 2007). This versatile metric derives from the quantum model of interdependence in the social interaction (Wendt, 2005), the topic for a symposium in 2007 (www.aaai.org/Symposia/Spring/sss07symposia). The quantum aspect indicates that information entangled among social objects once measured collapses into one of two observables, necessarily losing all information on the non-observed variable.

The loss of information opens a new area of study as indicated by tracking the trade-offs in two very different studies. First, in a meta-analysis of over 30 years of research, Baumeister and his colleagues (2005) found that the self-esteem of individuals was strongly consistent with their worldviews but not with their academic or work performances. Then in field studies of the Department of Energy’s Citizen Advisory Board (CAB) recommendations on cleaning up nuclear wastes at DOE sites, we have found that decisions by consensus ruled CAB’s were rationally consistent but not practical for their DOE sponsor, while decisions by majority ruled CAB’s were inconsistent but practical (Lawless & Whitten, 2007).

We have also considered the loss of information in business mergers (Lawless & Grayson, 2004). When a market is highly fragmented, like the current U.S. airline industry, it is unable to act cohesively, characterized on average by a loss of profit. In late 2006, US Airways made a hostile offer for Delta Airlines that could further consolidate the U.S. airline industry. As the average size in market share increases, a more focused business model implies an increase in execution in one trade-off interrelated with another that increases the market’s capacity to put more resources into executing its plans more quickly on average. A more focused market twice the size of a fragmented market should execute in one-half the time (where a focused business model can reflect a reduction of organizational duplication, personnel or overhead expenses; or correspondingly, an increase in operational readiness could occur with the wider deployment of new technology). If a fragmented market produces more information, a consolidated market reduces the information available. But there is also a loss of information caused by trade-offs during the acquisition process as well, what we have termed the measurement problem (Figure 1; from Lawless et al., 2005).

**Figure 1**: The measurement problem from the perspective of a merger target (bi-sided uncertainty relations exist for the acquiring organization).
For example, Strategy: after AT&T Wireless put itself on the auction block in 2004 and Cingular made the first offer, AT&T Wireless did not know whether bids would be received from other players such as Vodaphone, or how much more would be offered; Execution: Cingular expected that AT&T Wireless would execute its strategy by choosing the best bid by the deadline it had set, an expectation that turned out to be incorrect; Resources: AT&T Wireless did not know whether Cingular or Vodaphone would increase their bids to an amount it considered sufficient; Time: while the bidders believed incorrectly that the deadline was firmly established, AT&T Wireless was uncertain of the time when the bids would be offered. Finally, although power goes to the winner, it was not easy to determine who won and who lost in this auction. AT&T Wireless was unable to enact phone number portability and became the prey, but its CEO exacted a superior premium for his company and stockholders; while the merger on paper made Cingular the number one wireless company in the U.S., it may have overpaid for the merger; and during the uncertainty of regulatory review (both the length of the regulatory review period and the regulatory decision), with AT&T Wireless losing customers as competitors exploited the regulatory uncertainty, it was unknown how costly the eventual merger would be based on the assets remaining once the merger had been consummated.

Quantum agents: Our present research is directed at designing an organization composed of quantum (bistable) agents. These agents should be able to reside in at least one of two states: either in a baseline or excited state; either in an action or observational state; and influenced more by either belief illusion A or B.

PERVASIVE INFORMATION IN THE NETWORKED ENTERPRISE

Philip Barry and Matthew Koehler
The MITRE Corporation

This talk will examine the issues surrounding pervasive information in an enterprise. The effect of high interconnectivity with little control over the veracity of the data within the system has had a number of effects on the functioning of an enterprise, be it a high-tech firm or a net-centric fighting force. Not all of the effects of this interconnectivity have increased the task completion performance of the enterprise, though the prevailing assumption is that it has. This talk questions the assumption that more information is better for an enterprise. We assert that with increased availability of information cognitive effects such as anchoring and hypervigilance have the potential of playing a much larger role due to the sheer volume of information to be processed. Further, with the advent of persistent connectivity, the propagation effects of potentially non-optimal decisions can be significant if not catastrophic. We describe a framework to examine the value of information to the enterprise as well as to individual decision-makers. We also look at the propagation effect of networked decisions across an enterprise and discuss the effects of maximizing local decision-making and task completion performance versus global maximization. Experimental results from agent based simulations are offered as supporting evidence for the points in this talk. The talk concludes with future directions and implications for large emerging enterprises.

