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Abstracts Book

edited by Tommaso Bertolotti

MODEL-BASED REASONING IN SCIENCE AND TECHNOLOGY Abduction, Logic, and Computational Discovery

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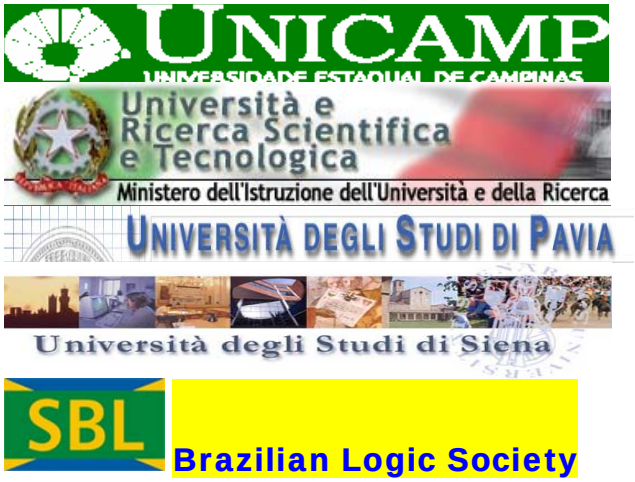

Brazilian Logic Society

INFORMATION ABOUT THE CONCLUDING SESSION

The final session of the Conference will take the form of an open discussion concerning the future of the domain. The issues covered might include (but are not restricted) the following:

1. **What are the major directions of research in the foreseeable future?**
2. **What are the most interesting open questions at present?**
3. **What applications are presently the most interesting?**
4. **MBR conferences to come. MBR Workshop on abduction in China (Guangzhou) in 2010 ABDUCO_010.**
5. **Collocation of MBR conferences to come with IJCAI (discussion of IJCAI offer).**

We hope that you will have time to give a little thought to issues such as these before session, and come along prepared to discuss them. If you have other questions on the topic that you think it might be worth discussing, please suggest them to Lorenzo Magnani and Walter Carnielli during the conference.

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ABSTRACTS

Good experimental methodologies and simulation in autonomous mobile robotics

Francesco Amigoni, and Viola Schiaffonati

Experiments have proved fundamental constituents for natural sciences and it is reasonable to expect that they can play a useful role also in engineering, for example when the behavior of an artifact and its performance are difficult to characterize analytically, as it is often the case in autonomous mobile robotics. Although their importance, experimental activities in this field are often carried out with low standards of methodological rigor. Along with some initial attempts to define good experimental methodologies, the role of simulation experiments has grown in the last years, as they are increasingly used instead of experiments with real robots and are increasingly considered as a good tool to validate autonomous robotic systems. In this work, we aim at investigating the relationship between real and simulation experiments in autonomous mobile robotics, in the context of the definition of good experimental methodologies.

Imagination in thought experimentation

Margherita Arcangeli

We attribute the capability of imagination to the mad as to the scientist, to the novelist as to the metaphysician, and last but not least to ourselves. The same, apparently, holds for thought experimentation.
Ernst Mach was the first to make an explicit link between these two mental acts; moreover -in his perspective- imagination plays a pivotal role in thought experimentation. Nonetheless, it is not clear what kind of imagination emerges from Mach's writings. Indeed, heated debates among cognitive scientists and philosophers turn on the key distinction between sensory and cognitive imagination. Generally speaking, we can say that sensory imagination shares some processes with perception, cognitive imagination with the formation of belief.
Both the vocabulary used in the literature on thought experiments and what I call the "Mach's tradition" indicate imagination as a notion of central importance in the reasoning involved in thought experiments. However, most authors have really focused on sensory (in particular, visual) imagination, but have neglected the second kind. Moreover, some authors attribute to Mach the idea that it is visual imagery that is primarily at work in thought experiments.
I claim another interpretation is possible, according to which Mach can be said to deal with cognitive imagination. The main aim of this paper is to retrace Mach's original arguments and establish a connection with the cognitive literature on imagination. I will argue that imagination tout court could play a role in thought experimentation. Once imagination is seen as the key to the "cognitive black-box" of the thought experiment, we will have moved a step closer to a simulative imagining-based account of thought experimentation.

From predicate modeling to semantic analysis of predicates: The use of logic in computer science

Ken Archer

Since the introduction of independent data storage mechanisms in the 1970s, database design has been characterized by the modeling of predicates, or attributes, and their interrelationships. This paper critiques prevailing data modeling methodologies – relational data modeling and AI-based fact modeling in RDF and OWL – as leading to the unrestrained creation of predicates in information models. The absence of a principle controlling when new predicates should no longer be created is fundamentally rooted in the theoretical basis of these information modeling techniques – first order logic (FOL) – which also lacks such a principle of restraint. The paper then proceeds to revisit the larger logical project within which FOL emerged, semantic analysis, which does guide the selection of appropriate predicates. It is claimed that the purpose of FOL was never to express any and all predicates that could ever been spoken or written. Rather, FOL provides a grammar suitable for expressing the results of semantic analysis. If computer science and artificial intelligence seek fidelity to logic, it is claimed here, then semantic analysis must become a central discipline and critical first step in computation. The paper reviews approaches to semantic analysis and makes recommendations for the future of semantic analysis. Finally, a thorough history of the concerns of modern logic that led to semantic analysis and FOL is provided, with a concluding revision of the common misconception

that the formality of FOL implies lack of intentionality or semantics in FOL.

Values of post-classical outlook

Lydumilla Baeva

From the position of existential axiology values are considered as dominants of consciousness and existence, which creatively influence on the internal development of person and surrounding world. Value is a striving of human to clarity meaning and significance in our existence, it is an act of freedom, expression of subjectivity because it based on personal experience, preference. Values are meaningfully-significant purposes of existence, a special type of information, reflecting originality of the subject and expressing the most significant longings to self-perfection his quality. Values express the maximum amount of information about the subject and emerge in the world as his highest manifestation.

Values are considered as Answers of a person to key existential question, attempts to make the life, that had no predetermined aim and sense, meaningful, to create (or change) yourself or the world in accordance with your own preferences. Axiological creativity is a representation of freedom of a person in relation to natural and social programme, an opportunity to "recode" your own Ego and the surrounding world towards a significant ideal, and consequently it is an important factor for development.

The main dynamic trend of axiosphere of the present time is transmission from classical values to neoclassical ones, connected with the epoch of consumption, informatization, globalization etc. Classical values, which had been developing since the antique classics to 19th century. Global changes in person's attitude towards the world, nature, power, property resulted in absolutely new orienting points, the essence of which consists in the turn to corporality, pluralism, irrationalism and so on. Neoclassical values suggest shifting of person's attention and care from the spiritual (intellectual and moral) sphere to the material (corporal and external) one; replacing ethnic cultural dominants with globally unified ones; transforming the cult of knowledge and enlightenment into the cult of pleasure and naturality; leaving aesthetic and axiologic monism for "forced pluralism"; "liberation" from conation to the ideal and transcendent world in the favor of utilitarianism; substitution of creativity with consumption, life – with the game, real relations – with virtual ones, contents – with the form. ***Abstract only.***

Abduction and temporality – a semiotic narrative perspective

Kristian Bankov

"Abduction" is among the most interesting and thought provoking notions in Peirce. Nevertheless its semiotic implications have been studied relatively less than other "classical" notions. The same (concerning the semiotic context) is true for the notion of "temporality". With this paper I shall try to outline some crossing points between the two conceptual areas, trying to suggest that it is time for the semioticians to introduce in the study of signification some more dynamic issues. Such issue might be considered the narrative construction of the temporal dimension of the future - not in speculative terms, but grounding the semiotic input on empirical evidence of how the emergence of the awareness of temporality takes place in children and how different cultures built different conceptual sets to cope with the unpredictability of future and how innovation is produced in social context. I shall consider the extension of the notion of abduction from an "instant instance" as an iconic insight, metaphor or diagram, to an extended narrative sequence and even a plurality of competing scenarios, within the abductive activity of the same subject. The references of this proposal will list the classical semiotic background, dominated by Peirce, the notions of temporality in Bergson and Heidegger, the narrative/hermeneutic horizon of Ricoeur, and in general the consequences of what Jens Brockmeier quotes as the "narrative turn" in psychology, anthropology, sociology and many other humanities in the last two decades. In conclusion I shall try to point out what added value such considerations can bring to cognitive science and laboratory research.

Affordances as abductive anchors

Emanuele Bardone, Lorenzo Magnani

In this paper we aim at describing how the notion of abduction may be relevant in describing some crucial aspects related to affordance originally introduced by the ecological psychologist James J. Gibson (1979). The thesis we will develop in this paper is that an affordance can be considered as an abductive anchor. The notion of abduction will clear the field from ambiguities and misconceptions still present in current debate. Going beyond a mere sentential conception, we will argue that the role played

by abduction is two fold. First of all, it decisively leads us to a better definition of affordance. Secondly, abduction turns out to be a valuable candidate for solving the problem related to whether affordance detection is mediated or not.

Ontological models as boundary objects in multidisciplinary technology design

Merja Bauters, and Sami Paavola

Design teams face increasing problems when attempting to follow the changes in the proposed design methods due to the changes of the use and technical development of the digital tools. The change is partially caused by the adaption of tools, which are based on Web 2.0 and semantic web technologies, but also because of the increasing emphasis on the knowledge intensive collaborative work. Different kinds of models have been suggested for providing a shared object to the design team.
The models work as mediating artefacts, or as "epistemic artefacts" (Knuuttila 2005: 41 and Morgan & Morrison 1999). It especially means that "[taking] models as epistemic artefacts attributes their epistemic value to the interplay of their material and intentional dimensions, which is due to their being both purposefully constrained and materially defined, yet interpretatively open things. […]" (Knuuttila 2005: 68). Both of the points are important for our approach, i.e., the epistemic nature of the models and the materiality, which enable models to act as mediating artefacts – as boundary objects to deepen and broaden the common ground between the participants working through the model.
In this presentation our aim is to discuss especially ontological models and their potentiality to work as boundary or shared object/artefacts in design processes. Our approach has its basis on Charles Sanders Peirce's Theory of Signs. We will focus especially to the meaning and knowledge creation processes, through the concepts of shared (epistemic) objects/artefacts, common ground as the basis of any joint work to occur, and to the role of materiality of the shared (epistemic) objects/artefacts have in the process.
We will further exemplify our ideas through a case study in which an ontological model (called a Reference model) was developed and attempted to be used for the various purposes.

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Knuuttila, Tarja (2005), Models as Epistemic Artefacts: Toward a Non–Representationalist Account of Scientific Representation. *Philosophical Studies from the University of Helsinki 8*. Helsinki: University of Helsinki.
Morgan, Mary S. and Margaret Morrison (eds.) (1999), Models as Mediators. *Perspectives on Natural and Social Science*. Cambridge: Cambridge University Press.

The dawn of paraconsitency: Russia's logical thought in the turn of XX century

Valentin A. Bazhanov

The birth and becoming of paraconsistency idea was determined both by the attempts of apprehension and critics of certain logical principles, as well as particular philosophical considerations. What kind of philosophical discourse and problems contributed to the prehistory of paraconsistency idea? To what extent they may be regarded as heuristic prerequisites? What thinkers were concerned with philosophical problems explicitly and tacitly implied paraconsistency, and to what degree we can speak about their contribution to the real history of paraconsistent logic development?
Being informal (and thus in certain sense fuzzy) philosophical ideas often serve as a good culture medium for pioneer scientific theories. Namely, the same fate had in store for the idea since 1976 known as paraconsistency. The critic of the law of contradiction from the standpoint of traditional dialectics corroded foundations of classical logic. This critic was inherent both for the philosophy of religion context (Father P. Florensky study of the Holy Writ contradictions and the role of lucid state of a person in resolving these contradictions) or the quest for the new semantic approach to truth (N. Lossky). Philosophical in essence critic was reinforced by logical considerations related, say, to non-universality of the laws of contradiction and excluded middle (J. Lukasiewicz). The program of logic construction on the basis of new ontology which permits contradictory objects/features and thus presupposes new sensational organization of person (the type of psychologism) led N. Vasiliev (1910) to the idea of imaginary logic, tolerant for contradictions (remind A. Meinong's "impossible" objects as well). Ch. Darwin's idea of evolution upon applied to logic and analogy with non-Euclidian geometry pushed towards the idea of new – "curved" – logic, embodied in imaginary logic. Moreover, for N. Vasiliev, poet-symbolist,

the idea of “another” worlds was pretty common; he just endowed these worlds with contradictory properties. This fact might be considered as one more heuristic prerequisite for the new logic.
In 1928 the quest for novel – dialectical – logic of natural sciences resulted in the logic of compatibility of propositions, happened to be the first version of relevant logic (I. Orlov).
All these events belong to the prehistory of paraconsistency. The real history starts with the discursive logic of S. Jaskowski (1948), and works by N.C.A. Da Costa (1958), D. Nelson and T. Smiley (1959).

