Evidence
Lecture 5 (8. Jun 2022)
To Confirm Frameworks and Methods

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Contents

This lecture covers: Curiel (2021)

1 Admin Crap

1. REMEMBER TO RECORD THE LECTURE!
2. ongoing poor health: how to handle missed lectures, and possibility of more
3. next week zoom
4. I still need to update the schedule of lectures and readings to reflect delay caused by the missed lecture

2 The Orthodoxy on Confirmation of Frameworks

Frameworks—roughly, architectonic theoretical systems within which scientific systems can be formulated, tested and confirmed—cannot themselves be confirmed. They are not the sort of thing one can have evidence for.

Or so orthodoxy holds. Consider:

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Carnap all propositional reasoning of any epistemically principled sort occurs within the context of some framework or other; thus, one cannot reason about frameworks in an epistemically principled way; one can rather only propose heuristic arguments that adduce pragmatic considerations such as fruitfulness, simplicity, tractability, and so on, in order to motivate one's choice of one framework over another. If one can speak of (epistemically principled) "evidence" in favor of a framework, one can do so in only a Pickwickian sense, or perhaps as a sarcasm. (See Carnap 1956 for a canonical statement.)

Quine his pseudo-Duhemian holism holds that, ultimately, one cannot carve up bodies of belief and knowledge into separate domains, at least one of which is independent of and in a relevant sense prior to the others, in an epistemically principled way; in his inimitably glib aphoristic way (Quine 1980, p. 41), "[O]ur statements about the external world face the tribunal of sense experience not individually but only as a corporate body." That corporate body is not itself subject to further evidence, one way or another.[1]

Kuhn it's all messy, irrational bullshit at the level of frameworks ("paradigms"), and you just have to convince the rest of your socio-scientific commuity that your framework is right and those of your competitors wrong, in any way you can do so (including, but not limited to, "Yo mama" insults, grievous bodily harm, blackmail, brainwashing, direct stimulation of the brain's pleasure centers, free season tickets to FC Bayern, . . .). Nothing remotely like evidence in an epistemically principled way exists—grab what you can and devil take the hindmost. (See Kuhn 1996, chs. IX-X for a canonical statement.)

Lakatos, Laudan and Friedman Lakatos (1980), Laudan (1977) and Friedman (2001) each in his own interesting way develops views of scientific reasoning and theory construction and defense that attempt to address the problems left us by Carnap, Quine and Kuhn, with regard to the possibility of confirmatory evidence for frameworks.

3 Outline

1. For our purposes, in order to connect this week's reading with those of the previous 3 lectures, the most important point is that Newton's account of light and color is most naturally conceived of as a framework in the sense of Curiel (2021).

2. A theory formulable in that framework, then, would be, *e.g.*, some version of the wave-theory of light.

3. Two examples of Newtonian abduction in this context (Curiel 2021) would then be, first, a general one:[2]

$$\text{Newton's framework (metaphysics \& ontology of Account)} \Rightarrow \\ \text{(N's experiments} \Leftrightarrow \text{N's Account)} \tag{3.1}$$

1. You may have noticed that my claims here differ from those I made in Curiel (2021, footnote 1, p. 3814); I gave my reasons for my change of heart in the delivered lecture, which you can listen to the audio recording of, in the course's Dropbox folder.

2. See the course notes for Lecture 4 for a description of the metaphysics and ontology of Newton's framework, and of Newton's Account.

In this case, the Newtonian abduction does not single out a single, completely determinate theory, as in the case of the derivation of Newton’s Law of Universal Gravitation, but rather determines a family of possible theories, ruling out all those, *e.g.*, that do not have the capacity to represent and appropriately reason about what Newton called simple, homogeneal rays of light. The remaining possible theories include, *e.g.*, particle theories of the type Hooke championed, and wave theories of the type Huygens did. In this case, therefore, tha Newtonian abduction yields, if one likes, a sub-framework of the original framework.

The second example, a more specific one:

$$\text{N's Account} \Rightarrow (\text{diffraction} \Leftrightarrow \text{Young/Fresnel-type transverse-wave theories}) \tag{3.2}$$

In this case, the framework is Newton’s entire Account, and the Newtonian abduction, based on the empirical phenomenon of diffraction, yields an even smaller, more determinate sub-framework, in this case, the family of all those transverse-wave theories consistent with the constraints that Young’s and Fresnel’s accounts imposed.

