

Logics and Explanations

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Logic Colloquium 2018

University of Calgary

This talk draws on prior joint work with Gillman Payette, especially Nicole Wyatt and Gillman Payette. “How Do Logics Explain?” In: *Australasian Journal of Philosophy* 96.1 (2018), pp. 157–167 and Nicole Wyatt and Gillman Payette. “Logical Particularism”. In: *Pluralisms: Truth and Logic*. Ed. by Nathan Kellen, Nikolaj J. L. L. Pedersen, and Jeremy Wyatt. Forthcoming.

Logics and Natural Language

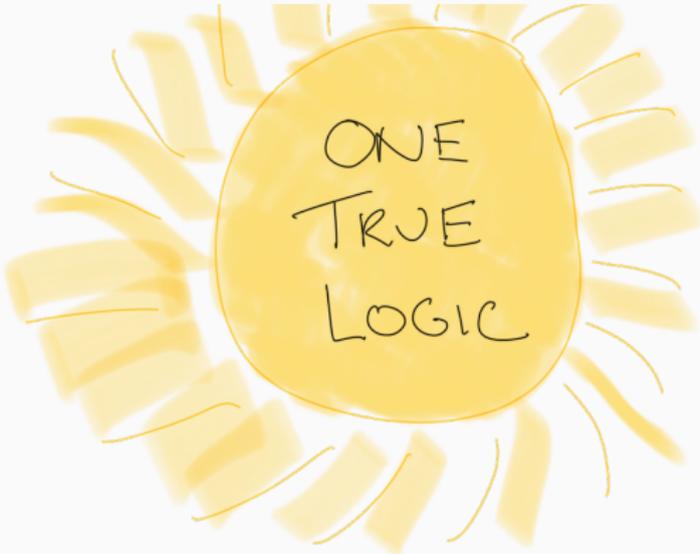
Relationship?



FDE □Q
Classical
 $\forall x (Fx \rightarrow Gx)$
Intuitionist?
A ∨ B
S5 excluded
¬ B middle

