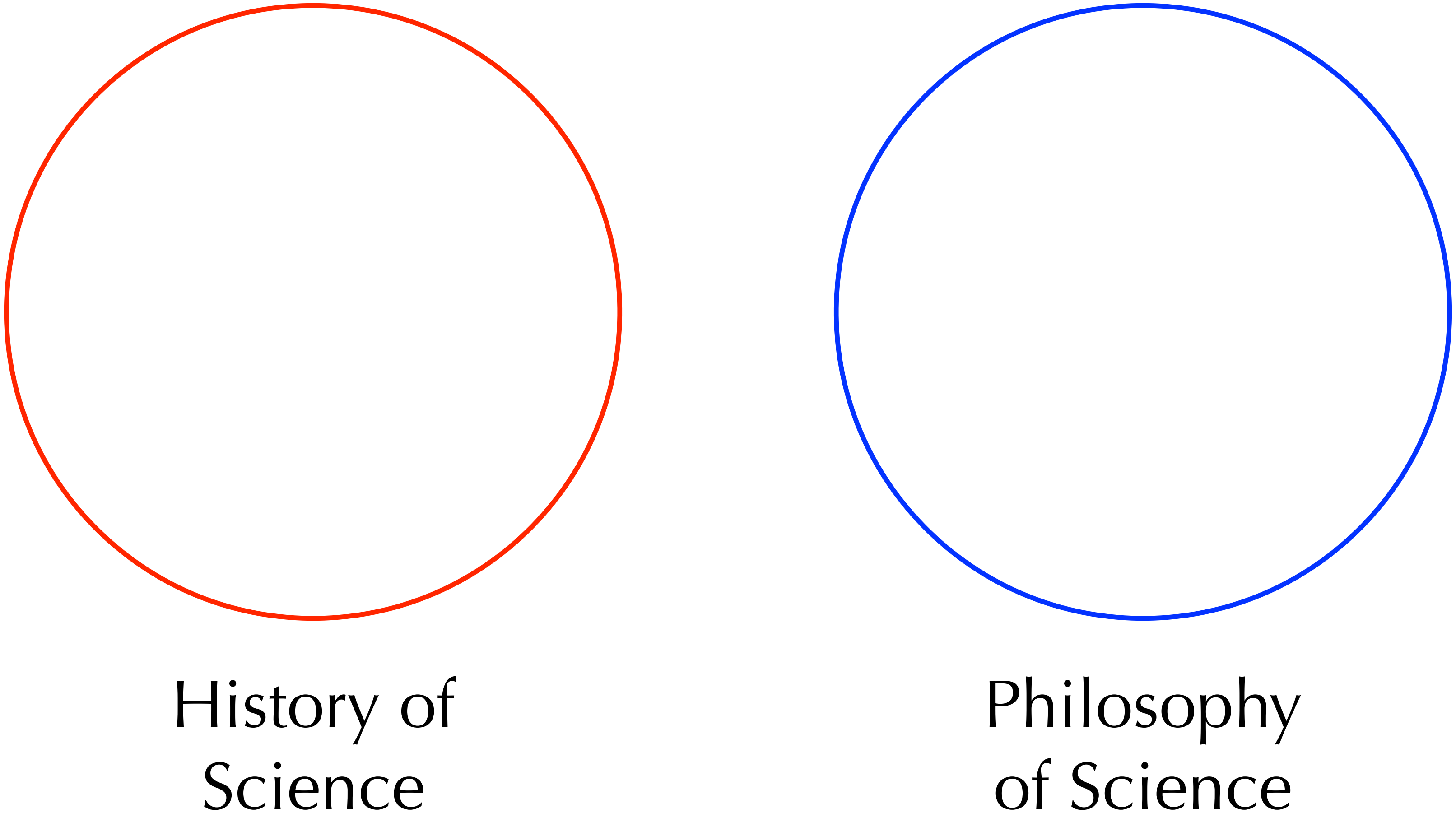
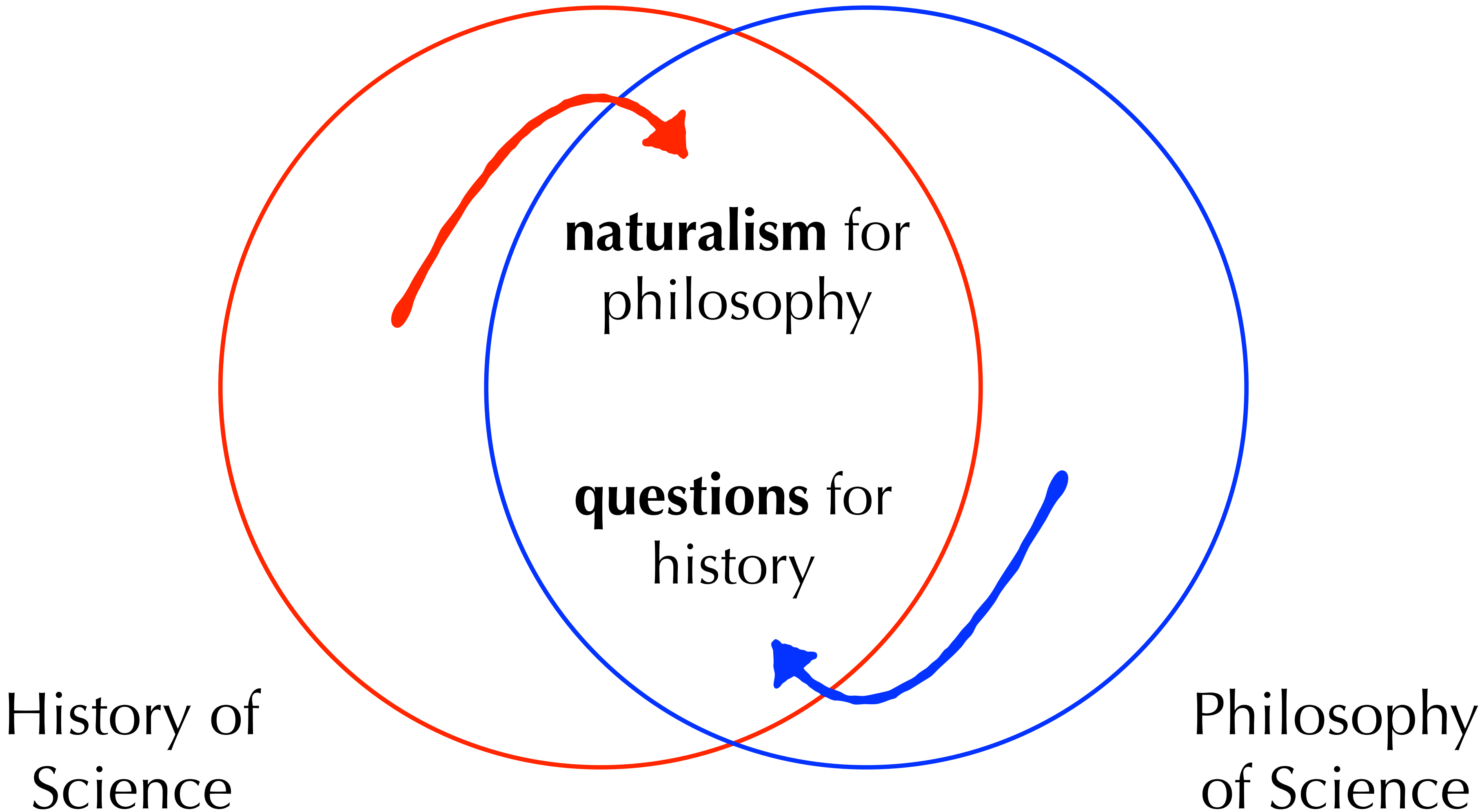
Confronting philosophical concepts with historical cases

Raphael Scholl (with Tim Räz)
Pittsburgh, November 4, 2014

Why integrated history and philosophy of science?