The formation of beliefs in supernatural agents and its abductive roots

Tommaso Bertolotti, Lorenzo Magnani

Our main objective is to provide an analysis of the cognitive processes that lead to the “invention” of those beliefs concerning supernatural agents. Such an invention is going to be considered to be abductive in its nature, and we shall see in what it differs from the formation of scientific concepts and beliefs. More precisely, we share with the traditional view on religion the idea that the origin of belief in supernatural agents rests on its ability to explain, but we contend that its very genesis has a much less intentional, conscious and theoretic nature than commonly thought. The idea of supernatural agents results from explanatory activity due to the cognitive urge of human beings to constantly make sense of the surrounding environment or part of it. Of course it quickly merged and was structured within human beings’ constitutive curiosity, and within the strife for knowing causes and origins of natural phenomena: still, in a diachronic perspective, the very first pulse of belief in supernatural agents might have rather sprouted from an essentially wired (and thus mostly unconscious), neuronal-cognitive processing of environmental signs.

A computational model of information integration in sequential diagnostic reasoning

Udo Böhm, Katja Mehlhorn, and Josef Krems

A crucial aspect of diagnostic reasoning is the integration of sequentially incoming information into a consistent mental representation. While research stresses the importance of working memory in such a task, it is not clear how the information represented in working memory can guide the retrieval of associated information from long-term memory. Factors that might influence this retrieval are the amount of information currently in the focus of attention (Lovett, Daily & Reder, 2000) and the time since the information first became available (Wang, Johnson & Zhang, 2006). By comparing the results of different ACT-R models to human data from a sequential diagnostic reasoning task, we show that these factors do not necessarily influence the retrieval. Our findings rather suggest that in a task where information has to be actively maintained in working memory, each piece of this information has the same potential to activate associated knowledge from long-term memory, independent from the amount of information and the time since it entered working memory.

The logical process of model-based reasoning

Joseph Brenner

Standard bivalent propositional and predicate logics are described as the theory of correct reasoning. However, the concept of model-based reasoning (MBR) developed by Magnani and Nersessian rejects the limitations of implicit or explicit dependence on abstract propositional, truth-functional logics or their modal variants. In support of this advance toward a coherent framework for reasoning, my paper suggests that complex reasoning processes, especially MBR, involve a novel logic of and in reality.
At MBR04, I described a new kind of logical system, grounded in quantum mechanics (now designated as logic in reality; LIR), which postulates a foundational dynamic dualism inherent in energy and accordingly in causal relations throughout nature, including cognitive and social levels of reality. This logic of real phenomena provides a framework for analysis of physical interactions as well as theories, including the relations that constitute MBR, in which both models and reasoning are complex, partly non-linguistic processes.
Here, I further delineate the logical aspects of MBR as a real process and the relation between it and its target domains. LIR describes 1) the relation between model theory – models and modeling - and scientific reasoning and theory (a confusing half-way situation, according to Hodges); and 2) the dynamic, interactive aspects of reasoning, not captured in standard logics. MBR and its critical relations, e.g., between internal and external representations, are thus not “extra-logical” in the LIR interpretation. I review several concepts of representations from an LIR standpoint. Essentially, one moves from ab-

duction as used by Magnani to explain processes such as scientific conceptual change to a form of inference implied by physical reality and applicable to it.
Issues in reasoning involving computational and sociological models are discussed to illustrate the utility of the LIR logical approach.

Concept combination, emergence and abduction

Peter D. Bruza, K. Kitto, B.J. Ramm, L. Sitbon, D. Song

Humans frequently produce emergent properties or associates when combining concepts in new ways. This presentation will examine the manner in which concept combination can generate emergent properties suggesting that the process is abductive in nature. A tensor baPsed approach is used to model concept combinations which allows such combinations to be viewed as interactions in a quantum-like way. Free association norm data is used to motivate the underlying basis of the dimensional space. Concept combinations will be viewed in a spectrum according to the degree of non-separability of the corresponding tensor representations. It is conjectured that non-separable tensors correspond to conceptual combinations with the propensity to yield emergent property.

Models for anodic and cathodic multimodalities

Juliana Bueno-Soler

A system is classified as multimodal if its language has more than one modal operator as primitive. We extend the so-called basilar multimodal systems to a class of logics called cathodic modal logics, defined as extensions of positive modal logics by adding degrees of negation plus consistency (and inconsistency) operators. In this way, cathodic multimodal logics are logics of formal inconsistency (the paraconsistent LFIs, as treated in [CCM07]) enriched with multimodal operators. We focus the attention on models for such classes of systems and discuss how modal possible translations semantics, as well as possible-worlds (or Kripke semantics, can be defined to interpret cathodic multimodal basilar systems. We emphasize here the modal possible-translations models, which are given by combinations of three-valued modal logics and explain their interest.

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An episodic memory implementation for a virtual creature

Elisa Calhau de Castro, and Ricardo Ribeiro Gudwin

The research agenda on intelligent virtual creatures is a very intense one, both in terms of philosophy and in computer science. The development of cognitive architectures to control such virtual creatures is mainly inspired by human neuro-cognitive and psychological abilities, where typical human cognitive tasks as perception, learning, memory, emotions, reasoning, decision-making, behavior, language, consciousness, etc. are in some way modeled and used as a source of inspiration. Earlier virtual creatures used to live only on the present, sensoring its surroundings and choosing its action based only on the current situation. Later creatures enhanced that by living not only on the present, but also with an eye on the future, being able to making plans and expectations, which clearly sophisticated its behavior. But few of them were able to refer to its past, just like we do as humans. We are able to remember what we did by this morning, some issues we lived last week, 2 months ago or even years ago. And more than this, we are able to build up a chronological time line, and order such events and locate them in this time line. We use this memory in order to learn things and to help us in performing our daily behavior. This is currently a missing gap in cognitive systems research. It will be an important improvement if our creatures were able to remember that they already were in such and such location, where they met such and such objects and creatures, and where such and such episodes were testified by them. This is the next step we are waiting for in cognitive systems research. Even though there are already some tiny initiatives in such a path, we are still very far from this being a well known technology to be widely embedded in our intelligent agents. In this work we report on our ongoing efforts to bring up such technology by building up a cognitive architecture where episodic memory is a central capability.

Implication, habit and abductive reasoning: a realistic approach

Ramon S. Capelle de Andrade, and Itala M. Loffredo D'Ottaviano

Regularities are inscribed in reality. According to Peirce (1958), regularities result from conditional final causes understood in terms of crystallised habits. A complete conditional sentence If *A*, then *B* is composed of two clauses, the antecedent, or the if part, and the consequent, or the then part. We understand the conditional sentence if *A*, then *B* in terms of a final cause. The antecedent *A* will be understood in terms of an efficient cause. So, for example, the consequent "activate the production of histidine" will be nomologically determined, given the presence of the state of affairs "histidine less than *X*", by the final cause "if the quantity of histidine is less than *X*, then activate the production of histidine". The aim of this work is to defend the following joint hypotheses: the logical form If *A*, then *B* is present in the dynamics of expression of a physico-chemical law, of a biological conditional and of a habit. But the nomological connection between the antecedent *A* and the consequent *B* is not the same, which leads us to relate different pairs of antecedents and consequents with different types of implication. We will argue that physico-chemical laws, which have strong nomological power, are compatible with strict implication (the antecedent implies the consequent in all possible states of affairs). However, biological conditionals, which have moderate nomological power, are compatible with material implication (the antecedent may be true and the consequent false). Habits, which have weak nomological power, are compatible with relevant implication (the antecedent may be true and the consequent false, but we need – to avoid vacuously true consequents – to suppose that there is a causal connection between the antecedent, or environmental circumstance, and the consequent, or mode of action). Finally we will defend the idea that the weak nomological power of a habit leaves room for the occurrence of abductive reasoning understood in terms of the creation of new hypotheses of action.

On deceiving: a logical analysis on bullshit attacks

Walter Carnielli

I wish to investigate how deceptive reasoning could be defined in logical terms, in which way it could be achieved in a discussion, and which would be the strategies for defense against deceptive attacks. The basic assumption is that some principles of rational discussion as the Principle of Rational Accommodation and some methods of logic such as maximal consistency can lead to argumentative positions susceptive to a bullshit attack, and may induce deceptive conclusions.

How can we be deceived, even if we are well aware of the roots of deception? In comparison, we know equally well what a proof in mathematics or in logic is, but we make much less flaws in logic or mathematics than in common reasoning - some errors of the former are famous, but in the latter errors are just too numerous to even be counted.

Which kind of forces may push us into jumping into conclusions, by assuming incorrect assumptions when we are not in possession of the whole knowledge about something? I argue that falling into deceptive reasoning is not anything irrational from our side, but rather a rational response from an opponent maneuver.

The Principle of Charity, also known, specially as focused by D. Davidson, as the Principle of Rational Accommodation, is a very basic principle in argumentation and in critical thinking which governs our interpretation to other people statements, and supposedly also other people interpretations to our discourse.

The notion of rational accommodation has strong connections not only to rhetoric, but to some deep philosophical problems concerning meaning, truth and belief, and how these are all connected; this even led Donald Davidson to turn his interests to the question of how are apparently irrational beliefs and actions even possible.

The Principle of Rational Accommodation thus functions as a warrant for the act of understanding a speaker's statement (or discourse) by interpreting his or her statements to be in principle rational in its highest way, and, in the case of any argument, by rendering the best, strongest possible interpretation of an argument. The principle forces us to find the most coherent or rational interpretation for the statements involved in an argument -in another words, the principle constrains us to interpret the assertions so as to maximize the truth or rationality of the opponent, but under certain conditions: it demands us to accommodate all statements in the best possible consistent way, if there is such a way.

I wish to open a discussion on how deceptive reasoning could be logically defined, in which way it can be achieved in argumentation, and which would be our strategies for defense against deceptive attacks. I argue that some basic principles of rational discussion and logic as the notion of maximal consistency and the Principle of Rational Accommodation are susceptive to bullshit attacks which may induce deceptive conclusions.

Decision biases and the cognitive architecture of problem solving

Balakrishnan Chandrasekaran

Rational decision-making is often modeled as choosing the alternative that maximizes utility for the decision maker. Over the last few decades, much evidence has been produced to demonstrate that human decision-making is subject to irrationalities, such as intransitivity and framing biases. I seek an explanation for how these irrationalities arise, specifically, how they relate to the intrinsic nature of problem solving as setting up and searching in problem spaces, guided by knowledge. Even in simple decision-making problems where the alternatives are small in number and clearly specified, problem solving is required to evaluate the alternatives. One source of the explanation of the irrationalities is the characteristic strategies that are used to evaluate the alternatives. When decision-making problems are complex, additional opportunities arise for sub-optimal decisions. I end with some ideas for how decision support system designers can use the analysis to reduce the opportunities for irrationalities.

Three next generation approaches to automated mathematical theory formation

Simon Colton

Around a decade ago, we introduced Automated Theory Formation as a technique for mathematical discovery, implemented in the HR system. Starting with some basic background information such as a set of axioms for an algebraic domain, or fundamental concepts such as addition and multiplication in number theory, HR forms concepts which categorise the examples; makes conjectures which relate the concepts; and generates proofs which explain the conjectures (or counterexamples which disprove them). In addition to inventing concepts and discovering theorems which have been published in the mathematical literature, HR has been applied successfully to AI tasks including constraint solving and machine learning. In the talk, I will describe three PhD projects which have been influenced by the Automated Theory Formation approach.

