# SIGABIS Exchanges,
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# Special Interest Group on Agent-based Information Systems (SIGABIS)

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S I G A B I S
www.agentbasedis.org

### History

This SIG was founded by Chris Schlueter Langdon and Riyaz Sikora and is one of the first six officially sanctioned groups announced in ISWORLD in July 2001.

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## S I G A B I S: An Introduction

### History

The Special Interest Group on Agent-Based Information Systems (SIGABIS) is affiliated with the Association for Information Systems (AIS), the premier global organization for academics specializing in Information Systems. Our SIG is one of the first six officially sanctioned groups announced in ISWORLD in July 2001. Chris Langdon and Riyaz Sikora prepared the proposal with guidance from Dan O'Leary and Mike Shaw. Our Web site went live in 2002, and 2003 is our first year of operations.

### Purpose

The **agent metaphor** has become popular in mainstream computing and business schools largely due to its suitability for the study of distributed systems, such as the Internet and the Web.

**Distributed systems** are increasingly becoming commonplace in applications such as manufacturing, business networks, channel relationships, ubiquitous information access, and grid computing. We expect to see the emergence of new **distribution channel structures** and **customer interfaces** (e. g., 1-to-1 customization, recommendation 'engines'), **supply chain topologies** (e.g., virtual business networks), and **market-making mechanisms** that use new kinds of intelligent, distributed computational processes in the form of agents.

### Mission

SIGABIS is a forum to bring together like-minded researchers and practitioners to:

- Collaborate in rigorously building agent-based computational theory and practice.
- Promote the advantages of agent-based computational modeling.
- Advance scientific research in areas that can benefit from agent-based techniques.

[Please visit our Web site for additional information and references.] (csl)

## Upcoming Events + Calls for Papers

### Mini-track

at **WeB**, a pre-ICIS Workshop on E-Business 2003, Dec. 13-14, Seattle, WA.

- Q-learning in the Cournot Game (Kimbrough and Lu)
- Conceptualizing Coordination and Competition in Supply Chains as Complex Adaptive System (Langdon and Sikora)
- Towards an Agent-Based Mass Customization Environment (Sugumaran, Kirn & Dietrich)
- LOGOS: An Agent-based NASA Ground Operations System Prototype (Yoon & Truszkowski)

### Special Issue

of *Journal of Information Systems and e-Business Management* on Agent-based IS (JISeB, published by Springer).

We welcome research that demonstrates how a business problem can be better solved using an agent-based, computational method.

Deadline: Feb. 1st, 2004
(csl)

### Track & Mini-track

at **AMCIS** Americas Conference on IS 2004, August 5-8, New York City, NY.

Track: **Agent-based IS**

Mini-track: **Intelligent Agents and Multi-Agent Systems**
Co-Chairs: Vijayan Sugumaran, Oakland University, and Stefan Kirn, University of Stuttgart/Hohenheim.
Deadline: Feb. 22nd, 2004
(csl)

The Association for Information Systems (AIS) is "the premier global organization for academics specializing in Information Systems" (www.aisnet.org).

**Agency theory** analyzes the costs of resolving two types of conflicts that can arise between principals and agents under conditions of incomplete information and uncertainty: **adverse selection** and **moral hazard**. Adverse selection is the condition under which the principal cannot ascertain if the agent accurately represents his ability to do the work for which he is being paid. Moral hazard is the condition under which the principal cannot be sure if the agent has put forth maximal effort (Eisenhardt 1989).

## SIGABIS Focus

Our group is strictly focused on agent-based information systems. It is therefore important to explain how we define this and the scope of our SIG.

**What is an IS?**
In line with the research literature, we define an IS as a group of information technology (IT) components serving a common purpose, which is to automate a particular set of business activities (S. Langdon 2003, Bakos 1985; Dewett and Jones 2001, 317-320).

**What is an "agent" and how is the term used in the IS literature?**
According to the Merriam Webster Collegiate Dictionary 2002 the origin of the term "agent" dates back to 15th century. The term can be defined as "one that acts or exerts power" or "a means or instrument by which a guiding intelligence achieves a result". We follow Holland, an artificial intelligence scholar and genetic algorithms pioneer, in our conceptualization of an agent in IS. In his research on complex adaptive systems--nonlinear systems defined by the interactions of large numbers of adaptive agents--Holland borrowed the term "agents" from economics "to refer to active elements without invoking specific contexts" (1995, 6-7).