History of Science
Philosophy of Science

The fundamental argument for an integrated history and philosophy of science



The "fundamental" argument for an integrated history and philosophy of science

naturalism for philosophy

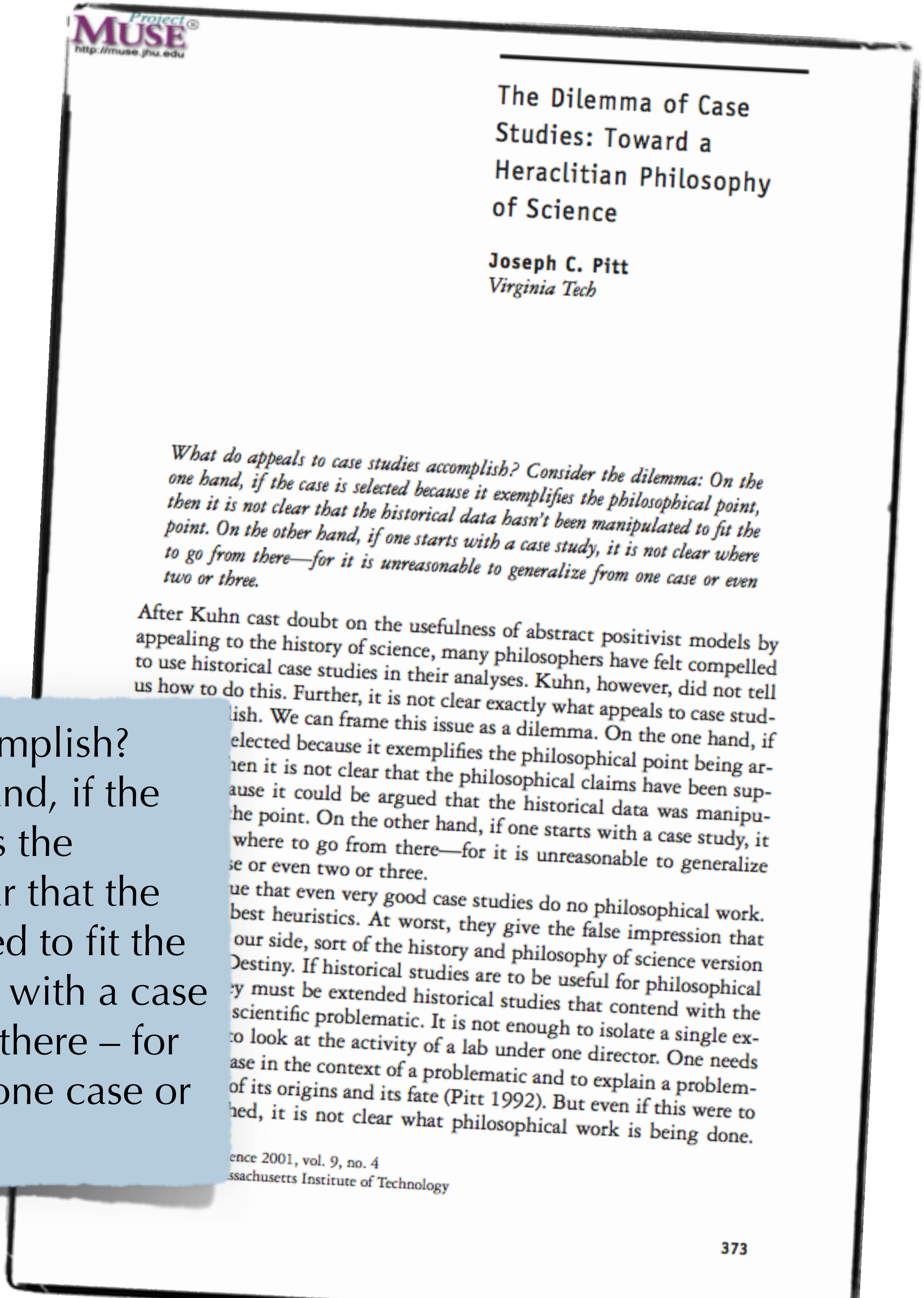
> Ronald Giere: "I came to the conclusion [in the 1980s] that the philosophy of science should be transformed into something like the theory of science. That is, philosophers should be in the business of constructing a theoretical account of how science works. Philosophical claims about science would then have the status of empirical theories." (Mauskopf & Schmaltz, 2011, Ch. 5)

questions for history

1. Historical sources are only as interesting as the questions we put to them…
2. …and the philosophy of science happens to be full of pertinent questions about the core epistemological concerns of science!

The Dilemma of Case Studies

What do appeals to case studies accomplish? Consider the dilemma: On the one hand, if the case is selected because it exemplifies the philosophical point, then it is not clear that the historical data hasn't been manipulated to fit the point. On the other hand, if one starts with a case study, it is not clear where to go from there – for it is unreasonable to generalize from one case or even two or three. (p. 373)



The Dilemma of Case Studies: Toward a Heraclitian Philosophy of Science

Joseph C. Pitt
Virginia Tech

What do appeals to case studies accomplish? Consider the dilemma: On the one hand, if the case is selected because it exemplifies the philosophical point, then it is not clear that the historical data hasn't been manipulated to fit the point. On the other hand, if one starts with a case study, it is not clear where to go from there—for it is unreasonable to generalize from one case or even two or three.

After Kuhn cast doubt on the usefulness of abstract positivist models by appealing to the history of science, many philosophers have felt compelled to use historical case studies in their analyses. Kuhn, however, did not tell us how to do this. Further, it is not clear exactly what appeals to case stud- ... ish. We can frame this issue as a dilemma. On the one hand, if ... elected because it exemplifies the philosophical point being ar- ... en it is not clear that the philosophical claims have been sup- ... ause it could be argued that the historical data was manipu- ... he point. On the other hand, if one starts with a case study, it ... where to go from there—for it is unreasonable to generalize ... e or even two or three.

... ue that even very good case studies do no philosophical work. ... best heuristics. At worst, they give the false impression that ... our side, sort of the history and philosophy of science version ... Destiny. If historical studies are to be useful for philosophical ... y must be extended historical studies that contend with the ... scientific problematic. It is not enough to isolate a single ex- ... o look at the activity of a lab under one director. One needs ... ase in the context of a problematic and to explain a problem- ... of its origins and its fate (Pitt 1992). But even if this were to ... hed, it is not clear what philosophical work is being done.

... ence 2001, vol. 9, no. 4
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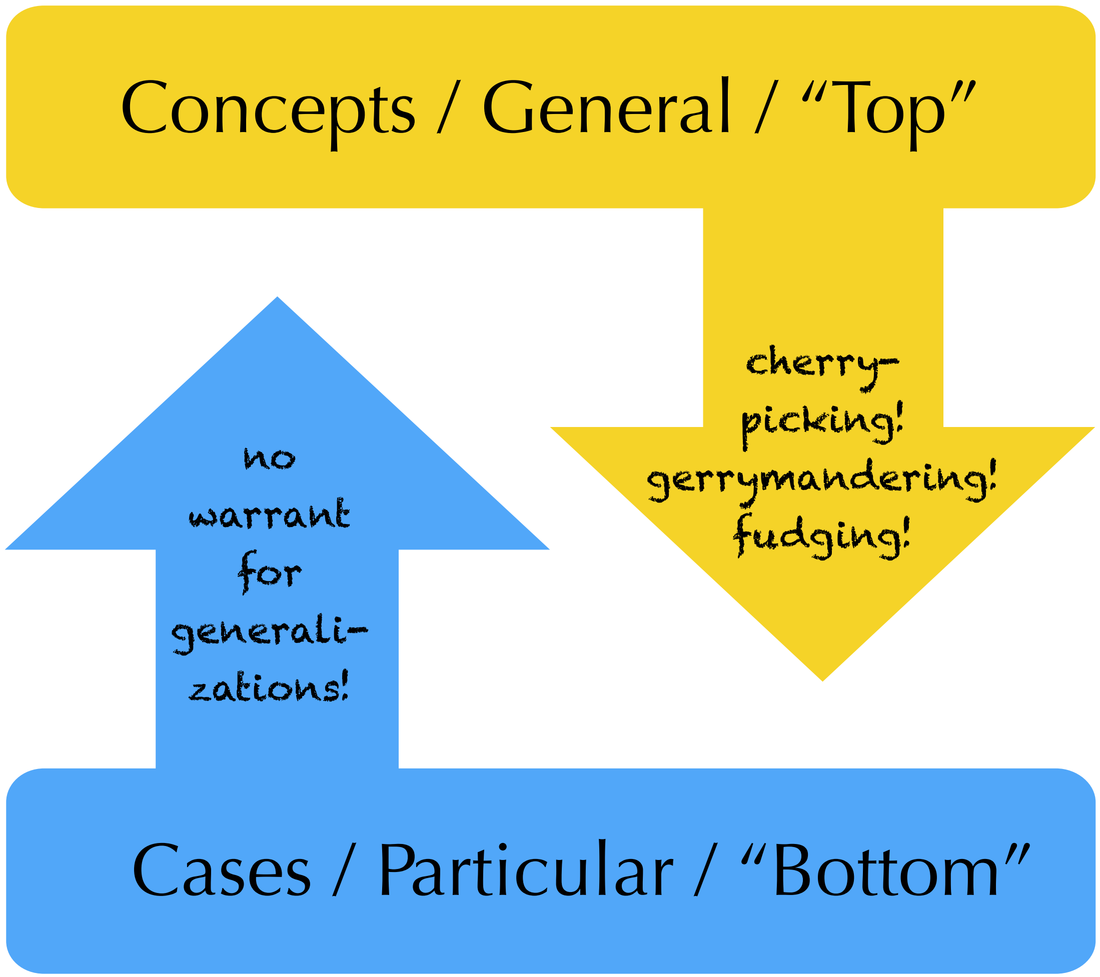
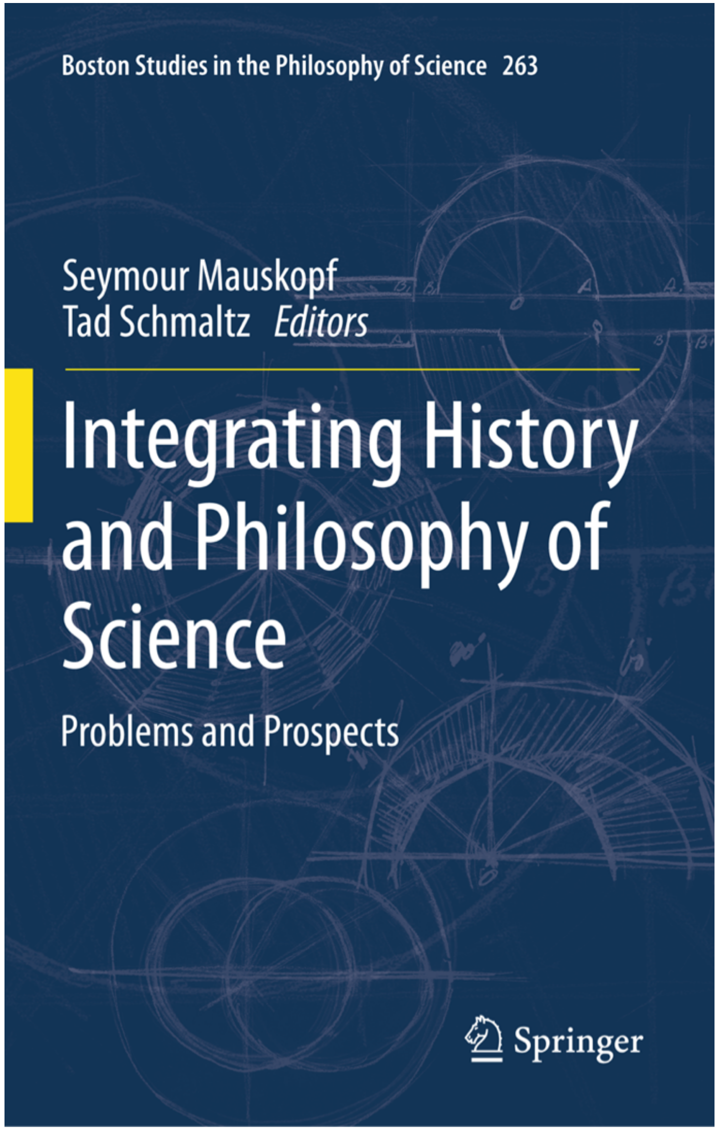
In-Principle Pointlessness