PLAYING IN THE SANDBOX: PARTICIPATORY AGENT-BASED SIMULATIONS WITH TANGIBLE INTERFACES

Stephen Guerin, Joshua Thorp; Owen Densmore
Redfish Group Santa Fe, New Mexico

This talk will demonstrate recent Redfish Group research into using tangible computing and augmented reality for use in participatory agent-based simulations. We will demonstrate techniques where simulations and visualizations are projected onto tables and sandboxes and where traditional user input devices like keyboards and mice are replaced with a variety of common physical objects to serve as user input. Users are able to concurrently manipulate the UI objects and simultaneously interact with the simulations. We will discuss computer vision techniques to recognize motion of tangible physical objects and hand gestures over the simulation projection surface which serve as user input.

The use of these tangible interfaces, we suspect, increases the engagement of stakeholders with their models and also encourages more spontaneous dialog among simulation users when compared to the more passive presentation of simulation results projected onto screens.
Examples will be shown from a recent wildfire evacuation project where emergency planners and responders manipulate physical objects to specify parameters like wind direction, locations to start fires and where to stage incident command posts.

**PREDICTING RISKY BEHAVIOR IN TRIBAL SOCIETIES: VALIDATING DECISION PARADIGMS AND EXPLORING MODELS**

*Larry Kuznar*

The field of decision theory is hotly contested among competing and seemingly incommensurable paradigms such as rational choice, bounded rationality, and prospect theory. Understanding decision making is critical for addressing economic issues (insurance, investment, consumer behavior), health concerns (drug use, sexual behavior), and political behavior (international relations, terrorism). Not only are decision paradigms difficult to compare, but each is plagued by deep uncertainties regarding parameter values, and they imply dynamic and evolving impacts on social behavior. Therefore, validating these paradigms in part or in whole is a challenging problem. I instantiate these paradigms in an agent-based model, and employ both quantitative, empirically based validation methods (Theil’s Inequality Coefficients) and more qualitative comparisons (Exploratory Modeling methods developed at RAND) to explore the relative strengths and weaknesses of different decision paradigms for predicting risky political behavior and the formation of coalitions. The test case for this study is the actual intra-tribal political alliances observed among the Kapauku of highland New Guinea. This study provides testbed for validating decision theories and understanding the dynamic shifts in tribal politics often encountered by Western businesses, diplomats and militaries. Conclusions on decision theories and the nature of tribal politics are presented.

**PREDICTION MARKETS AS AN AGGREGATION MECHANISM FOR COLLECTIVE INTELLIGENCE**

*Jennifer Watkins*

Collective intelligence is the result of the proper aggregation of local information from many individuals to generate an optimal global solution to a problem. Often, these solutions are more optimal than what any individual could have provided. In this article, we focus on prediction markets as the aggregation mechanism. Prediction markets, like commodity markets, channel inputs from all trading individuals into a single dynamic stock price. Instead of determining the value of a particular good, a prediction market is used to determine the probability of a particular event occurring. We present and discuss five features of prediction markets that urge a collective toward optimal solutions. Through the combination of these features, prediction markets lend themselves to the systematic study of the promising phenomenon of collective intelligence.

**SHARED TERMINOLOGY IN SOCIAL SCIENCE FIELDS USING MULTI-AGENT SIMULATIONS**

*Suarez, Eugenio D.*

This research agenda focuses on the use of Multi-Agent Simulations to perform analysis in social science fields, creating a shared terminology through which ideas from different disciplines can be communicated.

The simulation language to be developed represents a decomposition of intent, based on the idea that an agent’s behavior, whether it represents an individual or a group, can be seen as an emergent property of a collection of intertwined aims and constraints. The hierarchical composition involves many levels of agency, stressing the dichotomy between emergent vs. imposed behavior. This abstraction shall point out connections between the approach for describing human behavior and social phenomena by economics, social theory, psychology and evolutionary biology. Furthermore, the simulation platform will bridge gaps between disciplines. In particular, it will allow for the communication between sociological paradigms of behavior, where the group takes precedent, and the traditional economics model, where autarkic individuals take exogenous
decisions. It will also provide a framework for approaching the fields of behavioral economics, where psychological aspects of behavior come into play.

In traditional economics, society does not exist. It merely represents a collection of completely independent individuals. This paradigm therefore implies that no measurements of societal welfare can be made, or that at least no such statements can be made objectively (i.e. scientifically). Conventional decision-making methodologies attempting to optimize individual utility have a limited capability to account for complex emergent behaviors and the interactions that produce those behaviors.

We extend conventional utility theory to social utilities to seek a social balance between individual’s interests and the interests of others. The intended research thus creates a software platform for the simulation of social behavior in which aspects that are often overlooked in traditional linear science can be quantified.