The first project is the work of Alison Pease, and crosses the boundary between Artificial Intelligence and Philosophy by building and exploring a computational model of notions from Lakatos's philosophy of mathematics as advocated in his book "Proofs and Refutations". Via the HRL system, which simulates a classroom environment consisting of theory formation agents acting as a teacher and a set of students, Pease implemented methods identified by Lakatos such as strategic withdrawal and monster barring, which change the theory in reaction to the discovery of a counterexample to a conjecture under discussion. This led to both an advancement in the state of the art of automated theory formation, and a clarification of some of the issues raised and methods introduced by Lakatos.

The HR system is driven by production rules which turn old concepts into new ones. In his PhD work, Pedro Torres has addressed the meta-level question of automating the generation of production rules. Given a seed theory which contains fundamental background information and exemplar concepts known to be of interest in the domain, with his Suricata system, Torres has implemented methods for analysing the seed theory and deriving production rules which can be used to generate the exemplar concepts from the background material. We are currently investigating the potential of this method to streamline theory formation, so that, in addition to recreating the exemplar concepts, Suricata is able to generate focused theories with a high yield of interesting concepts and conjectures.

The combination of reasoning techniques such as induction, deduction and constraint solving has always been at the heart of automated theory formation. Taking inspiration from the Global Workspace Architecture model of human thought processing advocated by Baars and others in Cognitive Science communities, John Charnley implemented the GC framework for combining AI reasoning systems in a systematic, straightforward way. By removing the communication between processes in favour of a very pared-down blackboard-style system, Charnley has shown that complex combinations of reasoning can be achieved with relatively little effort from the system designer. He has configured his framework to undertake the tasks previously tackled by ad-hoc combined reasoning systems such as HR. This has the benefit of greatly simplifying the construction of combined reasoning systems, and can also take advantage of the natural parallelisation afforded by the Global Workspace approach.

Fibring of hypersequent calculi and preservation of rule-elimination

Marcelo E. Coniglio, and Martín Figallo

Hypersequents are a natural generalization of ordinary sequents and turn out to be a very suitable tool for presenting cut-free Gentzent-type formulations for diverse logics. We say that a commutative hypersequent calculus A has the r-elimination property if for every deduction in A there is another deduction in A without using the rule r; cut-elimination is a particular case of this notion. In this paper, we pre-

sent the category of hypersequent calculi, and define their combinations by means of unconstrained and constrained (categorical) fibring. Our main result states that the r-elimination property is preserved by unconstrained and constrained fibring of hypersequent calculus, provided that at least one of the calculi satisfy that metaproperty. In particular, fibring of (hyper)sequent calculi preserves cut-elimination.

Abducing the crisis

Ricardo Crespo, Daniel Heymann, Fernando Tohmé

As a general feature, macroeconomic crises are events marked by “broken promises” that shatter the expectations that many agents had entertained about their economic prospects and wealth positions. The large change in the economic (and possibly also, social and political) environment naturally leads to reappraisals of the views of the world upon which agents had based their expectations, plans and decisions, and to a reconsiderations of theories and models on the part of analysts. In other words, a crisis triggers widespread and large- scale efforts of abduction in search of new hypothesis and explanations. We will try to explore the abductive strategies that economic agents and analysts may apply during and after a crisis, and their possible repercussions on actual economic behavior.
Abduction is an essential component of economic analysis, theoretical and practical. Economic theory generally proceeds by constructing models, that is, mental schemes based on mental experiments. They are often written in mathematical language but, apart from their formal expression, they use metaphors, analogies and pieces of intuition to motivate their assumptions and to give support to their conclusions. In dealing with ongoing economic processes, agents and analysts must generally evaluate whether the situation resembles in a relevant way some instances observed or studied in the past, and whether this warrants applying somehow the “lessons” drawn from those experiences. The problem in judging “whether some pasts are good references for the future” becomes particularly severe when the economy is seen to undergo important changes.
In the paper we will discuss the concept of abduction, in connection with economic analysis and decision- making. Finally, we will consider the problem of representing the “abducing behavior” of the economic agent during crisis, and will also comment on how theoretical macroeconomic models may react “abductively” in order to learn from the experience of a crisis.

Mathematical modeling in physics: a philosophical perspective

Jairo José da Silva

The starting point of the investigation of physical reality conducted by physics is the substitution of reality by mathematical models of it. Between mathematical models and the real world physics sometimes interposes physical models of reality, “pictures” of how the world can reasonably be conceived to be like, given the relevant empirical data. A good example of a physical model of reality is Maxwell’s mechanical model for electromagnetic phenomena. An example of a purely mathematical model of reality is matrix mechanics.
This methodology raises some important philosophical questions: what models and the worlds they model have in common? How can physics tell us anything about reality from models that have, with respect to relevant aspects, nothing or little to do with how reality is in fact? What is the criterion of adequacy for physical or mathematical models of reality? In what precisely does the mathematical modeling of physical reality consist, and what does it say about the nature of physics and mathematics? In this talk I will tackle these questions, if only in an exploratory manner.

Turing machines and non-standard models

Anderson de Araújo, and Walter Carnielli

This paper presents an axiomatic first-order theory for determin- istic Turing machines. We show that this axiomatic is sound with re- spect to its standard interpretation, although incomplete. Moreover, we also prove that no first-order axiomatic is able to grasp the concept of Turing machines due to the existence of non-standard Turing machines that interpret the first-order axiomatics, in a similar way to the non-standard models of first-order Peano arithmetic. Nonetheless, we show that the recursive capabilities of such non-standard model constructions are quite different.

f -g-Simulation

José de Oliveira Guimarães

The central point of this research is to relate the machines that simulate and that are being simulated by a specific TM M with input x. We say a MT M_1 $f(n)$-$g(n)$-simulates a MT M_2 if there exists function h : $\mathbb{N}\rightarrow\mathbb{N}$ such that in the computation of $M_1(x)$ and $M_2(x)$, for every x, after $mf(n)$ steps of M_1 and $mg(n)$ steps of M_2, $1 \leq m \leq h(n)$, the write-only output tapes of both machines are equal. Besides that, M_1 and M_2 halt after $h(n)f(n)$ and $h(n)g(n)$ steps, respectively. Then each $f(n)$ steps of M_1 simulates $g(n)$ steps of M_2 given input x.

f-g-simulation does have some important characteristics. First, if M_1 f-g-simulates M_2 then M_1 is not as powerful as a UTM. M_1 always halts and an UTM may never halt. Second, if M_1 and M_2 are two machines and $M_1(x) = M_2(x)$ for every x, then M_1 f-g-simulates M_2. Third, if machine M_1 simulates M_2 by the common definition of simulation then M_1 f-g-simulates M_2. Each step of M_2 is simulated by a constant number of steps of M_1 and then $f(n)$ is constant.

This paper presents some results obtained based on the concept of f-g-simulation. It is shown that the set of machines that f-g-simulates a given one is enumerable given an enumerable set of functions f and g. This set is constructively built. It is also shown that the running time of all machines above a given TM M (in the simulating tower) is greater or equal than the running time of M. It cannot be less for one cannot in general simulate a $f(n)$ machine with another machine whose running time is asymptotically less than $f(n)$. Given two machines M_1 and M_2 such that M_1 f-g-simulates M_2, the paper relates functions $f(n)$ and $g(n)$ (there are restrictions brought by the definition of f-g-simulation) and the space taken by M_1 and M_2.

HI-TECH: Ethical Modus

Marina Dedyulina

High technologies become "trade" of the person, hardly probable not its destination. Increase of role Hi-Tech in society enters new components into « the moral equation ». So, the neurophysiologist J-P. Changeux believes, that « in any reasoning concerning ethics it is important to operate how scientists operate — to build patterns ". By way of our research technoethica the position of the mathematician and psychologist V.Lefevra will be interesting also. Lefevr the pattern of the subject (RIMS.) RIMS as special mathematical репрезентация the subject, leans on alternatives of activity of the subject has been developed reflectively-intention: first of, which utilitarian, and the second deontological. If the first is connected with practically favourable behaviour, i.e. decision-making, второй-with idealistic behaviour: kind and angrily. This model predicts probabilities, leaning on which, the subject chooses possible variants: one of which for it a pole positive, and another negative. The given method allows to investigate situations in which the moral choice of the subject can influence events which can occur in the future so it probably to use at the analysis of ethics in the field of The Converging Technologies (NBIC).

Models for moral behaviour: Rawlsian, quasi-rationalistic or Humean?

Sara Dellantonio, and Remo Job

Contemporary cognitive research identifies three fundamental models that describe moral behaviour and in particular the processes leading to moral judgments (Hauser 2006, p. 45). The first model is called Humean and is based on the idea that human beings are equipped with an innate moral sense, of an emotional kind, that drives judgments regarding right and wrong. A second model may be defined as quasi-rationalistic and starts from a hybrid view of moral judgment according to which the perception of a morally relevant situation produces both emotional reactions and utilitarian conscious reasoning. A third model – qualified as Rawlsian – explains moral judgments in analogy with Chomsky's grammaticality judgments and hinges on the idea that human beings produce their moral judgments on the basis of a moral modular faculty "that enables each individual to unconsciously and automatically evaluate a limitless variety of actions in terms of principles that dictate what is permissible, obligatory, or forbidden" (Hauser 2006, p. 36).

The research we propose aims to evaluate the Rawlsian hypothesis in comparison with the Humean and the quasi-rationalistic ones. Specifically the study addresses the Rawlsian model in order to show that the moral module actually coincides with or is part of a semantic module. This criticisms against the Rawlsian hypothesis will serve as a basis in order to argue for a quasi-rational model that combines both Humean and rational elements and that explains – among other things – why knowledge, reflection and reasoning may, at least in certain cases, drive or change the course of emotions.

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Spatial representations of temporal relations for primary-school teachers

Tania Di Mascio, and Rosella Gennari

Temporal reasoning is one of the many cognitive skills that children must develop in order to integrate in our culture and society. We are working on a web tool enabling teachers to modify contemporary short stories, and to elaborate temporal reasoning exercises for classes of novice readers (e.g., normally developing 7−9 olds). The tool will be highly visual. Given this, we face a non-trivial challenge in the design of the tool: how can we render Allen temporal relations with a spatial representation that is intuitive for primary-school teachers? This paper explores such an issue from the perspectives of AI and HCI combined.

Constructivist research and info-computational knowledge generation

Gordana Dodig-Crnkovic

Working within a project run jointly at Mälardalen University, Blekinge Institute of Technology and Lund University with the goal to provide a web-based support for knowledge exchange between academia, industry and research on Software Engineering Master Thesis, we noticed the lack of methodological support for a kind of research typical for the field, and in general representative of all of Computing and which we identify as Constructivist Research Method.
The aim of this paper is to provide characterization of the Constructivist Research Method and to make clear how it differs from Action Research. Constructivist Research is based on Constructivist Learning in the way Action Research is based on Action Learning, but unlike Action Research, Constructivist Research relies essentially on constructionist or design thinking. However, while Action Research is widely known and theoretically studied, Constructive Research appears to lack theoretical exposition and recognition, in spite of its abundance in research practice. The paper will characterize Constructive Research in the Computing field, with examples from Software Engineering and Cognitive Science taking into account its typically multi-disciplinary and cross-disciplinary nature. Finally the relationships of Constructivist Research method with the Info-Computational Paradigm of knowledge production will be addressed.

Towards a universal logic approach to abduction

Luis Estrada-González

Abstract. Contemporary studies on the logic of abduction arose first from some issues in the philosophy of science and then in researches on artificial intelligence and computational creativity. Most of proposals of logics of dis- covery, heuristics or creative processes have been designed taking into account the particular requirements of each particular field of application. But to study a phenomenon that occurs in contexts as varied as common sense, medical di- agnosis, and scientific discovery, suitably broad features must be provided, that cover a lot of cases, and yet leave some significant substance to the notion of abduction. We propose here a universal logic approach to abduction, i.e. a top-down, conceptual investigation on what the most general purely logical features of abduction are, as well as a research program to investigate to what extent it is a pervasive notion in logic.

Towards first-order cut-based abduction

Marcelo Finger

A traditional abduction problem is a pair $\{\Gamma, G\}$ such that $\Gamma \not\models G$ and $\Gamma \not\models \neg G$; a solution for it is a formula (or extra hypothesis) H such that $\Gamma, H \not\models G$, where $\Gamma \cup \{H\}$ is consistent if Γ is and $H \not\models G$.