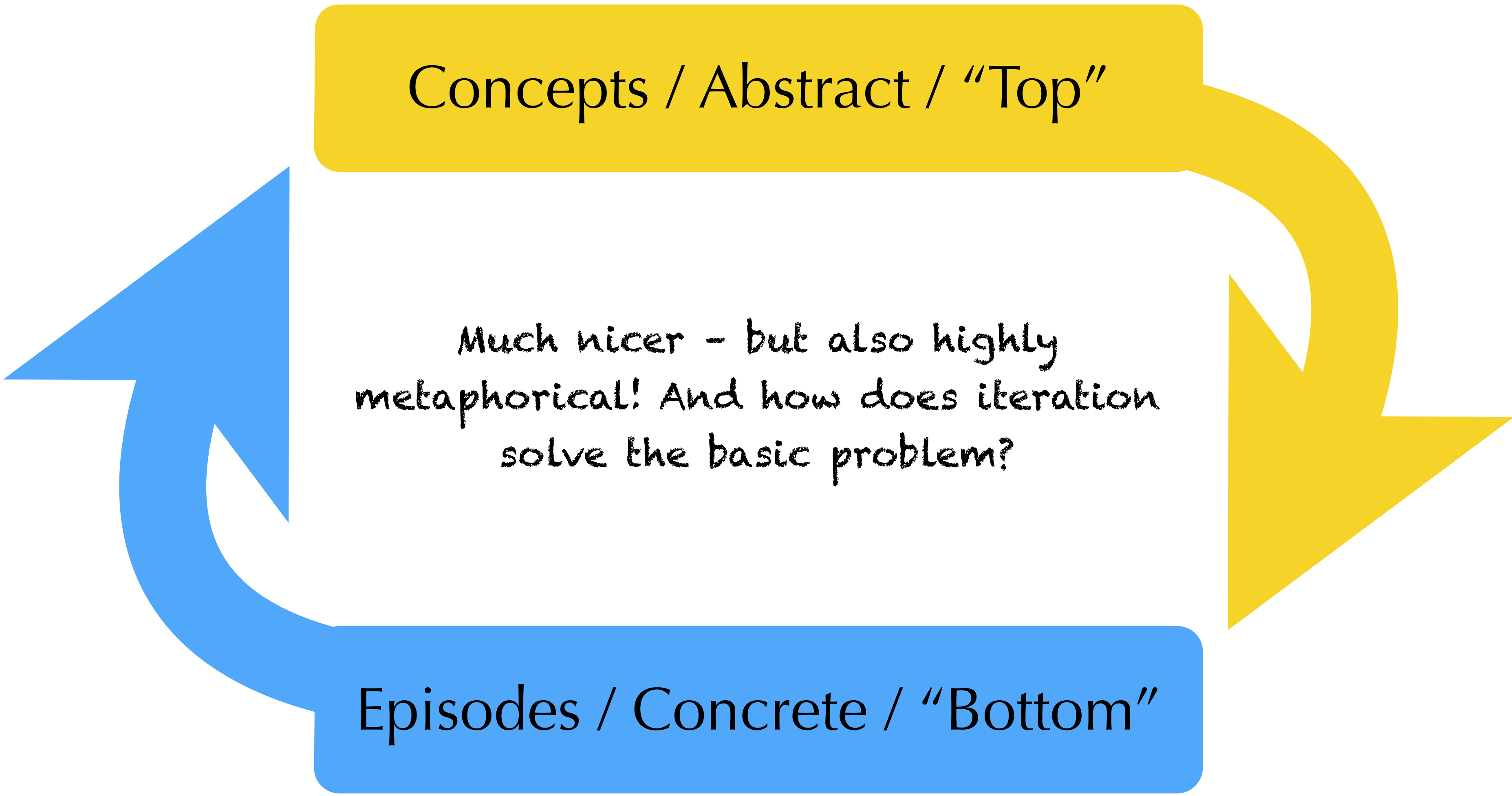
The Hasok Cha(ng)llenge



I prefer to speak of historical "episodes" rather than "cases". When we have an episode of *The Simpsons*, or *Buffy the Vampire Slayer*, or what have you, the episode is not really a case or an example of whatever the general idea of the show might be. Rather, the episode is a concrete instantiation of the general concepts (the characters, the setting, the type of events to be expected, etc.), and each episode also contributes to the articulation of the general concepts. To be sure, this analogy is very imperfect, but it does express something relevant about the relation between concrete historical episodes and abstract philosophical conceptions.

(Chang, 2011, pp. 110–111.)

The cyclical model of HPS



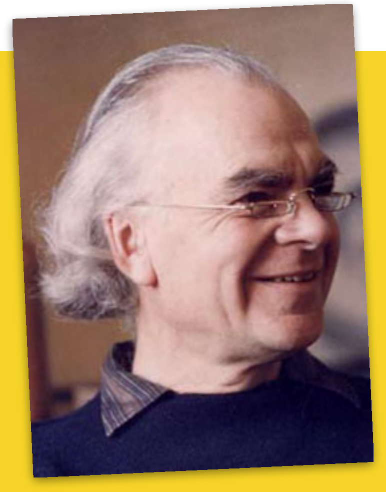
Selection of Cases

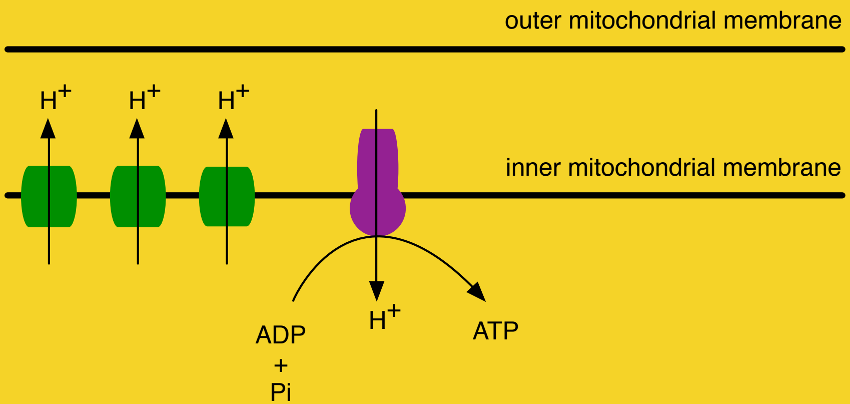
Selection of Hard Cases

Instead of illustrating a philosophical thesis particularly well, hard cases *challenge* the thesis.

If you've built a self-driving car, send it into the complex traffic of Beijing rather than the more easily manageable traffic of Zurich.

Scholl and Nickelsen have tested the power of strategies for hypothesis generation using the case of Peter Mitchell's chemiosmotic mechanism of oxidative phosphorylation. It has long been considered particularly original and counterintuitive. More cautious and merely extrapolative hypotheses *could not play this role*.





> Not since Darwin and Wallace has biology come up with an idea as counterintuitive as those of, say, Einstein, Heisenberg and Schrödinger.

(Leslie Orgel, 1999)

