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Formal methods in the Philosophy of Science

Jan-Willem Romeijn
Faculty of Philosophy
University of Groningen

ESF initiative:
The architecture of science

Team A: Formal methods

Formal philosophy of science

☝ Formal methods can clarify the practice of scientists and provide norms for good practice.

👎 Good-old logic is no longer the toolkit of choice for philosophers of science.

✋ Logic has seen major extensions and revisions in recent years.

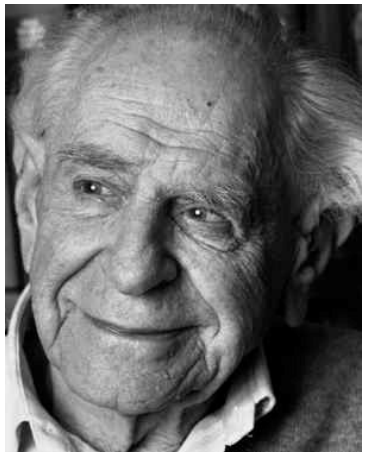
☞ High time for bringing logic back to the scene.

Outline of talk

1. The demise of logical methods
2. New methods: confirmation
3. New methods: statistics
4. New methods: uncertainty
5. Logic meets philosophy, again

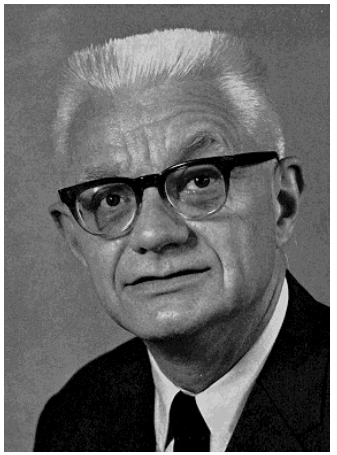
❶ The demise of logic

In early day philosophy of science, logical analysis played a key role, especially in confirmation theory.



Popper

Carnap

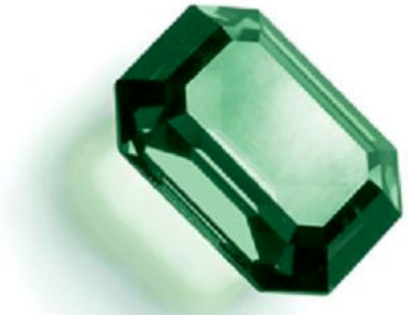


Hempel

❶

The poverty of syntax

The logical analysis ran into a number of paradoxes.



grue paradox

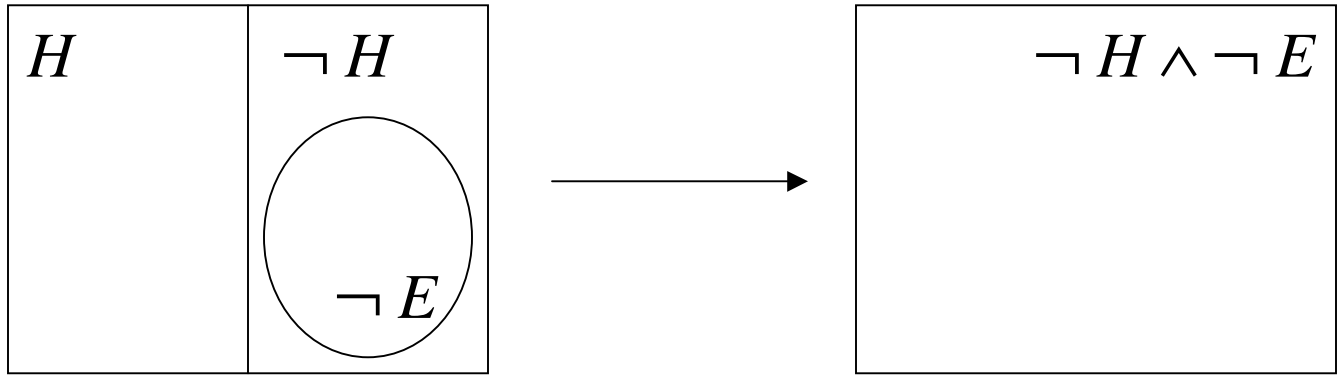
raven paradox

The bottom line was that traditional logic cannot cope with the complexity, or with the semantic aspects of scientific modeling.

❷ New methods: confirmation

Philosophers of science traditionally used classical deductive logic to capture confirmation.

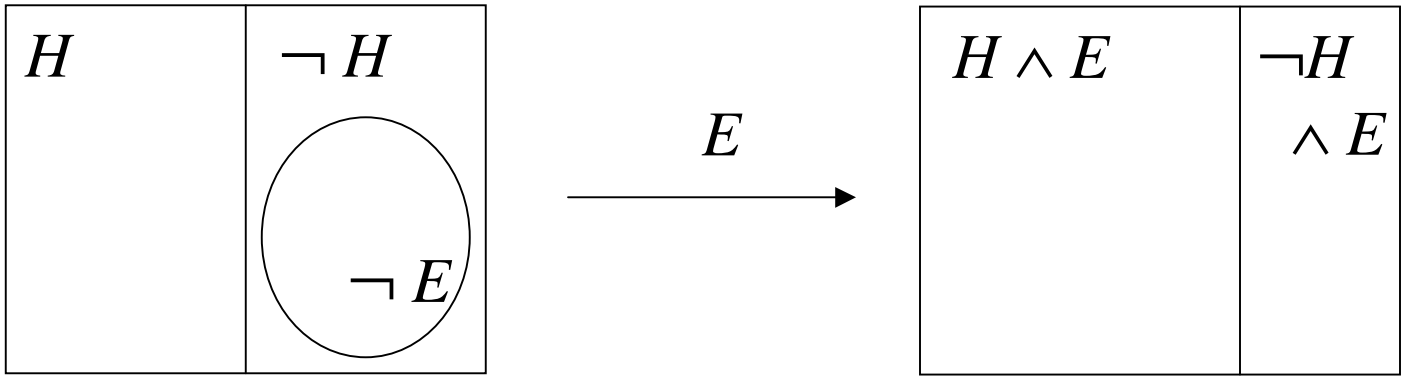
$$H \rightarrow E, \qquad \neg E \qquad \therefore \neg H$$



❷

Bayesian confirmation

Instead of truth valuations, we can also use a probability measure over an algebra to express confirmation.



$$P(H) = P(\neg H)$$

$$P(E \mid \neg H) < P(E \mid H) = 1$$

$$P(H|E) > P(\neg H|E)$$

❷

Using new logics?

