MS6: Models and Simulations in the Sciences: Perspectives from Philosophy, History, and Policy
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Short Abstracts – Ordered Alphabetically by Author

Barack, David. *Dynamical Models and Dynamical Mechanisms of Cognition*

Dynamical models of the physical mechanisms of cognition are beginning to exhibit surprising similarities. These similarities consist in repeated occurrences of the same pattern, for different formal models of processing and across different physical substrates. In this paper, I argue that this remarkable development in the cognitive sciences militates for a robust realism about the dynamical mechanisms of cognition, the referents of those models. I develop two arguments for this view: an argument from analogy to computer programs, and an argument from cognitive regularity. I respond to the objection from physical mechanisms and from the nonentailment of mechanisms from models.

Barberousse, Anouk and Julie Jebeile. *The Role of Empirical Agreement in the Validation of Computer Simulations*

An important criterion for the validation of a computer simulation is the agreement of its outputs with available empirical data. It seems that if this criterion is not satisfied, the simulation should be rejected without further investigation. However, empirical agreement may not be enough to assess the validity of a simulation. Our aim in this paper is to explore situations in which empirical agreement is not always a trustful guide toward the adequacy of underlying hypotheses.

Bechtel, William. *Using Computational Simulations to Understand Hypothesized Mechanisms*

The mechanisms biologists propose to explain phenomena are becoming increasingly complex, often involving non-sequential organization and non-linear reactions. Whereas historically biologists could mentally simulate the behavior of the mechanisms they advanced, they are now turning, sometimes reluctantly, to computational modeling to simulate their behavior. I focus on research in chronobiology that attempts to explain circadian rhythms. When molecular mechanisms involving transcription-translation feedback loops were first proposed in the 1990s, many chronobiologists regarded computational simulations as simply confirming what they already believed about how such mechanisms would work. As the hypotheses about the responsible mechanisms became more complex around 2000, researchers not only turned to computational simulations to determine how a proposed mechanism will behave but also to understand why it behaves that way.

Bolinska, Agnes. *An Account of Successful Epistemic Representation*

There are many ways to represent a target system, some of which are better suited for use as epistemic representations, or tools for gaining information about phenomena of interest, than others. I identify two features of successful epistemic representation: the vehicle must contain information about the phenomenon that is sufficiently accurate for the user's purpose and it must have the capacity to convey this information by making it salient to the user. Epistemic representation involves tradeoffs between these features, and the success of such representation depends upon the extent to which they are manifest.

Brumble, Kimberly. *Multi-Proxy Mean Temperature Reconstructions: Considerations from the Debate over the Statistical Methodology*

Multi-proxy mean temperature reconstructions are models which depict long-term trends in the earth's global surface temperature based on a record abstracted from climate proxies (geological and biological phenomena). These reconstructions are currently a key source of evidence of anomalous climate change in the 20th century. The first quantified large-scale reconstruction, now known colloquially as the "Hockey Stick Graph" has become the focus of a high-profile scientific controversy. I argue that, due to the conventional, empirical nature of developing and confirming statistical methodology, the controversy is a useful case study for understanding methodological and disciplinary uncertainty in the advent of Big Data.

de Donato Rodriguez, Xavier and Jose Luis Falguera. *Models as Abstract Objects Representing Fictional Systems*

We defend an approach according to which scientific models can be understood as abstract objects. By resorting to Peirce's semiotic ideas, we distinguish between models as abstract objects, which usually are the product of idealizations and theoretical constraints, and their representanda, fictional systems that could be in correspondence with parcels of the world. We propose to use Zalta's Abstract Object Theory to account for this kind of entities (models and their representanda). We also contrast our view with other recent approaches for scientific models, such as Frigg's account (based on Walton's pretense theory) and Contessa's dualist view.

Fagan, Melinda. *Generative Models: Human Embryonic Stem Cells and Multiplicity of Modeling Relations*

I argue that the generative aspect of models which are living things must be taken into account to fully understand their construction and use in scientific practice. I begin by characterizing the epistemic roles of classic model organisms in biomedical research. I then note four contrasts with another living model system: human embryonic stem cells (hESC). These contrasts bring out the significance of generative relations among models in biomedicine. Living models such as hESC form a network of model systems constructively related to one another, rather than serving as a single model system representing a wide range of targets.

