



SMARTDATA

IPSI SmartData International Symposium

Privacy meets Evolutionary Robotics: Protecting our Freedoms with Virtual Tools

University of Toronto, Canada •• May 14-16, 2012



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MONDAY MAY 14

SESSION 1

- 9:00 am — 9:10 am** Welcome/Opening Remarks, **Ken Anderson**, Master of Ceremonies
- 9:10 am — 9:30 am** **Dr. David Naylor**, President, University of Toronto, Toronto, Ontario, Canada
Dr. Dimitrios Hatzinakos, Department of Electrical and Computer Engineering, University of Toronto, Ontario, Canada
- 9:30 am — 10:00 am** **Why are we here today? Privacy and the Promise of SmartData**
Dr. Ann Cavoukian, Information & Privacy Commissioner, Ontario, Canada
- 10:00 am — 10:50 am** **SmartData — Privacy Meets Evolutionary Robotics in the Matrix: Protecting Freedom Using Virtual Tools**
Dr. George Tomko, Expert-in-Residence, Identity, Privacy and Security Institute (IPSI), University of Toronto, Ontario, Canada
- 10:50 am — 11:05 am** **BREAK**
- 11:05 am — 12:05 pm** **Perspectives on AI**
Dr. Inman Harvey, Visiting Senior Research Fellow, University of Sussex, Brighton, UK
- 12:05 pm — 1:15 pm** **LUNCH**

SESSION 2: OVERCOMING THE 'DEFINITION OF SMARTNESS' OBSTACLE

- 1:15 pm — 1:30 pm** **Session Introduction**
Dr. Don Borrett, University Health Network, University of Toronto, Ontario, Canada



MONDAY MAY 14

1:30 pm — 2:15 pm Can ZombieData be Smart?

Dr. Stephen Biggs, Professor, Department of Philosophy, Iowa State University, Ames, Iowa, USA

2:15 pm — 3:00 pm Relevance Realization and the Neuro-dynamics of General Intelligence

Dr. John Vervaeke, Professor, Department of Cognitive Science, University of Toronto, Ontario, Canada

3:00 pm — 3:15 pm **BREAK**

3:15 pm — 4:00 pm Agency as an Ecological Concept

Dr. Denis Walsh, Professor, Department of Philosophy, University of Toronto, Ontario, Canada

4:00 pm — 4:45 pm Philosophical Reflections on the Design of Autonomous Agents:
The Problem of Relevance

Dr. Michael Wheeler, Professor, Department of Philosophy, University of Stirling, Stirling, UK

4:45 pm — 5:30 pm Panel Session/Q & A

Moderator: Dr. Mark Kingwell, Professor, Department of Philosophy,
University of Toronto, Ontario, Canada

Participants: Don Borrett, Michael Wheeler, Stephen Biggs, Inman Harvey, Denis Walsh, John Vervaeke

5:30 pm Daily Wrap-up

TUESDAY MAY 15

SESSION 1: OVERCOMING THE 'EVOLUTION AND EMBODIMENT' OBSTACLES

8:55 am Introduction of Session

9:00 am — 9:45 am Evolutionary Robotics and SmartData

Dr. Inman Harvey, Visiting Senior Research Fellow, University of Sussex, Brighton, UK

- 9:45 am — 10:45 am** **Evolution/Development of Communication and Language in Embodied Agents**
Dr. Stefano Nolfi, Research Director, Institute of Cognitive Science and Technology, Rome, Italy
- 10:45 am — 11:00 am** **BREAK**
- 11:00 am — 11:15 am** **The Development of Autonomous Virtual Agents**
Dr. Karl Friston, Professor, Wellcome Trust Centre for Neuroimaging, University College, London, UK [Recorded PowerPoint Message]
- 11:15 am — 12:15 pm** **Evolution of Learning in Robots**
Dr. Dario Floreano, Professor, (EPFL) École polytechnique fédérale de Lausanne, Head of Laboratory of Intelligent Systems, Lausanne, Switzerland
- 12:15 pm — 12:35 pm** **Panel Session/Q & A**
Moderator: Dr. George Tomko, Expert-in-Residence, Identity, Privacy and Security Institute (IPSI), University of Toronto, Ontario, Canada
Participants: Inman Harvey, Stefano Nolfi, Dario Floreano, Hon Kwan
- 12:35 pm — 1:25 pm** **LUNCH**