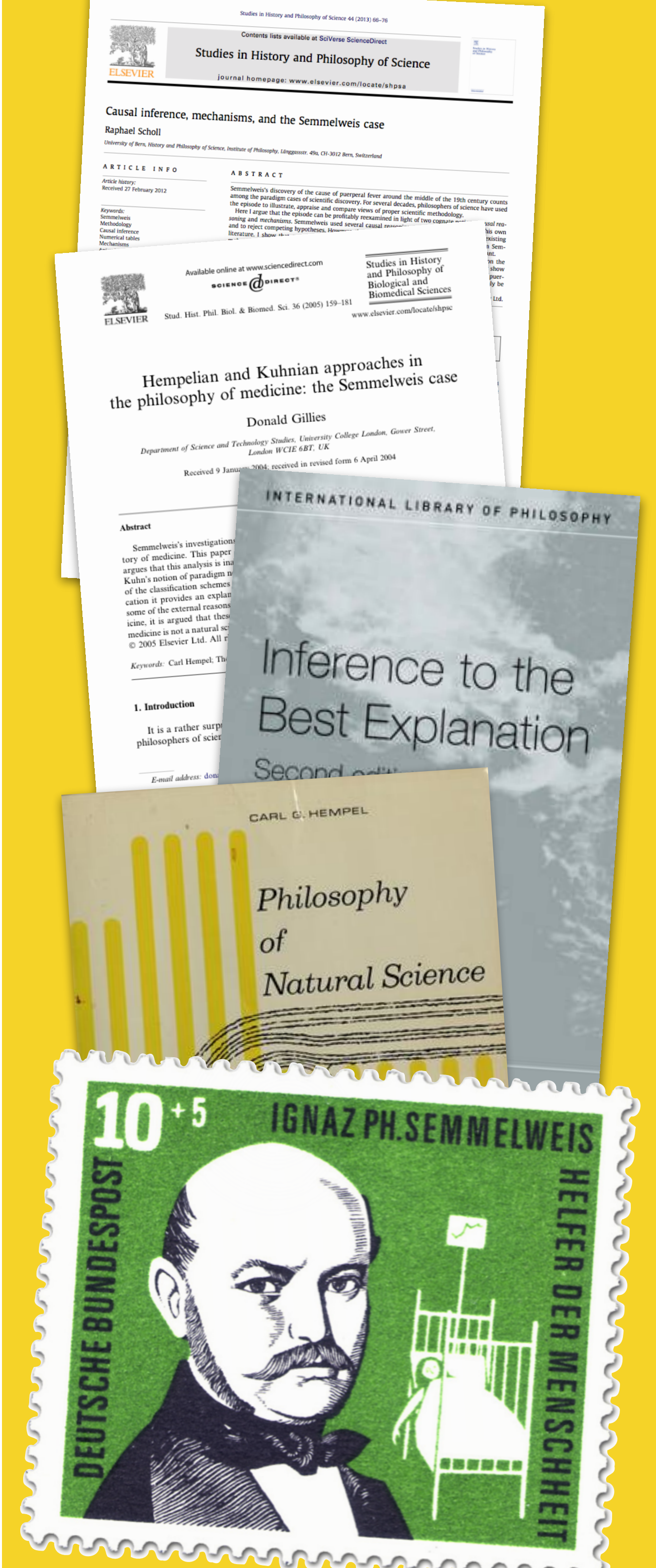
Selection of Paradigm Cases

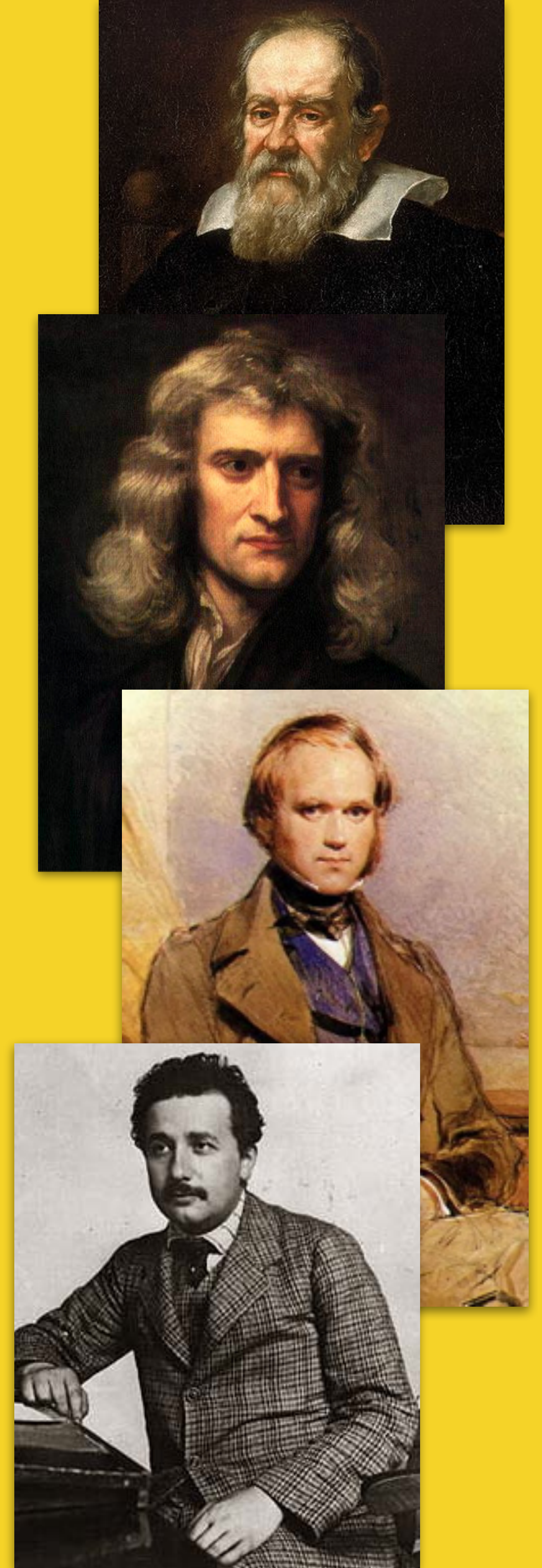
Some cases come to be seen as typical of particular aspects of science: they are the model organisms of HPS.

For instance, a long tradition from Hempel to Lipton to Gillies to Bird keeps returning to Ignaz Semmelweis to illustrate and test philosophical theses about confirmation.

Paradigm cases are already accepted as in some way typical and so are efficient tools for making new points and for revising existing concepts.

Whether a case deserves to be a paradigm case is open to debate. And the generalizability of finding about the paradigm case is an empirical questions.





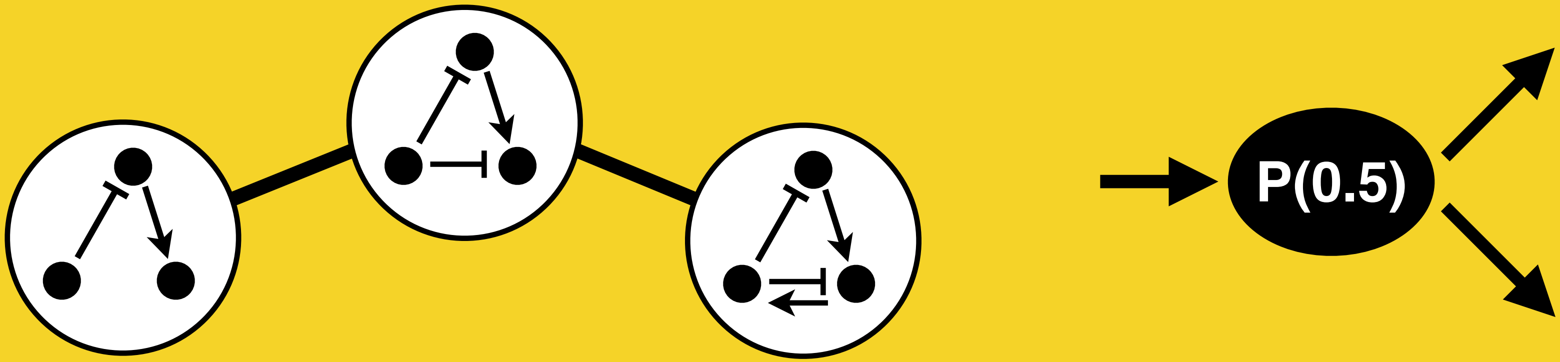
Selection of Big Cases

“Bigness” comes in many forms: a case may be a role model for further work; it may be the foundation of a large branch of modern science; it may concern a particularly fundamental insight.

Unlike paradigm cases, there is no reason to expect that big cases will generalize particularly well.

Similarly, not all big cases are “hard” in the sense discussed here – “hardness” will depend on the philosophical thesis under investigation.

So long as we keep these limitations in mind, selection bias is probably not a primary concern: Learning about big episodes is inherently fascinating.

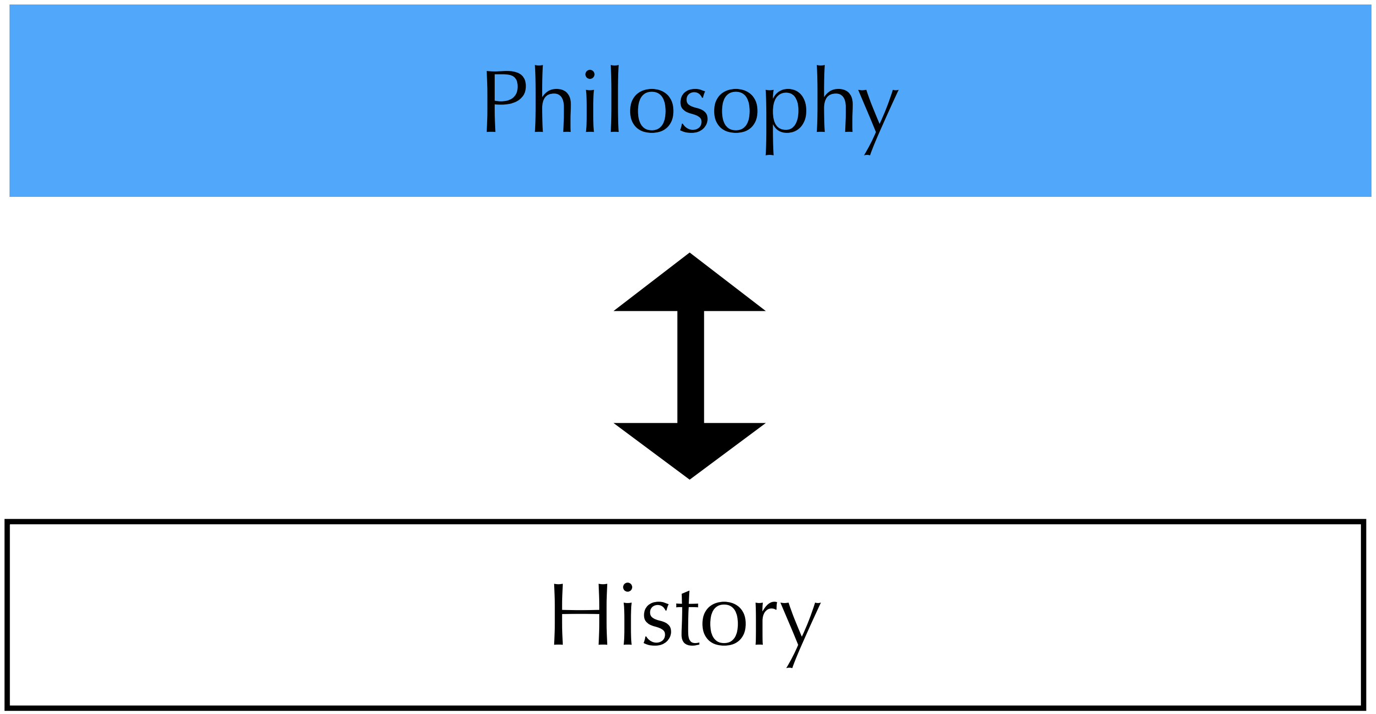


Exploration and Randomization

Exploratory cases are used as tools for developing concepts: Sometimes we're not out to test existing philosophical concepts, but to develop new ones on the basis of instructive cases.