The field of economics that Holland was referring to is **Agency Theory**, which explains how to best organize the relationship between one party--the **principal**--who determines the work, and another party--the **agent**--who undertakes the work (Ross 1973; Grossman and Hart 1983; and for a survey, see Sappington 1991). (csl)

"A **Web service** is viewed as an abstract notion that must be implemented by a concrete **agent**. The agent is the concrete entity (a piece of software) that sends and receives messages, while the service is the abstract set of functionality that is provided" (The World Wide Web Consortium 2003, 7).

## Research Area Strategy: Promoting Depth and Breadth

SIGABIS promotes rigorous research and, therefore, emphasizes depth by hosting highly focused **Research Areas (RAs)**. The breadth of agent-based IS knowledge grows with every new research area that is added to the SIG. The structure of the RAs are similar and edited by an **Area Editor (EA)**, who is an expert in this field. In 2003, our first year of operation, we have launched three exemplary RAs. Our first three RAs are:
RA1: Study of **Emergent Behavior and Strategic Simulation** using Complex Adaptive Systems (CAS).
RA2: **Agent Learning.**
RA3: **Distributed Systems Architectures and Web Services**—How innovation with I*T* (*T*echnology components: protocols, etc.) affects IS (Systems: e-delivery, etc.) capabilities.
In 2004 we would like to add RAs. Please don't hesitate to contact us if you are interested! (csl)

RA1 follows the tradition of laboratory experiments as a tool in **empirical economic analysis** established by Smith. He pioneered tests of predictions from economic theory by way of laboratory experiments (Smith 1962; overview in Kagel and Roth 1995).

Smith "initiated the use of the laboratory as a "**wind tunnel**" in order to study the performance of proposed institutional mechanisms for deregulation, privatization, and the provision of public goods" (The Royal Swedish Academy of Sciences 2002, 9).

## RA1: Emergent Behavior and Strategic Simulation

The use of multi-agent system and complex adaptive system modeling and simulation (MAS and CAS, respectively) extends well beyond the academic community. The U.S. Department of Justice, for example, has replaced structural analysis with simulation to analyze mergers in differentiated product industries. Business executives use it to complement conventional analytic tools to make better strategic decisions.
Simulation and computational experiments have been particularly helpful in areas that require an understanding of the *dynamics* of change and competitive *interaction*. This is typically the case where executives have to respond to deregulation, disruptive technologies, or market entry. Simulation-based analysis can allow decision makers to experiment with different scenarios. Furthermore, once a simulation system has been designed and implemented it can be reused and modified to evolve with a changing competitive landscape and thus provide ongoing decision support.

**Simulation**
Simulation in general is understood as "a technique for understanding and predicting the behavior of systems" (Simon 1996, 13). It refers to the creation of the artificial (as opposed to the natural) things that are synthesized by human beings, may imitate appearances in nature, and can be characterized in terms of functions, goals, and adaptation.

**Benefits**
The use of simulation experiments has been viewed as a promising approach (Courtney et al. 1997, 71, 78), particularly, because conventional analytic tools fail to solve even moderately complex economic models (Chaturvedi and Mehta 1999, Rust 1996). Furthermore, most mathematical and statistical tools rely on the assumption of linearity (a function is linear if its value is a weighted sum of the values of its arguments). Unfortunately, many phenomena are a of a non-linear nature. Often, the behavior of a whole system is

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more than a simple sum of the behavior of its parts. Organizations, for example, are considered to be complex, dynamic, non-linear, adaptive, and evolving systems (Prietula et al. 1998). Tools, such as trend analysis or the calculation of equilibriums, have proven very useful for generalizing observations of linear phenomena into theory. However, when applied to nonlinear problems, these tools produce approximations that often fail to provide relevant explanations. Although computer-based simulation is no more valuable than its underlying assumptions, significant benefits can be realized by its use (Simon 1996, 15–16):