4 Frameworks, Theories, Newtonian Abduction

The following consists of an expanded set of slides I used to present this material in a talk I gave a few years ago.

Outline

Frameworks

Newtonian Abduction

Examples

Framework Confirmation

What is a framework?

It's just this thing, ya know?

a little more precisely. . .

a system:

1. allowing formulation of propositions about kinds of physical system ("theories")
2. so as to support various kinds of reasoning about those systems (description, prediction, characterization, explanation, . . .)
3. which conduce to principled confirmation thereof (rules for possible evidence gathered in principled ways, for principled application to acceptability of propositions, . . .)

the (verbose) slogan

a *theory* is about a particular kind of physical system (viscous fluid; elastic solid; pendulum; self-gravitating collection of point-particles; Maxwell field; . . .)

a *framework* provides the conceptual and mathematical resources for formulating, using and confirming theories

framework: architectonic

abstract model

formal equation or relation, *e.g.*, Newton's Second Law:

$$\vec{\boldsymbol{F}}(t,\,\boldsymbol{\xi}) = \mathbf{m}\vec{\boldsymbol{a}}$$

- $\vec{\boldsymbol{F}}$ a second-order variable, quantified over all possible predicates representing all possible forms of force laws
- $\boldsymbol{\xi}$ also, quantified over collections of variables representing physical quantities accruing to systems (position, velocity, pressure, viscosity, electric current, ...)
- $\mathbf{m}\vec{\boldsymbol{a}}$ also, quantified over all forms of "inertial mass" and "acceleration" (appropriately generalized)

framework: applications

generic model

specification of form of abstract equations, *e.g.*, particular equation of motion for particular kind of physical system:

$$F(t, \vec{x}) = G \frac{m_1 m_2}{r^2(t, \vec{x})}$$

individual model

representation of state and dynamical evolution of individual system, *e.g.*, planetary orbit with definite values for masses—a dynamical path on space of states, a solution of generic model for fixed initial data

concrete model

a collection of experimentally or observationally gathered results analyzed, structured and interpreted in such a way as to allow identification with an individual model (also *structured data*)

and yet a little more precisely...

a framework: everything needed to transform an abstract model into generic and individual ones, guide the construction of concrete models, and facilitate their identification with individual ones:

- abstract model
- constraints on abstract model (Newton's First and Third Laws)
- additional mathematical structure, relations and formulæ ($\vec{v} =_{\mathsf{df}} \dot{\vec{x}}$; additivity of mass; affine structure on Newtonian spacetime; ...)
- family of accepted experimental techniques
- standards of good argumentation (accepted approximative techniques, heuristics for informal arguments, ...);
- rules for connecting experimental outcomes with formal propositions (semantics, pragmatics, representation)
- rules of evidential warrant (what can be evidence, how to apply it, reckoning error tolerance, ...)
- guidelines for judging legitimacy of proposed extensions of all these

Frameworks

Newtonian Abduction

Examples

Framework Confirmation

Original and Canonical Example

Newton's derivation of universal gravity

1. Second Law (Book i)
2. mathematical derivations:
   - 2.1 area law ⇔ central force (Props. i.1, i.2)
   - 2.2 orbital shapes, periods ⇔ acceleration $\propto \frac{1}{r^2}$ (Props. i.3, i.4 Cors. 6–7)
   - 2.3 orbital precession ⇔ acceleration deviates from $\frac{1}{r^2}$ (Prop. i.45 "precession theorem")
3. experimentally observed orbital properties ⇔ $\frac{1}{r^2}$ (book iii)
4. Third Law (book iii)

Ergo, universal gravity

logical form

$$\text{FW} \Rightarrow (\text{concrete model} \Leftrightarrow \text{generic model})$$

(Carnapian conditional definition!)

comparison

abduction

abstract model + observed, concrete evolutions $\Rightarrow$ generic equations of motion

(abs mod $\Rightarrow$ (conc evol $\Leftrightarrow$ gen eoms))

induction

observed, concrete evolutions + universal generalization $\Rightarrow$ generic eoms

deduction

generic equations of motion + concrete initial data $\Rightarrow$ future (past) dynamical evolution