SESSION 2: OVERCOMING THE 'DYNAMICAL SYSTEMS' OBSTACLE

- 1:25 pm** **Introduction of Session**
- 1:30 pm — 2:00 pm** **Context Dependent Information Processing Entails Scale Free Dynamics**
Dr. Don Borrett, University Health Network, University of Toronto, Ontario, Canada
- 2:00 pm — 3:00 pm** **Patterns of Attractors in the "Brain"— Wild Dynamics at the Edge**
KEYNOTE **Dr. Enrique Pujals**, Professor, Associacao Instituto Nacional de Matematica Pura e Aplicada, Rio de Janeiro, Brazil



TUESDAY MAY 15

3:00 pm — 3:15 pm BREAK

3:15 pm — 4:15 pm Autonomy and Embodiment vs. 'Embodiment-lite'

Dr. Pablo Funes, Vice President of Research & Development, ICOSYSTEM, Cambridge, Massachusetts, USA

4:15 pm — 5:30 pm Panel Session/Q & A

Moderator: Dr. Hon Kwan, Professor, Department of Neurophysiology, University of Toronto, Ontario, Canada

Participants: George Tomko, Inman Harvey, Enrique Pujals, Pablo Funes, Don Borrett

5:30 pm Daily Wrap-up

6:00 pm — 9:00 pm Conference Banquet, kindly sponsored by Google

WEDNESDAY MAY 16

SESSION 1: OVERCOMING THE 'TECHNICAL' OBSTACLES

8:55 am Introduction of Session

9:00 am — 9:45 am What Matters: Real Bodies and Virtual Worlds

Dr. Michael Wheeler, Professor, Department of Philosophy, University of Stirling, Stirling, UK

9:45 am — 10:25 am IBM's Blue Gene/Q System and Implications for Simulation and Data Analysis

Dr. Kirk Jordan, Emerging Solutions Executive, Computational Science Center at IBM Watson Research Center, Cambridge, Massachusetts, USA

10:25 am — 10:40 am BREAK



WEDNESDAY MAY 16

10:40 am — 11:20 am Emerging Ideas in Computer Architecture

Bob Blainey, IBM Fellow, Hardware Acceleration Laboratory, IBM Software Group

11:20 am — 12:00 pm The GENI Testbed: Enabling Disruptive Technical Innovation in Network Science

Mark Berman, Experimentation Director, Global Environment for Network Innovations Program Office, Waltham, Massachusetts, USA

12:00 pm — 12:30 pm Panel Session/Q & A

Moderator: Dr. Greg Steffan, Professor, Department of Electrical and Computer Engineering, University of Toronto, Ontario, Canada

Participants: Michael Wheeler, Kirk Jordan, Bob Blainey, Mark Berman, George Tomko, Inman Harvey

12:30 pm Conference close

CLOSED MEETING OF EXPERTS

1:00 pm — 5:00 pm Participants: Symposium Speakers

Goal: Summarizing knowledge gained at the Symposium, and determination of next steps for research and collaboration.



TOPICS

MONDAY, MAY 14

SESSION 1

SmartData — Privacy Meets Evolutionary Robotics in the Matrix: Protecting Freedom Using Virtual Tools

Dr. George Tomko

Expert-in-Residence, IPSI
University of Toronto, Ontario, Canada

Technology must form an integral component in the defence of our personal privacy. Policies and regulations will serve, at best, as lagging remedies in the fast-paced world of cyberspace. In a world where personal information can increasingly be transmitted and used in multiple locations simultaneously, protecting privacy may only truly be accomplished if the information itself becomes “intelligent” and capable of making appropriate decisions, relating to its release, on behalf of the data subject. In other words, the data must become smart — we need SmartData. This presentation will discuss the growing need, the challenges, and ultimately, the benefits of developing intelligent agents to protect our privacy online.

Perspectives on AI

KEYNOTE

Dr. Inman Harvey

Visiting Senior Research Fellow
University of Sussex, Brighton, UK

Artificial Intelligence means different things to different people. For some, it is the building of useful intelligent tools for humans. When new — as computer programs and Google once were — they are ‘indistinguishable from magic’ but once familiar, they cease to be thought of as AI. For others, AI means attempting to build synthetic humans — and philosophical differences as to what is the essence of a human lead to different assumptions built in. If rational intelligence is taken as the core, then perhaps computers and logic may be taken as the appropriate models. But if humans are seen in a biological context, as a particular form of adaptive organism, then very different techniques and models will be used — perhaps neural networks and evolution.

In this talk I will try and tease out the differing assumptions, often implicit and unrecognised, that people bring to AI; and point out the technical consequences of the different choices made.

SESSION 2

Can ZombieData be Smart?