Fillion, Nicolas. *Backward Error Analysis as a Model for Scientific Computation*

We argue that a residual-based a posteriori backward error analysis (based on the powerful error-theoretic concepts of backward error, conditioning, and residual) provides a general framework to establish the correctness of mathematical inferences in numerical contexts. Moreover, thanks to its similarity with standard perturbation methods used in dynamical systems, it increases our epistemological understanding of scientific theorizing by making clear that a key aspect to mathematical modeling is to exactly solve nearby problems.

Frisch, Mathias. *Calibrating Climate Simulations and the Problem of Old Evidence*

In this paper I critically examine recent arguments concerning the effect that tuning or calibration of climate models has on the confirmation of climate models. While naïve Bayesian likelihood reasoning is an inadequate tool in this context, since it runs afoul of the problem of old evidence, a more sophisticated Bayesianism supports at least some of the worries climate scientists express about the process of tuning parameters in climate simulations to existing data. At the same time, tuning allows for comparative confirmation between different base models.

Fumagalli, Roberto. *No Learning From Minimal Models*

This paper examines the issue whether consideration of so-called minimal models can prompt learning about real-world targets. Using a widely cited example as a test case, I argue against the increasingly popular view that consideration of minimal models can prompt such learning. In particular, I criticize the proponents of this view for systematically overstating the epistemic import of minimal models and for failing to explicate in virtue of what properties minimal models supposedly prompt learning. I then consider and rebut three arguments one might use to defend the claim that consideration of minimal models can prompt learning about real-world targets.

Gallegos, Sergio. *The Role of Abstraction in Simulations: a Proposal*

In this paper, I argue that abstraction plays a central role to account for the explanatory value that simulations have. Granting that abstraction is a process by which we focus on certain features of certain objects at the expense of others, I show that abstraction is required so that simulations can have explanatory value with respects to the processes or operations that they aim to model by considering two specific cases: agent-based simulations in economics and agent-based simulations in ecology.

Gildenhuy, Peter. *Probability in Classical Population Genetics*

I offer a novel account of what motivates the introduction of probabilities into classical population genetics models, focusing on the probabilities introduced by variance effective population size, Nev, the parameter that quantifies drift. I also set out a definite, credentist interpretation of those probabilities, saying specifically what would have to be learned by a researcher so that she could discharge the probabilities from classical models, so far as it is possible to do so.

Gross, Ari. *The View from Practice: what Philosophers of Scientific Models and Representation can learn from Historical Case Studies*

Despite the popularity of scientific representation among philosophers, there exist few efforts to study this subject through the lens of historical case studies. This paper serves to remedy this situation by examining the histories of August Kekulé's and Alexander Crum Brown's competing visual representations of molecular structure, a close examination of which will shed light onto several critical factors that underlie successful scientific representations. Furthermore, this paper will demonstrate how such an integrated HPS approach to the subject of scientific representation can unite disparate philosophical approaches as well as distinguish meaningful questions from attractive yet ultimately unimportant ones.

Guralp, Genco and Mohammad Safarzadeh. *Simulation and Model Confirmation in Cosmology: The Case of Lyman-Alpha Forest Power Spectrum*

Cosmology has recently become an experimental science, employing data-driven computational models and providing mathematically robust explanations of the large scale structure of the universe. This paper aims at explicating the epistemology of model confirmation in this context of experimental cosmology, via a case study. We examine how cosmologists produce models and run simulations in their study of an inter-galactic absorption phenomena known as the Lyman-alpha forest, to determine the matter power spectrum. We argue that Morgan

and Morrison's account of "models as autonomous agents" fails to capture the complexity of the case and offer an extended account that we refer to as the model-simulation nexus.

