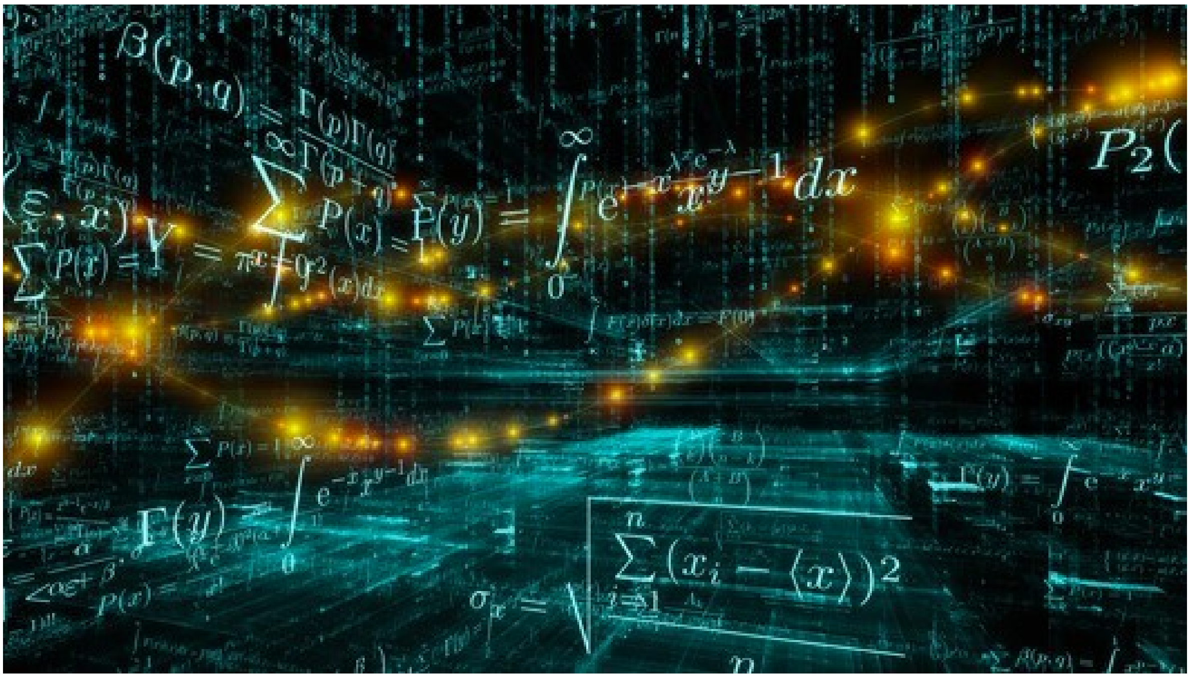
Models & Inferences in Science



Science continually contributes new models and rethinks old ones. The way inferences are made is constantly being re-evaluated. The practice and achievements of science are both shaped by this process, so it is useful to understand how models and inferences are made. This conference sets out to investigate the way we employ these tools. Different viewpoints will be examined. Discussion will include: the role of the models; how science shapes our conceptions of models; how to model the pursuit of scientific knowledge; the relation between our conception of models and our conception of science; the comparison of different models in different scientific domains; models and scientific explanation; models in the semantic view of theories; the applicability of mathematical models to the world; our conceptions of inference in our conceptions of science; the relation between models and inferences; inference as a means for acquiring new knowledge.

Rome, Villa Mirafiori – Via Carlo Fea, 2
11-13 September 2014, Room XII

Open to the public

SAPIENZA
UNIVERSITÀ DI ROMA

Department of Philosophy
PhD Program in Philosophy
SILFS Italian Society for Logic and Philosophy of Science

financial support: **PRIN-MIUR**; **Studio Ippoliti**

organizzation & info: Emiliano Ippoliti – emi.ippoliti@gmail.com
Fabio Sterpetti – fabio.sterpetti@uniroma1.it