Randomization is a well known procedure for avoiding selection bias. We may be able to transfer this to HPS by creating databases of historical episodes –and this would even give renewed unity to a discipline (lately) dominated by local studies.

Dynamics of Confrontation



The monolithic view invites two sins:

- The ∀ sin: Take single cases as sufficient confirmation of philosophical accounts.
- The ∃ sin: Reject philosophical accounts wholesale on the basis of single counterexamples.

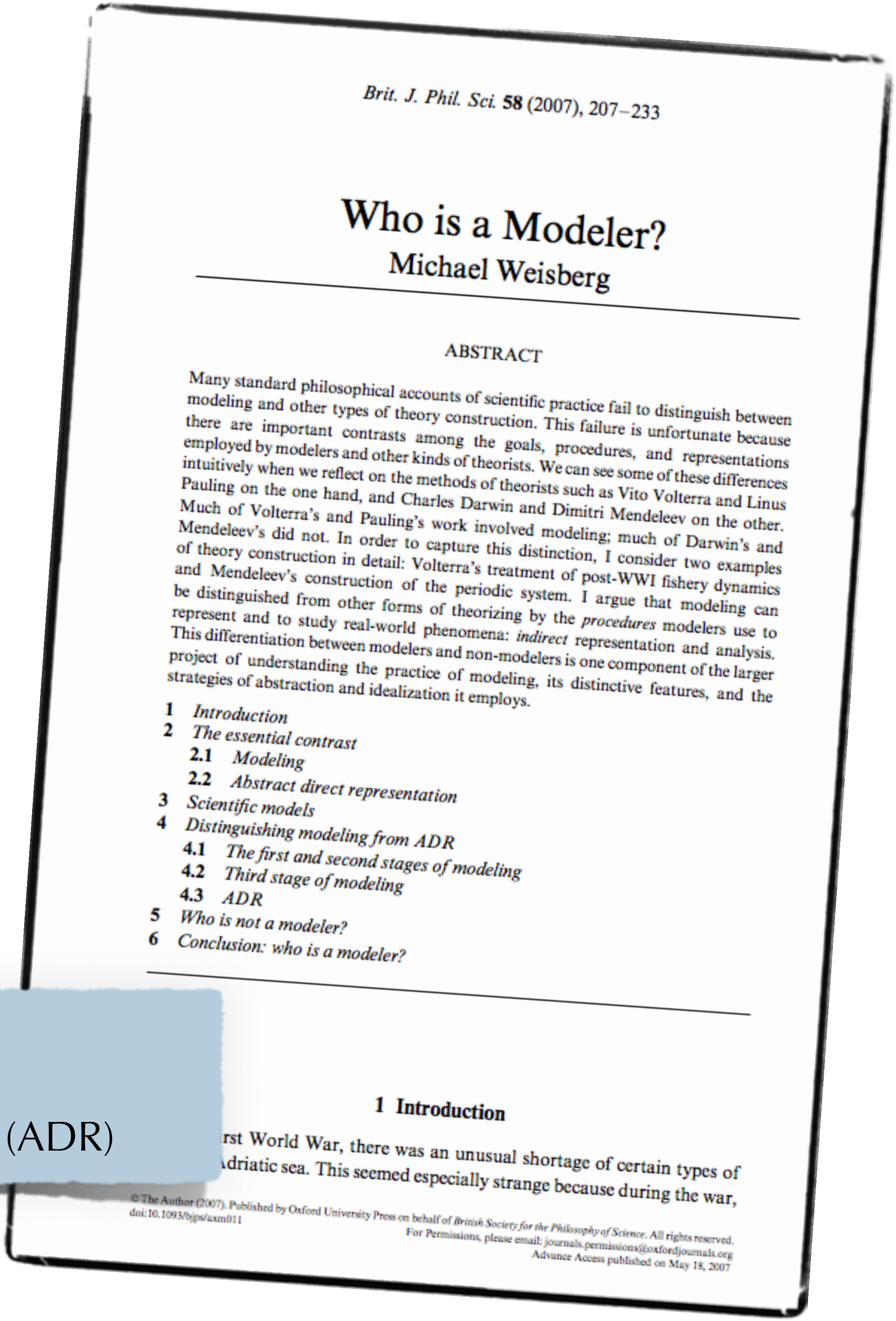
Brit. J. Phil. Sci. **58** (2007), 207–233

Who is a Modeler?

Michael Weisberg

ABSTRACT

Many standard philosophical accounts of scientific practice fail to distinguish between modeling and other types of theory construction. This failure is unfortunate because there are important contrasts among the goals, procedures, and representations employed by modelers and other kinds of theorists. We can see some of these differences intuitively when we reflect on the methods of theorists such as Vito Volterra and Linus Pauling on the one hand, and Charles Darwin and Dimitri Mendeleev on the other. Much of Volterra's and Pauling's work involved modeling; much of Darwin's and Mendeleev's did not. In order to capture this distinction, I consider two examples of theory construction in detail: Volterra's treatment of post-WWI fishery dynamics and Mendeleev's construction of the periodic system. I argue that modeling can be distinguished from other forms of theorizing by the *procedures* modelers use to represent and to study real-world phenomena: *indirect* representation and analysis. This differentiation between modelers and non-modelers is one component of the larger project of understanding the practice of modeling, its distinctive features, and the strategies of abstraction and idealization it employs.



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1 Introduction

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driatic sea. This seemed especially strange because during the war,

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Advance Access published on May 18, 2007

2. The essential contrast
- 2.1. Modeling
- 2.2. Abstract direct representation (ADR)

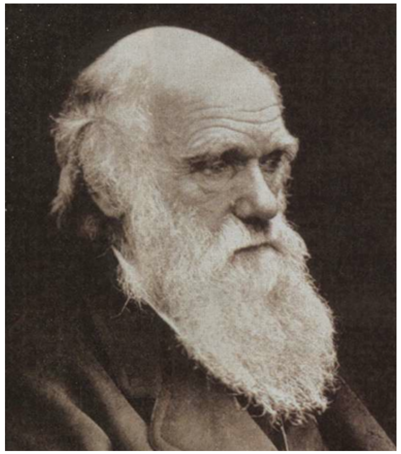
The theory-reality relationship

The theory-reality relationship

Modeling

ADR

Volterra on population dynamics



Darwin on coral atolls

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ORIGINAL PAPER IN PHILOSOPHY OF SCIENCE

Modeling causal structures

Volterra's struggle and Darwin's success

Raphael Scholl · Tim Räz

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Abstract The Lotka–Volterra predator-prey-model is a widely known example of model-based science. Here we reexamine Vito Volterra's and Umberto D'Ancona's original publications on the model, and in particular their methodological reflections. On this basis we develop several ideas pertaining to the philosophical debate on the scientific practice of modeling. First, we show that Volterra and D'Ancona chose modeling because the problem in hand could not be approached by more direct methods such as causal inference. This suggests a philosophically insightful motivation for choosing the strategy of modeling. Second, we show that the development of the model follows a trajectory from a "how possibly" to a "how actually" model. We discuss how and to what extent Volterra and D'Ancona were able to advance their model along that trajectory. It turns out they were unable to establish that their model was fully applicable to any system. Third, we consider another instance of model-based science: Darwin's model of the origin and distribution of coral atolls in the Pacific Ocean. Darwin argued more successfully that his model faithfully represents the causal structure of the target system, and hence that it is a "how actually" model.

Keywords Modeling · Causal inference · Volterra · Predator-prey-model · Darwin · Coral atolls

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1 Introduction

After the first World War, there was an unusual shortage of certain types of fish in the Adriatic sea. This seemed especially strange because during the war,

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ACTUALITÉS SCIENTIFIQUES ET INDUSTRIELLES

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EXPOSÉS DE BIOMÉTRIE ET DE STATISTIQUE BIOLOGIQUE

Publiés sous la direction de
GEORGES TEISSIER
Sous-directeur de la Station Biologique de ROSCOFF

V

LES ASSOCIATIONS BIOLOGIQUES
AU POINT DE VUE MATHÉMATIQUE

PAR

M. VITO VOLTERRA et M. UMBERTO D'ANCONA

PARIS
HERMANN ET Cie, ÉDITEURS
6, Rue de la Sorbonne, 6
1935

methodological reflections

CHAPITRE PREMIER

~~CONSIDÉRATIONS GÉNÉRALES~~

1. L'importance qu'ont dans le monde animal et végétal les rapports entre espèces différentes a été relevée pour la première fois par Charles Darwin, lorsque, voulant expliquer comment se conservent les variations utiles, le père du transformisme essaya de démontrer qu'à la ressemblance de la sélection opérée par les éleveurs parmi les animaux domestiques, il se produit une *sélection naturelle*, fondée sur la *lutte pour l'existence*. Par ce terme il convient de comprendre soit l'ensemble des réactions que les organismes manifestent contre l'action des forces physiques du milieu, soit ce que nous appelons plus proprement la *concurrence vitale* et qui consiste en une compétition entre individus de la même espèce ou d'espèces différentes dans le but de conquérir les ressources indispensables à leur subsistance.

La notion d'*association biologique* ou de *biocœnose* fut introduite plus tard par Mœbius, qui, en étudiant les bancs d'huîtres du Schleswig-Holstein, fut frappé par l'importance qu'avaient les échanges de nutrition entre les organismes d'espèces différentes vivant ensemble sur les mêmes bancs. Ce fut aussi Mœbius qui reconnut comment ces rapports mutuels entre espèces différentes ont pour effet l'établissement d'un état d'équilibre qu'aujourd'hui on désigne communément par le terme d'*équilibre biologique* ou *biocœnotique*.

