Lite Best Systems Theories

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Seminar on fundamentality

Best-system theory The laws are the sentences in the "best system"

System: set of true sentences

Simplicity: a measure of the syntactically simplest axioms that logically imply every sentence in the system.

Strength: a measure of how much the system says

Balance: a function of the strength and simplicity scores of a system.

Best: a system whose balance score is at least as high as every other system.

1. Objectivity and measures of balance

How to define strength, simplicity, and balance?

In terms of actual scientific practice?:

> To be a law is to be a member of the system that best balances the virtues of strength and simplicity by the measure operative in physics departments on Earth in the year 2023

—unacceptable modal consequences. Rigidification?:

> "To be a law is to be a member of the system that best balances the virtues of strength and simplicity by measure M", where M is a rigid designator whose reference is fixed by the description 'the measure operative in physics departments on Earth in the year 2023'

—"[This] doesn't make the problem go away, it only makes it harder to state" (Lewis, 1994, p. 479). (I think the problem is one of objectivity. The existence of alternate meanings, corresponding to different ways we could have fixed the referent of 'M', under sentences about lawhood have different truth-values, makes lawhood nonobjective.)

Lewis's own answer:

> If "nature is kind", in the actual world, lawhood will coincide for all "reasonable" measures.

2. The need for naturalness

What language do we use to construct the systems in the competition?

If no constraints, then $\{\forall x F x\}$ (for Lewis's predicate F, true of all and only actual individuals) will be the winning system, and every true statement will count as nomologically necessary.

Lewis's solution: in all systems, the predicates must stand for perfectly natural properties and relations.

3. A gap between science and metaphysics

> Physics aims to find nature's scientific joints, but these may not coincide with her metaphysical joints. (Loewer, 2020, pp. 1077)

3.1 The Gell-Mann example

> …consider the case of Murray Gell-Mann and others organizing mesons and baryons into octets—now seen as representations of SU(3) symmetry—in what became famous as the Eightfold Way. The theory relies on the positing of new fundamental properties, in particular, fractional charge. The Eightfold Way seems to scientists the on balance strongest and simplest systematization of the relevant phenomena. Is it a law (or at least a corollary of a law)? Of course, it might fail to be because further experiments might reveal more phenomena that demand a better system, or because someone keener than Gell-Mann might come along and systematize the field even better. Stipulate for the sake of argument, however, that Gell-Mann reasoned impeccably and had all the facts available to him; given the kinds he [chose], the Eightfold Way really is the best systematization of the relevant facts. Even granting this much, [Lewis] cannot guarantee that the Eightfold Way is a law (law corollary); for there is nothing to guarantee that fractional charge is one of the properties enshrined as perfectly natural. (Cohen and Callender, 2009, p. 12)

First (and main) objection: it just *is* possible that physicists could follow the best scientific methodology and yet be wrong.

But also, in C&C's scenario, in which the properties that Gell-Mann posits aren't perfectly natural; are they supposed to be *reasonably natural*?

If yes, then those properties have simple definitions in terms of perfectly natural properties. Then Gell-Mann's system, after substituting definiens for definienda, would win the Lewisian competition, and be the laws after all.

If no, then Gell-Mann's terms would never have referred to these properties. This doesn't require reference magnetism; the terms are theoretical terms.

3.2 Metaphysical versus physical fundamentality

A more direct objection: physicists are interested in physically fundamental properties, not metaphysically fundamental properties.

But Lewis's view does not imply that there is a difference between metaphysical and physical fundamentality. Physically fundamental properties, on his view, just *are* natural properties that play a role in physics.

(The objection might simply be that the metaphysics of naturalness is false. I am replying to an understanding of the objection on which it is meant to convict Lewis's account of, *on its own terms*, opening up an unacceptable gap, of proposing an account of scientific practice that is unrecognizable as our own.)

Compare these two analogous cases:

> A philosopher of physics objecting to Tim Maudlin: "Your insistence that a physical theory must include an ontology opens up a gap between physics and metaphysics. It implies that physicists who follow correct methodology might posit the existence of quarks (say) and yet be wrong because there don't 'really', or 'metaphysically' exist quarks."
>
> An idealist objecting to an external-world realist: "Your view also opens up such a gap. For even if all the evidence favors the existence of black holes, it might not be 'really' or 'metaphysically' true that there are black holes, even though it would be scientifically true".