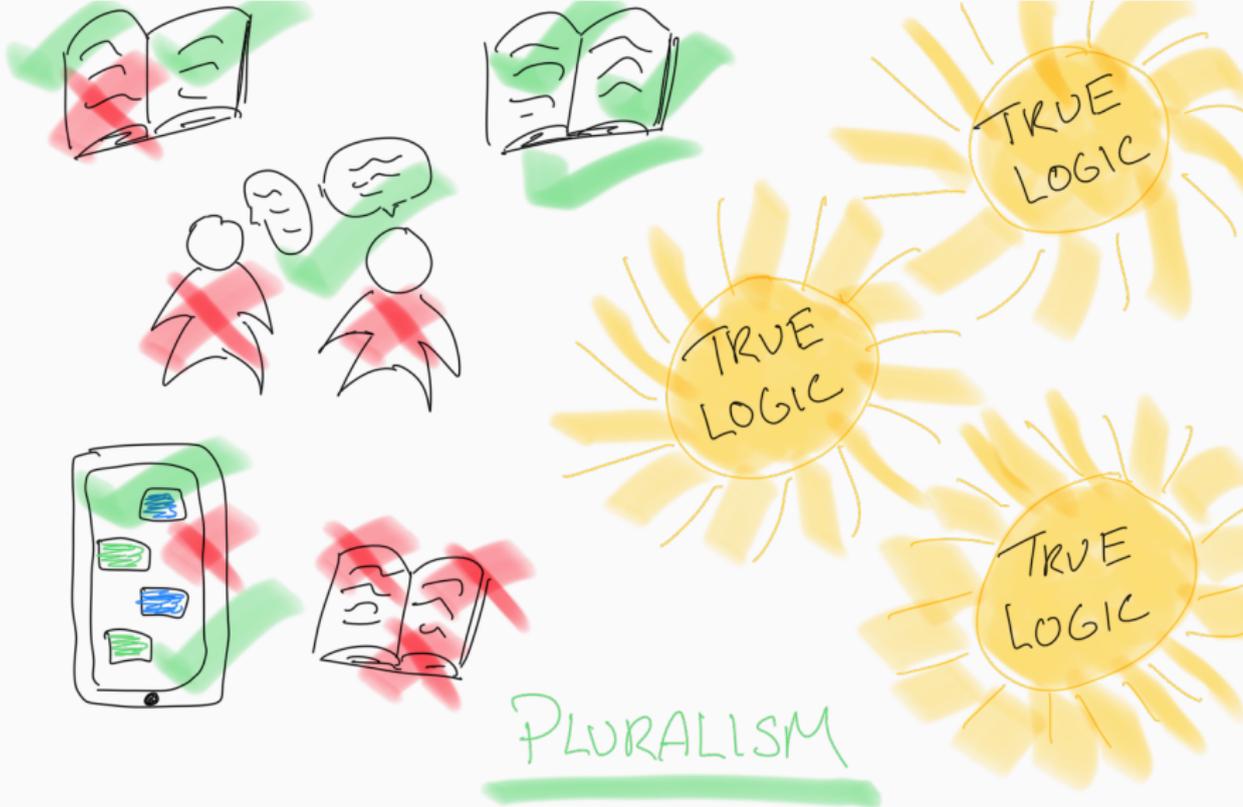
FORMAL SYSTEMS

Monism



MONISM

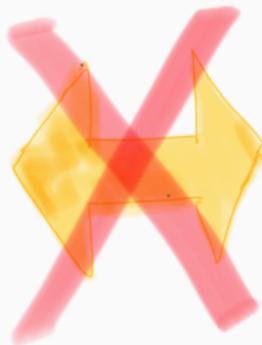
Pluralism



Nihilism



NIHILISM



FDE $\square Q$
Classical
 $\forall x (Fx \rightarrow Gx)$
Intuitionist?
 $A \vee B$
S5 excluded
 $\neg B$ middle
FORMAL SYSTEMS

Woody and Scientific Explanation

Functional Approaches to Explanation

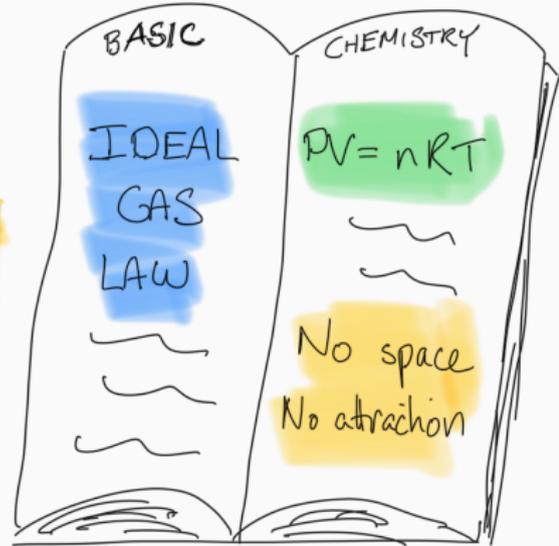
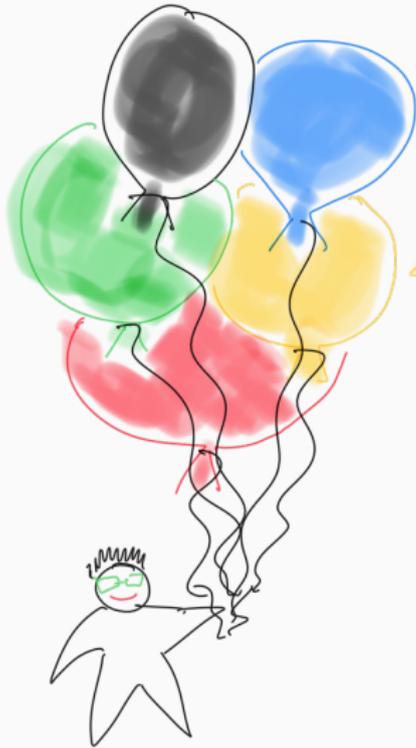
[B]ecause explanatory discourse inculcates particular patterns of reasoning, it functions to sculpt and subsequently perpetuate communal norms of intelligibility. In effect, explanations encode the aims and values of particular scientific communities, telling practitioners what they should want to know about the world and how they should reason to get there.

Andrea I. Woody. “Re-Orienting Discussions of Scientific Explanation: A Functional Perspective”. In: *Studies in History and Philosophy of Science Part A* 52 (2015), pp. 79–87, p. 81

... [the] reasons have to do with the task of explaining. ... we have to decide what kinds of factors can be cited in explanations. One thing that ceteris paribus laws do is to express our explanatory commitments. They tell what kinds of explanations are permitted

Nancy Cartwright. *How the Laws of Physics Lie*. Oxford University Press, 1983, pp. 47-48.