Heinonen, Matti. *A Model Based Approach to Collective Intentional Action*

This paper discusses contemporary philosophical accounts of collective intentional action from a meta-theoretical perspective, and argues for an interpretation of their theoretical status according to which they should be seen as models of hypothetical unified or distributed agential systems that can serve to represent the social cognition and behavior of suitable kinds of real agents acting together in complex social environments, but which do not by themselves make truth-valued claims either about how such agents actually function or about the cognitive mechanisms underlying their behavior. The model-based approach to collective intentional action is defended by its ability to negotiate the conceptual commitments and ontological construals of different philosophical accounts of collective intentional action with one another and to provide a feasible platform for philosophically informed interdisciplinary research on collective intentional action.

Herfeld, Catherine. *Explaining Principles and Predicting Patterns: Potentials and Limitations of Rational Choice Theory for Modeling Complex Phenomena in Economics*

Behavioral economists and philosophers of economics have argued that (formal) economic models suffer from poor empirical performance. One reason often drawn upon in these critiques is that economic models rely upon the (empirically inadequate) theory of rational choice. One solution suggested to this problem is to develop models of choice that are better supported by psychological evidence. In this paper, I defend the view that much of this critique of rational choice theory misses the point insofar as it rests upon two questionable premises: first, is presupposes that economics is and should indeed be a science that explains individual decision-making. Second, it often presupposes a commitment to the traditional deductive-nomological model of scientific explanation. I argue that both premises are questionable. In most cases, economists are neither concerned with explaining individual behavior, nor do economic explanations frequently rest upon laws of human behavior. Many phenomena of interest for economists result from social interaction. These are macro-level phenomena, patterns, which emerge from unintended consequences of individual behavior within a social and institutional setting. As such, they are characterized by fundamental complexity. In those cases, economists can only provide what Hayek called 'explanations of the principle' and 'pattern predictions'. While an account of the human agent is a necessary condition for such explanations, a fully developed psychological theory of individual behavior is not. To explain and predict the behavior of macro-phenomena, the real challenge for economists is not to find laws of human behavior, but rather to arrive at an adequate description of the relevant mechanism that give rise to the patterns of interest.

Hochstein, Eric. *The Essential Interactions Between Conflicting Models*

When we are presented with different models of the same system that cannot be integrated, scientists and philosophers often claim we are left with three options: determine the correct model and eliminate the others, alter and refine the different models until they converge into a single correct account, or determine whether the models are describing the system at different levels and thus are autonomous from each other. In this paper, I argue that these three options do not exhaust the possibilities on the table. I propose that an overlooked fourth option remains which better accounts for the dynamic interplay between the various conflicting models, and that better fits with actual scientific practice.

Hoover, Kevin. *The Ontological Status of Shocks and Trends in Macroeconomic*

Can shocks and stochastic trends, which are latent exogenous variables in structural vector autoregressions a common empirical modeling tool in macroeconomics can be regarded as observations of real latent entities rather than merely artifacts of the representation of variables in the model? The question is important to practical counterfactual policy analysis and to the philosophical analysis of causation – especially to approaches using the causal Markov condition and to Cartwright's "byproducts" objection to it.

Humphreys, Paul. *Applying Probabilistic Models*

An account is given of how to preserve the purely mathematical content of abstract probability theory when statistical models are used in applications. Empirical content is restricted to a mapping between elements in the last model of an hierarchy and the question of the relation between a random variable and its realization is addressed. The approach is generalizable to theories other than probability. Some remarks will be made about the advantages of syntactic approaches to theories within this method.

Katzav, Joel. *The Epistemology of Climate Models and Some of Its Implications for Climate Science and the Philosophy of Science*

I bring out the limitations of four prominent views of what the target of climate model assessment is. In doing so, I argue that an approach to such assessment that neither demands too much nor threatens to be unreliable will typically have to target something other than claims about how the climate system actually is as what it primarily aims to confirm. This means, I suggest, that the growing focus on probabilistic climate model assessment is misguided. So too, it means that standard epistemologies of science with pretensions to generality, e.g., Bayesian epistemologies, fail to illuminate climate model assessment. I go on to defend my own view of such assessment.