**SOCIAL NEUROSCIENCE: LESSONS FROM EXPLORING AGENTS’ MINDS**

*Dario Nardi*

*Human Complex Systems, UCLA*

Multiagent simulations often strive to include rules that capture agents’ mental representations of systems. Some simulations strive to model patterns of transactions between agents. These details are particularly useful when modeling small groups of agents, whether couples or teams. Yet what goes on within real human minds? Can we learn anything from neuroscientific models? And can neuroscience help us locate more fitting models of agents’ minds?

I will present relevant background plus a simulation of a (very) simplified human mind based on the results of social neuroscience experiments using EEG equipment. Relevant phenomena captured by the simulation include attention to social feedback and embarrassment, mirror cells and empathy, values-based responses, recall of factual vs. aesthetic data, evaluation of risk and uncertainty, and a learning process seen time-and-again in neuro-imaging studies.

No prior neuroscience knowledge is required; this session is designed as an introduction on the topic for agent modelers, with an emphasis on using the information in one’s simulations.

**SOCIODYNAMICS:**

**TOWARDS A FUNDAMENTAL SCIENCE OF SOCIAL DYNAMICS**

*Klaus Jaffe*

*Universidad Simón Bolívar, Caracas, Venezuela*

When studying social systems, it soon becomes evident that complex phenomena are involved and that a reductionistic approach is not likely to enhance our understanding of the working and evolution of societies. Are there such thinks as fundamental laws of social dynamics? What is the adaptive value of society? What are the mechanisms and immediate causal forces that drive the social dynamics?

I approach these questions using different time windows for its analysis and applying analytical techniques borrowed from different disciplines. The data lead us to conclude, that all social structures evolved by biological beings on this planet, follow a common set of features which include: the presence of cohesive forces, homophily (preference for other who are like us), tendency for a division of labor or the specialization of tasks, emergence of synergy in the interactions between the component parts.

On the other hand, computer simulations of societies in artificial worlds, using the model Sociodynamica, show that societies are adaptive only if they provide positive fitness benefits to the average member of the group, that homophily is a means to accelerate social evolution, and that specialization is a means to achieve greater synergy but affects the social dynamics. Mechanisms such as mutualism, social investments, altruistic punishment, shame, fame, and learning by imitation, play a vital role in certain stages of social development.

Social simulations with simulation models focusing on the evolutionary dynamics, show that societies allow for synergies to emerge between biological evolution driven by mutations, natural selection and vertical transmission of infor-
mation; and culture, driven by learning from parents and from peers. Thus, societies not only increase the fitness of whole populations but they also accelerate evolution, serving as a catalyst for their own emergence and evolution.

**TOWARDS NETWORK AUTONOMY:**
**AN AUTONOMY-ORIENTED COMPUTING (AOC) PERSPECTIVE**

Jiming Liu  
*Professor and Director of School of Computer Science, University of Windsor, Ontario, Canada*

This talk will focus on one of the most important manifestations of human complex systems, namely, communities of locally-interacting, autonomous agents. These communities will establish and maintain a vast collection of socially or scientifically functional networks. The dynamic interaction among autonomous agents, such as information exchanges, experience sharing, and service transactions following some predefined protocols, will lead to the dynamic formation, reformation, and consolidation of such networks. As a result, networks of common practice or shared markets will emerge.

The dynamic interaction among autonomous agents is a complex one, in which various types of interesting emergent behavior can be induced and observed. Not only should the dynamics of formation and growth of the networks be modeled, but more importantly the dynamics of network functions with respect to certain purpose-directed criteria should be characterized. Such dynamically emergent behavior will depend on the local interaction policies adopted. Knowledge gained from these studies will be invaluable in that it allows us to determine the structural characteristics, computational efficiency, and functional optimality of self-organizing networks, and provides us with insights into the role of local interaction policies.

Autonomy-Oriented Computing (AOC) can be regarded as a new computing paradigm that pays special attention to the role of self-organization and is well-suited to undertaking the above-mentioned challenges. It deals with the problems that involve large-scale, distributed, locally interacting, and sometimes rational agents. AOC has been found to be extremely appealing in the following aspects:

To capture the essence of emergent autonomy in natural and artificial systems;
To solve computationally hard problems, e.g., large-scale computation, distributed constraint satisfaction, and decentralized optimization, that are dynamically evolving and highly complex in terms of interaction and dimensionality;
To characterize complex phenomena or emergent behaviors in natural and artificial systems that involve a large number of self-organizing, nonlinearly interacting entities;
To discover new laws and mechanisms underlying complex phenomena or emergent behaviors.

In the talk, I will discuss the AOC-related research questions and methodologies underlying the studies on network autonomy.
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