“Survey” of Formal Epistemology: Some Propaganda, and an Example

Branden Fitelson

Department of Philosophy
Group in Logic and the Methodology of Science
&
Cognitive Sciences Core Faculty

University of California–Berkeley

`branden@fitelson.org`
`http://fitelson.org/`

- What *is* “Formal Epistemology”?
  - Not sure, really.
  - I first heard the term from Sahotra Sarkar in 2003 <story>.
- It seems that it is quite a broad field, which includes:
  - Ampliative inference (including inductive logic);
  - Game theory and decision theory;
  - Formal learning theory;
  - Formal theories of coherence:
  - Foundations of probability and statistics;
  - Formal approaches to paradoxes of belief and/or action;
  - Belief revision theory;
  - Causal modeling, causal discovery, causal learning.
- I guess *I* think of it (nowadays) in *even broader* terms:
  - Analytic (Western) philosophy which makes serious use of (or does serious philosophy about) formal methods and is not analytic metaphysics. Or, perhaps more concisely: “Core”, non-metaphysics, involving formal methods.
- I want it to be an area (not called “logic”!), where logic and other formal methods are used, and non-apologetically!

- The **F**ormal **E**pistemology **W**orkshops (FEW) have been organized by Sahotra Sarkar and me, since 2004.
  - Berkeley, 2004. Mainly, probability and induction people.
    - Keynote: Pat Suppes.
  - Austin, 2005. Mainly, causal modeling/learning people.
    - Keynote: Brian Skyrms.
  - Berkeley, 2006. A broader mixture of areas.
    - Keynote: Tim Williamson.
  - CMU, 5/31–6/3/07. Abstract deadline: **End of this month**!
    - Invited Speakers (not confirmed): Isaac Levi, Joe Halpern, ?.
  - Future Sites: Madison, Wisconsin (2008 or 2009). Your University? If you’re interested in hosting one, let me know.
- I prefer to think of FEW as a place where traditional and formal epistemologists can meet and learn from each other (especially, with an eye toward inspiring graduate students).
- Please submit an abstract this month!
- And, please encourage any graduate students you know (especially ones who like formal methods) to submit/attend (we have limited funds for graduate student travel).

- The SEP has just replaced the (too narrow, and not taken very seriously by mainstream philosophers) “Inductive Logic and Decision Theory” area with “Formal Epistemology”.
- Brian Skyrms, Jim Joyce, Alan Hájek, and I will be editing this area. We will be commissioning many new entries.
- If you have suggestions for new entries/contributors, please let me know! This will help solidify FE’s place in philosophy.

- *Studia Logica* is also changing its scope.
- It’s broadening from being just a “Polish Logic Journal” to a journal where “Formal Philosophy” can be showcased.
- Several new editors are editing exciting special issues:
  - Leitgeb: Psychologism in Logic
  - Douven & Horsten: Applied Logic in Philosophy of Science
  - Behounek & Keefe: Vagueness
  - Fitelson: Formal Epistemology
- I urge you to re-work your conception of *Studia Logica*, and to consider submitting “Formal Philosophy” papers there!

- Here is a "*reductio*" of classical deductive logic (this is naïve and oversimplified, because my emphasis today is C*I*L):
  - (1) For all sets of statements X and all statements p, if X is inconsistent, then p is a logical consequence of X.
  - (2) If an agent S's belief set B entails a proposition p (and S *knows* $B \vDash p$), then it would be reasonable for S to believe p.
  - (3) *Even if* S knows their beliefs B are inconsistent (and, on this basis, they also know $B \vDash p$, for any p), there are still *some* p's that it would be *un*reasonable for S to believe.
  - (4) $\therefore$ Since (1)–(3) lead to absurdity, our initial assumption (1) must have been false — *reductio* of the "explosion" rule (1).
- Harman [9] would concede that (1)–(3) are inconsistent, and (as a result) that *something* is wrong with premises (1)–(3).
- But, he would reject the relevantists' diagnosis that (1) must be rejected. I take it he'd say it's (2) that is to blame here. (2) is a *bridge principle* linking *entailment* and *inference*. (2) is correct *only* for *consistent* B's. If B is inconsistent, then the correct response *may* be to reject an element of B.

- I'll *assume* Harman is right about the "relevantist" argument.
- Now, I will argue that Goodman's "Grue" argument against (Carnapian) inductive logic fails for analogous reasons.
- For this, we need some background on Goodman, Hempel & Carnap. I'll discuss Hempel, then Carnap, then Goodman.
- Hempelian inductive logic (confirmation theory) is based on deductive entailment. The theoretical details aren't important.
- We just need 3 properties of Hempel's confirmation relation:

(EQC) If E confirms H and $E \dashv\vDash E'$, then E' confirms H.