Kelly, Kevin and Konstantin Genin. *A New Frequentist Explanation for Ockham's Razor in Statistics*

Ockham's Razor is often justified by appeal to the over-fitting argument: estimating overly-complex models trades predictive accuracy for good fit to the training data. But what sort of decision theory favors Ockham's Razor at finite samples? We consider minimax and minimax regret frameworks, argue that none are satisfactory, and propose a new foundation. All consistent model selection methods can be forced to perform dramatic retractions of opinion as data accumulate. Ockham methods minimize the worst-case number of retractions. We simulate the retraction behavior of several standard methods and suggest ways they can be improved.

Kuorikoski , Jaakko and Samuli Pöyhönen. *Computer Simulations as Tools for Data Integration in the Social Sciences: an Inferential Approach*

Agent-based models are increasingly used in the social sciences for predicting the behavior of complex social systems and the consequences of possible policy-interventions on them. We examine and compare two cases of social science research where empirically calibrated simulations function as platforms for integrating different kinds of scientific evidence regarding an actual complex target system. We argue that an inferentialist approach to the epistemic role of models provides a clear account of why and how simulations can be used to learn about their targets, and that the approach provides useful tools for assessing the justification of different kinds of model-target inferences.

Lenhard , Johannes. *Autonomy and Automation: Computational Modeling, Reduction, and Explanation in Quantum Chemistry*

This paper discusses how computational modeling combines the autonomy of models with the automation of computational procedures. Computational modeling will be investigated by discussing the particular case of ab initio methods in quantum chemistry. Two claims will be argued for; the first belongs to general philosophy of science and states that computational modeling typically has to face a trade-off, namely enlarging predictive force at the cost of explanatory capacity. The second thesis is about the philosophy of chemistry: The methodology of computational modeling seems to question claims in favor of the reduction of chemistry to physics.

Lewis, Cory. *Nonlinearity, Invariance, and Modeling*

This paper attempts to clarify what makes nonlinearity a philosophically interesting property of some systems, using the framework of models as mediators. I will argue that nonlinearity can, in some cases, threaten our ability to make models which can act as mediators between theories and the world. This is because nonlinearity is a species of variability, and models function as mediators by identifying invariances - collecting and organizing the possible states of a system. This clarifies the relevance of nonlinearity, and also puts pressure on the idea that theories can be identified straightforwardly with their 'models' in van Fraassen's sense.

Li, Bihui. *Complete Microscopic Models and Their Relevance to Idealizations: Lessons from Quantum Field Theory*

Some accounts of how to evaluate idealizations rely on a "mapping'' of the physical system to a complete microscopic model. I argue that these are unhelpful for understanding idealizations in quantum field theory, where we lack an account of the physical details of systems at arbitrarily small scales. Rather, these idealizations are understood by mathematical proofs of the insensitivity of macroscopic physics to the unknown microscopic physics. I argue that the lack of a complete microscopic model is ubiquitous in physics, so we should look for explanations of effective macroscopic idealizations that do not require appeals to complete microscopic models.

Luczak, Joshua. *Toy Models: Interesting? Yes. Approximations? Idealisations? No.*

Scientific models are frequently discussed in philosophy of science. A great deal of the discussion is centred on idealisation and approximation. Toy models are unlike idealisations and approximations. It is not central to these models that they represent some actual (target) system. They can teach us things about actual systems without themselves representing any real system. They feature in explanations and aid the construction of sophisticated theories. Despite the importance, distinct nature, and widespread use of toy models in physics, they have received little attention from philosophers. This paper attempts to remedy this situation. It aims to elevate the status of toy models by distancing them from other models and by elaborating on the way a particular toy model is used in statistical mechanics: the Kac ring.

Lusk, Gregory. *Can Simulation Produce Empirical Knowledge?*

It has long been claimed that experiment and measurement are special among scientific investigations due to their ability to produce empirical knowledge. Simulations, which have repeatedly been compared to these traditional investigations, have been denied such special status based on the perception that simulations do not access their

target systems beyond probing mere mathematical representations of those systems. I show that such perceptions are mistaken. Certain computer simulations do in fact have a means of accessing their target. I present a case study of data assimilation in atmospheric physics. Data assimilation produces empirical knowledge because its results are dependent on causal interactions with the target system, and are, in some situations, reliable producers of information regarding the target. By reliably producing accurate results that are causally influenced by their targets, these instances of simulation have established themselves as producers of empirical knowledge.