There is no difference, according to Maudlin or the external-world realist, between "metaphysical" and "scientific" existence. There is just existence.

4. Package deal account

Idea: the choice of properties and relations to be signified in systems is itself part of the Lewisian competition. Entries are thus "package deals", pairs $\langle S, I \rangle$,

where:

> S is a system (set of true sentences);
>
> I is an interpretation of the language of S (an assignment of referents to names and properties and relations to predicates);
>
> No naturalness constraint on I is made;
>
> The strength of the package is a measure of how much information is conveyed by S as interpreted by I; and
>
> The simplicity of the package is a syntactic feature of S alone, regardless of its interpretation.

If we don't say anything further, a package $\langle\{\forall x F x\}, I\rangle$, where F is a one-place predicate and I is an interpretation assigning to F Lewis's property (had by all and only objects in the actual world), will be maximally simple and strong. Let's explore various ways of avoiding this result.

4.1 Syntactic constraints on systems

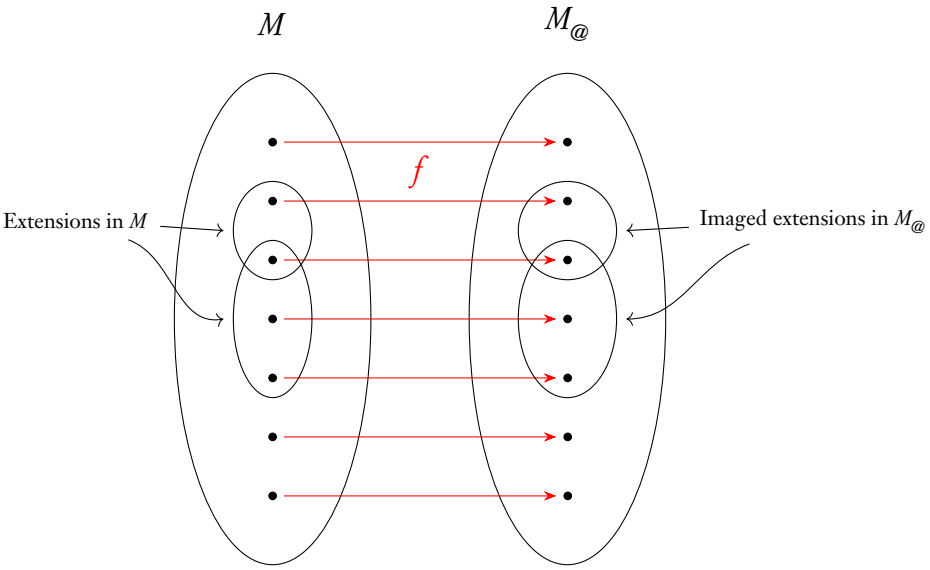
Idea: require systems to satisfy some syntactic constraint.

Won't work. Let S be any system whatsoever that obeys the syntactic constraint. We can still choose some interpretation in which S is true only in the actual world, assuming that these two conditions hold:

1. S has a model, M, whose domain is no larger than the set of concrete objects.
2. For no cardinality is S true in every model whose domain has that cardinality.

Begin with M. "Image" it through some one-to-one function from its domain

to concrete actual objects, to get a new model, $M_@$.



All sentences in S are true in $M_@$.

Now to turn $M_@$ into an interpretation that assigns properties and relations (not just extensions) to the predicates in S: by assumption 2, for each w other than the actual world, there is a model M_w of S's language in which S is not true, whose domain consists of concrete objects at w. Let I assign to any predicate Π in S's language, a relation whose extension in any world w is the extension of Π in M_w. Under I, S is true in @ but not in any other world.

So: choose the simplest possible system S that obeys the syntactic constraint. We just showed that there is an interpretation I in which S is true at, but only at, the actual world. So $\langle S, I \rangle$ will be the winning system. So every true proposition is again nomically necessary.

(A variant of this argument could be given even if you thought of physical theories as being about "quantities" rather than properties and relations, so long as we assume a principle of plenitude for quantities, the rejection of which would be tantamount to assuming naturalness.)