Dr. Stephen Biggs

Professor, Department of Philosophy
Iowa State University, Ames, Iowa, USA

Advocates of SmartData have taken seriously two connections between SmartData and consciousness. (1) By developing SmartData, we can discover the otherwise elusive nature of consciousness. What motivates (1)? While we can't program a conscious agent top-down, we can evolve a conscious agent while developing SmartData, which must be conscious in order to be truly smart. Once we have evolved a smart, conscious agent, we can look back at the evolutionary process and discern exactly how it was built. One who knows how something is built thereby knows its nature. So, by developing SmartData, we can discover the nature of consciousness. (2) In order to develop SmartData, we must know antecedently the nature of consciousness. What motivates (2)? There are some capacities that SmartData must have in order to be smart. Only conscious agents could have some of these required capacities. We cannot make SmartData conscious unless we know the nature of consciousness. So, in order to develop SmartData, we need to know the nature of consciousness. There is a clear tension between (1) and (2). In this talk I'll dissolve the tension by rejecting both claims. I'll suggest that developing SmartData cannot reveal the nature of consciousness and more importantly, that we don't need to know much about consciousness in order to develop SmartData. Put another way,

developing SmartData doesn't require deciding whether ZombieData can be Smart. Accordingly, discussions of consciousness should not be at the forefront of our explorations of SmartData. I'll then close by briefly noting some ways in which philosophy of mind more broadly may contribute to the development of SmartData.

Relevance Realization and the Neuro-dynamics of General Intelligence

Dr. John Vervaeke

Professor, Department of Psychology
University of Toronto, Ontario, Canada

Vervaeke, Lillicrap, and Richards (2009) have argued that the central problem facing the project of cognitive science is explaining how cognitive agents selectively attend to relevant information while somehow flexibly ignoring a vast amount of irrelevant information in a manner that renders them capable of intelligent problem solving. Vervaeke et al. then went on to propose a dynamical solution to this problem they called relevance realization. Work in progress by Vervaeke, Ferraro, and Irving argues that relevance realization is the core process of general intelligence and that this is being implemented in the self-organizing criticality of the brain.



TOPICS

Agency as an Ecological Concept

Dr. Denis Walsh

Professor, Department of Philosophy
University of Toronto, Ontario, Canada

The central concept that unites the projects of robotics, machine cognition, psychology, and action theory is that of agency. Thinking things are, first and foremost, agents. To build a thinking thing, then, one must build an agent. An agent, I maintain, is not primarily a reckoning machine, or an information-processing device. I use recent advances in evolutionary biology to argue that an understanding of the nature of agency can be gleaned by looking at the role of organisms in evolution. Organisms are agents par excellence, and an understanding of organismal agency is crucial to an understanding of the dynamics of adaptive evolution. I argue that an agent is a purposive entity that inhabits what I shall call an 'affordance landscape.' An affordance landscape is an emergent entity jointly constituted by the capacities of an entity and the features of its physical surroundings. Agency is thus not an architectural, computational, or informational phenomenon. It is an ecological phenomenon. To build an agent, then, one must build an entity that is capable of a certain kind of purposive ecological engagement with an affordance landscape.

Philosophical Reflections on the Design of Autonomous Agents: the Problem of Relevance

Dr. Michael Wheeler

Professor, Department of Philosophy
University of Stirling, Stirling, UK

Even in the sort of dynamically-shifting and open-ended scenarios in which we often find ourselves, human beings are extraordinarily proficient at maintaining psychological and behavioural focus on what is relevant in a situation, while ignoring what is irrelevant. This adaptive capacity for context-dependent relevance sensitivity is something that we would like to bestow upon artificial autonomous agents. The history of AI provides good evidence that this is a hard problem. In this talk, I shall argue that although autonomous agent research (or at least parts of it, given a certain philosophical gloss) and philosophical phenomenology (or at least parts of it, given a certain scientific gloss) have recently converged on a potential solution for the case of within-context relevance sensitivity, we do not yet have a compelling solution for the case of between-context relevance sensitivity (i.e., for the case of fluid and flexible context switching).

TUESDAY, MAY 15

SESSION 1

Evolutionary Robotics and SmartData

Dr. Inman Harvey

Visiting Senior Research Fellow
University of Sussex, Brighton, UK

When using artificial evolution to design AI systems, you are forced to make very explicit, in operational and testable terms, what properties you wish to select. If these properties relate to interactions with humans, then you must weigh up the costs of evolving in the real world against the perils of using simulations. The financial crash is a salutary reminder of the difference between models and the real world, and how common intuitions can mislead when applied to complex systems.

Is trust in tools and in people a social phenomenon? What are the key features of the context in which SmartData avatars would need to operate? Is there a minimal toy scenario to demonstrate the key issues? Is there an evolutionary pathway from such toy worlds to the messy complex real world? This talk will present more questions than answers.