MacLeod , Miles and Nancy Nersessian. *Understanding without Explanation in Systems Biology: The Role of Top-Down Abstraction*

In this talk we draw upon rich ethnographic data of two systems biology labs to explore the role of explanation and understanding in large-scale systems modeling. We use this data to show that while explanation in the form of mathematical and mechanistic explanation undoubtedly plays a role in practice, much systems modeling in our labs proceeds by trading away information necessary to mechanistic explanation in favor of tractability through what we call top-down abstraction. Top-down abstraction uses high level computational and mathematical techniques that average out mechanistic detail in order to fix a complex set of parameters to the available data and thereby to represent and simulate a systems' dominant dynamical relations. This suggests that in many instances systems biologists are aiming at a more pragmatic non-explanatory form of understanding, which can be philosophically connected as we'll show to the widely-used notion of a "systems-level" understanding. As such this paper contributes to the position that understanding in scientific practice is not always tied to explanation and signals the potential for diverging or shifting epistemic goals in biological science with the advent and importation of new computational methods.

Miller, Boaz. *Must a Computational Model Track the Time-Evolution of a System to Count as a Simulation?*

I argue – against the received view – that tracking the time-evolution of a system is not a necessary feature of computer simulation. I review two methods for solving a class of problems known as "flow problems". While the first method tracks the evolution of the model through time, the second does not. Yet, the two methods are epistemically equivalent. Therefore, if the first constitutes a simulation, so should the second. I further argue that even algorithms that supposedly track the time-evolution of a system may, in practice, not do so when run on actual computers. Hence, the received view is false.

Mirowski, Philip. *Information in Economics: a Fictionalist Account*

I start by contrasting an older account of models as analogies in economics, as against a newer account of models as fictions (associated with Mary Morgan). With an eye towards exploration of the weaknesses of approaching models as fictions, I have been inspired by the paper by Arnon Levy, "Information in Biology: a Fictionalist Account" *Nous* (2011), and here seek to explore some parallel appeals to 'information' in postwar economics. I shall summarize a much larger project (joint with Edward Nik-Khah) on the history of the treatment of information in postwar orthodox economics. Philosophers should care, I think, that the trajectory of the postwar orthodoxy has had the side effect of rendering philosophers redundant, if not altogether abjuring conscious knowledge almost entirely.

Murphy, Taylor. *Minimal Models and Interscale Mechanisms*

Neuroscientists are increasingly looking to the formal methods of statistical mechanics in order to analyze brain function at a whole-systems scale, viewed as a system poised near criticality, which facilitates information flow. I focus on models in mathematical neuroscience that exemplify "asymptotic reasoning," i.e., the modeling of phase transitions in an idealized infinite neural system. Contrary to other cases, this example provides no evidence that emergent phenomena on larger scales yields a new, non-mechanistic style of explanation. The take-home point is that the interesting philosophical questions statistical mechanics raises are about the discovery of interscale mechanistic explanations and the representations of noise as a novel (yet causal) kind of difference-maker.

Parke, Emily. *The Value of Simulations and Experiments*

Experiments are thought to have two epistemic virtues which give them privileged status over simulations. First, they are thought to generate greater inferential power; second, they are thought of as superior (or, the only) sources of productive surprises. I argue that both of these ideas are mistaken. Basing judgments about epistemic value on categories of investigative method muddies the waters of an important and more complex task: accounting for how our objects of study inform us about targets of inquiry in the natural world. We should not base in-principle judgments about epistemic value on the simulation/experiment distinction.

Pence, Charles. *Why Use Statistical Models? Nonidentifiability in Divergence Time Estimates*

The case of nonidentifiable parameters in divergence time estimates in evolutionary theory offers an interesting example for the study of statistical models. Even in the limit of complete observational data, the rates and absolute times of lineage divergence still cannot be specified without statistical uncertainty. It is not true, that is, that a statistical model is only used because we are practically incapable of obtaining a sufficient quantity of data. This offers an interesting analogy with quantum mechanics, and has implications for our understanding of the role of chance in evolutionary theory.