There are several proposals for abduction for propositional classical logic and even for some non-classical logics [Car06,CNSDM04,CP95]. From the definition of abduction one may declare that the abduction problem for first-order logic is undecidable, for the initial condition of Γ not proving φ nor its negation cannot be decided in general.
A recent approach towards the effective study of first-order abduction employs decidable restrictions of first-order logic. In [RAN06], the notion of n-abduction is introduced, such that first-order inference is restricted to finite models whose domain size is at most n. A sound and complete analytic tableau in-

ference was provided for such restricted logic, in which propositional abductive procedures could be applied. In this way, the objection over undecidable preconditions was overcome.
In a distinct direction, the notion of *cut-based abduction* was introduced by [DFG09] in the propositional setting. The aim of the current work is to apply cut-based abduction to first-order logic.
Cut-based abduction does not require that, given a pair $\{\Gamma, G\}$, the fact that $H \models G$ be decided. With this form of generalisation of the traditional notion of abduction, cut-based abduction covers simultaneously two cases:

- if $\Gamma \not\models G$ the problem reduces to traditional abduction, which searches for the best explanation hypothesis H such that $\Gamma, H \models G$
- if $\Gamma \vdash G$ is provable, the task is not that of explaining a given set of data, but that of facilitating its proof, in a process of *lemma generation*. It is expected that the provable sequent $\Gamma, H \vdash G$ has a simpler proof than $\Gamma \vdash G$, where "simpler" may mean "shorter" or just "easier to grasp" or a compromise between both.

It turns out that one abductive step, consisting of lemma generation as above, may be combined with other steps by means of the *cut inference rule*, so as to compose a proof for the original sequent, or to obtain a counterexample for it. In propositional logic it is guaranteed that such a process always terminates. In first-order logic the same iterated process can be performed, but no guarantee of termination is obtainable.
Putting together several abductive steps can be done only in non-analytic proof systems that allow for the cut rule. Abductive processes based on analytic methods, such as [Ali97,CP93,RAN06] cannot be used in this process. Instead, we apply inference based on KE-tableaux [DagM94], which allows for the cut rule in the form of a *principle of bivalence*. In this case, one of the basic results is that each lemma generation abductive step (that is, the abduction process) always terminates evene when the decision of the initial sequent $\Gamma \vdash^{?} G$ never terminates.

By studying first-order extensions of KE-tableau we hope to be able to perform apply abduction procedures analogous to those of [DFG09] so as to be able to perform first-order cut-based abduction.

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Communication towards happiness and peace
Problem-oriented life aid across languages

Ekkehard Finkeissen

Humans are facing various problems in this world preventing their inner happiness and outer peace. Starting from birth through multiple stages, many questions emerge in the communication with oneself, other individuals, amongst groups, and the rest of the world.
Is it possible to establish a complete list including all problems in human interaction? Does anybody keep track of the complete set of these questions? What has to be included? What problems and answers have already been identified? Without structuring we will never know.

If we had a 'global map' on problems in human communication we could distinguish both new questions and new answers from old ones. Implemented on a computer system, such a structured encyclopaedia on problems and solutions in human communication could be accessed by users for identifying existing and adding new questions including all our answers towards happiness and peace.

Alice in moral land

Torgeir Knag Fylkesnes

Recent moral philosophical developments in model-based reasoning (MBR) provide interesting opportunities to explore moral change. An aspect shared by these approaches is their emphasis on the environment of individual morality. Here, moral belief is constituted in a continuous interplay with the individual's environment. Individual morality is thus perceived as a result of interplay in a distributed moral habitat. Change occurs when moral mediators bring (new) moral knowledge, informing the moral environment of the individual. Empirical trials and tests of this new approach on real cases are however scarce.
In this talk, "Alice" will take center stage. Alice is an idealized nurse, existing in a hospital environment that in moral terms work according to the dynamics prescribed by the new moral philosophical approach. Alice's hospital environment has undergone fundamental changes over the last ten years. These changes directly affect her every-day practice; the introduction of new public management tools, of incentive systems and budget discipline have given her less time to care for patients, forced quick decision making, and running by the clock.
According to the new moral philosophical approach, the changes to the hospital environment would manipulate Alice's morals as well. What are the dynamics of this change?

A paraconsistent non monotonic model of explanation

David Gaytán Cabrera

Scientific explanation is an element of scientific methodology that works as a convergence point among several important philosophical problems. To characterize what we understand by scientific explanation means to offer a sketch of scientific reasoning. I have constructed a formal model of explanation. My formal model makes use of some results in non-classical logic, specifically non-monotonic and paraconsistent logic. In particular, I used Reiter's Logic for default reasoning and a hierarchy of calculus of Newton da Costa. Basically, the model of explanation consists of two types of argument-schema functioning as rules in an adequate system for them. I suppose we can, with this system, analyze relations between theories and logics, and I try, with this formal environment, to approach the kind of complexity that is involved by scientific explanations. There are four basic problems in Philosophy of Science, that I want to help solving with this formal proposal:

I) The problem of representation of scientific explanation as a final product of a certain kind of reasoning.
II) The problem of representation of the explanation and a part of his theoretical context involved.
III) The problem of representation of the explicative change.
IV) The problem of representation of the scientific explanation in inconsistent theoretical contexts.

A model-based reasoning approach to prevent crime

Charlotte Gerritsen, and Tibor Bosse

Within the field of criminology, one of the main research interests is the analysis of the displacement of crime. Typical questions that are important in understanding the displacement of crime are: When do hot spots of high crime rates emerge? Where do they emerge? And, perhaps most importantly, how can they be prevented? In this paper, an agent-based simulation model of crime displacement is presented, which can be used not only to simulate the spatio-/temporal dynamics of crime, but also to analyse and control those dynamics. To this end, an explicit domain model of crime displacement has been developed, and, on top of that, model-based reasoning techniques are applied to the domain model, in order to analyse which environmental circumstances result in which crime rates, and to determine which support measures are most appropriate. The model can be used as an analytical tool for researchers and policy makers to perform thought experiments, i.e., to shed more light on the process under investigation, and possibly improve existing policies (e.g., for surveillance). The basic concepts of the model are defined in such a way that it can be directly connected to empirical information.

Nanosim: an interactive classroom simulation of the National Nanotechnology Initiative

Michael E. Gorman

What does it take to sustain a civilization in an environment where emerging technologies can have a progressive or disruptive effect—or both at the same time? One way of approaching this question from the perspective of social psychology of science is to use simulations that allow participants to experiment, making decisions about sustaining or transforming civilizations. This presentation will discuss an example of such a simulation designed for classroom use, and will speculate on how it could be used as a kind of experimental modeling environment.

Nanosim is a classroom simulation of the U.S. National Nanotechnology initiative in which participants play roles in agencies, NGOs and laboratories like:

- Congress
- Regulatory agencies
- Funding agencies like DARPA and NSF and NIH
- Companies like IBM and entrepreneurial start-ups
- University laboratories
- NGOs like the Project on Emerging Technologies and ETC
- A newspaper that reports to all the other groups

Laboratories and companies make choices about what nanotechnologies to create, and collaborate or compete. Congress supplies funding, depending on how the research is justified, and can supply rules to the regulators for ensuring fairness, societal goals, etc. NGOs can use a variety of strategies to encourage or block technologies. In order to create new technologies, participants have to create trading zones to exchange resources, intellectual property and time). Outside events can be introduced to alter the simulation.

Nanosim has been used with students, but could also be used with policymakers in a way similar to how war gaming is used to anticipate military responses to global events. The class of interactive simulations creates a space for modeling the kinds of scenarios that would be most useful for anticipatory governance.

Is technological thinking a cultural activity?

Emilia Guliciuc

The search for an answer to the question if the technological thinking is a cultural activity is followed from the history of ideas perspective. Technology demonstrates that it is a cultural activity, so a philosophical analysis of it became that door open to the revalorization of philosophy itself in a technological world.

Moravec, Moore and Kurzweil in paradox. On knowledge as belief

Viorel Guliciuc

Starting from the presentation of the Moravec's Paradox, of the More's Law and from the Kurzweil's Law of Accelerating Results, the research put in evidence their strong dependency to a subjective selection of data. The type of model based reasoning those "law" or "paradoxes" is, finally, a linear one and fully indebted to a strong belief in the unlimited power of reverse engineering.

In fact, they are passing from knowledge to belief.

The symbolic model for algebra: functions and mechanisms

Albrecht Heeffer

In MBR 2004, we introduced the idea of symbolic algebra as a model-based activity. The emergence of symbolic algebra in Renaissance Europe could thus be characterized as a shift from a geometrical model to a symbolic one. In this paper we will characterize the functions and mechanism of this symbolic model.

In 1830, George Peacock, published his Treatise on Algebra, in two books. The first book is on Arithmetical algebra, the second on Symbolic algebra. Peculiarly both works use symbols, but in arithmetical algebra "we consider symbols as representing numbers, and the operations to which they are submitted as included in the same definitions". What this means is that Peacock formulates restrictions on the operations of algebra so that the results always remain natural numbers. A quadratic equation is

therefore not allowed in arithmetical algebra as it can lead to negative, irrational or imaginary roots. Symbolic algebra is then seen as a generalization of arithmetical algebra in which all of its truths are preserved. For this property he coined the term "the principle of the permanence of equivalent forms".
Now, from the point of model-based reasoning both Peacock's arithmetical and symbolic algebra use a symbolic model. The operations allowed in his arithmetical algebra preserve closure for the natural numbers, while his symbolic algebra allows for all the operation valid for the arithmetic on integers, natural, irrational, and complex numbers. If we use the principle of permanence of equivalent forms to this last class of numbers, we can characterize the entire history of symbolic algebra until the advent of non-commutative algebras (quaternions).
We would like to demonstrate that this is a fruitful framework for studying changes in the history of the number concept. We will show by two examples, one on the rules of signs and one on the emergence of negative numbers, how new mathematical concepts emerged by using the symbolic mode of reasoning for arithmetical problems.

Logic as a theory of computation

Jaakko Hintikka

What is the relation of the ordinary first-order logic and the general theory of computation? A hoped-for connection would be to interpret a computation of the value b of a function $f(x)$ for the argument a as a deduction of the equation $(b=f(a))$ in a suitable elementary number theory. This equation may be thought of as being obtained by a computation in an equation calculus from a set of defining equations plus propositional logic plus substitution of terms for variables and substitution of identicals. Received first-order logic can be made commensurable with this equation calculus by eliminating predicates in terms of their characteristic functions and eliminating existential quantifiers in terms of Skolem functions.
It turns out that not all sets of defining equations can be obtained in this way if the received first-order logic is used. However, they can all be obtained if independence-friendly logic is used. This turns all basic problems of computation theory into logical problems.

Model-based reasoning and semiotics.

Natalia Kareva

In our time the model-based reasoning has an active use due to its sign, visual, game and dialogic aspects. The model like a sign helps to concentrate attention on important and exclude unimportant information, to set a direction of thought with the purpose of conviction. Persuasiveness of the argumentation increases due to the fact that the model creates a visual image which assumes a possibility of a manipulation with it like in game. So the model-based reasoning has to do with early semiotic fields of visual perception and active familiarization of reality by game. These fields have especially clarity for human, they are similar at everyone and therefore are convincing for all. And at last, the model-based reasoning is so topical because it has a dialogical aspect. A model is less fixed that a sign and allows possibility of some interpretation. A model creates an image and space beside itself, opened for reflective dialogue. In the conclusion the model-based reasoning has clarity, persuasiveness and induces to cogitative search.

The revelator game of complex adaptive reasoning for deep cognitive assistance in strategic thinking

Mary Keeler, Sheri Hargus, Arun Majumdar, and Josh Johnson

Revelator, a game of complex adaptive reasoning (CAR), is conceived as a self-correcting methodology for dialogue and narrative contexts of collaboration. While "normal form" games have preprogrammed possible strategies and effects, Revelator must be an "extensive form" game to give players the dynamic power to create their own "game world": a simulation context for building narrative arguments. Just as we can build simulations to examine complex physical, biological, or social systems, we can build simulations to examine complex logical arguments that represent complex issues. Players can improve their own strategic thinking skills by engaging to elucidate complex issues and reveal possible solutions to puzzling problems. Our current work in Revelator-building focuses on natural language processing (NLP) query support for controlled natural language (CNL) formulation of game plays. We pursue a prototype of two-player gameplay for editorial use in the conversational contexts of news blogs and research wikis. Revelator is a game for improving human reasoning with appropriate deep cognitive assistance from technology.