Evolution/Development of Communication and Language in Embodied Agents

Dr. Stefano Nolfi

Research Director
Institute of Cognitive Science and Technology,
Rome, Italy

Understanding the evolution of communication and human language is one of the hardest problems in science. Of significant research and practical interest is the related artificial perspective: How can populations of artificial agents evolve/develop forms of communication of varying complexity, analogous to animal and human communication? Recent progress in this area permit us to progress our understanding of long-debated issues such as how symbols and meaning originate or the relation between language and action. Moreover, progress in this area can allow us to develop autonomous artefacts able to cooperate and communicate to solve real-life problems.

The Development of Autonomous Virtual agents

Dr. Karl Friston

Professor, Wellcome Trust Centre for Neuroimaging
University College, London, UK

This commentary considers some of the basic issues in the development of autonomous virtual agents from a rather general and theoretical viewpoint.

It is predicated on an understanding of agents as ideal Bayesian observers, which follows in the long tradition of Helmholtzian ideas about how the brain works and subsequent developments in machine learning and computational neuroscience. The aim of this commentary is to define some key aspects of the problem and discuss potential solutions in relation to a series of specific research questions. In what follows, we try to cast the problem in terms of optimization, which is particularly pertinent from the point of view of evolutionary schemes. The focus will be on maximizing the evidence for an agent's model of his world or, more precisely, minimizing a variational free energy bound on negative model log-evidence or surprise. This has proven to be a useful framework in the computational neurosciences; and can be shown to be a fairly universal explanation for action and perception. Within this setting, the notion of a model (entailed by a subject) and a model of that subject (entailed by an agent observing the subject) is central. Framing the problem in terms of models raises key questions about their nature, particularly their dynamical form and implicit state spaces. A model-based perspective provides many clear answers to these questions. However, there are some key choices that may need to be formulated carefully, particularly in relation to the difference between simply modelling the behaviour of a subject and modelling that behaviour under the constraint that the subject is modelling his world. We will focus on this distinction in terms of the difference between Bayesian and meta-Bayesian modelling of subject behaviours by virtual agents.

Evolution of Learning in Robots

Dr. Dario Floreano

Professor

(EPFL) École polytechnique fédérale de Lausanne
Head of Laboratory of Intelligent Systems
Lausanne, Switzerland

It is widely believed that the continuous change of neuronal connections provides animals with the capability to adapt and learn from experience. Several algorithms have been developed over the past 50 years to reproduce specific learning capabilities in artificial neural networks. However, little is known about the way in which these algorithms work together in a behaviorally-autonomous individual facing partially-unknown and changing environments. I will describe a series of experiments on the evolution of learning in autonomous robots that show the power of this adaptive method, provide an explanation to biological questions, and challenge assumptions on the link between synaptic plasticity and learning.

SESSION 2

Context Dependent Information Processing Entails Scale Free Dynamics

Dr. Don Borrett

University Health Network

University of Toronto, Ontario, Canada

We postulate that a requirement for the development of autonomous agents capable of context-dependent

information processing entails that the dynamics of their neural network controllers are scale free. This idea is elaborated at two levels: the cognitive (mechanistic) and the phenomenal. At the cognitive level, this requirement is used as a constraint to limit the search space in the evolution of these agents. However, this constraint also has ramifications for the development of agents that exhibit a naturalized phenomenology in whom a neural correlate of subjective experience is identified. At this level, scale free dynamics is a necessary condition for a subject to be able to interpret its own experience.

Patterns of Attractors in the “Brain” — Wild Dynamics at the Edge

KEYNOTE

Dr. Enrique Pujals

Professor

Associacao Instituto Nacional de Matematica Pura e Aplicada, Rio de Janeiro, Brazil

It is common place to say that the internal dynamical structure of autonomous agents evolved by biological principles should exist at “the edge of chaos.” In the present talk, we will try to address this view through the study of the main dynamical properties of a concrete evolvable agent. To describe the dynamical properties of an agent’s neural structure or “brain,” we will use a general paradigm developed using the qualitative theory of dynamical systems. This methodology explores the fundamental dynamical properties and patterns that an evolved complex agent should exhibit — focusing on the structure

and patterns of attractors that reside within an evolved autonomous agent’s neural structure. We approach this analysis from a twofold perspective: on one hand, studying the interaction between the “brain,” the environment, and the tasks; on the other hand, the evolutionary process involved in the development of the autonomous agent. We will try to demonstrate how this analysis may aid in the evolution of autonomous agents by limiting the size of the search space.