Pronskikh, Vitaly. *Modeling and Simulation: towards an Epistemic Distinction between Verification and Validation*

Simulation is often regarded as being intermediate between experimenting and theorizing. Two activities crucial to argue for reliability of simulations such as verification and validation are sometimes thought of as being entangled due to a Duhem problem that in the case of a discrepancy between a simulation output and the real-world data one cannot distinguish whether the model or its computational representation fails. I argue that because models of object structures and models of processes are distinct, there should be a clear epistemic distinction also between verification and validation as well as modeling (as theorizing) and simulation (as experimenting).

Potochnik, Angela. *Idealization and the Limits of Science*

Idealizations are rampant and unchecked in science. That is, they exist throughout our best representations, and there is little focus on eliminating them or controlling their influence. This is because idealizations, despite their falsity, play a positive representational role. This account of idealization motivates a reconstrual of the aims of science. Science has a variety of epistemic and non-epistemic aims, and the ultimate epistemic aim is understanding, which can be furthered by sacrificing truth. The deemphasis of scientific truth drives a wedge

between scientific results and any metaphysical implications regarding ontology, causation, or levels of organization.

Record, Isaac. *Who is a suitably prepared model user?*

I argue that the "goodness" of models should be assessed relative to the interests and capabilities of "suitably prepared" model users. Suitable users are those for whom the affordances of a model to produce valid and relevant inferences are readily perceptible. I propose that a good model must be easier to manipulate than its target and afford users useful inferences about its target. If it was not "easier to manipulate" than the target in some respect, we would just manipulate the target directly. If the model did not afford useful inferences, we would not use it, no matter how easy.

Solomon, Monica. *Two Models in Newton's Scholium*

In this paper I suggest that two well-known thought-experiments in the Newtonian Scholium to the definitions (the rotation bucket and the revolving globes) are best understood as models. First, I argue that they do not simply give instantiate the mathematical concepts previously defined and that they do not give a simplified description of direct observations. By comparing them with similar scenarios from Descartes's and Huygens's relevant works, I show that Newton's main use of models in the Scholium is to show the types of inferences that are licensed by the definitions when trying to conceptualize a well-known situation. More specifically, both examples illustrate strict mathematical(geometrical) correlations between changes and interventions effected on a physical system and the effect we expect from such manipulations.

Strikwerda, Robert. *Analogies, Representations, and Morphological Explanation in Durkheim's Research Program*

In 1898 Emile Durkheim published "Individual and Collective Representations" an analysis of psychological theories of memory. Why would an anti-reductionist sociologist who aimed to free sociology from psychology devote attention to debates among psychologists and physiologists about the location of memories? Unpacking this involves examining the place of scientific analogies in Durkheim's philosophy of science, his use of biological analogies to structure his own approach to social science while maintaining a distance from "organicist" and Marxist sociologies, explicating concepts such as morphology, physiology, force, germ, milieu, and substratum, and charting changes in explanatory strategy in his research program.

Suárez, Mauricio. *The Modelling Attitude and its Roots in 19th Century Science*

I locate the origins of the contemporary model-based scientific methodology in the 'modelling attitude' of philosophically minded scientists in the second half of the 19th century. I distinguish an English speaking modelling school (identified with William Thomson, James Clerk Maxwell, and their followers in Victorian British physics), and a German-speaking modelling school (identified with Hermann Von Helmholtz and his Berlin school, as well as Heinrich Hertz and Ludwig Boltzmann). I argue that both schools share a commitment to the 'relativity' of knowledge, and a consequent emphasis on reasoning via models as the main method for the acquisition of knowledge about the natural world.