Revelator's CAR methodology, inspired by J. Holland's complex adaptive systems (CAS), is designed to model complex logical relations among conjectures (represented in "If … then" rule form) that players articulate in game plays. The game's agent-based representation of these rule-plays gives them adaptive capability, strategies for robust hypotheses to be tested. CAR's dynamic model derives from C. Peirce's theory of reasoning in three stages of argument: abduction or conjectural reasoning, deduction or necessary reasoning, and induction or experimental reasoning. Revelator is designed to strengthen weaknesses identified in both abduction and deduction, which must work effectively together in creating and conducting strategic virtual experiments. Peirce's theory of reasoning encourages us to imagine a Revelator research framework to explore the intricacies of relations among reasoning stages, revealing their hidden complexities and the potential for emergence in knowledge evolution.

Acting thoughtfully, thinking reflectively: An ecological perspective on model-based cognition and expertise

Alex Kirlik

Over the past 15 years we have been engaged in studying and supporting, via technology, expert cognition and performance in a wide variety of settings, including hurricane forecasting, air traffic control, electrical power generation, short order cooking, search and rescue operations, intelligence analysis and professional sports. In these contexts and others, we have found that the development and use of external (perceptible, manipulable) models makes a crucially important contribution to expert inference and judgment. As such, the mechanisms responsible for expert performance are distributed across the boundary of the skin, requiring one to adopt an ecological perspective for studying and supporting expertise. By ecological, I mean a perspective in which the psychological unit of analysis and object of theoretical scrutiny is the integrated human-environment system, rather than solely internal cognitive activity (Kirlik, 2006; 2009).

I will illustrate these points by presenting two examples in some detail. In the first, we discovered that the highest (but not lower) levels of expert performance were enabled by the performer spontaneously structuring the ecology to become a concrete, perceptible model of the ecology's otherwise covert structure (i.e., "acting thoughtfully"). This allowed the expert to perceive what other performers had to infer, most likely by the use of an internal, rather than external, model. In the second study in an unrelated context, we turned our findings on their head, so to speak. That is, we sought to determine whether performance could be enhanced by providing experts with external (perceptible, manipulable) models of their own reasoning. We found that doing so allowed experts to examine and better appreciate the statistical basis of their inferences ("thinking reflectively") and to thereby significantly outperform experts who were not provided with such external models. Theoretical implications will be discussed.

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"Information" as an ontological element: a phenomenological approach

Mamede Lima–Marques

Authors argue that the word 'information' is polysemic. In the field of information theory, several authors have different meanings to that word; as a consequence, both the use and theoretical support are not congruent. Obviously, some of these concepts are applicable, and produce interesting results. Among other open issues in the Philosophy of Information, Floridi (cf. [1, 3]) shows that the elementary question: 'what is information?' is still an elusive concept. However, a unified concept is necessary, given its importance in almost all fields of knowledge.

The goal of this article is to show that whereas it is currently unfeasible to define its nature, it is possible to demonstrate that 'information' is an element that belongs to the realm of Ontology. Based upon Husserl's phenomenological theory (cf. [2, 4]), subject, world and knowledge come together. In this context knowledge is a set of properties of the world apprehended by the subject. 'Information' has no other place in this scheme but the realm of ontology. From this point of view our aim is to show that it is possible to characterize the domain of 'information' even without a unified theory of information.

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Models as points of view
The case of system dynamics

Manuel Liz, and Margarita Vázquez

We propose an analysis of the notion of model as crucially related to the notion of point of view. A model in that sense would always suggest a certain way of looking at a real system, a certain way of thinking about it and a certain way of acting over it. We focus on System Dynamics (SD) as a paradigmatic case with respect to many of the features and problems we can find in the field of modelling and simulation. We analyse in detail some of those features. All of them would be very important with respect to modelling and simulation beyond the field of SD. They are features that are present in many other cases of construction and use of models. Furthermore, all those features would support the thesis that a model can be fruitfully understood as offering a point of view over a real system. Such point of view would include both non-conceptual and conceptual contents, it would have a particular complex behaviour, and it would have direct consequences on the decisions made by the subject –individual or collective-- of the point of view.

A formal explication of the search for explanations
The adaptive logics approach to abductive reasoning

Hans Lycke

Most logic–based approaches characterize abduction as a kind of *backwards deduction plus additional conditions*, which means that a number of conditions is specified that enable one to decide whether or not a particular abductive inference is sound (one of those conditions may for example be that an abduced formula should be compatible with the background theory). But, although these approaches succeed in specifying which formulas may count as valid consequences of abductive inference steps, they do not explicate the way in which people actually reason by means of abductive inferences. This is most clearly shown by the absence of a decent proof theory. Moreover, also the search procedures that are provided to obtain the right abductive consequences do not by far resemble human reasoning.
In order to explicate abductive reasoning more realistically, an alternative approach will be provided in this paper. This alternative approach is based on the *adaptive logics programme*, which means that, proof theoretically, the inference schema *Affirming the Consequent* (**AC**: $A \supset B, B \vdash A$) is interpreted as

a defeasible rule of inference. More specifically, the consequences obtained by means of **AC** are accepted only for as long as certain conditions are satisfied – for example, in case their negation has't been derived from the background theory. As a consequence, adaptive logics for abduction will only retain the unproblematic *applications* of **AC**, while they will reject the problematic ones. In this way, these logics nicely capture the way people do reason by means of abductive inferences. Moreover, as multiple kinds of abduction will be explicated, the adaptive logics approach is not restricted to a particular kind of abduction process, but can be considered a general approach towards the explication of abductive reasoning.

Smart abducers as violent abducers
Hypothetical cognition and "military intelligence"

Lorenzo Magnani

I will describe the so-called coalition enforcement hypothesis, which sees humans as self-domesticated animals engaged in a continuous hypothetical activity of building morality, incorporating punishing policies at the same time. Its main speculative value stresses the role in human and animal groups of more or less stable stages of cooperation through morality and related inexorable violence: morality and violence are seen as strictly intertwined with social and institutional aspects, implicit in the activity of cognitive niche construction. *Hypothetical thinking* (and so *abduction*) is in turn very often embedded in various linguistic kinds of the so-called fallacious reasoning (which in turn constitutes a relevant part of the linguistic cognitive niches where human beings are embedded). Indeed, in evolution, coalition enforcement works through the building of social cognitive niches seen as new ways of diverse human

adaptation, where guessing hypotheses is central and where guessing hypotheses is occurring as it can, depending on the cognitive/moral options human beings adopt. I will stress the moral and violent effect played by human natural languages, focusing on the analysis of the relationships between language, logic, fallacies, and abduction. This "military" nature of abductive hypothetical reasoning in linguistic communication (military intelligence) is intrinsically "moral" (protecting the group by obeying shared norms), and at the same time "violent" (for example, harming or mobbing others – members or not of the group – still to protecting the group itself). However, the "military" power can be considered also active at the level of *model-based cognition*: taking advantage of the naturalistic perspective of a "physics of abduction", where the abductive generation of new hypotheses or the selection of them can be interpreted in terms of a catastrophic rearrangement of the parameters responsible for the behavior of a system. Catastrophe theory demonstrates that *pregnances* and *saliences* provide a further help in increasing knowledge about abductive "hypothesis generation" at the level of both instinctual behavior and representation-oriented behavior, where *nonlinguistic* features drive a "plastic" model-based cognitive role: all physical phenomena, and so cognition, gain a fundamental semiotic, eco-physical, and "military" significance, which nicely furnishes further insight into a kind of "social epistemology" [Magnani, 2009].

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Pathophysiology of cancer and the entropy concept

Konradin Metze, Randall L. Adam, Gian Kayser, and Klaus Kayser

Entropy may be seen both from the view point of thermodynamics, and from information theory, as an expression of system heterogeneity.

Entropy, a system–specific entity measures the distance between a biological system's present and predictable end-stage, Entropy is based upon statistics of internal characteristics of the system, A living organism maintains its low entropy level and reduces the entropy level of its environment due to communication between the system and its environment.

Carcinogenesis is characterized by accumulating genomic mutations and is related to a loss of internal cellular information. The dynamics of this process can be investigated with the help of information theory. It has been suggested that tumor cells might regress to a state of minimum information during carcinogenesis and that information dynamics are integrally related to tumor development and growth

The great variety of chromosomal aberrations in solid tumors, has limited its use as a variable to measure tumor aggressiveness or to predict prognosis.

The introduction of Shannon's entropy to express karyotypic diversity and uncertainty associated to sample distribution has overcome this problem.

During carcinogenesis mutations of the genome and epigenetic alterations (e.g. changes in the methylation or protein composition) occur, which reduce the information content by increasing the randomness and raising the spatial entropy inside the nucleus. Therefore, we would expect a raise of entropy of nuclear chromatin in cytological or histological preparations with increasing malignancy of a tumor. In this case entropy is calculated based on the co-occurrence matrix or the histogram of the gray values of digitalized images. Studies from different laboratories based on various types of cancer demonstrated that entropy derived variables describing chromatin texture are independent prognostic features with increasing entropy values associated with shorter survival. In summary the entropy concept helped us to create in a parsimonious way a theoretical model of carcinogenesis, as well as prognostic models regarding survival.

Abduction and analogy: On the logic of analogical reasoning

Gerhard Minnameier

Analogical reasoning has been investigated by philosophers and psychologists who have produced different approaches like "schema induction" (Gick and Holyoak) or the "structure-mapping theory" (Gentner). What is commonplace, however, is that analogical reasoning involves processes of matching and mapping. Apart from the differences that exist between these approaches, one important problem appears to be the lack of inferential precision with respect to these processes of matching and mapping. And this is all the more problematic, because analogical reasoning is widely conceived of as "inductive" reasoning.

However, inductive reasoning – in a narrow and technical sense – is not creative, whereas analogical reasoning counts as an important source of human creativity. It is C. S. Peirce's merit to have pointed to this fact and that induction can merely extrapolate and generalize something already at hand, but not

the kind of reasoning that leads to new concepts. Indeed, inventive reasoning is usually identified with abduction, and consequently abduction should play at least some role in analogy. Peirce has claimed that analogy is a compound form of reasoning that integrates abduction and induction, but the intriguing question is still, how these two inferences are to be reconstructed precisely.
In the proposed paper I hold that analogical reasoning can indeed be analyzed in this way and that this helps us to reach a much more precise and differentiated understanding of the forms and processes of analogical reasoning. In particular I hold that (at least) two forms of analogical reasoning have to be distinguished, because they represent different inferential paths. The underlying inferential processed will be explicated in detail and illustrated by various examples.

Tableaux for structural abduction

Ángel Nepomuceno-Fernández, Francisco J. Salguero-Lamillar, David Fernández-Duque

Abduction has been logically studied as a kind of explicative inference. So, given an abductive problem, a theory that does not entail a formula (and does not entail its negation either), a logical explanation is obtained when a new formula is found which, along with the theory and the logical calculus, entails the first given formula.
As it is known, searching for an explanation can be made in a systematic way by means of a logical method such as semantic tableaux. But a variation of the abductive problem is relative to the logical calculus itself: given a theory and a formula such that it is not a (logical) consequence of the theory, it may be that new logical rules could be found to be added to the given calculus, so that the corresponding extended calculus provides us with an explanation; that is to say, in the modified calculus the formula is consequence of the theory. This variation of the abductive problem will be called the structural abduction problem.
In this work we shall study how to apply semantic tableaux to solve structural abductive problems when the inferential context is a normal modal logic. One of the most attractive characteristics of this method is that when the consequence relation (or the validity) does not hold, then open branches show what would be necessary to close such branches and a suitable solution can be proposed. In the case of modal logic, we can use the open branches to see what properties should hold of the accessibility relation, and consequently which new rules should be added.