web: http://web.uniroma1.it/logic/M&I

Program

Thursday 11 September 2014

10:00-10:10	Opening: **Stefano Petrucciani** – *head Department of Philosophy*
10:10-11:10	**James Ladyman** (University of Bristol), *Revisiting the Semantic Approach*
break	
11:30-12:30	**Lorenzo Magnani** (University of Pavia), *Scientific Models Are Distributed and Never Abstract*
Chairman:	Thomas Nickles
15:00-16:00	**Emiliano Ippoliti** (Sapienza University of Rome), *Ways of Advancing Knowledge. A Lesson from Knot Theory and Topology*
16:00-17:00	**Carlo Cellucci** (Sapienza University of Rome), *Models of Science and Models in Science*
break	
17:20-18:20	**Thomas Nickles** (University of Nevada – Reno), *Toward a Frontier Theory of Inquiry*
Chairman:	Emily Grosholz
20:30	Social Dinner

Friday 12 September

10:00-11:00	**Fabio Sterpetti** (Sapienza University of Rome), *Scientific Realism, the Semantic View of Theories and Evolutionary Biology*
break	
11:20-12:20	**Juha Saatsi** (University of Leeds), *Models, Idealisations, and Realist Commitments*
12:20-13:00	**A tribute to Carlo Cellucci**, Chaired by Giovanna Corsi (University of Bologne), *President of SILFS* (*Italian Society for Logic and Philosophy of Science*)
Chairman:	Lorenzo Magnani
15:15-16:15	**Emily Grosholz** (Penn State University), *Solar System, Galaxy, Cosmos: How Models Work in Astronomy*
16:15-17:15	**Raffaella Campaner** (University of Bologne), *Representing, Explaining and Intervening: On Modeling Disorders*
break	
17:40-18:40	**Richard Dawid** (Ludwig Maximilian University – Munich), *Modelling Scientific Confirmation*
18:40-19:20	**Reuben Hersh*** (University of New Mexico), *Mathematics as an Empirical Phenomenon, Subject to Modeling* (*Emily Grosholz's reading)
Chairman:	Dag Prawitz

Saturday 13 September 2014

09:40-10:40	**Sorin Bangu** (University of Bergen), *Wigner's Puzzle: Unreasonably Effective?*
10:40-11:40	**Cesare Cozzo** (Sapienza University of Rome), *Dummett on Inference*
break	
12:00-13:00	**Dag Prawitz** (Stockholm University), *Deductive Inference and Models in Sciences*
Chairman:	Carlo Cellucci

Speakers (in alphabetical order) and abstracts of the papers

Sorin Bangu (University of Bergen), *Wigner's Puzzle: Unreasonably Effective?*

Abstract

This paper revisits Eugene Wigner's famous claim that "the appropriateness of the language of mathematics for the formulation of the laws of physics" is a "miracle". This pronouncement has been known to philosophers (of mathematics) and to reflectively-inclined scientists for more than half a century now, and there is no shortage of proposals on how to understand it, as well as on how to remove its puzzling connotations. In this talk I first review a couple of such proposals, and I highlight their shortcomings. Then I present, and suggest improvements to, what I take to be the most promising route to responding to Wigner's challenge. I'm especially interested in discussing the relevance of the puzzle in the context of a recent attempt by Alvin Plantinga (2011) to enlist it among the arguments supporting theism.

Raffaella Campaner (University of Bologna), *Representing, Explaining and Intervening: On Modeling Disorders*

Abstract

It is nowadays widely agreed that most pathologies are complex, multilevel phenomena, involving many variables. A large debate has been developing on the intertwining of different kinds and levels of variables in the onset of disorders and their evolving in time, and a spectrum of reflections have been focusing on whether and how interactions among such different levels in biological and biomedical phenomena shall be modeled. Many difficulties arise with respect to the design of adequate representations and explanations of various disorders' causes, core characters and development, which in turn influence interventions on patients and treating strategies in health care systems. Stressing how modeling always depends on its purposes and context – e.g. the disciplinary field in which it is performed, and what it is performed for – I shall here address some issues arising from mechanistic modeling of disorders, its explanatory role in biomedical research, and uses into clinical practice. A special attention will be devoted to underlying assumptions and ontological commitments in the construction of models, and to relations between etiological and constitutive aspects in modeling diseases, with specific reference to neuropsychiatric disorders.