Autonomy, and embodiment vs. ‘embodiment-lite’

Dr. Pablo Funes

Vice President of Research & Development
ICOSYSTEM, Cambridge, Massachusetts, USA

Embodiment has long been identified as a central challenge in Artificial Intelligence. Robotic creatures interacting with the real world face the difficulties, and opportunities, afforded by the complexity, variability, and noise of the physical realm. We argue that robotics is not the only form of embodiment. Virtual agents living in online domains may interact with reality as well, with such interactions mediated by the physical creatures or “users” living in it. We will describe our experiments using a game to demonstrate co-adaptive phenomena between a collective of evolutionary online agents and their human users in the general context of co-evolutionary dynamics and investigate other cases of agent/human co-evolution.



TOPICS

WEDNESDAY, MAY 16

SESSION 1

What Matters: Real Bodies and Virtual Worlds

Dr. Michael Wheeler

Professor, Department of Philosophy
University of Stirling, Stirling, UK

Is there something about our distinctive nature as embodied beings that will inevitably frustrate the attempt to develop web-based virtual agents which, operating as our online surrogates in dynamic cyber-environments, perform acts of context-sensitive information exchange and decision-making on our behalf? I shall begin this talk by identifying certain considerations which, it might be thought, strongly indicate that the answer to this question is 'yes'. However, using, as an analytical tool, a conceptual distinction between implementational materiality (according to which the body is conceptualized as 'no more than' a material realizer of functionally-specified cognitive architectures) and vital materiality (according to which bodily acts and structures make a non-substitutable contribution to thought and reason), I shall argue that what really matters about our physical embodiment may be rather less hostile to virtuality than my preliminary analysis suggested.

IBM's Blue Gene/Q System and Implications for Simulation and Data Analysis

Dr. Kirk Jordan

Emerging Solutions Executive
Computational Science Center at IBM Watson
Research Center, Cambridge, Massachusetts, USA

High Performance Computing (HPC) is a tool frequently used to understand complex problems involving large amounts of data in numerous areas such as aerospace, biology, and climate modeling. In order to satisfy the demand for increased performance to achieve breakthrough science and engineering, we turn to parallelism through large systems with multi-core chips. This talk will give an overview of the Blue Gene/Q system and the ever-increasing amounts of data from simulations. There is tremendous potential with this new system, but new approaches may be needed to take full advantage of this potential and follow on systems as we move ever closer to Exascale.

Emerging Ideas in Computer Architecture

Bob Blainey

IBM Fellow, Hardware Acceleration Laboratory
IBM Software Group

The capabilities of computers have improved at such an astounding rate over the past few decades that they have even out-pacing the wildest speculations of experts in the field. While there is every reason to expect continued growth at this rate for some time, we are in a period of change. The improvements

COMMITTEE

in performance for many years were driven by the fundamental properties of semiconductors and our ability to continue shrinking the size of devices and improving their switching speed. We have reached a point of diminishing returns from this approach, in recent years, forcing new kinds of innovation in system and software design to stay on the historical performance curve. In this talk, I will survey the state of the art in computer architecture and explain some trends that we can expect to unfold over the next 5 to 10 years.

The GENI Testbed: Enabling Disruptive Technical Innovation in Network Science

Mark Berman

Experimentation Director
 Global Environment for Network Innovations
 Program Office, Waltham, Massachusetts, USA

The Global Environment for Network Innovations (GENI) is sponsored by the U.S. National Science Foundation, with a mission to enable the study of evolving technological and social networks. These networks, intertwined and worldwide in scope, are rapidly transforming societies and economies. GENI's work is open and broadly inclusive, providing collaborative and exploratory environments for academia, industry, and the public to catalyze groundbreaking discoveries and innovation in these emerging global networks. GENI is building a virtual laboratory at the frontiers of network science and engineering, for exploring future internets at scale.

Dr. Ann Cavoukian (Chair), Information & Privacy Commissioner, Ontario, Canada

Dr. Dimitrios Hatzinakos, Department of Electrical and Computer Engineering, University of Toronto

Dr. George Tomko, Expert-in-Residence, Identity, Privacy and Security Institute (IPSI), University of Toronto

Dr. Inman Harvey, Visiting Senior Research Fellow University of Sussex

Dr. Hon Kwan, University of Toronto

Dr. Don Borrett, University Health Network, University of Toronto

IPSI SMARTDATA

INTERNATIONAL SYMPOSIUM

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Registration Details:	Early Bird	Regular Rate
(Banquet included)	(Before April 30)	(After April 30)
Students	\$ 99 CAD	\$149 CAD
Other	\$199 CAD	\$249 CAD

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