- *First*, simulation eases the discovery of implications of assumptions, such as recognition of patterns.
- *Second*, the application of computing power, allows for the consideration of many more variables, which enriches models and increases relevance of results.
- *Third*, simulation is seen as being particularly viable if interesting aspects arise merely from the organization of individual parts, without dependence upon the properties of those parts. (csl)

## RA2: Agent Learning

One of the key challenges in designing a MAS is coordinating the actions of agents. In a dynamic environment where the actions of agents are interdependent, it is critical that agents learn to adapt their behavior to the actions of other agents. Furthermore, when designing agent systems it is a challenge to model all potential situations an agent may encounter and define behavioral repertoires optimally *ex ante*. Agents, therefore, could be modeled to learn from and adapt to their environment. Until recently, research in the field of machine learning (ML) mainly concentrated on learning techniques and methods in single-agent or isolated-system settings. More and more, ML is being explored as a vital component to address challenges in multi-agent systems. For example, many application domains are envisioned in which teams of software agents or robots learn to cooperate amongst each other and with human beings to achieve global objectives. Learning may also be essential in many non-cooperative domains, such as economics and finance, where classical game-theoretic solutions help structure a problem but fail to predict outcomes At the same time, multi-agent learning poses significant theoretical challenges, which makes it a fertile area of research: the numerous and significant theoretical developments of the 1990s, in fields such as Bayesian, game-theoretic, decision-theoretic, and evolutionary learning, can now be extended to more challenging multi-agent scenarios. (rs)

## RA3: Distributed Systems Architectures & Web Services

"Ever since the first program was divided into **modules**, software **systems** have had **architectures**, and programmers have been responsible for the **interaction** among the modules and the global properties for the assemblage" (Shaw and Garlan 1996, xii).

With "IS emerging as the factory" in many industries it becomes imperative to ensure that a firm's **IS architecture strategy** remains effective. In many organizations, the information technology (IT) infrastructure, with its many different systems provided by numerous vendors, has emerged over many years--even decades--often without a strategic plan. With a more disruptive business environment on the one hand, and, therefore, sharply increased requirements for integration and flexibility, and more distributed information systems (IS) choices, such as **Web services technology**, on the other, companies often overlook, however, urgently need to reassess their IS architecture strategy. We investigate architecture alignment and fit, and provide an IS perspective of the business value of Web services investments in the context of "utility computing," considered by Forrester Research as the "third major computing revolution" (BW 8/25/03). (csl)

## Research Note: Computational Modeling and Explanation

(by Steven Kimbrough)

Agent methods are often used to facilitate computational modeling. Steve provides a current and comprehensive summary of the state-of-the-art of computational modeling. He continues to explain the history and growing importance of computational explanation in information and management sciences. (csl)

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### RA1: Emergent Behavior & Strategic Simulation

### Project P1: Cournot Competition

New talk and paper at the

Eighth INFORMS **Computing Society Conference**, January 8-10, 2003, Chandler, AZ.

Conference Theme: **Optimization and Computation in the Network Era**

**Competition in Business Networks with Industry-Level Feedback**

Chris Langdon and Riyaz Sikora

Firms specialize to benefit from lower fixed cost, less assets and increased flexibility. However, specialization makes firms more dependent on industry structure and the behavior of suppliers and channel partners. Specialized firms are particularly vulnerable to market foreclosure. We have developed a model that recognizes foreclosure risk in a supply chain setting in which specialized firms compete with vertically integrated incumbents based on a fixed cost advantage of specialization.

We have formalized this problem as a complex adaptive system because it allows us to model industry structure and transaction cost as endogenous variables. The behavior of firms in the model is based on micro-economic cost theory. Interaction between firms is modeled as a repeated Cournot game. Experiments have been conducted using discrete event simulation. We generated results for a two-tier serial supply chain with a symmetric structure. (csl)

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**Abstract**

Computational explanations appeal to computational models, in contrast to equations or axioms, to explain their target systems. These models are typically inspired by natural phenomena and the term natural computation has been used in the literature. Darwinian or evolutionary models and explanations are a prominent form. This paper presents and reviews the concept of computational explanation, and its uses in the social sciences. Emphasis is placed on recent innovations in algorithms for computational modeling.