Carlo Cellucci (Sapienza University of Rome), *Models of Science and Models in Science*

Abstract

With regard to science, one may speak of models in different senses. The two main ones are models of science and models in science. A model of science is a representation of how scientists build their theories, a model in science is a representation of empirical objects, phenomena, or processes of some area of science. In my talk I will consider five models of science: the analytic-synthetic model, the deductive model, the abstract deductive model, the semantic model, and the analytic model. After considering their respective merits, I will discuss to what extent each of them is capable of accounting for models in science.

Cesare Cozzo (Sapienza University of Rome), *Dummett on Inference*

Abstract

The notion of inference plays a pivotal role in Michael Dummett's thought. In the first part of my paper I pinpoint some salient features that distinguish Dummett's conception of inference and his views on the relations between inferential practice, logical theory and the theory of meaning. In the second part I take up the problem "how can a deductive inference be both legitimate and useful?" and expound Dummett's proposed solution. The last part is reserved for some critical comments.

Richard Dawid (Ludwig Maximilian University – Munich), *Modelling Scientific Confirmation*

Abstract

Bayesianism constitutes the currently most popular framework for modeling scientific confirmation. Canonically, the Bayesian approach is linked to the understanding that confirmation is provided by observations in the theory's intended domain, that is by observations that are predicted by the confirmed theory. In this talk, I will present the idea that a wider approach to Bayesian confirmation offers a more adequate model of scientific confirmation. The resulting broader concept of confirmation seems crucial for an adequate understanding of contemporary fundamental physics. More generally, it raises interesting questions about the epistemic status of scientific theories.

Emily Grosholz (Penn State University), *Solar System, Galaxy, Cosmos: How Models Work in Astronomy*

Abstract

When Isaac Newton formulated his three laws of motion and the law of universal gravitation, he exhibited the power of his new theory not by showing how it worked for apples falling from apple trees, but by how it worked for our solar system. The birth of modern physics was successful in part because we are lucky enough to live in a collection of planets (and some odd debris) around a star: the system is isolated, it has only a few moving parts, and there is only one pertinent force—gravity. We are also lucky that our planet isn't always shrouded in mist: we can see and track the other members of our system as they cross the daytime or night sky on the great circle of the ecliptic. The first applications, in Book I, are to a simplified model of the solar system: in Book I, Proposition XI, the proof of the inverse square law proceeds in terms of a diagram that represents a center of force (the sun) and a single body moving around it (the earth, perhaps). The two body problem is immediately tractable; as later astronomers were to discover, the three-, four- and n-body problems are not. The geometrical model (adumbrated by ratios and proportions and some proto-calculus) mediates between the mathematically formulated, "universal and necessary" laws and the physical setting in which we find ourselves. It allows us both to refer to the sun and a planet, and to explore the mathematical "conditions of intelligibility" of their interaction. In Book III, "The System of the World," Newton begins the process of building more complexity into the model. He successfully treats the sub-systems of Mars and its moons, and Jupiter and its moons, and the sub-systems of the sun and each of the other planets, whose trajectories, like that of earth, obey Kepler's rules transformed by Newton. But the moon presents a problem of analysis (the earth, the sun and the moon constitute the first 3-body problem to be worked out in detail) and the comets present a problem of reference (are they really part of the solar system? what are their conditions of identity?) Looming behind the geometrical model is another discourse: the records kept by astronomers in Europe in the 16thcenturies, first and foremost the records of Tycho Brahe which inspired the rules enunciated by Kepler. Newton appeals to such records throughout Book III. The modeling depends on half a dozen different kinds of