Frameworks

Newtonian Abduction

Examples

Framework Confirmation

Lagrangian Mechanics...

as exemplar *nonpareil*

action principle/Euler-Lagrange equation (abstract model)

+ concrete dynamical evolutions identifiable with paths in tangent bundle (concrete models)

$\Rightarrow$ generic equations of motion for type of system

ELE $\Rightarrow$ (paths $\Leftrightarrow$ gen eoms)

concrete examples

general relativity
: FLRW, Schwarzschild from Einstein Field Equation and observed symmetries; inference to dark energy and dark matter, and so standard ΛCDM model in cosmology, from galactic velocity dispersion, large-scale acceleration

quantum mechanics
: form of Hamiltonian from Schrödinger equation plus phase portrait (same in Hamiltonian mechanics)

quantum field theory
: form of Lagrangian from observed symmetries of, constraints on phenomena

statistical mechanics
: form of Maxwell-Boltzmann distribution from defining abstract equations of statistical quantities and constraints imposed by empirically observed properties of the phenomena of thermodynamical equilibrium

Standard Form of Confirmation

1. theory + aux hypotheses + initial conditions $\Rightarrow$ prediction
2. verify prediction
3. apply quantitative measure of degree of confirmation

not wrong—but misses form of reasoning at least as important

Newtonian abduction

shows framework capable of accounting for phenomena by providing generic form of equations of motion/forces from which specific predictions can be derived; this *grounds* the standard form of confirmation

(logical form of Newtonian abduction entails H-D proposition)

- One of the most important differences between this sort of HD reasoning and Newtonian abduction is that the concrete model plays no role in the HD reasoning itself.
- It rather comes into play only after the reasoning is complete, in the attempt to identify the deduced individual model with a concrete model in order to test the prediction.
- The reason for this is simple: a theory, in conjunction with initial data, can at most entail an individual model; it cannot entail structured data derived from an actual experiment.
- In Newtonian abduction, to the contrary, the identification of a concrete model with an individual model forms an essential part of the reasoning itself that results in the theory.
- This is possible because one has already the concrete model in hand, as one does not in HD.

structural confirmation

Such a derivation does not so much substantiate the resulting model as being the most correct one among a field of competitors.

It rather demonstrates, *eo ipso*, that *the derived equations have the structure appropriate and adequate for modeling the concrete dynamical evolutions of the system, and nothing more*—because the structure of the derived generic equations of motion is directly determined, biconditionally, by the structure manifest in those dynamical evolutions (the concrete models, identified with the individual models).

appropriate the framework's structures allow one to identify in the relevant sense individual models of a theory in the framework with concrete models of physical systems in the genus treated by the theory

adequate one can use that identification to engage in substantive, successful scientific reasoning about those physical systems, and, moreover, one has good reason to believe that such identifications can be carried out for a much broader range of relevantly similar systems than the ones already treated

This is a far stronger and more substantial form of confirmation than that provided by merely deducing predictions and matching them against observations.

brief aside about realism, and that sort of thing

- the identification of individual with concrete models neither presupposes nor implies any substantive isomorphism between the two
- there are many ways one can legitimately conclude that an individual model in a theory can be identified with a concrete model constructed from experimental results
- one can agree with the idea of structural confirmation while remaining agnostic about all issues pertaining to realism and anti-realism, as any good confirmatory relation should allow

deduction

equations of motion adequate for modeling systems of that type

induction

equations of motion possibly appropriate for modeling systems of that type

abduction

structure of framework indubitably appropriate for modeling systems of that type, and very likely adequate for modeling other systems beyond that narrow type

theory-mediated agreeing measurements (Harper, Smith)

theory $\Rightarrow$ (parameter value $\Leftrightarrow$ concrete model)

the logical structure of the argument is the same; it provides confirmatory support for the framework itself, for that is the only thing the representations of the different phenomena, treated by different theories, measuring the parameters have in common (*e.g.*, ΛCDM standard cosmological model)

subjunctive conditionals

Newtonian abduction supports subjunctive conditionals in a way H-D doesn't:

- "if phenomena had been different, laws would have been thus": set principled bounds on how far wrong derived laws can appear to be, and still be within margin of error (precession theorem)
- NOT: "if laws had been different, phenomena would have been thus": shows nothing of epistemic import

- as remarked above, concrete models play no role in the logic of HD
- HD predicts an individual model
- concrete models come into play only after the logical derivation of the individual model, in the attempt to identify the deduced individual model with a concrete model, to test the HD prediction
- this is why Newtonian abduction automatically shows the theory to be appropriate and adequate for treating the phenomena that yielded the concrete model in a way that HD can never do, since the concrete model itself forms an essential part of the reasoning
- since the identification of individual model with concrete model occurs in HD only after the reasoning has concluded (if it is possible at all), there can be no such necessary conclusion about the propriety of the theory in treating the phenomena

Non-Contrastive

doesn't need confirmation by being stronger than rivals, and no worry about "unconceived alternatives": one has shown it does everything one could possibly ask of a framework; asking more would be to demand the supererogatory

In sum, Newtonian abduction is a form of reasoning that indubitably shows that a theoretical apparatus can be applied to empirical data in such a way as to produce, in the context of the apparatus, representations of the relevant systems that are of necessity predictively accurate; those representations, moreover, are automatically fruitful in the sense that they are instantly ready to apply to the attempted representation of further systems one has reason to believe are of the same genus. The systematic production of successful theoretical representations of the nature and behavior of physical systems, however, is the most fundamental and most important form of confirmation, whatever form that production may take.

I am *not* claiming

a physical theory has strong confirmation only in so far as one can cast it in Lagrangian form, or only in so far as there is a biconditional between its equations of motion and a collection of experimentally described evolutions

confirmation as understanding

"Understanding" is something like "the capacity to operate successfully in the scientific enterprise, in all its aspects and parts":

- to use our representations and instruments as the basis for the fruitful continuation of the enterprise
- and as part of evidential warrant in testing
- and as basis for predictions and characterizations
- and as inspiration for potentially fruitful new investigations
- and as the grounds for conceptual clarification and innovation in foundational work
- and perhaps most of all to grasp how our representations and our instruments relate to, inform, and substantively contribute to the constitution of each other, and to grasp that in such a way as to ground their use in the succesful continuation of the enterprise

- Much of my discussion of confirmation implicitly rejects an idea that seems to be popular today: that confirmation must be conceived of as giving a reason to think the thing confirmed is true.
- I, however, do not see why one needs to be a realist in order to talk about and accept the idea (and practice) of confirmation.
- For me, if one can show that a theoretical structure in conjunction with methodological and epistemological principles, appropriately applied, all conduce, in ineliminable ways, to success in the scientific enterprise, then one has *eo ipso* endowed them with some measure of confirmatory support.

A piece of reasoning that succeeds in applying theoretical apparatus, based on empirical evidence, to the fruitful representation of the world in a way that gives one warrant to accept the theoretical apparatus and continue to use it *eo ipso* provides the apparatus with confirmatory support. That is what confirmation is. Newtonian abduction does this.

[T]he importance of [the] equations [of motion] does not depend on their being useful in solving problems in dynamics[, i.e., in deducing predictions of future behavior when the forces acting on a system are known]. A higher function which they must discharge is that of presenting to the mind in the clearest and most general form the fundamental principles of dynamical reasoning.
¶ In forming dynamical theories of the physical sciences, it has been a too frequent practice to invent a particular dynamical hypothesis and then by means of the equations of motion to deduce certain results. The agreement of results with real phenomena has been supposed to furnish a certain amount of evidence in favour of the hypothesis.
¶ The true method of physical reasoning is to begin with the phenomena and to deduce the forces from them by a direct application of the equations of motion.

Maxwell
"On the Proof of the Equations of
Motion of a Connected System"

5 Invitation to a Short Essay

I invite you to write me a short discussion (no more than 2 pages, *i.e.*, no more than 1000 words) on any issue discussed in this lecture or any of this week's readings, required or suggested. You can raise further questions, propose answers or interpretations, or whatever seems of most interest to you. If you get it to me by the start of next lecture (15. June), then I will return it to you with my comments the following week.

References

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