**Law, Axiomatic and Computational Explanation**

Scientific research reliably and routinely produces substantial progress within its several disciplines. Physicists increase our knowledge of physics, biologists advance biology, social scientists advance social science, and management scientists advance management science. Much more unusually, scientific research produces--invents or discovers—new ways of doing science. My topic in this note is one such development. I aim to describe and characterize it in introductory fashion and then to comment on what it means--on the opportunities it presents--for the management sciences.

The innovation I have in mind has been noticed by others, and indeed as we shall see has developed at least since the 19th century. It has not, as far as I know, been recognized with a commonly-accepted name, even though the idea has been accepted in at least parts of several disciplines. So to begin, I shall give it a name: computational explanation.

The core thought is that a **computational explanation** is an explanation that appeals to a computation to do its explaining. Phenomena are explained as resulting from a computational process. If the phenomena in question are produced by a computer program, then a computational explanation is surely one we would think appropriate, even mandatory. What is new, and perhaps surprising, is the applicability of computational explanations in the biological, social, and management sciences. That is what I want to discuss.

There are other kinds of explanation and they have predominated in scientific study. Without pretending to cover the topic with any justice, it will suffice for present purposes to focus on two contrasting types of explanation: covering law, and axiomatic. Covering **law explanations** are most familiar from physics. A general rule or law is presented, typically in the form of a differential or other sort of equation, and given initial conditions the state of a system can be predicted and explained subsequently. Think of Newtonian physics. Such explanations are something of a “gold standard” in science; the problem outside of physics has been the scope of their application. If more could be found, that would be welcome; in the meantime progress accumulates under other standards.

In what I’m calling an **axiomatic explanation**, a system of axioms replaces the covering law. Often, the axioms are motivated as much or more by normative considerations as by empirical findings. Think of utility theory. An ideal kind of preference is axiomatized. With initial conditions we may then deduce-and explain and predict-behavior of an ideally rational agent. Much more economics and game theory follows this basic pattern of reasoning. The challenge is to abstract a reasonable representation, formalize a description of it axiomatically, derive properties of the formal system, and test the conformance of the formal system with particular concrete instances.

All of this is well and good. Why should anyone be interested in any other form of explanation? The general complaint has been that, at least outside of physics, the techniques of covering law and axiomatic explanation have been insufficiently productive. There is, many have though, much more to be achieved with scientific thought than can be achieved with these two methods. In particular, the successes of computational explanation in its various forms are, on the positive side, what has so encouraged its pursuit.

A different, significantly longer version of his Research Note has been published: Kimbrough, S. O. 2003. Computational Modeling and Explanation. In: Bhargava, H. K., and N. Ye (eds.). *Computational Modeling and Problem Solving in a Networked World*. Interfaces in Computer Science and Operations Research Series. Kluwer Academic Publishers: Boston, MA, pp. 31-57.

How does computational explanation differ from covering law and axiomatic explanations? To a first approximation, a computational explanation is:

- *Procedural.* In contrast to declarative (both covering law and axiomatic explanations tend to be declarative).
- *Constructive.* In some sense it answers to “If you can’t make one, you don’t know how it works.” Each step in the procedure is doable by the entity in question; a mechanism is available for performing each of the steps in the procedure.
- *Representational.* Semantic, or meaningful. Basically the procedure has an interpretation; its states carry information or meaning about the world outside of the system. Purely random arrangements do not, but once we have selections, there is (some) such information and meaning present. Computational explanations add to the more basic procedural or constructive explanations aren’t just procedures. They are (at least) procedures that are the way they are because of what they are.

These requirements are in order of increasing stringency.

**Key Objectives**

The computational modeling enterprise seeks to model naturally-occurring processes as computations, either broadly or narrowly defined. Model and, of course support explanations, predictions, interventions, and all the purposes of science generally. It is not (primarily) the investigation of algorithms as abstract entities (as in computer science); rather it is the attempt to discover and understand computational, or algorithmic, processes in nature and practice. Computational modeling may be contrasted with equational and axiomatic modeling, and as such it presents a genuinely distinct mode of doing science and engineering, i.e., of seeking explanations and predictions, and of supporting interventions and innovations.

Impressum

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