discourses: mathematics in the service of Newton's four physical laws and the definitions that accompany them, as well as geometry, the new algebra, and the new infinitesimal calculus; and tables that record existing objects in our solar system. These modes of representation exist in some concord and some conflict, dialectical relations that drive the evolution of physics. As Newtonian mechanics develop, the calculus is elaborated using the notation and theory of differential equations due to Leibniz, the Bernoullis, and Euler; geometry is re-configured by the advent of non-Euclidean geometry and the annexation of complex analysis in the work of Gauss and Riemann; and astronomical record-keeping is continually improved, along with telescopy, transformed by its alliance with photography in the late nineteenth century. In the last two sections of my paper, I will argue that this pattern of physics developing in terms of models that invoke multiple discourses is also evident in the early investigations of galactic structure by Fritz Zwicky and Vera Rubin in the mid-twentieth century; and in current investigations of cosmic structure carried out by Abhay Ashtekar and colleagues. My philosophical point is that these developments are far from the application of a formal theory to a structure, the ideal of the logical positivists; instead, we find the real world mapped and tracked by a variety of modes of representation whose main intent is accurate reference, and a variety of mathematical schemes whose intent is to articulate the conditions of intelligibility of problematic things. The important models emerge in a turbulent dialectic, created by the tug and nudge of these discourses as scientists struggle to understand astronomical systems.

Reuben Hersh (University of New Mexico), *Mathematics as an Empirical Phenomenon, Subject to Modeling*

Abstract

Mathematics is described or studied—that is to say, "modeled"—by logicians, historians, neuroscientists, and even mathematicians. This multiplicity of models offers a challenge to philosophy. ***For personal reasons, Reuben Hersh won't be able to attend the conference. Emily Grosholz will read the paper in his stead.***

Emiliano Ippoliti (Sapienza University of Rome), *Ways of Advancing Knowledge. A Lesson from Knot Theory and Topology.*

Abstract

Knot theory and topology provide a privileged viewing point—a sort of laboratory—on the ways of generating hypotheses, posing and solving problems, and advancing knowledge. In particular, I will employ results from knot theory and topology to examine how mathematical entities are introduced and manipulated, how representations, models, notations, definition are used and constructed, and inferences put forward in order to obtain explicative hypotheses and new knowledge.

I will show how and to what extent these tools and inferences are endpoints of an interpretative process based on ampliative inferences, in particular analogies. Eventually, I will discuss several viewpoints on this issue.

James Ladyman (University of Bristol), *Revisiting the Semantic Approach*

Abstract

The Semantic Approach to scientific theories has largely replaced the syntactic approach that used to be known as the 'received view'. According to the former, theories are to be thought of as families of models rather than as sets of sentences in a first-order language as the latter would have it. The semantic view has been criticised on the grounds that it cannot account for scientific representation in terms of the notion of isomorphism, and that it gets the ontological status of theories wrong. Much recent work has approached both these

issues by considering models as fictions. I will review the debate and defend a semantic view arguing against a fictionalist account of models and for the importance of isomorphism in understanding scientific representation, but I will also argue that the semantic view should be freed from its set-theoretic chains.

Lorenzo Magnani (University of Pavia), *Scientific Models Are Distributed and Never Abstract*

Abstract

My main aim is to revise and criticize fictionalism, also reframing the received idea of abstractness and ideality of models with the help of recent results coming from the area of distributed cognition (common coding) and abductive cognition (manipulative). The presentation will also illustrate how scientific modeling activity can be better described taking advantage of the concept of ``epistemic warfare", which sees scientific enterprise as a complicated struggle for rational knowledge in which it is crucial to distinguish epistemic (for example scientific models) from non epistemic (for example fictions, falsities, propaganda) weapons.