4.2 Strength as logical consequences about physics

> Choose some vocabulary X, thought of as "physical" vocabulary. The interpretation of X is *given* (not supplied by package deals). The strength

of $\langle S, I\rangle$ is inversely proportional to the set of possible worlds in which all logical consequences of S that only contain X-vocabulary are true.

But what is X?

4.3 Strength as logical consequences about micro-distances

Super-Humeanism (Esfeld, 2017; Esfeld and Deckert, 2017): X contains just one predicate: 'the distance between particle x and particle y at time t is d'. In any package deal $\langle S, I\rangle$, the system S must use this time-dependent distance predicate, along with any further chosen predicates that are interpreted by I.

(Irony: intrinsic metric structure is, according the geometrical conventionalists, "metaphysical" in the same way that naturalness is accused of being.)

Concern: this is committed to fundamental particles, a fundamental metric, a preferred notion of time, etc. (Loewer, 2024)

4.4 Strength as logical consequences about macro-distances

Idea: X consists of predicates concerning "the positions and motions of paradigm physical objects (planets, projectiles, particles, etc)" (Loewer, 1996, p. 110).

> Unlike super-Humeanism, the [package deal account] doesn't fix a one-size-fits-all fundamental ontology of propertyless particles, but rather leaves the ontology and fundamental properties up to physics. However, it accepts super-Humeanism's (and for that matter, Descartes's, John Bell's, and others') claim that the first job of physics is to account for the positions and motions of material bodies and how these positions record the measurements of other quantities. By building on this, while rejecting both fundamental ontologies of perfectly natural properties and propertyless particles as the basis for an account of laws, the [package deal account] moves in the direction of naturalizing metaphysics. This way, it moves toward a view of fundamental properties and laws from inside the perspective of science, in contrast to Lewis's and Esfeld's more *a priori* "God's eye", and metaphysics first perspective. (Loewer, 2024, chapter 7)

(Caveat: Loewer does not develop the idea in exactly the present terms; I may not be discussing his intended view!)

4.4.1 How "fine-grained" is the vocabulary?

Is X "fine-grained"? E.g. does it include precise real-valued attributions of distance, such as 'material body B_1 is precisely 5.347 meters from material body B_2'?

But ordinary physical objects are extended in space, have irregular shapes, and have vague boundaries.

And will it include precise, real-valued temporal information, such as 'B_1 is 5.347 meters from B_2 precisely 2.53 seconds after B_3 is 19.87 meters from B_4'? That would seem to sacrifice neutrality about the nature of time.

Or is X "coarse-grained", more like traditional observation-reports, e.g.:

> "Measuring rod r_1 is clearly longer than measuring rod r_2"
>
> "r_1 is one meter long, plus or minus two centimeters"
>
> 'Event e_1 is clearly after event e_2"

But then lawhood—and thus, given the package deal, all claims about properties of unobservables—might be highly non-unique.

4.5 Bridge laws

In a scientific package deal $\langle S, L \rangle$, S won't use any of the vocabulary in X (scientific laws don't mention measuring rods). Thus S won't logically imply any (nontrivial) sentences using X-vocabulary at all. So we apparently must measure the strength of a package deal by examining the logical consequences of the package's system together with some "bridge laws".

4.5.1 Bridge laws parts of packages; don't affect simplicity

Are the bridge laws chosen as parts of package deals? Suppose yes, and that they don't affect simplicity:

> A package is a triple $\langle S, I, B \rangle$; S and I are as before; B is any set of true sentences in the combined language of S and X; the strength of the package is inversely proportional to the size of the set of worlds in which every X-sentence that is logically implied by $S + B$ is true; simplicity is a function solely of S.

No good: for any S and I one likes, one can simply choose B as X itself, making the package maximally strong.

4.5.2 Bridge laws parts of packages; do affect simplicity

Next idea: as before, but now B's simplicity *does* enter into the calculation of simplicity.

Again no good. The mere logical possibility of there being an appropriately simple bridging theory spanning the gap between S and X guarantees that we can introduce an interpretation in which S and the bridging theory are true.

More fully:

1. Let S be any set of sentences
2. Let B be any set of sentences whose language includes the languages of S and X
3. Suppose there is some model M of the combined languages of X and S such that:
   (a) All sentences in S, X, and B, are true in M.
   (b) There is some one-to-one function f from M's domain onto the set of concrete objects such that for each predicate F of X's language, the image through f of F's extension in M is F's intended extension, and for each name n of the language of X, f sends the referent of n in M to n's intended referent.