L'étude des rapports interspécifiques, de l'économie des associations et des états d'équilibre dont l'établissement (dans ces mêmes associations) est le résultat de ces rapports, constitue actuellement tout un chapitre important de l'*œcologie animale*. Dans le domaine de la zoologie l'importance de ces rapports interspécifiques est bien connue, et c'est pourquoi il nous paraît inutile de citer des exemples qu'on trouvera exposés, avec tous les détails, dans les œuvres consacrées expressément à ce sujet.

Le phénomène des équilibres interspécifiques, ainsi que les variations auxquelles ces équilibres sont sujets, ont été aussi suffisamment étudiés sous leur aspect qualitatif. On en connaît même les effets pratiques, soit dans le domaine de l'entomologie agricole, où l'on applique sur une vaste échelle la méthode de la *lutte biologique*, fondée précisément sur l'utilisation d'insectes qui sont les parasites d'autres insectes, nuisibles aux plantes, soit dans le domaine de l'épidémiologie où on a reconnu, particulièrement pour certaines maladies d'origine parasitique, l'existence d'équilibres semblables, soit encore dans le domaine de la biologie des poissons comestibles, au sujet desquels on a pu constater des fluctuations plus ou moins périodiques.

2. La connaissance qualitative de ces phénomènes devait naturellement conduire à l'idée de les étudier du point de vue quantitatif. L'emploi en biologie des méthodes propres aux sciences exactes s'étend chaque jour davantage et, depuis assez longtemps, certaines branches particulières de la biologie, et notamment la physiologie, ont largement eu recours aux méthodes quantitatives qui ont conduit aux applications mathématiques.

Mais dans le domaine de l'œcologie ces méthodes n'ont été jusqu'à présent que fort peu appliquées et cela s'explique, si l'on songe que les phénomènes biologiques ne sauraient devenir l'objet d'une étude quantitative qu'après avoir été isolés des causes extrinsèques susceptibles d'agir sur leur cours et d'en troubler les résultats. Or, si cet isolement est réalisable lorsque, par exemple, le physiologiste soumet à des expériences de laboratoire un animal isolé et placé dans les conditions requises, la même chose ne peut aussi aisément s'effectuer quand on étudie les rapports interspécifiques, tels qu'ils se déroulent spontanément dans leur milieu naturel et où se trouvent engagés non pas des individus isolés, mais des populations plus ou moins nombreuses.

3. Cependant on peut aussi concevoir l'application de la méthode expérimentale à l'étude quantitative des rapports interspécifiques. Il ne serait pas impossible, en effet, de réaliser — au moyen d'élevages — une association expérimentale sur laquelle il serait loisible d'essayer l'application de la méthode quantitative.

What would be the preferred method?

"[In] the domain of ecology, these [quantitative] methods have rarely been applied up to the present, and this is explained upon consideration by the fact that biological phenomena will only become the object of quantitative study after having been isolated from external causes which are liable to influence their course and to confound the results."

The prime example of the method: the laboratory physiologist, who can isolate organisms in controlled environments.

How to experiment with populations?

Il est vrai qu'à l'exécution un tel type d'expérience se heurterait à des difficultés très réelles. Qu'on songe seulement que, pour obtenir dans une semblable expérience des rapports comparables à ceux qui s'établissent dans la nature, il faudrait prendre pour champ d'action un milieu relativement vaste, en proportion à la taille des animaux soumis à l'examen, il faudrait encore obtenir dans cette expérience une uniformité relative des conditions du milieu (température, humidité, composition chimique, teneur des substances toxiques, etc.) afin que des facteurs extrinsèques ne viennent pas fausser la marche de l'expérience même. Ces considérations font conclure à la nécessité d'effectuer l'expérience dont il est question sur des organismes relativement petits.

Une autre difficulté surgit de ce qu'il est nécessaire que l'expérience se poursuive sur plusieurs générations successives et que, par conséquent, sa durée soit relativement longue.

On ne s'étonnera donc pas que, quoique l'on ait des résultats d'observations qualitatives complètement acquises depuis longtemps, nous ne possédons jusqu'à ce jour, que bien peu d'exemples de rapports interspécifiques ayant été soumis, par voie d'expérience, à un examen quantitatif. Il faut remarquer que les recherches systématiques à cet égard ne font que commencer.

4. Une autre méthode d'étude quantitative appliquée aux rapports interspécifiques, consiste dans le traitement statistique des phénomènes, ayant trait à la concurrence vitale telle qu'elle se développe librement au sein de la nature. Bien entendu, ces recherches statistiques ne pourront s'effectuer qu'à l'égard d'espèces ayant une importance économique car pour les autres il est peu probable qu'on se soit donné la peine de les dénombrer. Ainsi nous disposerons de chiffres concernant les animaux utiles de la mer ou bien les animaux à fourrure et quelques autres catégories, peu nombreuses, du même genre.

Il va de soi que les rapports interspécifiques se développant librement dans leur milieu naturel subiront aussi l'influence des facteurs qui ne seront pas toujours constants. En raison de quoi les effets perturbateurs de facteurs extrinsèques se glisseront dans les données de l'étude statistique et les résultats de cette dernière ne seront qu'approximatifs : ce n'est qu'en continuant les recherches sur une longue série d'années, qu'on pourra compenser les erreurs et aboutir à des nombres toujours plus exacts.

"a relatively vast environment"

"relative uniformity of conditions (temperature, humidity, chemical composition, content of toxins)"

"relatively small organisms"

"a relatively long duration"

How to overcome this lack of epistemic access?

Toutes les considérations qu'on vient d'exposer nous montrent à quel point l'étude quantitative, par voie d'observation et d'expérience, des associations biologiques est chose ardue. Mais ces difficultés ne doivent point nous décourager, ni nous empêcher de poursuivre ce genre de recherches. Chaque fois que la science s'aventure dans un domaine encore peu exploré elle voit se dresser des obstacles considérables.

5. D'ailleurs s'il apparaît trop difficile d'effectuer l'étude quantitative par voie d'expérience et d'obtenir ainsi les lois qui règlent les rapports interspécifiques dans les associations biologiques, on pourra tenter de découvrir ces mêmes lois par voie déductive et de voir ensuite si elles comportent des résultats applicables aux cas que présente l'observation ou l'expérience. Sans doute faut-il procéder dans cette voie avec une extrême prudence car, du point de vue mathématique, on ne peut que construire une série de théorèmes qui, tout en étant parfaits dans leur déduction, pourraient être fondés sur des présuppositions hypothétiques qui s'éloignent trop de la réalité. Pour éviter ce danger il faut prendre pour point de départ des prémisses appuyées le plus possible sur l'expérience ; et il faut encore qu'au cours du développement de la théorie, les résultats, chaque fois obtenus, soient confrontés avec les indications de l'expérience pour vérifier leur conformité ou du moins leur vraisemblance.

D'autre part, il ne faut pas trop se préoccuper si on envisage des éléments idéaux et l'on se place dans des conditions idéales qui ne sont pas tout à fait ni les éléments ni les conditions naturelles. C'est une nécessité et il suffit de rappeler les applications des mathématiques à la mécanique et à la physique qui ont amené à des résultats si importants et si utiles même pratiquement. Dans la mécanique rationnelle et dans la physique mathématique on envisage en effet les surfaces sans frottement, les fils absolument flexibles et inextensibles, les gaz parfaits, etc.

L'exemple de ces sciences est un grand exemple que nous devons avoir toujours présent à l'esprit et que nous devons tâcher de suivre.

On peut procéder en effet de même dans l'étude des associations biologiques en ne les considérant que sous des formes idéales typiques.

6. Dans l'étude mathématique du problème des associations

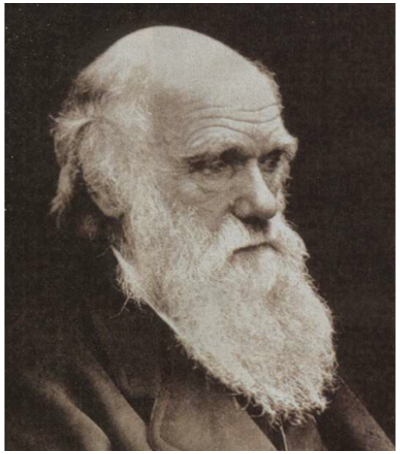
"Since it appears too difficult to carry through quantitative studies by experiments and thus to obtain the laws that regulate interspecific relationships, one could try to discover these same laws by means of deduction, and to see afterwards whether they entail results that are applicable to the cases presented by observation or experiment."