Thomas Nickles (University of Nevada – Reno), *Toward a Frontier Theory of Inquiry*

Abstract

Almost by definition, resources are sparse at the more challenging, creative frontiers of science. Any legitimate source of information would therefore seem to be valuable. But which sources are legitimate? The Baconian-Newtonian inductivist approach insisted on data-gathering prior to theorizing, and it shunned hypotheses. (That general approach remains valuable in the mining of large databases today.) The modern method of hypothesis (including its extension to Bayesian reasoning)permits the use of hypothesis as virtual knowledge (e.g., to be used as premises in arguments), provided that the hypotheses are subsequently subjected to severe empirical tests. However, the method of hypothesis provides even less help than inductivism in identifying good problems and in constructing solutions. Modeling enables a further relaxation of methodological strictures that can bring new resources into play while also providing constructive guidance. Relaxation how? The method of hypothesis supposed that the hypotheses are candidate truths, while most models are known to be false, strictly speaking, from the start. A further relaxation may sometimes be possible, e.g., when faced with decision-making under uncertainty (as are many decisions at the frontier), namely use of the "less is more" heuristics of the kind championed by Gerd Gigerenzer and his group. These heuristics deliberately ignore some information sources. Such behavior seems to fit much frontier research, in which old data sets are sometimes ignored and old constraints broken. Thus we have the irony that, in frontier epistemology, the way ahead may often be to make sparse information even sparser! The question becomes more one of salience regarding fertility than of traditional epistemic legitimacy. This may be good news for the progress of inquiry but bad news for strong realism positions.

Dag Prawitz (Stockholm University), *Deductive Inference and Models in Sciences*

Abstract

There is a quite generally accepted concept of deductive inference according to which such an inference gives a conclusive ground for the conclusion given that one has conclusive grounds for the premisses. This is commonly taken for a conceptual truth, but although for a long time this notion of deductive inference has played an essential role in our understanding of mathematics and the sciences, little has been done to clarify the notion more precisely or to explain how there can be such a phenomenon as deductive inference.

Furthermore, in view of the fact that the ground for the conclusion of a deductive inference may be weaker than the grounds for the premisses when these grounds are less than conclusive, little has been done to explain how there can be any essential use of deductive inference in empirical sciences, whose general assertions are commonly taken to be merely more or less well established.
An explication of the concept of deductive inference will be presented for which it will indeed come out as a conceptual truth that such inferences preserve the conclusiveness of grounds.
It will be argued that the reason why deductive inferences conceived in this way are useful in empirical sciences depends on the fact that such sciences mainly use deductive inference, not in reasoning about empirical phenomena, but in investigations of models for such phenomena.
It is part of the definitions of these models that certain universally quantified statements hold in them, and therefore reasoning about them has access to conclusive grounds.

Juha Saatsi (University of Leeds), *Models, Idealisations, and Realist Commitments*

Abstract

Scientific realists believe that predictively successful models often get something right about the unobservable world beyond the ‘phenomena’. How should the realist capture the way in which models thus 'latch onto' unobservable reality? This is a pressing question, since familiar features of modelling present an obvious challenge to realism: scientific modelling essentially incorporates various kinds of idealisations and approximations that are indispensable to both the predictive and explanatory use of models. The role of idealisations – naturally understood as deliberate, simplifying *falsehoods* – and their indispensability suggests that the empirical success of modelling is at least partly due to those aspects of models that *cannot* be interpreted realistically. Furthermore, in as far as idealisations contribute to a model furnishing the best explanation of some phenomenon, a forthright application of abductive reasoning in a realist spirit seems doomed, too.
This paper examines the question and the challenge above, and reviews some recent responses to it (e.g. by Weisberg, Sorensen, Levy). By refining my own earlier take on theissues at stake I argue that there is scope for the realist to respond to the prima facie challenge in various cases. Admittedly, though, there are some cases that are more troublesome – to say the least – for the realist than others.

Fabio Sterpetti (Sapienza University of Rome), *Scientific Realism, The Semantic View of Theories and Evolutionary Biology*

Abstract

The semantic view of scientific theories is normally considered to be an account of theories congenial to Scientific Realism. Recently, different authors have argued that the scientific realist conceptual apparatus could be fruitfully applied to some of the philosophical issues peculiar to the scientific field of biology. Given the central role that models have in the semantic view, and the relevance that mathematics has in the definition of the concept of model, we will focus on population genetics, which is one of the most mathematized areas in biology. We will analyze some of the difficulties that arise when trying to make Scientific Realism compatible with the semantic view and with some of the crucial issues in evolutionary biology.