Belief revision vs. conceptual change in mathematics

Woosuk Park

In his influential book *Conceptual Revolutions* (1992), Thagard asked whether the question of conceptual change is identical with the question of belief revision. One might argue that they are identical, because “whenever a concept changes, it does so by virtue of changes in the beliefs that employ that concept”. According to him, however, all those kinds of conceptual change that involve conceptual hierarchies (e.g., branch jumping or tree switching) cannot be interpreted as simple kinds of belief revision.
What is curious is that Thagard’s interesting question has failed to attract any serious response from belief revision theorists. The silence of belief revision theorists may be due to both wings of their fundamental principle of informational economy, i.e., the principle of minimal change and the principle of entrenchment. Indeed, Gärdenfors and Rott conceded that their formal theory of belief revision “is concerned solely with small changes like those occurring in normal science”. [Gärdenfors and Rott (1994)]
In this paper, I propose to re-examine Thagard’s question in the context of the problem of conceptual change in mathematics. First, I shall present a strengthened version of the argument for the redundancy of conceptual change by exploiting the notion of implicit definition in mathematics. If the primitive terms of a given mathematical structure are defined implicitly by its axioms, how could there be other conceptual changes than those via changing axioms? Secondly, I shall examine some famous episodes of domain extensions in the history of numbers in terms of belief revision and conceptual change. Thirdly, I shall show that there are extensive and intricate interaction between conceptual change and belief revision in these cases. Finally, I shall submit and examine a wild hypothesis that they could be extensionally identical, even though intensionally and/or procedurally different.

Visual reasoning for mathematical concept formation

Alison Pease, Alan Smaill, Markus Guhe, and Ramin Ramezani, and Simon Colton

Debate about the role of visual reasoning in mathematics has tended to centre around the controversy about whether they can be used to prove, or to merely illustrate, a theorem. This follows the general

focus in the philosophy of mathematics on proof and the status of mathematical knowledge. In contrast, we focus on the often over-looked mathematical skills of forming and evaluating concepts, conjectures and axioms. We hold that visual reasoning does occur in this context. We support our argument that visual reasoning plays a role in mathematical theory formation with a case study of automated visual reasoning in concept formation, in the domain of number theory. Rearranging *n* counters as different rectangular patterns and categorising the results can suggest concepts such as *equality* (two separate collections of counters that can be arranged into exactly the same rectangular configurations), *evens* (numbers that can be arranged into two equal rows), *primes* (a collection of counters that can only be arranged as a rectangle with either 1 column or 1 row), and *squares* (a collection of counters that can be arranged as a rectangle with an equal number of rows and columns). HR-V interfaces Colton's machine learning system HR with his Painting Fool, and is able to invent standard number types using number rectangle definitions of them. For instance, given diagrammatic rectangular configurations of counters on a grid for numbers 1-20, HR-V discovered evens, odds, squares, primes, composites and refactorable numbers (integers which are divisible by the number of their divisors). We conclude by discussing further directions which could be taken in order to develop this previously overlooked area.

Analog modeling of human cognitive functions with tripartite synapses

Alfredo Pereira Jr, and Fábio Augusto Furlan

Recent research focusing on the participation of astrocytes in glutamatergic synapses has revealed a connection between four human cognitive functions: learning, perception, conscious processing and memory formation/retrieval. In Computational Neuroscience, associative learning and memory formation are classically illustrated at the synaptic level by means of a model composed of two (the pre- and postsynaptic) connected neurons, and their respective inter and intracellular signaling pathways. The discovery of the participation of astrocytes as active elements in these processes has led to the construction of broader models, composed by functional units of two neurons and one astrocyte, the tripartite synapses. Astrocyte terminations wrap the synaptic cleft (in some brain regions, each astrocyte can contact up to 140,000 synapses) and respond to presynaptic input by means of calcium waves and release gliotransmitters that modulate neural activity. Also, neighboring astrocytes are coupled by gap junctions forming a functional syncytium. In a series of publications we have described how human cognitive functions, including conscious perception, can be modeled by an ensemble of tripartite synapses connected by the astrocytic syncytium. In this presentation, we aim to show that this kind of model can be useful to explain the cognitive roles of neuronal membrane potentiation and depression, as well as calcium waves in astrocytes. The model contains a diagram of molecular mechanisms present in tripartite synapses and contributes to explain the physiological bases of cognitive functions according to the following stages: a) Glutamatergic heterosynaptic converging input to a neocortical or hippocampal neuron activates AMPA receptors and the resulting depolarization opens NMDA receptors of the NR2A subtype, promoting calcium ion entry that cause membrane potentiation related to associative learning (mostly by means of a signaling cascade and gene expression that leads to an increase in AMPA-dependent response); b) Local synchronized glutamatergic input from a population of neurons converging to metabotropic receptors of one astrocyte elicits coherent, amplitude and/or frequency modulated calcium waves with the potential of integrating local information; c) calcium waves travel across the gap junctions and, in a situation of global brain synchronization, allow the astrocytic syncytium to integrate sensory patterns from distinct neuronal populations into a conscious episode ; d) Glutamate released from astrocytes to post-synaptic neurons in tripartite synapses binds to extrasynaptic NMDA receptors of the NR2B subtype, which drives slow inward calcium currents, causing a delayed depolarization and an increase of CaMKII phosphorylation and AMPA excitability (a process we called “meta-potentiation”), or, alternatively, triggering a process of Long Term Depression.

Modeling the causal structure of the history of science: The case of experiments with thermal radiation

Osvaldo Pessoa Jr.

This paper is part of an ongoing project which aims at building causal models for episodes in the history of science, to be implemented in computer language. The approach selects units of scientific knowledge, to be called “advances”, connected by probabilistic causal relations. Advances may be either theoretical or experimental, and after they have arisen, their “causal strength” (degree of acceptance, etc.) usually changes with time, due to the appearance and changes in strengths of other causes. The focus of this article is the causal structure involving the experiments which revealed the nature of thermal (infrared) radiation, in the beginning of the 19th century.

Causal abduction and alternative evidence: a logical problem in penal right.

Claudio Pizzi

Epidemiological investigations very often allow saying with certainty that there is a relation between a macrophenomenon *F* and a certain value of increase or decrease of a certain pathology *P*. The abductive inference which leads to such a conclusion, however, does not normally allow establishing which cases of the pathology *P* are actually caused by cases of F and which are not. Given that in order to determine penal responsibility in most Western countries the law requires that there is a causal relation among token - events (which here we will identify with so-called Kim-events) it is frequently argued that in such cases no causal relation, and a fortiori no penal responsibility, can be properly established.
The problem will be examined with the tools of quantified conditional logic. The aim is to prove (i) that there is a difference between proving that a determined causal relation of a certain kind exists and proving that every effect of such a relation can be determined (ii) that determining causes but not effects of a certain relation is enough to establish penal responsibilities.

Time and natural language semantics A tense-logical framework and the debate over temporalism

Maria Ponte Azcarate

Prior's approach on time has been neglected by semanticists for several reasons. The main one, we believe, is the impossibility of Priorean tense logic to refer to times. The second one, is the impossibility to account for some important features of natural language such as temporal anaphora and the role of temporal constructions in discourse. The use of Priorean tense logic as a model for the semantic of natural language has, however, one important advantage over other accounts: the internal perspective of time (due to its modal nature). This paper examines extensions of Priorean tense logic in which reference to times is possible, focusing on the so-called hybrid temporal logic. We will outline some of its main features and analyse some of its philosophical implications. ***Abstract only***.

Abduction in consistent, anomalous and paraconsistent settings by means of goal-directed proofs

Dagmar Provijn

In [8], Meheus and Provijn proposed an alternative procedure for Aliseda's algorithms for the generation of *plain* and *consistent abductions*. However, further research made clear that the alternative procedure only generates *potential abductive explanations*. Briefly: given a theory $\mathcal{T}$, an explanandum $\mathcal{E}$ and a formula $\mathcal{A}$, $\mathcal{A}$ is a potential abductive explanation (**pae**) iff $\mathcal{T} \cup \{\mathcal{A}\} \vdash \mathcal{E}$ (the condition for plain abductions), $\mathcal{T} \nvdash \mathcal{E}$, $\mathcal{A} \nvdash \mathcal{E}$ and $\mathcal{A}$ is 'minimal' (in this paper interpreted as parsimony); abductions are consistent when also $\mathcal{T} \nvdash \neg \mathcal{A}$. In the first part of the paper, the original procedure from [8] is extended with a classical compatibility test for generating consistent potential abductive explanations (**cpae**). The adaptations made in view of this extension render a procedure that also allows for a sensible treatment of abductive anomaly ($\mathcal{T} \nvdash \mathcal{E}$ and $\mathcal{T} \vdash \neg \mathcal{E}$) and in some cases even for generating abductive explanations from inconsistent theories.
The procedure from [8] is based on the fact that proofs, according to the goal-directed proof search procedure for classical logic (**CL**) from [5] called **pCL**, contain information about the reasoning steps that are needed in order to derive $\mathcal{T}$ whenever $\mathcal{T} \nvdash \mathcal{E}$. However, as 'Ex Falso Quodlibet' is isolated in **pCL**, it can be removed from the procedure without losing 'Addition' or 'Disjunctive Syllogism' – resulting in **pCL**$^-$ [4]. Moreover, if $\mathcal{T}$ is consistent, the consequence set of **pCL**$^-$ equals the one of **pCL**. As such, whenever $\mathcal{T}$ is consistent, the new procedure will render the same results as before, adding the possibility to determine the **cpae**. On the other hand, if the theory would turn out to be inconsistent, the procedure will still render a rather sensible (depending on 'where' the inconsistency is 'located' in $\mathcal{T}$) set of **pae**. The new procedure will be compared with the results from both [1] and [6].

In the second part of the paper I will present a more promising procedure for paraconsistent settings, based on the results from both [3] and [7]. This procedure for the generation of **pae** and *paraconsistently compatible potential abductive explanations* (**pcpae**) is based on an 'as consistent as possible'

interpretation of inconsistent theories. I will show that the results from this adaptive procedure are more refined than the ones obtainable by means of a paraconsistent logic (such as **pCL**$^{-}$).

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Educational models of knowledge prototypes development Connecting text comprehension to spatial recognition in primary school

Flavia Santoianni

May implicit and explicit collaboration influence text comprehension and spatial recognition interaction? Visuospatial representation implies implicit and visual processing, visual and spatial processing of actions and concepts at different levels of awareness. Implicit learning is linked to unaware, nonverbal and prototypal processing, especially in the early stages of development when it is prevailing.
Spatial processing is studied as knowledge prototypes, conceptual and mind maps. According to the hypothesis that text comprehension and spatial recognition connecting processes may also be implicit, this paper analyzes the possibility to identify and to define implicit non verbal criteria for organizing concepts into spatial representation. The focus of the research question is if prototypal processing (mainly implicit, but also explicit) criteria of conceptual organization may be model based. According to Thinking Prototypes Theory, explicit knowledge could be supported by implicit models of basic processing. On implicit side, conceptual development could be the resultant of the increasing complexity of prototypal implicit models interaction during individual lifespan, as in conceptual change research explicit conceptual development may be dependent on correlation. Unlike Theory Theory in Thinking Prototypes Theory implicit processing may collaborate with explicit knowledge without transforming itself from implicit to explicit. Prototypal implicit processing is considered as an entanglement of basic functions operating sinergically in a complex way. Prototypical implicit processing units may be classified as far as they concern different basic thinking operations (add, chain, each, compare, focus and link).
The experimental design was developed in order to organize concepts in verbal phrases and non verbal spatial representations oriented by the same implicit organizing criteria. The task was finalized to correspondence finding. Students' associations (83 students of primary school third and fifth class in Naples) have been analyzed.

