Workshop: "Model Transfer and Its Challenges in Science"

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ABSTRACTS (in alphabetical order)

Almeida Brandao, Pedro (Federal University of Rio de Janeiro): ***Is Model Transfer a Challenge to Scientific Realism?***

Scientific realism can be identified with some basic assumptions: the objects investigated by science are mind-independent entities; propositions asserted by scientific theories are true assertions about these objects; scientific theories produce knowledge of the mind-independent reality. This presentation discusses the challenges model transfer poses to this view. Model transfer involves using mathematical or conceptual models, initially developed in one scientific domain, to explain phenomena in another, seemingly unrelated domain. This practice raises several concerns: Ontological Ambiguity: Using the same model for different entities can blur what the model represents. For example, the Ising model, initially for magnetic spins, has been employed in social sciences to represent individual decisions. How could "spins" have anything to do with "decisions"? Epistemological Challenges: This transfer necessitates validation in the new domain, raising questions about the criteria for this validation. Is it empirical fit, theoretical coherence, or another measure? Instrumentalism Resurgence: The success of model transfer might lend support to instrumentalism, indicating that theories or models are merely tools for predicting phenomena, not necessarily true descriptions of reality. To address these issues, we will draw upon Knuuttila and Loettgers' categorization of the constituents of a model template: for the application of transdisciplinary models, more than a mathematical or computational skeleton is required, but also a generic ontology, common prototypical properties and a general conceptual framework. Basing ourselves on the simple case of Poisson distribution, we would like to suggest that the ontologies and properties typically involved in model transfer are sufficiently generic for these commonalities to be a problem for scientific realism to deal with. This way, we would like to argue that models do capture certain structures of phenomena, but partial structures. A preliminary conclusion is that what could initially be considered challenges for scientific realism can be navigated with careful consideration of the underlying ontologies.

Baragith, Karim and Thomas Reydon (Leibniz University Hannover): ***Cases of Model Transfer in Evolutionary Frameworks***

In this talk, our emphasis will be on a specific category of models that are notably well-suited for transfer between different scientific domains: evolutionary models (EM's). EM's have a history of extensive use in economics and other scientific fields. These instances of model transfer prompt various philosophical inquiries, such as defining the exact object of transfer and exploring the relationship between the model and the target domain. Furthermore, they

raise questions about the specific challenges encountered in such transfers and their broader implications for the progression of scientific knowledge. We will provide a systematic examination with a specific emphasis on the applicability of EM's. To establish a coherent framework, we will first present a classification of generalized evolutionary approaches that have found utility in the interdisciplinary fields of (1) cultural evolutionary theory, (2) evolutionary economics and (3) evolutionary linguistics. Subsequently, we will delve into specific EM's, including: the Price Equation, Replicator Dynamics, Evolutionary Game Theory and Phylogenetic methods of 'tree-building'. Within each of these cases, we will analyse how the process of model transfer has impacted and reshaped the respective scientific disciplines, as well as the models themselves. By scrutinizing these instances, we aim to elucidate the underlying dynamics of model transfer and its significant philosophical implications in the context of interdisciplinary knowledge exchange.

Gelfert, Axel (TU Technical University of Berlin): ***Models Beyond Borders: The Epistemic Pitfalls of Model Transfer***

The transfer of scientific models from one domain to another has been described as a distinctive feature of contemporary (techno)scientific practice, and is often hailed as demonstrating the epistemic reach of modern science. Yet, model transfer occurs at different levels, e.g., in the form of the transfer of 'model templates' or by transposing whole 'modeling frameworks'. In a number of cases, such transfer can be credited with, amongst others, injecting new life into stagnant research programmes and recovering a (suitably qualified) notion of scientific progress. Yet, model transfer also runs up against limits related to the nature of disciplinary traditions and material differences in subject matter. Advocating caution, I argue that the transfer of models beyond established disciplinary boundaries also carries with it epistemic risks – not least that of falling prey to what has been called the 'illusion of depth of understanding' in science.