Roughly: "S and B are consistent with the cardinality of the actual world and the totality of facts stateable in the language of X".

Now let's image M through f as before. We get a model $M_@$ whose domain is the set of concrete objects, in which every sentence in X, B, and S is true, and in which the meanings of expressions in X are the same as their intended meanings. Then turn $M_@$ into a property-and-relation interpretation, I, in any way you like that keeps the extensions as in $M_@$.

Thus for any S and B meeting the above conditions, $\langle S, I, B\rangle$ is a package in the competition. So the only role that the concrete world plays in determining the winner of the competition is i) its cardinality, and ii) its determination of the members of X. The view amounts to instrumentalism.

4.5.3 Bridge laws not part of packages

Idea: the strength of $\langle S, I \rangle$ is a matter of the X-sentences that are logical consequences of S together with the *true* bridging theory.

But what is that? How about:

> "The set $S + X$ of all truths in the language whose vocabulary combines those of S and X"?

? —No: $S + X$ includes X as a subset; each system would be maximally strong.

How about:

> The set of all true conditionals "If A then B", where A is in S's language, B uses only X vocabulary, and A *metaphysically necessitates* B

?—No: where ϕ is any true sentence using X-vocabulary and F is Lewis's predicate, the conditional "if $\forall x F x$ then ϕ" is necessarily true—the package $\langle \{\forall x F x\}, I \rangle$ would be maximally simple and strong.

Replace 'metaphysically necessitates' with 'grounds'? But the fan of the package deal account won't want *that*— too metaphysical. (Given ground, one can define naturalness.)

Introduce a weakened notion of ground, focused only on macro-micro?

4.5.4 Ceteris paribus conditions

Final problem (independent of how we define the bridging theory). Winning systems won't logically imply *atomic* X sentences. At best, they will logically imply X-generalizations. But not "strict" generalizations, only ceteris paribus generalizations, such as:

> "if you drop two objects from the Tower of Pisa *and nothing interferes*, then they'll land at the same time…".

But there may be no way to fill in "and nothing interferes" using X language, in which case winning systems won't imply any nontrivial X sentences at all.

Super-Humeanism has the same problem.

4.6 Constraining packages using modality

Go back to Lewis's modal understanding of strength. Restrict the vocabulary that occurs in systems thus:

> For any package deal $\langle S, I \rangle$ in the competition, there must exist some set P of properties and relations such that:
>
> i) Any two possible worlds with the same distribution of P-properties and relations are alike in every way;
>
> ii) The meaning that I assigns to any predicate that occurs in S must be a member of P; and
>
> iii) Any member of P must be assigned by I as the meaning of some predicate that occurs in some sentence in S that isn't a logical truth

This will disqualify packages based on Lewis's property of F-ness:

> F-ness isn't a supervenience basis all by itself (too specific)
>
> Minimal complete sets including F-ness (e.g., the set of all "world-specific" properties) are unlikely to enable simple and strong systems.

4.6.1 Modality too "metaphysical"?

4.6.2 Anti-haecceitism required

If anti-haecceitism is false, then there is a possible world that is qualitatively just like the actual world, but in which two electrons "swap qualitative roles"; then no package deals containing scientific properties will be allowed into the competition. The view will need to assume anti-haecceitism.

But given anti-haecceitism, possibilities can't be generated "combinatorially". They must be constrained by "individual essences". That seems no less "metaphysical" than naturalness.

(Bizarrely, in the philosophy of physics literature, it is *haecceitism* that is regarded as being overly "metaphysical".)

4.6.3 Restriction to qualitative facts

Idea: require the properties and relations expressed by any package's predicates to collectively form a minimal supervenience basis for all *qualitative* facts.

Concern: qualitative is in the same family as 'natural' (though "less strong").

Concern: in a sense, even the notion of properties and relations is in the same family of notions.

4.6.4 Intra-world versus inter-world naturalness

The view allows this reductive definition of naturalness: a property p is "natural" if and only if for some winning package deal, p is a member of the set of properties and relations expressed by that package deal's predicates.