The Leyden Jar in Luigi Galvani's thought: A case of analogical visual modeling

Nora Alejandrina Schwartz

I will analyze an historical case of scientific research that leads to establishing the "animal electricity" hypothesis. I will focus on the role that the Leyden Jar and the electrical circuits it was part of played in Luigi Galvani´s thinking. The purpose is to examine in which measure the visualization of those dispositives took part in the formulation of a new scientific hypothesis. I am going to show that Leyden Jar and electrical circuits images mentioned before worked out as visual models. And that, as visual models, they were useful tools to the analogical solving of problems related with the electrical dicharge production in animals.
In *De viribus electricitatis in motu muscolari. Commentarius*, Luigi Galvani offers an "analogical modelling" case where he "retrieves" the perceptual structure of the representation of the Leyden experiment

pertaining to the electricity domain, and where he extracts a solution from that perceptual structure and transfers it –fitting it- to the animal physiology domain.
The "retrieval" of the Leyden experiment representation and the "mapping" between the electrical circuit in it and the electrical circuit that goes through the frog when the muscles of its foot become contracted, strengthen Galvani´s suspicion and surpise about the existence of an "animal electricity".
Galvani knew that putting the conductive arc of electricity on the Jar is the mechanism that yields the electricity flow in the Leyden experiment. Once the Jar is electrified it itself works as a source of electricity. Making needed adjustments, this solution is translated to the biology domain. "Model based reasoning", Galvani infers that what yields nervous fluid in the frog is the putting of the conductive arc of electricity on it, which also is a source of electricity.
Galvani transfers to the biological domain not only the explicative hypothesis of the conductive arc but also its interpretation in terms of the Franklin´s theory of a unique electrical fluid.

An approximate approach to belief revision

Luan Shangmin, Guozhong Dai, and Lorenzo Magnani

Computational approach is a main area of interest for researchers working in belief revision modeling, and several algorithms have been introduced in the literature. This paper combines syntax-based and model-based ap-proaches to produce a novel approximation approach for belief revision. We first introduce approaches to revising and contracting a belief set and a belief base. Then the properties of these approaches are shown. Furthermore, we demonstrate the implementation of these approaches**.**

Abduction and meaning in evolutionary soundscapes

Mariana Shellard, and José Fornari

This article is based on the analysis of a multi-modal artwork developed using principles of Evolutionary Computation and the triadic model of thought: Abduction, Induction and Deduction, as conceived by Charles S. Peirce. This artwork is named RePartitura and proposes the mapping of gestural drawings in sounds, thus combining sonic and plastic aspects into an Evolutionary Computation system that engenders the creation of sonic landscapes, also known as: Soundscapes.
This methodology comes from the Evolutionary Sound Synthesis (ESSynth) that is used in the creation of RePartitura soundscapes. RePartitura initiates with the mapping of the series of gestural drawings, which have the characteristic of being similar but never identical. The set of drawings is interpreted as a population of individuals who are distinguished by specific characteristics of each design. The mapping that characterizes each individual is converted into sonic aspects, determining their genotype. This results into the self-organization of a landscape of complex sound segments, in constant transformation, although keeping a cognitive similarity.
The objective of this Article is to assess and discuss the capacity of self-organization of this artistic evolutionary system, for its possibility of presenting musical meaning, and its adaptive nature as the conveyance of aspects that can be defined as of a form of artificial abduction.

Does everyone think, or is it just me? A current perspective on the other-minds problem

Cameron Shelley

It has been roughly 60 years since Turing wrote his famous article on the question, "Can machines think?" His answer was that the ability to converse would be a good indication of a thinking computer. This procedure can be understood as an abductive inference: That a computer could converse like a human being would be explained if it had a mind. Thus, Turing's solution can be viewed as a solution to the other-minds problem, the problem of knowing that minds exist other than your own, applied to the special case of digital computers.
In his response, Turing assumed that thinking is a matter of running a given program, not having a special kind of body, and that the development of a thinking program could be achieved in a simulated environment. Both assumptions have been undermined by recent developments in Cognitive Science, such as neuroscience and robotics. The physical details of human brains and bodies are indivisible from the details of human minds. Furthermore, the ability and the need of human beings to interact with their physical and social environment are crucial to the nature of the human mind.
I argue that a more plausible solution to Turing's question is an analogical abduction: An attribution of minds to computers that have bodies and ecological adaptations akin to those of human beings. Any account of human minds must take these factors into consideration. Any account of non-human minds should take human beings as a model, if only because we are best informed about the human case.

A modal framework for modelling abductive reasoning

Fernando Soler-Toscano, David Fernández-Duque, Angel Nepomuceno-Fernández

We present a framework for understanding abduction within modal logic and Kripke semantics. Worlds represent possible theories (different logics with a common language), and theoretic change is understood as a passage from one world to an adjacent possible world. To formalize this, the accessibility relation *R* models the possibilities of evolution of a theory: *wRw'* means that the theory *w'* is a possible modification of w. We introduce modal operators which allow us to express the different possibilities of change of a given theory.
Within this approach the classical notions of abductive problem and abductive solution can be formalized, not in terms of the metalogic, but in the modal framework itself. Abduction is commonly characterized at the metalogical level because it is defined in terms of the negarion of the entailment relation: however, our framework allows us to describe an abductive problem within our formal language by stating that from a theory w there is an accessible theory w' where the observation is a matter of fact and a theory w'' where it is not. Moreover, not only abduction can be modeled; we can also talk about the inner structure of theories, as well as relations between them, allowing us to interpret many ideas from philosophy of science within the well understood framework of modal logic.
This approach does not depend on the exact structure of the underlying logics, so that the abductive process can be studied with formal tools, not depending on a particular logic. Its behavior depends only on the properties of the accessibility relation. This allows us to separate abduction from deduction; the former is to be understood within the modal framework (passing from one theory to another), the latter at the base level (inferences within a theory).

On the logical formalization of theory change and scientific anomalies

Ricardo Sousa Silvestre

An investigation of what might be called the logical formalization to the process of theory change due to anomalies is presented. By “anomaly” we mean an observed fact falling into the explanatory scope of a theory that cannot be explained by the theory and accepted auxiliary hypotheses. As a first approach to restore the explicative power of the theory, some new auxiliary hypotheses are proposed to replace the old ones. In order to capture this refutable character of auxiliary hypotheses we investigate the use of a nonmonotonic inferential mechanism. Also, since the several tentative auxiliary hypotheses are mutually exclusive and may produce conflicts, we take a paraconsistent inferential relation as the monotonic basis of the proposed systems. By representing both laws and auxiliary hypotheses through this nonmonotonic and paraconsistent logic we think we can provide an inferential machinery in which the effects of both appearance and solution of an anomaly upon the theory can be fully represented.

The living and intelligent universe

Julio Michael Stern

The main goal of this article is to continue the development of an epistemological framework based on Cognitive Constructivism. The development of this framework is related to a novel statistical technique for testing sharp hypotheses, the FBST or Full Bayesian Significance Test.
Mirror houses used to be a popular attraction in fun fairs and amusement parks. The entertainment in such mirror houses came from misperceptions about oneself or other objects. More precisely, from the misleading ways in which a subject sees how or where are the objects inside the mirror house, or how or where himself stands in relation to other objects. The objective of this paper is to show how similar misperceptions in science can lead to ill-posed problems, paradoxical situations and even misconceived philosophical dilemmas

How brains make mental models

Paul Thagard

Many psychologists, philosophers, and computer scientist have written about mental models, but have remained vague about the nature of such models. Do they consist of propositions, concepts, rules, images, or some other kind of mental representation? This talk will argue that a unified account can be achieved by understanding mental models as representations consisting of patterns of activation in populations of neurons. The fertility of this account will be illustrated by showing its applicability to causal reasoning and the generation of novel concepts in scientific discovery and technological innova-

tion. I will also discuss the implications of this view of mental models for evaluating claims that cognition is embodied.

Perceptual and motor spatial representations in word recognition

Barbara Treccani, Claudio Mulatti, and Remo Job

The parallelism between the human brain/mind and the computer hardware/software, which had driven most of the psychological research in the last century, led to the assumption (still widely-shared) that cognitive representations are inherently non-perceptual (or amodal) and conceptual processing can be investigated irrespective of perceptual and motor processes. In contrast, modern approaches stress the role of perception and action in cognition: they conceive of cognitive systems as grounded, modal, and tied to both perceptual and motor systems. In line with this theoretical innovation, Barsalou (1999) proposed his theory of perceptual symbol systems, which posits that sensorimotor simulations (i.e., the re-enactments of perceptual, motor, and introspective states acquired during experiences with actual instances of a given concept) underlie the representation of concepts.
If accessing the meaning of a word involves the re-enactment of perceptual and motor states, then sensorimotor aspects of meaning (e.g., the typical position of the object to which a word refers to, or the direction of actions this object suggests) become crucial, even when the access to these specific aspects is not explicitly required.
Spatial perceptual aspects of the simulated states have been shown to have a major role in language processing. Recently, Treccani, Mulatti, & Job (in preparation) also show the involvement of spatial aspects of motor programming: spatial representations evoked when accessing word meaning can interact, not only with spatial attributes of physical stimuli, but also with spatial attributes of responses. These findings demonstrate that the presentation of isolated words primes spatially compatible responses: nouns activate responses toward the location where their referent typically occurs and verbs activate responses congruent with the direction of the movement they suggest. More in general, these results corroborate the hypothesis that information about the typical position of an object is necessarily retrieved and interacts with the current cognitive functions.

A pattern language to Roberto Burle Marx landscape design

Carlos Vaz, and Gabriela Celani

Patterns were developed by Christopher Alexander (1977) to synthesize rules of good design practice. Although he does not tell us where he took his patterns from, it is possible to infer that they are the result of his sensible observation of existing situations in European cities. However, these solutions are not necessarily true for situations in other countries, with different climates, economies and societies.
The Brazilian landscape designer Roberto Burle Marx is considered to have achieved the highest level of excellence and success in his designs for private gardens and public open spaces. In other words, there is no doubt about his being considered a “specialist”, in the AI (artificial Intelligence) sense, in his field.
The present paper proposes a systematization of the knowledge present in the work of Brazilian landscape designer Marx as “patterns” that can be used by students to overcome their difficulties related to the lack of professional experience. Instead of describing these patterns verbally, like Alexander, we propose to describe them graphically, as production rules, like in Stiny´s shape grammars (STINY, 1980). We expect that this research may contribute to the teaching of landscape design in undergraduate schools in Brazil.

Modeling defeasible reasoning by means of logic games

Peter Verdée

In this talk I shall present a dynamic logic game for adaptive logics. Adaptive logics provide an elegant generic format for a wide variety of defeasible reasoning forms. The game is based on (*i*) Logic Games as elaborated by Johan van Benthem (and others) on the one hand and (*ii*) the dynamic proof procedures for adaptive logic as elaborated by Diderik Batens and myself on the other hand. The games are based on standard logic games, but they have the extra property that some moves are retractable. I shall argue that the games form intuitive reasoning models for defeasible reasoning contexts. Moreover, I shall also demonstrate that the tableaux give a good insight in the abstract complexity of defeasible reasoning forms.

Different cognitive styles among industrial and academic researchers

Riccardo Viale

Previous studies on obstacles between universities and companies analyzed only superficial economic, legal, and organizational aspects, mainly focused in transfer of patents and licences. Since research collaboration implies a complex phenomenon of linguistic and cognitive coordination and attuning among members of the research group I think that a deeper cognitive investigation about this dimension might give some interesting answer to academy-industry problem. The main hypothesis is that there can be different cognitive styles in thinking, problem solving, reasoning and decision making that can hamper the collaboration between academic and industrial researchers. These different cognitive styles are linked and mostly determined by a different set of values and norms that are part of background knowledge. Different background knowledge is also responsible of bad linguistic coordination and understanding and of the difficulty of a successful psychology of group.
I will analyse 6 dimensions of the interaction: language, group, thinking, problem solving, reasoning, and decision making.
The results of a pilot study on three different technological domains will be presented.

Models, dichotomies and modern theorizing

Gabriel Viera

Dichotomies are a pervasive feature of modern theorizing and they are a constant source of controversies and debates. These debates usually fall into three main categories: those concerned with which side of the dichotomy is “true”, those surrounding attempts to integrate, transcend or reject dichotomies and those concerned with the ethical implications of dichotomous thinking. A remarkable feature of dichotomies is that no matter how many arguments are advanced in favour of one side or how many attempts are made to integrate, transcend or reject them they keep re-emerging and re-igniting the same debates. There is a vast literature dedicated to these debates for specific dichotomies. However, despite their ubiquity and contested nature, little attention has been given to the general characteristics of dichotomies and how these relate to the debates dichotomies generate. The aim of this article is to make two contributions in this direction. First, I argue that dichotomies are best understood as consisting of models of an aspect of the world constructed from two different perspectives and that such a view explains their persistent nature and points to the complementary character of different ways of dealing with them and most importantly it can shed some light on the ethical issues involved in dichotomous thinking. Second, I argue that modern theorizing can be characterized as based on and giving rise to the “division” of the world into three ontological “regions” associated with three dominant perspectives – “material”, “social” and “mental” – which generate the dichotomies behind some of the most prominent and persistent intellectual debates and controversies about knowledge. A model-based perspective, I argue, provides a useful framework for examining the nature of this modern ontological division, its formation and reproduction, its fruitfulness and productivity and the epistemic and ethical implications of its inherent limitations. ***Abstract Only***.