Thomson-Jones, Martin. *Realism about Missing Systems*

Modelling often involves the describing and imagining of systems which are missing from the world around us, and this gives rise to a number of puzzles. The *fiction approach* to modelling addresses these puzzles by seeing certain sorts of modelling as kinds of fiction-making. I present a new version of this approach, on which missing systems are abstract artifacts—a form of realism about missing systems. I show how the account solves the puzzles, and weigh its merits against those of some of its rivals, including the appealing anti-realist version of the fiction approach developed by Frigg and Toon.

Verreault-Julien, Philippe. *Understanding through Counterfactual Analysis Modeling*

Models misrepresent, but models allegedly give us knowledge of the world because they represent. Accounts of scientific explanation usually require faithful representation for explanation. Responses to the conundrum have traditionally either argued that models do, in fact, represent faithfully, or that a true explanans is not necessary for explanation. I argue that modelling may be seen as analysis of counterfactual claims. Counterfactual knowledge, it turns out, contributes to our understanding because it allows to answer 'what-if-things-had-been-different' questions. My proposal does not require amending our theories of explanation while nevertheless accounting for the understanding models provide.

von Stein, Alex. *Models and Conventions*

Pragmatic factors play an important role in many contemporary accounts of modeling. I propose to extend attention to a wider domain of pragmatic factors that have not been considered by other accounts. These features include the modeler's audience as well as conventions governing model use.
These factors affect how models are and ought to be evaluated and I also consider in some detail how these very factors have shaped the use of the logistic growth model in population ecology. This case study demonstrates that not only can convention affect the practice of modeling, but it has.

Wayne, Andrew. *Idealization and Explanation: A Deductivist Approach*

Generalizations describing dependency relations that are true of a highly idealized model of a physical system yet false of the system itself may in some cases be used to explain phenomena in the system. How are we to make sense of this practice? The approach to explanation taken here falls within the deductivist tradition (Hempel and Oppenheim 1948; Hempel 1965; Kitcher 1989). The first goal of this talk is to diagnose where deductivism went wrong. The second goal of this talk is to develop one key element of a more modest deductivist approach that avoids past mistakes. This talk argues that what is essential for explanation is theoretical integration between the local idealized model of the physical system (described in the explanans) and a global theory, such as the standard model in particle physics or the general theory of relativity (GTR), that has independent explanatory power. The talk sketches an account of theoretical integration in terms of the justification of idealizing steps in model construction. It illustrates this account using the case of explanations of gravitational waves in GTR.

Wrigglesworth, Walter. *Models and Simulations in the Defense Industry – Setting a Cost requirement on Human Life (or Death)*

Modeling and simulation have long been used in the Defense Industry. Mathematical models of the ballistic trajectories of artillery shells have been employed to effectively aim guns since the first formulation of the laws of physics. These models have been successfully used to maximize the casualties on the opponent's side while minimizing the casualties on the side of the "defender". The concept of allowable casualties permeates the Defense Industry and modeling and simulation is the most effective way to quantify the effects of a modern engagement. This presentation will present an overview of how models and simulation are currently used in the Defense Industry; including the day to day design decisions, the impact on business development including competitive bidding and staffing, and finally how the models affect public and foreign policy in such things as military budgets and treaties.

Woody, Andrea. *Modeling meets Social Epistemology: Models and Explanatory Practice from the Functional Perspective*

In recent work I have been developing what I call the functional perspective on scientific explanation. In this talk, through a set of examples from chemistry, I will explore some of the ways that models can be explanatory and in particular, ways that the functional perspective might offer fresh insights concerning the explanatory status of models. In particular, because the functional perspective stresses the normative role of explanatory practice, this discussion will emphasize how explanatory models play crucial roles with respect to the social epistemology of modern sciences, including the development of coherent social practice, the perpetuation of community norms and the enculturation of new members, and the roles of cognitive and practical authority, expertise, and trust. I will also argue that the functional perspective deflects certain worries voiced in recent philosophical literature about the explanatory status of models generally and offers resources to reorient the intense debate regarding whether false models can explain. My examples will be diverse at the level of representation, including mathematical, diagrammatic, and mechanistic models, drawn from across the chemical sciences. This diversity is intended both to display the generality of the functional perspective and to highlight issues unique to particular representational types, which I take to be essential to assessing the explanatory status of models.