The theory-reality relationship

Modeling

Volterra on population dynamics

ADR



Darwin on coral atolls

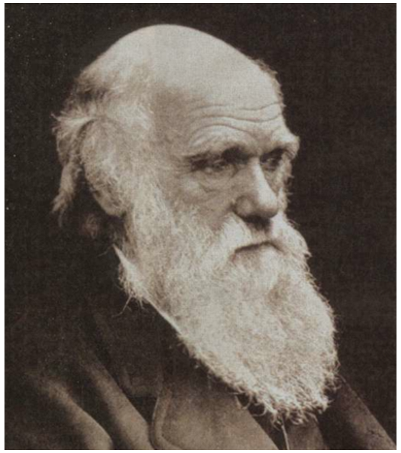
The theory-reality relationship

Modeling

ADR

Causal inference

Volterra on population dynamics



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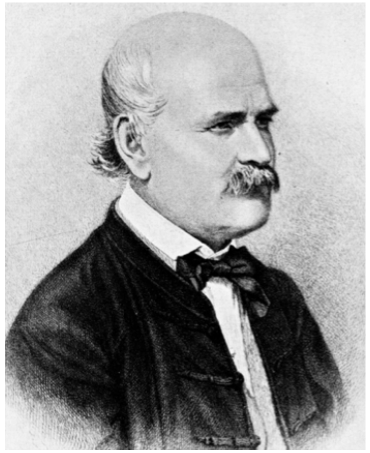
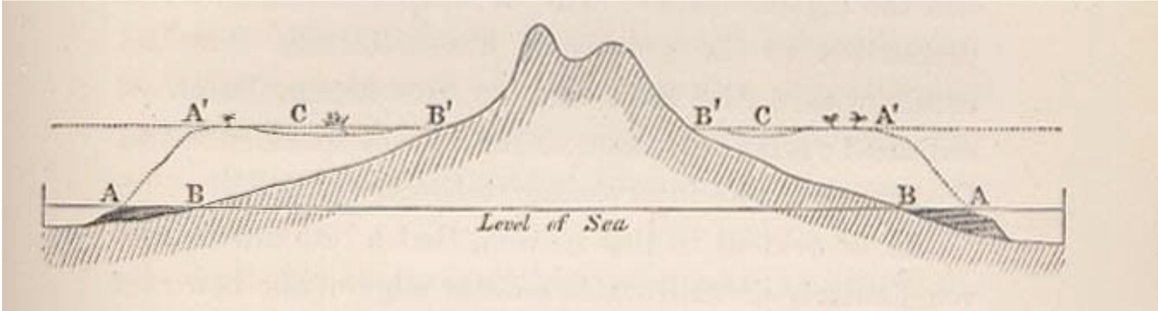
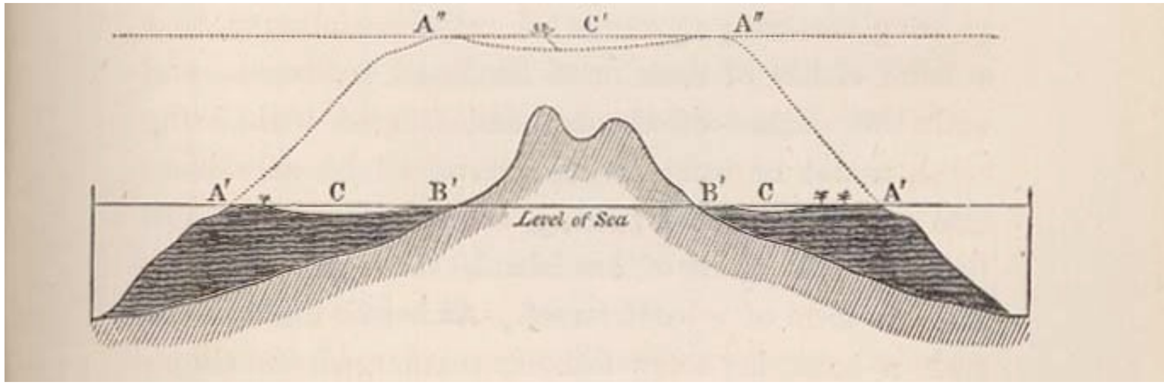
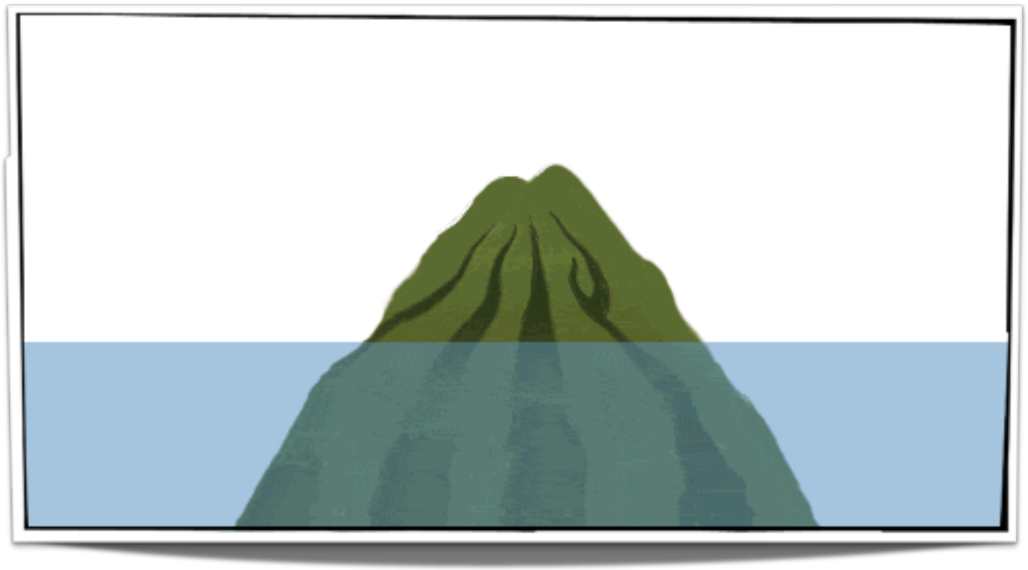


Semmelweis on puerperal fever

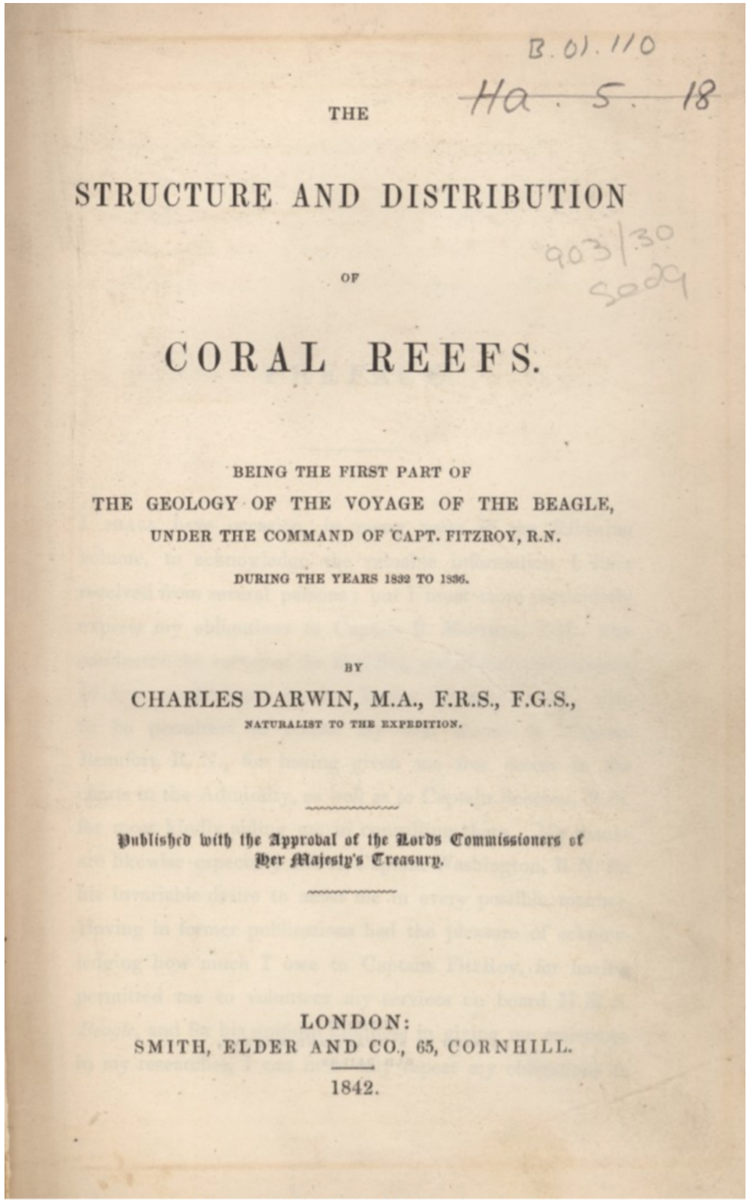




Darwin, C. R. 1842. *The structure and distribution of coral reefs.* London: Smith Elder and Co.



Darwin is a modeller!


THE

STRUCTURE AND DISTRIBUTION

OF

CORAL REEFS.

BEING THE FIRST PART OF
THE GEOLOGY OF THE VOYAGE OF THE BEAGLE,
UNDER THE COMMAND OF CAPT. FITZROY, R.N.
DURING THE YEARS 1832 TO 1836.

BY

CHARLES DARWIN, M.A., F.R.S., F.G.S.,
NATURALIST TO THE EXPEDITION.

Published with the Approval of the Lords Commissioners of Her Majesty's Treasury.

LONDON:
SMITH, ELDER AND CO., 65, CORNHILL.

1842.

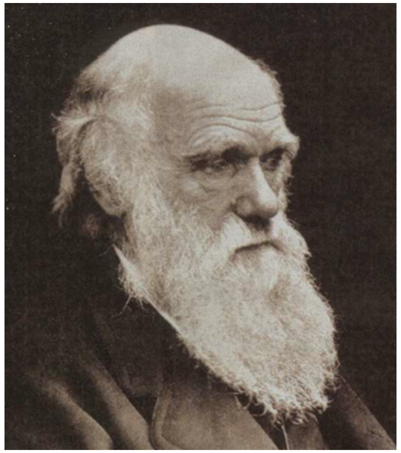
Let us in imagination place within one of the subsiding areas, an island surrounded by a 'fringing reef,' – that kind, which alone offers no difficulty in the explanation of its origin. … Now, as the island sinks down, either a few feet at a time or quite insensibly, we may safely infer from what we know of the conditions favourable to the growth of corals, that the living masses bathed by the surf on the margin of the reef, will soon regain the surface. The water, however, will encroach, little by little, on the shore, the island becoming lower and smaller and the space between the edge of the reef and the beach proportionally broader. … Let the island continue subsiding, and the coral-reef will continue growing up on its own foundation, whilst the water gains inch by inch on the land, until the last and highest pinnacle is covered, and there remains a perfect atoll.