Grüne-Yanoff, Till (KTH Royal Institute of Technology Stockholm): ***The Methodological Relevance of Model Transfer***

Studying model transfer has provided important insights into the workings of science, including the detailed descriptions of interdisciplinary exchange and the identification of conditions that explain why such transfer occurs. Yet it remains unclear what methodological lessons to draw from such studies. What do they tell the working scientist who wonders how to justify their method choice? Does it matter for such a justification that the model was transferred from another domain (rather than constructed from scratch) - and if so, how can a valid justification be crafted from this fact? In the extant literature, two broad positions can be distinguished: an irrelevancy position, most clearly laid out in Humphreys (2019), which denies that transfer has any methodological relevance. In contrast, several authors seem to claim that model choice can be at least partly justified with reference to the context from which it is transferred – be this through "re-sanctioning" of models against the foil of the old

context (Bradley and Thébault 2019), "model template entanglement" (Knuuttila & Loettgers 2023) or "contextual spillover" (Lin 2022). In this presentation, I will analyze these positions from a methodological perspective, scrutinizing their normative claims and their practical relevance for justifying model choice.

References:

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Hasnes Beninson, Zvi (Cohn Institute for the History and Philosophy of Science and Ideas, Tel Aviv University; Max Planck Institute for the History of Science, Berlin):
Epistemic Commitments Have No 'Off' Button: On the Embodiment of Commitments by Way of Model Formulation

The ability to transfer models across scientific domains raises the following concern: when a model is used to explore a target system that is different from its original one, it carries with it ideas and modeling assumptions that were appropriate for the original context, but when applied to the new context they can easily become implicit. The implications of these implicit assumptions may come to seem necessary. My paper aims to address this issue, namely, when a model is re-purposed to studying a new target system, which commitments does it carry with it? The first step in addressing this question concentrates on the characteristics of commitments. Once these characteristics are defined, the second step is to show how the practice of model formulation could introduce commitments with those features to an epistemic community. The third step is to demonstrate the analytical framework with a case study. My paper focuses on Richard Levins' approach to loop analysis, and especially the way it embedded his commitment to dialectical view of nature, a methodological commitment that derived from his interpretation of the Hegelian-Marxist tradition. Two general conclusions can be drawn for the case study: first, once a commitment is formalized, it can be rejected, but not on the grounds of the motivations behind it. Second, the terms of success or failure of an agent to persuade her community to adopt her commitments as general standards could be divorced from the agent's own terms of success.

Knuuttila, Tarja and Andrea Loettgers (University of Vienna): ***Transdisciplinary Model Templates: The Many Applications of the Sherrington-Kirkpatrick Model***

We discuss the notion of a model template, consisting of its mathematical structure, ontology, prototypical properties and behaviors, focal conceptualizations, and the paradigmatic questions it addresses. We use the Sherrington-Kirkpatrick model of spin glasses to exemplify model templates. This model is itself a descendant of another powerful model template: the Ising model of ferromagnetism. We argue that what appears to be an interdisciplinary model transfer between different domains, turns out, from a broader perspective, to be the application of transdisciplinary model templates across a multitude of domains. Apart from its applications across different disciplines, such as statistical physics, computer science, neural networks, and financial economics, the Sherrington-Kirkpatrick model has also been employed as a powerful optimization method. The Sherrington-Kirkpatrick model formalizes the phenomenon of disorder resulting from competing interactions between magnetic moments in spin glasses. The competition among magnetic moments results in a highly structured energy landscape, consisting of a large number of local energy minima. This particular topology is the key to the diverse applications of the Sherrington-Kirkpatrick model template. We also point out a further feature of template-based modeling that so far has not been discussed: template entanglement. Over the time various network templates with different origins have become aligned, giving rise to a novel transdisciplinary research field devoted to the study of dynamical processes in complex networks.

Kuorikoski, Jaakko (University of Helsinki): ***Importing Computational Templates: Lessons from the Computational Social Epistemology of Science***

The use of simple simulation models to explore the social organization of science has quickly grown into a lively subfield of philosophy of science. This research program was really kickstarted with the importation of two simple computational templates from economics and ecology. I use the early reception of these two simulation models as a cautionary tale of model template transference into a field lacking proper methodological norms regulating the responsible use of such off-the-shelf templates. I hypothesize that the lessons learned from this case concerning model validation and robustness analysis generalize more broadly to responsible theoretical use of simple simulation models in general.

Lin, Chia-Hua (Fairfield University): ***Explaining the Success of Model Transfer Requires a Pluralist Approach***

Mathematical models originally developed to describe one type of complex natural behavior can sometimes successfully model other types of complex natural behaviors. This phenomenon, sometimes referred to as model transfer, has been explained through two major approaches: the school of thought that focuses on the empirical-formal mappings (e.g., Humphreys 2019; Bradley and Thébault 2019) and the school of thought that emphasizes

conceptual-explanatory aspects of scientific modeling (e.g., Knuuttila and Loettgers 2022; Rice 2021; Potochnik 2017). However, I argue that due to the attempt to provide a unitary justification, each view in these two schools has limitations, including the failure to offer a realistic account for, or neglecting the challenges in the practice of, model transfer. I use the example of applying game theory's Prisoner's Dilemma in mathematical oncology to illustrate these limitations. I will then propose an alternative account that integrates the adaptive and functional analysis aspects of model transfer, which I call "target profiling," and advocate a pluralist approach to justify model transfer.