(NC) For all constants x and all (consistent) predicates ϕ and ψ: $\ulcorner \phi x \,\&\, \psi x \urcorner$ confirms $\ulcorner (\forall y)(\phi y \supset \psi y) \urcorner$.

(M) For all x, for all (consistent) ϕ and ψ, and all statements H: If $\ulcorner \phi x \urcorner$ confirms H, then $\ulcorner \phi x \,\&\, \psi x \urcorner$ confirms H.

- These three properties are the only ones needed to reconstruct Goodman's "Grue" argument against Hempel.
- Before giving a precise reconstruction of Goodman's "Grue" argument, we'll look at the essentials of Carnapian IL/CT.

- Carnapian confirmation theory (as I will use the term today) is based on *probabilistic relevance*, not entailment.
- As such, Carnap's confirmation theory has *only one* of the 3 Hempelian properties: (EQC). It has *neither* (NC) *nor* (M) [4].
- As we will see shortly, this allows Carnapian inductive-logic to avoid the full brunt of Goodman's "Grue" argument.
- More precisely, Carnapian IL is based on the following explication of "inductive-logical support" (confirmation):
  - E confirms H, relative to K iff $\Pr(H \mid E \,\&\, K) > \Pr(H \mid K)$, for some "suitable" probability function Pr (or class thereof).
    - Note: Carnap thought that "suitable for inductive-logic" implied "logical". But, Goodman's argument against Carnapian IL *does not depend on which* Pr *is used*.
- For Carnap, confirmation is a *logical* relation (akin to entailment). Like entailment, confirmation can be *applied*, but this requires *epistemic bridge principles* [akin to (2)].
- Carnap [1] discusses various bridge principles. The most well-known of these is the *requirement of total evidence*.

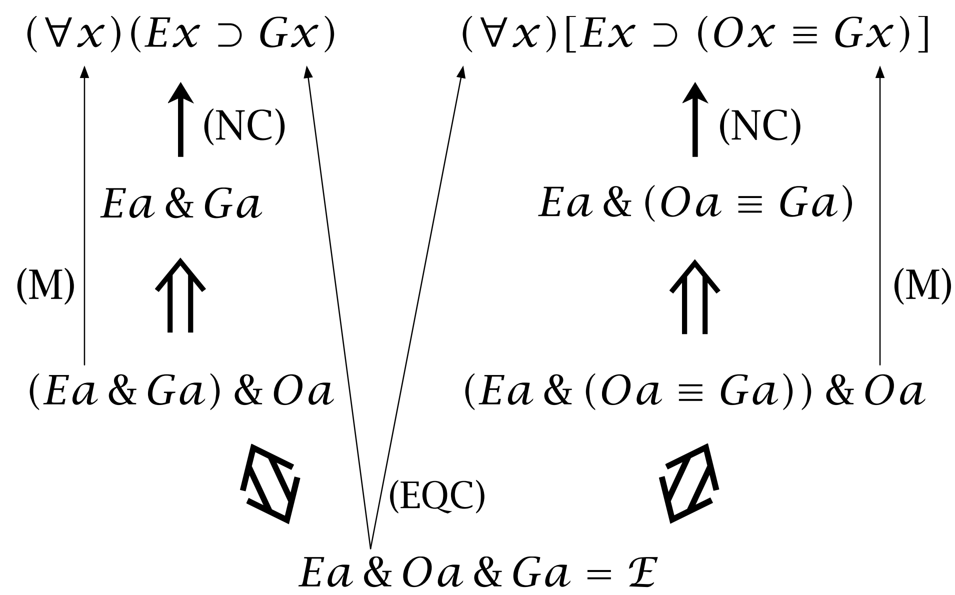
- **The Requirement of Total Evidence**. In the application of IL to a given knowledge situation, the total evidence available must be taken as a basis for determining the degree of confirmation.
- More precisely, we have the following *bridge principle* connecting *confirmation* and *evidential support*:

(RTE) E evidentially supports H *for* S *in* C iff E confirms H, relative to K, where K is S's *total evidence in* C.

- Again, for Carnap, confirmation is relative to a "logical" probability function. But, this is irrelevant today.
- The (RTE) has often been (implicitly) presupposed by Bayesian epistemologists (both subjective and objective).
- However, as we will soon see, the (RTE) is dubious, and most modern Bayesians reject it for independent reasons. Moreover, Goodman's "Grue" argument relies *more heavily* on (RTE) than the relevantists' argument relies on (2). This is an interesting disanalogy not noted in the literature.
- Before reconstructing the argument, a brief "Grue" primer.