(Darwin, 1842, pp. 99–101.)

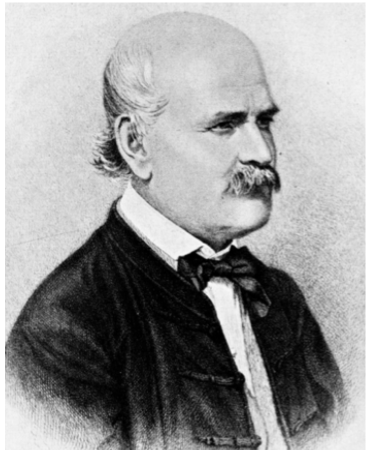
The theory-reality relationship

Modeling | ADR | Causal inference

Volterra on population dynamics



Darwin on coral atolls

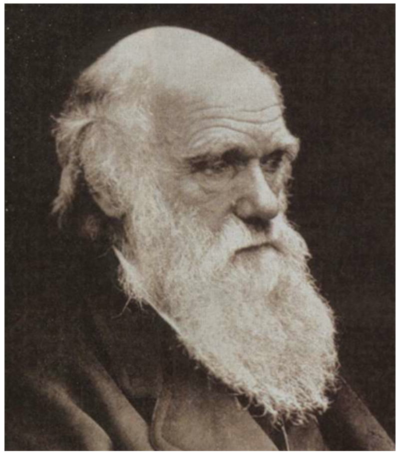


Semmelweis on puerperal fever

The theory-reality relationship

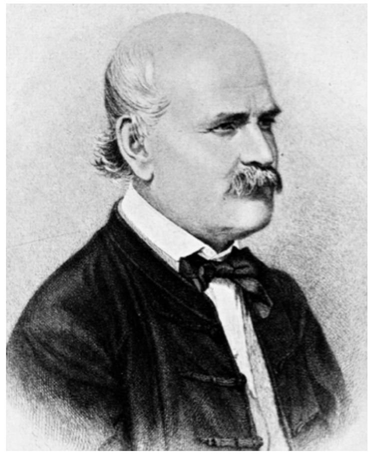
- Modeling
- ~~ADR~~
- Causal inference

Volterra on population dynamics



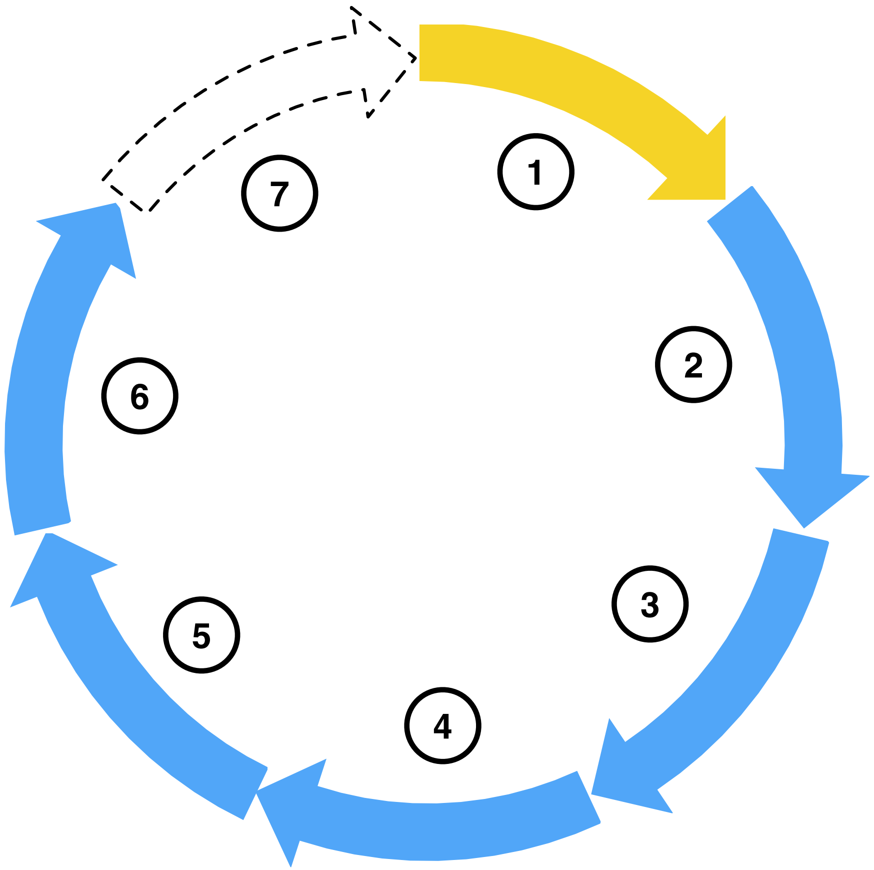
Darwin on coral atolls

~~Mendeleev on the periodic table~~



Semmelweis on puerperal fever

Beyond the ∀ and ∃ sins: Cyclical HPS in action



1. Choice of Volterra as a **paradigm case** of model-based science
2. **Agreement**: Modeling as a category fits the case
3. **Conflict**: Sources suggest "ADR" is not a good contrast for modeling
4. **Incompleteness**: Introduce causal inference as a better contrast
5. **Range of applicability**: Reassign Darwin to modeling category
6. **Redundancy**: "ADR" loses Mendeleev, becomes redundant
7. Further exploration using additional cases

Although grand theories about the nature of science are currently out of fashion, I think we need to rehabilitate them. We need to construct theories about science the way that scientists construct theories about fluids, gene flow and continental drift. To construct such theories, we need data, and our only source of data is the study of science, past and present. (p. 473)

Agreed, but: Our "grand theories" will probably look less like theoretical physics than overlapping models in economics...

Testing Philosophical Claims about Science[1]

David Hull

Northwestern University

...e of evidence in testing statements both *within* science and ...inations are possible. Logical empiricists such as Hempel ...e plays a crucial role in the sort of testing that goes on in sci...sions of science, logical empiricists also include occasional ...nce, both current and past, but these examples function only ...ts that they are making about science, not as tests. A com...hers of science, and not just logical empiricists, is that no ...what scientists actually do and the sorts of claims that ...cience. Even if no scientist ever explained anything by de...re, the covering-law model of scientific explanation would ...ion is deduction, and nothing about the conduct of science ...to these philosophers, evidence may play a crucial role in ...that scientists make about the natural world but no role ...rt of meta-level claims that philosophers of science make ...about science. Such philosophical claims must be supported in some other way.

According to one prevalent reading, Kuhn (1962) advocates the opposite position with respect to the role of evidence in science and the study of science respectively. To the extent that evidence plays any role whatsoever in scientists choosing between different paradigms, it is never decisive. However, Kuhn urges a greater role for the history of science in the choice between different philosophies of science. Incommensurability between scientific theories precludes a decisive role for evidence with respect to theory choice within science, but the even greater incommensurability that characterizes different philosophies of science somehow does not preclude a decisive role for the history of science as evidence in choosing between these meta-level theories.

Some of Kuhn's social constructivist disciples have carried his position to even more extreme lengths. As Collins (1981a, p. 218) sees it, advocates of the radical program in the sociology of knowledge, "must treat the natural world as though it in no way constrains what is believed to be." However, sociologists of science should "treat the social world as real, and as something about which we can have sound data" (Collins 1981a, p. 217). Other social constructivists have pursued what they take to be Kuhn's views to their logical conclusion—total relativism. Evidence plays no role

PSA 1992, Volume 2, pp. 468-475

Conclusions

Chapter 8

Beyond Case-Studies: History as Philosophy

Hasok Chang

8.1 The Trouble with Case-Studies, and the Active Philosophical Function of History

What can we conclude from a mere handful of case-studies? This has been a vexing question for integrated history and philosophy of science (HPS). The field of HPS has witnessed too many hasty philosophical generalizations based on a small number of conveniently chosen case-studies. This was seen as detrimental to philosophy and history both. On the philosophical side, case-studies may end up as empty gestures parading as evidence confirming one's pre-existing biases about the nature of science and its methods. At best what we get is "grand conclusions by induction from absurdly small samples", in Richard Burian's words (2001, 388). The deeper problem, as Joseph Pitt (2001, 374) put it, is that "if philosophers wish to use historical cases to bolster their positions, then . . . we will have to figure out how to relate the history to the philosophical point without begging the question." On the historical side, even philosophically sympathetic histo
of the oversimplifications that philosophers were apt to make of c
cal material through the case-study approach. John Hedley Brook
typical and apt (1981, 257): "When the circumstances and the pr
complex, the isolation of a single philosophical or methodological
to an adequate explanation must lead to a distortion of emphasis."
neglect to clarify the nature of the history–philosophy relationshi
has contributed decisively to a widespread disillusionment with
enterprise.

Emblematic of this disillusionment is Thomas Kuhn. He had a p
reaction against Imre Lakatos's explicit treatment of history as te
philosophical theories of scientific method, with his predilection for
structions of history. Against Lakatos's dictum (1971, 91) that "history of science without philosophy of science is blind", Kuhn retorted (1971, 143): "What Lakatos

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S. Mauskopf, T. Schmaltz (eds.), *Integrating History and Philosophy of Science*, Boston Studies in the Philosophy of Science 263, DOI 10.1007/978-94-007-1745-9_8,

> I believe that the neglect to clarify the nature of the history–philosophy relationship in case-studies has contributed decisively to a widespread disillusionment with the whole HPS enterprise.

(Chang, 2011, p. 109)

The “fundamental” argument –
questions for history and naturalism for philosophy

Selection of case studies

- hard cases
- paradigm cases
- big cases
- exploratory cases
- randomized cases

Dynamics of confrontation

- agreement
- conflict
- ranges of applicability
- incompleteness and redundancy