Margoni, Emilia and Elena Castellani (Università degli Studi di Firenze): ***Cluster Transfer: The RG Case***

In the framework of the current debate on the nature and methodology of knowledge transfer processes, beside the key notions discussed in the literature (analogical reasoning, template, model template, ..), we propose here a new unit of analysis, which we call "cluster transfer", as the most appropriate to deal with cases of knowledge transfer as the one on which we focus here. This is the case of cross-fertilization between the research areas of high-energy and condensed matter physics in the application of renormalization group methods. We argue that a proper reconstruction of the renormalization group case requires a cluster transfer of concepts and tools, that is neither secured within a single field of inquiry, nor reducible to the parlance of explicit (empirical) *vs* implicit (formal) similarities within different fields of inquiry.

Morgan, Mary (London School of Economics and Political Science): ***What Travels in, or With, a Model?***

Do models embed ideas and concepts from their science, or are they rather thin and simple objects that appear context free, ready to be re-interpreted for different purposes in travelling to new homes? It is easy to suppose that the former travel with ‘baggage’ which might be incompatible with their new home, while the latter travel ‘lite’ and can be adapted easily. But this judgement is too neat. Thinness may hide that the new home may not be a compatible context, that thinness hides rather than reveals the model’s potential to address the questions in its new home, and that the specific model language may be inappropriate for the new problem. The problems of transfer of both fat and thin models may, perhaps, be overcome by being explicit about the issues of adapting a model to its new home. Does the scientist rethink the problem and its context to fit the incoming model, or adapt the model to fit its new home? This is perhaps the basic design question for modellers.

Mößner, Nicola (Leibniz University Hannover): ***On Being Connected - Ludwik Fleck and the Circulation of Ideas***

Ludwik Fleck is best known for his important epistemological work on social dynamics in science. He discusses the role of “thought collectives”, that is, groups of people clustering around a shared “thought style”. Contrary to Thomas Kuhn’s work on “paradigms” which is

focused on the scientific domain only, Fleck takes his theses to be of relevance in the everyday context, too. He argues that people of different social contexts are in constant exchange, that is, communication processes of various kinds play a crucial role in his theoretical approach. One potential consequence of such a "circulation of ideas" is the genesis of metaphors in science which, as he claims, can be the origin of new theories.

In my talk, I will present Fleck's theses on the development of metaphors and critically discuss them. Taking into account Fleck's claims about the gradual embedding of individuals in their communities and, thus, in different thought styles, it can be asked how much background knowledge and how much theoretical understanding has to be presupposed so that processes of metaphor-formation in Fleck's sense can (successfully) take place. Another interesting question concerns the applicability of Fleck's ideas to the development of models in science and beyond. Do these processes work in a similar way or are there crucial differences?

Noichl, Max (Utrecht University): ***On Modeling Model Transfer***

Due to their central role in interdisciplinary contacts, the transfer of models between disciplines has garnered considerable attention from philosophers of science. They have analyzed these connections through notions of templating, as discussed by Humphreys (2002, 2004, 2019) and Knuuttila & Loettgers (2007, 2014, 2016), with primary examples including the Lotka-Volterra, the Kuramoto, and the Ising model, among others.

Most of this research has been conducted through case studies which, because of their focused nature, struggle to provide a basis for claims about larger-scale relations among multiple, ever-expanding scientific disciplines (see Herfeld & Doehne 2019). In this contribution, we propose that philosophers of science use modern science mapping techniques along with methods borrowed from mathematical information retrieval to trace connections between modeling techniques across extensive parts of the scientific literature.

We explain how these techniques function and apply them to a large, contemporary, and multidisciplinary dataset (n=383,961 articles). We demonstrate how to find formulaic structures that are particularly likely to link different disciplines and develop a measure for the general strength and commonality of such relationships. Our findings suggest that in our sample, the widespread distribution of mathematical forms is the norm rather than the exception. We also offer some thoughts on the role of computational analysis in the philosophy of science and provide a perspective on how new techniques could help bridge the gap between traditional and computational methods.