Formats of representation in scientific theorizing

Marion Vorms

This paper is intended to sketch out the definition of a methodological tool – the notion of a format of representation – for the study of scientific theorizing. Theorizing – seen as hypotheses forging and testing as well as teaching and communicating – always implies reasoning with and sometimes literally manipulating devices, such as diagrams, equations, graphs, schematic drawings, etc.: in order to draw inferences, one has indeed to reason with some concrete device, even if merely mentally represented. These devices are at the same time computational and representational tools. The notion of a format is intended to help us analyze the various forms under which such devices are displayed, and the influence such variety has on reasoning. Acknowledging that representations are “formatted” means that two representations can contain the same information though convey it in different ways, and that such changes matter to the inferential processes one can draw from it. The notion of a format is intended to characterize the differences between various types of representational devices used in scientific theorizing, from the point of view of the inferences they enable cognitive agents to do. By briefly presenting two case studies (the various formulations of Classical Mechanics, and the case of Feynman’s diagrams), I will try to show that an analysis of the different formats that are used in scientific practice should give us a way to understand the double aspect of theorizing (computation and representation).

Essence and relevance: modeling the epistemological multipolarity of semiotic objects

Zdzisław Wąsik

For practitioners of semiotics the most controversial issues constitute the status and nature of the semiotic object equalized with the sign as an entity or the unity of the sign and its reference. The popular sign concepts that prevail in semiotic usage are formulated either in terms of (I) a unilateral sign in which the sign-vehicle and its referent are treated as separate entities or (II) a bilateral sign whose two parts, the signifier and the signified, comprise a twofold psychical unity. Some semioticians adhere to the concept of (III) a semantic triangle in which the sign-vehicle, its meaning (thought or notion), and its referent form separate parts, and some prefer (III') a trilateral sign concept where the sign-vehicle, its meaning (the interpretant generating one or more signs), and its object of reference form a threefold unity. Separately noted are also the concepts of (II') the sign as a dyadic relation and (III") the sign as a triadic relation. These varieties of sign conceptions exhibit not only differences in terminology but also in the formation of their visual presentations.
Bearing in mind the need for their analysis and comparison, the practitioner of semiotic disciplines has to find a parameter or a matrix that would contain features and components characteristic for particular approaches to their forms of being and manifestation. Within the framework of my lecture, the conference participants will be provided with a theory-and-method related outlooks on the token and type relationships between the mental and concrete existence modes of semiotic objects and their objects of reference. Having reviewed all hitherto known sign structures, I will demonstrate how their two main components, the *signans* and *signatum*, with their collective and individual properties, may be modeled as oscillating between four epistemological positions: logical positivism, rational empiricism, empirical rationalism, and absolute rationalism.

Applications of an implementation story for non-sentential models

Jon Waskan

A major challenge facing those who support the notion that human cognition involves utilization of non-sentential representations akin to scale models is that of specifying how a set of electrochemical circuits might realize such representations. Taking my cue from work in computational (viz., mechanical) engineering, I show that a certain way of meeting this challenge not only bolsters the credibility of scientific hypotheses that invoke non-sentential models but also solves a collection of very closely related problems spanning several disciplines. This provides a determinate computational solution to (one version of) the frame problem of artificial intelligence, and it (as a version of the model-based approach to reasoning) thereby supplies what may be the only concrete account of open-ended mechanical reasoning as it occurs in humans and (perhaps) some other creatures. This approach also forms the core of a theory of explanation that remedies a number of the philosophical defects with its deduction-based counterpart. Deductive theories of explanation have difficulty accounting for our tacit knowledge of the innumerable implications of explanations and their innumerable defeaters, and, by the same token, they fail to account for our capacity to both establish which conditions bear on the assessment of explanations and hang onto explanations come what may. Another problem with deductive theories of explanation is that we are often unable to voice any of the laws which reputedly form the basis for our explanations. The present view promises a solution to such problems, and it may even illuminate why philosophers themselves have been unable to articulate any of the laws whose discovery supposedly justifies the claim that fields like psychology, anthropology, and geology are sciences.

Understanding and augmenting human morality: an introduction to the ACTWith model of conscience

Jeffrey Benjamin White

Recent developments, both in the cognitive sciences and in world events, bring special emphasis to the study of morality. The cognitive sciences, spanning neurology, psychology, and computational intelligence, offer substantial advances in understanding the origins and purposes of morality. Meanwhile, world events urge the timely synthesis of these insights with traditional accounts that can be easily assimilated and practically employed to augment moral judgment, both to solve current problems and to direct future action. The object of the following paper is to present such a synthesis in the form of a model of moral cognition, the ACTWith model of conscience.
The ACTWith model is at root a bottom-up hybrid architecture. The basic model is modified in light of key insights from neurology, and situationist psychology is emphasized. Key terms conscience and consciousness are redrawn from this perspective. These points are briefly reviewed. Then the model is detailed. The model is a four-step cycle, with each step a related mode of information processing. These modes are illustrated, both graphically and descriptively. First, they are examined individually. Then, the model is set in motion. It is illustrated in terms of moral archetypes resulting from routine em-

ployment of different modes in different contexts. In discussion, the model is framed and results interpreted in terms of traditional moral philosophy. Universal moral law is stated in terms extended from the operation of the model. Comparisons with Kantian formulations are made. Finally, the potential for immediate application is assessed, and research directions are indicated.

Virtuous distortion in model-based science

John Woods

The use of models in the construction of scientific theories is as wide-spread as it is philosophically interesting (and, one might say, vexing). Neither in philosophical analysis nor scientific practice do we find a univocal concept of model; but there is an established usage in which a model is constituted, at least in part, by the theorist's idealizations and abstractions. Idealizations are expressed by statements known to be false. Abstractions are achieved by suppressing what is known to be true. Idealizations, we might say, over-represent empirical ephenomena, whereas abstractions under-represent them. Accordingly, we might think of idealizations and abstractions as one another's duals.
In saying what is false and failing to say what is true, idealization and abstraction introduce distortions into scientific theories. Even so, the received and deeply entrenched view of scientists and philosophers is that these distortions are both necessary and virtuous. A good many people who hold this view see the good of models as merely instrumental, in a sense intended to contrast with "cognitive". Others, however, take the stronger and more philosophically challenging position that the good done by these aspects of scientific modeling is cognitive in nature. Roughly speaking, something has instrumental value when it helps produce a result that "works". Something has cognitive value when it helps produce knowledge. Accordingly, a short way of making the cognitive virtue claim is as follows: Saying what's false and suppressing what is true is, for wide ranges of cases, indispensable to the production of scientific knowledge.
Given the sheer volume of traffic in the modeling literature, focused discussions of what makes these distortions facilitators of scientific knowledge attracts comparatively slight analytical attention by philosophers of science and philosophically-minded scientists. This is perhaps less true of the distortions effected by abstraction than those constituted by idealization. Still, in relation to the scale of use of the models methodology, these discussions aren't remotely as widespread and, when even they do occur, are not particularly "thick".
The principal purpose of this paper is to thicken the analysis of the cognitive virtuosity of falsehood-telling and truth-suppression. The analysis will emphasize the influence of these factors on scientific understanding. Connections, real or imagined, with abduction and analogy will be considered en passant.

How messages are stored in the brain

Wang Yihong

How are messages stored in the brain? In an effort to answer this question, I will consider some recent research concerning mental representation, mental imagining, and the concept of working memory, also taking advantage of some neuroscientific ideas, such as the problem of embodiment and externalized distributed information. These results will be brought to bear in an analysis of the theory of mental imagery to show how mental imaging can be represented through a particular intertwining between the theory of visual perception and the theory of mental representation.

Language of thought-based modeling on the mental states of the scientific method for mathematical structures

Wang Yihong

This paper focuses on the concept of a "language of thought," expressing the idea that mental states are the representational framework for ordinary life.Fodor (1976) introduced the notion of a "language of thought." He proposed that the "language of thought" could be expressed in terms of cognitive mechanisms of mental representation. This paper synthesizes this concept of representational architecture with that of a mathematical logic based input/output system, thereby emphasizing the role of language in the language of thought. The result is a view in which language not only represents the contents of the world, but also the mental processes responsible for their conception. On this view, the same representational structure is both an elementary unit in ordinary reasoning, and a medium for communication, expressing not only thoughts, but thinking.

Symposium on Peirce's Existential Graphs

Organizer: Ahti-Veikko Pietarinen

Charles Peirce's century-old theory of Existential Graphs (EGs) has caught the attention of many contemporary logicians, mathematicians and philosophers. This symposium brings together scholars interested in Peirce's graphical and diagrammatic approaches to logic, their foundations, interpretation, and contemporary relevance and application.

The significance of Peirce's existential graphs

Jaakko Hintikka

Every ordinary first-order formula can be represented by Peirce's graphs, e.g. as a disjunction of constituents. (They have an especially clear graphical structure.) Whether this representability can be extended depends on how dependence and priority scopes are expressed graphically. A successful extension could mean that Peirce's logic is richer than Frege's. In any case, the graphs can be seen as a partial answer to the important philosophical question about the model-theoretical meaning of formal logical operations.

A visual model of Peirce's 66 classes of signs unravels his late proposal of enlarging semiotic theory

Priscila Borges

In this paper I will present the visual model of Peirce's 66 classes of signs, which I call the Signtree Model, and show how the model helps on developing the enlarged semiotic system that Peirce left unfinished. Peirce's best-known classification is that of 10 classes of signs. However, in his later years, when developing the sign process in much greater detail, Peirce proposed a classification of no less than 66 classes of signs. In contrast to the first classification, Peirce never worked out the details, making it a difficult topic that has received little attention from semioticians. For a better understanding of the 66 classes, I built the Signtree Model, which makes clear that the 66 classes work together composing a single dynamic system. As the Signtree describes all the 66 classes and visually shows how they are related in a dynamic system, the model can be a powerful tool for semiotic analysis, revealing details of a complex process composed of many elements and multiple relations emphasizing semiosis and the growing of signs. More than that, the Signtree gives clues about philosophical issues such as the relation between semiotic and pragmatism, between semiotic and metaphysics, and the relation among the three branches of semiotic: speculative grammar, critical logical and methodeutic.

On the auditory logic of sounds: How possible are non-visual diagrammatic logics?

Ahti-Veikko Pietarinen

This paper addresses the question of the possibility of logic that has no visual and no written appearance: no symbols, no marks, no language. Is such logic conceivable at all? I will sketch a positive answer that builds upon the idea of diagrammatic logic of Existential Graphs suggested by Peirce. According to him, the category of diagrams is not confined to visual forms of representation. My case study here concerns developing a propositional logic based on sounds. I will also propose how one might go ahead extending such 'auditory logic of sounds' with an 'acoustic' mechanism for quantification.

Consequences of a diagrammatic representation of Paul Cohen's forcing technique based on C. S. Peirce's existential graphs

Gianluca Caterina, and Rocco Gangle

This presentation examines the "forcing" technique developed by Paul Cohen in his proof of the independence of the Generalized Continuum Hypothesis from the ZFC axioms of set theory in light of the diagrammatic system of Existential Graphs elaborated by Peirce. The history of the development of Cohen's method is summarized, and the method itself is then translated from the relevant subsections of Cohen's set-theoretic proof into diagrammatic form according to a modified version of Peirce's EG-γ.

Some of the philosophical consequences entailed by this diagrammatic representation of forcing are then discussed. Interpreted on the basis of the work of Kant, Cantor, Wittgenstein and Badiou in particular, the diagrammatic systematization of forcing appears as not limited merely to offering a visual presentation of Cohen's method, but promises beyond this to open the ground to further explorations of the limits of and the relations between language, truth and their formal-ontological representations. These philosophical issues are themselves not simply theoretical, but hold practical consequences potentially for the worlds of computationalism and cognitive modeling. In particular, we argue that the construction of a diagrammatic model of forcing opens avenues of development for physical computationalism.

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