Ideal Gas Law



Logics as explanatory frameworks

Features of 'false' models in science

- abstraction
- contrastive explanation
- counter-factual reasoning
- explanatory scaffolding

Abstract mathematical models in ECOLOGY overcome two obstacles for studying real systems: a) the time scale on which they operate tends to exceed the time available for study, and b) their complexity makes it difficult to manipulate them systematically.

Jay Odenbaugh. “Idealized, Inaccurate but Successful: A Pragmatic Approach to Evaluating Models in Theoretical Ecology”. In: *Biology and Philosophy* 20.2-3 (2005), pp. 231–255

Contrastive Explanation

GALILEO'S THEORY OF FALLING BODIES predicts that all bodies will fall at the same speed. Of course that is not what we observe in the actual world. But Galileo's theory allows us to explain why in our world anvils fall faster than feathers precisely via attention to the unrealistic assumption that falling happens in a vacuum. Galileo's false model points us to the correct explanation—air resistance—and away from the incorrect one—mass.

Frank Hindriks. "False Models as Explanatory Engines". In: *Philosophy of the Social Sciences* 38.3 (2008), pp. 334–360, pp. 342-3.

Counter-factual reasoning

BOHR'S MODEL OF THE HYDROGEN ATOM, while fictional, allows us to answer a wide range of 'what-if-things-had-been-different' questions. There is a pattern of counter-factual dependence between the emission spectrum of hydrogen and the elements of Bohr's model.

Alisa Bokulich. "How Scientific Models Can Explain". In: *Synthese* 180.1 (2011), pp. 33–45

Explanatory scaffolding

In chemistry, THE IDEAL GAS LAW provides allows chemists to conceptualize actual gas properties as deviations from the ideal, and thus unifies the treatment of all gases under a single false model.

Andrea I. Woody. “How is the Ideal Gas Law Explanatory?” In: *Science & Education* 22.7 (2013), pp. 1563–1580; Andrea I. Woody. “Re-Orienting Discussions of Scientific Explanation: A Functional Perspective”. In: *Studies in History and Philosophy of Science Part A* 52 (2015), pp. 79–87.

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Yalcin and Modus Tollens

A marble is selected at random and placed under a cup.

	Big	Small
Red	30	10
Blue	10	50

(P1) If the marble is big, then it's likely red.
(P2) The marble is not likely red.

Seth Yalcin. "A Counterexample to Modus Tollens". In: *Journal of Philosophical Logic* 6 (2012), pp. 1001–1024, p. 1002

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(P2) The marble is not likely red.
(C1) **The marble is not big.**

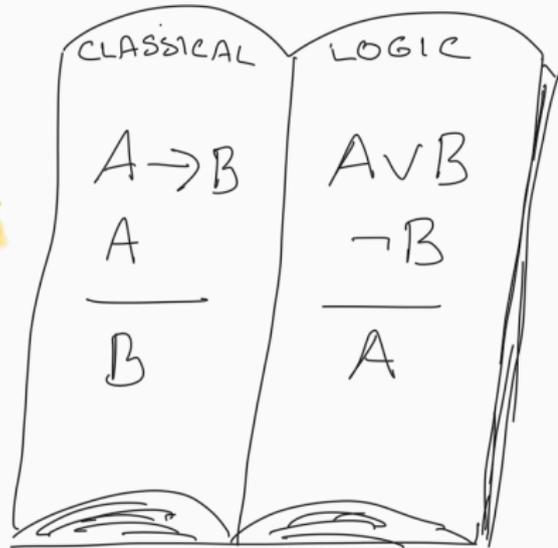
Seth Yalcin. "A Counterexample to Modus Tollens". In: *Journal of Philosophical Logic* 6 (2012), pp. 1001–1024, p. 1002

Yalcin's solution

- model the semantic values of sentences like probably- ϕ in terms in terms of constraints on information states.
- two different formal semantics for a language including as operators the conditional, 'might', 'probably', negation, and conjunction.
- both invalidate cases of modus tollens involving the probability operators of the language while preserving the validity of other cases of modus tollens.
- doesn't account for some other cases of modus tollens failure involving alternative vocabulary

- both *modus tollens* and classical logic more generally (as well as the standard semantics which support them) are serving an explanatory role like the ideal gas law
- the counterexample is not explained away
- offers an account of the 'problem' cases in terms of deviations from the standard semantics
- conforms to the expectation that logical explanation will be of the same kind as found in classical logic
- offers an analysis of his counter-examples on which logics endorsing *modus tollens* can be seen as assuming the absence of probability operators.

Logics and natural language



THANK YOU