Confirmation theory can be improved in various ways:

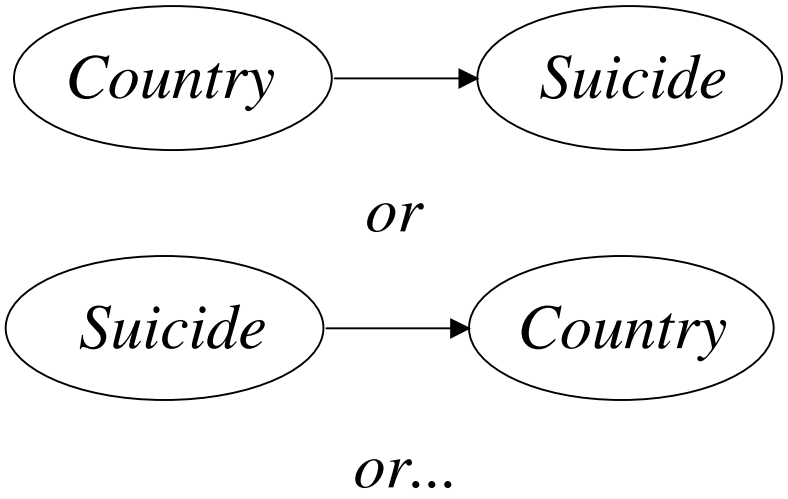
- Scientific models often concern causal relations. Causal hypotheses invite different confirmations.

- Issues are sometimes decided by the scientific forum, by voting or by consensus formation.

- In many instances of confirmation, logical and probabilistic knowledge must be combined.

❸ New methods: statistics

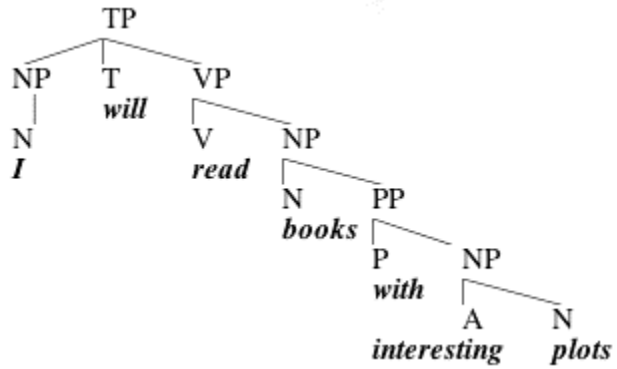
Causal networks and Bayesian methods are having increasing impact on statistics in the social sciences.



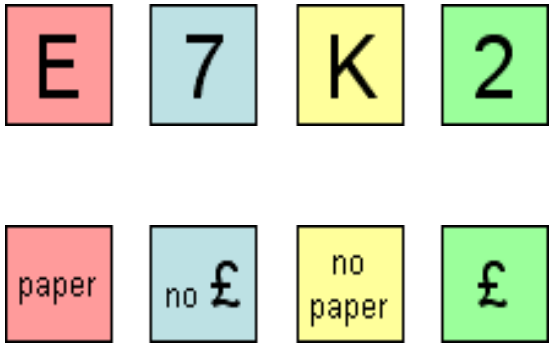
❸

Integrating logic and statistics

Often we also have logical constraints on parameters and interactions in the statistical model. How can we integrate the two?



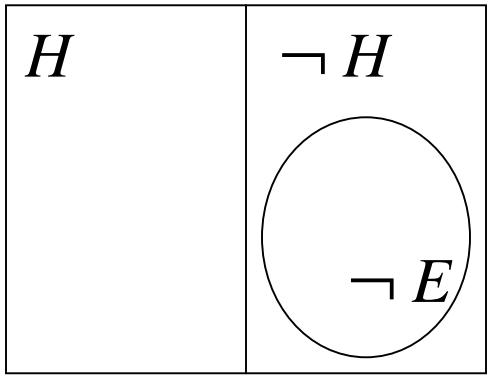
linguistics



psychology

❹ New methods: uncertainty

Additive normed measures are not the only tool for representing epistemic uncertainty.



uncertain evidential bearing:

$$¼ < P(E \mid \neg H) < ½$$

uncertain about the evidence:

$$P(E) > P(\neg E)$$

❹

Models of agents

Alternative representations of uncertainty can be used in methodology, but also in scientific modeling itself.

- The uncertainty of economic agents and psychological subjects are perhaps better represented with other measures than probability.

- Different representations of uncertainty might mesh better with new models of how agents interact, e.g., alternatives to decision and game theory.

❺ Logic meets philosophy, again

☆ Logic can provide new tools for the philosophy of science.

☆ We must be careful to give priority to the sciences, not to what tools happen to be around.

☆ To convince scientists of new methods, we need a killer application.

Thanks

j.w.romeijn@rug.nl

http://www.philos.rug.nl/~romeyn

J.W. Romeijn
University of Groningen / Philosophy
Oude Boteringestraat 52,
9712 GL Groningen
The Netherlands