- Let $Gx \stackrel{\text{def}}{=} x$ is green, $Ox \stackrel{\text{def}}{=} x$ is examined prior to t, and $Ex \stackrel{\text{def}}{=} x$ is an emerald. Goodman introduces a predicate "Grue"
$$\mathcal{G}x \stackrel{\text{def}}{=} x \text{ is grue} \stackrel{\text{def}}{=} Ox \equiv Gx.$$
- Consider the following two universal generalizations
  - (H_1) All emeralds are green. $[(\forall x)(Ex \supset Gx)]$
  - (H_2) All emeralds are grue. $[(\forall x)[Ex \supset (Ox \equiv Gx)]]$
- And, consider the following instantial evidential statement
  - ($\mathcal{E}$) $Ea \,\&\, Oa \,\&\, Ga$
- Hempel's confirmation theory [(EQC) & (NC) & (M)] entails:
  - (†) $\mathcal{E}$ confirms H_1, *and* $\mathcal{E}$ confirms H_2.
- As a result, his theory entails the following weaker claim
  - (‡) $\mathcal{E}$ confirms H_1 *if and only if* $\mathcal{E}$ confirms H_2.
- What about Carnapian theory? Does *it* entail even (‡)? Interestingly, the answer is NO! There are *some* K/Pr's relative to which $\mathcal{E}$ confirms H_1 but $\mathcal{E}$ *dis*confirms H_2.
- In this sesne, Hempel was an easier target for Goodman than Carnap (Goodman targets Carnap in a footnote).
- Next, a counterexample to (‡), then Goodman's argument.

Proof of (‡) in Hempel's Theory of Confirmation



- Following I.J. Good [7], we can construct the following counterexample to (‡) for probabilistic relevance theories of confirmation (like Carnap's). Let K be the following corpus:

(K) Either: (H_1) there are 1000 green emeralds 900 of which have been examined before t, no non-green emeralds, and 1 million other things in the universe, or (H_2) there are 100 green emeralds that have been examined before t, no green emeralds that have not been examined before t, 900 non-green emeralds that have not been examined before t, and 1 million other things.

- Imagine an urn containing true descriptions of each object in the universe (Pr $\stackrel{\text{def}}{=}$ urn model). Let $\mathcal{E} \stackrel{\text{def}}{=}$ "$Ea \,\&\, Oa \,\&\, Ga$" be drawn. $\mathcal{E}$ confirms H_1 but $\mathcal{E}$ *dis*confirms H_2, relative to K:
$$\Pr(\mathcal{E} \mid H_1 \,\&\, K) = \frac{900}{1001000} > \frac{100}{1001000} = \Pr(\mathcal{E} \mid H_2 \,\&\, K)$$
- This K/Pr constitute a counterexample to (‡), assuming a "Carnapian" theory of confirmation. Now, we're almost ready for Goodman's *reductio* argument against Carnap.

- There is just one more ingredient in Goodman's argument:
  - The agent S who is assessing the evidential support that $\mathcal{E}$ provides for H_1 *vs* H_2 in a Goodmanian "grue" context $C_{\mathcal{G}}$ has Oa as part of their total evidence in $C_{\mathcal{G}}$. (See [14].)
- Now, we can run the following Goodmanian *reductio*:
  - (i) E confirms H, relative to K iff $\Pr(H \mid E \,\&\, K) > \Pr(H \mid K)$.
  - (ii) E evidentially supports H *for* S *in* C iff E confirms H, relative to K, where K is S's *total evidence in* C.
  - (iii) The agent S who is assessing the evidential support that $\mathcal{E}$ provides for H_1 *vs* H_2 in a Goodmanian "grue" context $C_{\mathcal{G}}$ has Oa as part of their total evidence in $C_{\mathcal{G}}$ [*i.e.*, $K \vDash Oa$].
  - (iv) If $K \vDash Oa$, then $\mathcal{E}$ confirms H_1 relative to K iff $\mathcal{E}$ confirms H_2 relative to K, for ***any*** Pr [if $K \vDash Oa$, then (‡), for ***any*** Pr].
  - (v) Therefore, $\mathcal{E}$ evidentially supports H_1 for S in $C_{\mathcal{G}}$ if and only if $\mathcal{E}$ evidentially supports H_2 for S in $C_{\mathcal{G}}$.
  - (vi) $\mathcal{E}$ evidentially supports H_1 for S in $C_{\mathcal{G}}$, but $\mathcal{E}$ does *not* evidentially support H_2 for S in $C_{\mathcal{G}}$.
- ∴ (i)–(vi) lead to an absurdity. Hence, our initial assumption (i) must have been false. Carnapian inductive logic refuted?