But this defines a contingent status of naturalness. This will undermine "inter-world" applications of naturalness, such as the definition of intrinsicality via duplication. Are there any "inter-world" applications of naturalness that cannot be easily dismissed?

5. Relativism

Lawhood relativism (Cohen and Callender, 2009) There is no such property as being a law. Rather, there is a relation, lawhood-relative-to, holding between sentences and sets S of properties and relations:

> A system-relative-to-S is a set of sentences, closed under logical implication, all of whose predicates express properties and relations in S
>
> A law-relative-to-S is any member of the system-relative-to-S that best balances strength and simplicity

5.1 Creeping relativism

Simplistic argument that this leads to relativism about counterfactuals:

> There is some true definition of counterfactuals:
>
> If it had been that A then it would have been that $B =_{\text{df}} \phi$
>
> where ϕ contains the predicate 'is a law'. So if lawhood on the right-hand-side is relative to sets of properties and relations, so are counterfactuals.

But if lawhood and counterfactuals are relative, then the allegedly true definition would be ill-formed.

Better argument:

> Our evidence for accepting the original definition supports, when combined with lawhood's relativity, the conclusion that i) counterfactuals are also relative, and ii) are defined by:
>
> $$(\text{If it had been that } A, \text{ it would have been that } B)_S =_{\text{df}} \phi_S$$
>
> where ϕ_S is the result of replacing references to lawhood in S with references to lawhood$_S$.

Or, without relying on "definition":

> We have a certain body of evidence, which we normally take to support a class of statements of the form "if the laws are such-and-such then so-and-so counterfactuals are true", but together with the claim that lawhood is relative, the class supports correspondingly relativized conditional statements.

One way or another, if lawhood is relative, so are counterfactuals. Similarly, so is causation. And so, so is pretty much everything else.

The relativity is not just "around the edges", since there are no restrictions on the sets S. Practically nothing we ever say about the physical world—that grass is green, that the sky is blue, that we ourselves exist—is true simpliciter.

5.2 Local objectivity

Idea: "We always employ the same set of properties and relations. The only missing sort of objectivity is a misguided sort of cosmic objectivity."

Point 1: "employ" is intentional/semantic, thus causal, thus relative. (This is a structural disanalogy with more familiar forms of relativism.)

The claim must therefore be, with respect to some S:

> All humans employ$_S$ S when talking about lawhood and related matters; our judgments about lawhood are correct if and only if they are true of lawhood$_S$; when we wonder what the laws are, we wonder what the laws$_S$ are; and so on. (Similarly for causation, and everything else.)

Point 2: is it any easier to know what the laws$_S$ are than to know what the Lewisian laws are?

We can't define 'employs' in terms of the properties that scientists actually use. (They might be wrong.) In fact, it isn't clear what it could possibly mean.

6. Lawhood by list

Pretend that the laws are Newton's. What makes them the laws? Lewis's answer: because i) Newton's laws are the best systematization of the facts about mass and position over time, and ii) these are the natural properties and relations. But why not cite i) alone? In general:

> There is a certain set of properties and relations, S, such that what it is to be a law is to be the best systematization of S.

I think this is the best "lite" best-system theory.

> *Modal objection:* it is metaphysically possible that the laws involve properties and relations other than those in S.
>
> *Epistemic objection:* Newton believed that it was a law that $F = ma$, but he didn't believe that "$F = ma$" is part of the best systematization of S

A modal skeptic won't be moved by the modal objection.

The epistemic objection ignores that epistemic contexts are "opaque". One can believe that one is in pain without believing that one's C-fibers are firing, even if pain = C-fibers firing.

> *Explanatory objection:* there must be some explanation for why the particular properties in S play the role that they do in an account of the laws of nature.

Not every fact has an explanation. The objection must be that Lewis's theory is *more explanatory*, because it's not list-like.

The view could be seen as offering a reduction of naturalness: to be natural is to be a member of S. Perhaps the fact that the very same list recurs throughout the Lewisian constellation of explanations—lawhood is a matter of mass or charge or spin or spatiotemporal separation, and so is causation, and so is mental content, and so is…—mitigates the explanatory objection.

The dispute has boiled down to a disagreement about explanation. This often happens in metaphysics.

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