Sergi, Francesco (University of Paris Est Créteil): ***Model Transfer in Macroeconomics: Policymaking Institutions, Multi-Country Models, and Computers***

The literature on the history of large-scale macroeconometric models developed at policymaking institutions emphasizes materiality (models as "artefacts", resulting from

"bricolage"; Halsmayer, 2017). Moreover, it also stresses "embeddedness", that is, every modelling choice (from the level of disaggregation, theoretical apparatus, empirical strategy, etc.) is context-specific to these institutions (e.g., Goutsmedt et al., 2023). Thus, transferring such artefacts from an institution to another seems a complex and perilous operation. And yet, this is what modellers following a decentralized approach to multi-country modelling do (Acosta et al., 2023). Our communication starts by outlining the intellectual and material obstacles to model transfer in the domain of multi-country modelling, relying on the case study of the Directorate General for Economic and Financial Affairs (DG II) of the European Commission (Rancan and Sergi, forthcoming). We document how intellectual obstacles to model transfer resulted mostly from the fact that European macroeconomists did not yet share the same representation of the economy. However, we show that, during the 1970s and the 1980s, material obstacles (most specifically, the difficulties related to the type of computer tools used) played a more crucial role in making model transfers possible (or impossible). This leads us to look at a second case study, documenting the role played by a specific computer tool (the "Dynare" package) in facilitating model transfer in macroeconomics from the early 1990s on (Cherrier et al., 2023). We document how the crafting of Dynare (itself a case of model transfer from engineering and computer science) addressed existing computational and material issues for the circulation of macroeconomic models across academia and policymaking institutions.

References:

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Rancan, A. and Sergi, F., forthcoming. Modelling Europe. A History of Multi-Country Models at the European Commission (1970-2005). London: Palgrave.

Stoll, Frauke (University of Bonn, TU Dortmund): ***Analogy- and Interaction-based Model Transfer in Physics – The Case of Black Hole Thermodynamics***

In contemporary science, model transfer across disciplines and within fields is common. I propose two forms of model transfer, analogy-based and interaction-based, illustrated through Black Hole Thermodynamics and distinguished by two central concepts: functionalism and interactionalism. Functionalism, focusing on the function of concepts rather than their characteristics, is a key tool in this context. It allows for describing systems where diverse underlying structures exhibit the same behaviour, making it applicable to various domains. This framework facilitates analogy-based model transfer, where the same model describes different phenomena with the same functional role. Interaction-based model transfer goes a step further, as phenomena not only share functional roles but also interact, leading to an identification of concepts and deeper understanding.
Functionalism and Interactionalism are crucial elements for distinguishing between these forms. By applying these perspectives, I establish a framework for understanding model transfer, exemplified by the analogy between thermodynamics and black hole mechanics. This approach aims to enhance our understanding of how idea exchange fuels scientific progress and theory expansion.

Tan, Peter (Fordham University): ***Generality vs. Analogy in Interdisciplinary Model Transfer***

Philosophers of science interested in the epistemology and methodology of interdisciplinary science have recently become interested in model and template transfer between scientific disciplines, i.e., the application of representational tools from one discipline into another. Existing discussions of interdisciplinary model transfer sometimes treat it as a subclass of analogy or analogical reasoning in science. This talk observes that there may be an epistemically significant difference between applications of model templates: those that are analogical and those that appeal to generality. After introducing some examples where such a difference might be observed, the talk then articulates why the distinction matters for the epistemology of model transfer, including its justification and its possible explanatory or noetic benefits.

Truc, Alexandre and Muriel Dal Pont Legrand (Côte-d'Azur University): ***Agent-Based Models: Impact and Interdisciplinary Influences in Economics***

It has become commonplace to consider that economists who use agent-based models (ABMs) have ultimately been responsible for the emergence of an innovative interdisciplinary approach known as ``agent-based computational economics''. In the present paper, we investigate the diffusion of agent-based models (ABMs) in economics using a quantitative approach to better understand how the emergence of this tool influenced the structure of economic research in recent years. Our analysis shows that the proliferation of ABMs has resulted in the emergence of diverse research subfields rather than one unified research program. Most notably, we highlight how interdisciplinarity plays a pivotal role in understanding the diversity of ways in which agent-based models are integrated into economics. While in some cases ABMs are used by economists as an imported tool to

address economics-oriented questions, in other cases ABMs are a vehicle for more interdisciplinary transfers (e.g., concepts) and interactions (e.g., interdisciplinary co-authorship) that are more challenging to the traditional frontiers of economics.