- Premise (vi) is based on Goodman's *epistemic intuition* that, in "Grue" contexts, $\mathcal{E}$ evidentially supports H_1 but *not* H_2. I will just grant this assumption here (it could be questioned).
- Premise (v) follows logically from premises (i)–(iv).
- Premise (iv) is a theorem of probability calculus (***any*** Pr!).
- Premise (iii) is an assumption about the agent's background knowledge that's implicit in Goodman's set-up. See [14].
- Premise (ii) is (RTE). It's the *bridge principle*, akin to (2) in the relevantists' *reductio*. This is the premise I will focus on.
- I want to emphasize two main points about "Grue":
  - (ii) must be rejected by Carnapians for independent reasons.
  - Carnapian confirmation theory *doesn't even entail* (‡). [Hempel's theory does, just as deductive logic entails (1).]
- This suggests Goodman's argument is *even less* a *reductio* of (i) than the relevantists' argument is a *reductio* of (1).
- Next, I will explain why Carnapians/Bayesians should reject (ii) on *independent* grounds: The Problem of Old Evidence.

- As Tim Willimson points out [16, ch. 9], Carnap's (RTE) must be rejected, because of the problem of old evidence [3].
- If S's total evidence in C entails E, then, according to (RTE), E cannot evidentially support *any* H for S in C.
- As a result, one cannot (on pain of triviality) allow K to entail E *itself*, when assessing the *evidential import of* E.
- This is what motivates Williamson (a modern Carnapian about "support," as I read him) to understand "support" as *relative to a priori/empty background/probability* $K_\top/\mathrm{Pr}_\top$.
- In his discussion of Hempelian confirmation, Carnap defines "initial confirmation" in precisely this way [1, *p*. 500].
- And, Hempel explicitly *required* that confirmation be taken *relative to* $K_\top$ in all treatments of the paradoxes [10, 11].
- Hempel's *theory* [(M)!] does not *allow* confirmation relative to $K_\top$ but disconfirmation relative to a K *stronger than* $K_\top$ [4]. So, Hempel's *stuck* with the paradoxes. But, Carnap *isn't*!

- Carnap never re-wrote the part of LFP [1] that discusses the (RTE), in light of a probabilistic *relevance* ("increase in firmness" [2]) notion of confirmation. This is too bad.
- If Carnap had discussed this ("old evidence") issue, I suspect he would have used his "initial confirmation" relation (as Williamson does) in his explication of evidential support.
- Various other philosophers have proposed similar accounts of "support" as some probabilistic relation, taken relative to an "informationless" or "*a priori*" background/probability.
- Richard Fumerton (who, unlike Williamson, is an epistemilogical *internalist*) proposes such a view in his [5].
- Patrick Maher [13] applies such relations extensively in his recent (neo-Carnapian) work on confirmation theory.
- Brian Weatherson [15] uses a similar, "Keynesian" [12] inductive-probability approach to evidential support.
- So, many Bayesians *already* reject (RTE). They shouldn't be *too* worried about "Grue". It's a new twist on "old evidence".

[1] R. Carnap, *Logical Foundations of Probability*, 1st *ed.*, Chicago Univ. Press, 1950.
[2] R. Carnap, *Logical Foundations of Probability*, 2nd *ed.*, Chicago Univ. Press, 1962.
[3] E. Eells, *Bayesian problems of old evidence*, in C. Wade Savage (*ed.*) *Scientific theories*, *Minnesota Studies in the Philosophy of Science* (Vol. X), 205-223, 1990.
[4] B. Fitelson, *The Paradox of Confirmation*, *Philosophy Compass* (online publication), Blackwell, 2006. URL: `http://fitelson.org/ravens.htm`.
[5] R. Fumerton, *Metaepistemology and Skepticism*, Rowman & Littlefield, 1995.
[6] C. Glymour, *Theory and Evidence*, Princeton University Press, 1980.
[7] I.J. Good, *The white shoe is a red herring*, *BJPS* **17** (1967), 322.
[8] N. Goodman, *Fact, Fiction, and Forecast*, Harvard University Press, 1955.
[9] G. Harman, *Change in View: Principles of Reasoning*, MIT Press, 1988.
[10] C. Hempel, *Studies in the logic of confirmation*, *Mind* **54** (1945), 1–26, 97–121.
[11] ______, *The white shoe: no red herring*, *BJPS* **18** (1967), 239–240.
[12] J. Keynes, *A Treatise on Probability*, Macmillan, 1921.
[13] P. Maher, *Probability captures the logic of scientific confirmation*, *Contemporary Debates in the Philosophy of Science* (C. Hitchcock, *ed.*), Blackwell, 2004.
[14] E. Sober, *No model, no inference: A Bayesian primer on the grue problem*, in *Grue! The New Riddle of Induction* (D. Stalker *ed.*), Open Court, Chicago, 1994.
[15] B. Weatherson, *The Bayesian and the Dogmatist*, manuscript, 2007. URL: `http://brian.weatherson.org/tbatd.pdf`.
[16] T. Williamson, *Knowledge and its Limits*, Oxford University Press, 2000.