



# UNDERDETERMINATION OF THEORY BY EVIDENCE

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# Background

- Underdetermination of theory by evidence:
  - Concerns the limited ability of evidence discriminate between theories/beliefs
- One motivation for its importance:
  - Accuracy is important
  - Science as a model of rational accurate belief
  - But science confronts problems of underdetermination
  - This may provide insight into general epistemological limitations

# Outline

- Historical background:
  - Pierre Duhem
  - Willard van Orman Quine
- Two kinds of Underdetermination:
  - Holistic underdetermination
  - Contrastive underdetermination
- Responses to holistic underdetermination
- Responses to contrastive underdetermination
- Next time:
  - A Bayesian take

# Pierre Duhem (1861-1916)

- Holistic underdetermination:
  - When the prediction of a theory is falsified, the falsification shows only that there is at least one error in the network of propositions (including the theory and auxiliary hypotheses) that produced the prediction, but it does not indicate exactly where the error lies
- My example:
  1. Central hypothesis: All iron melts at 1250 degrees Celsius
  2. Auxiliary hypothesis: This metal is iron
  3. Auxiliary hypothesis: This metal is heated to 1250 degrees Celsius
  4. Prediction: this metal will melt
  - Possible reactions to the false prediction:
    - Reject 1
    - Reject 2
    - Reject 3

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- Duhem's example:
  - Wave/particle theory of light: Foucault proposed an experiment to test whether light travels faster in water than in air
    1. Either light is a wave or it is a collection of particles
    2. If light is a wave, then it would travel faster in air than in water (since the water particles would slow the wave down)
    3. If light is a particle, then it would travel faster in water than in air
    4. Light travels faster in air than in water
    5. Therefore, light is a wave and not a particle
  - Possible reactions:
    - Reject 1: Maybe light is something other than a particle or a wave
    - Reject 3: Maybe particles act differently when interacting with specific media

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- Duhem's example:
  - “In sum, the physicist can never subject an isolated hypothesis to experimental test, but only a whole group of hypotheses; when the experiment is in disagreement with his predictions, what he learns is that at least one of the hypotheses constituting this group is unacceptable and ought to be modified; but the experiment does not designate which one should be changed.” Duhem, *The Aim and Structure of Physical Theory* ([1914] 1954, 187)
- Note:
  - He presents this as a *real challenge scientists face*, not a mere philosophical puzzle
  - He is committed to underdetermination *only about physics*

# W.V.O. Quine (1908-2000)

- Quine's contributions include...
- Generalizing beyond physics:
  - “our statements about the external world face the tribunal of sense experience not individually, but only as a corporate body” - “Two Dogmas of Empiricism” (1953, 41)
- The unfalsifiability of *any* singular statement:
  - “any statement can be held true come what may, if we make drastic enough adjustments elsewhere in the system” - “Two Dogmas of Empiricism” (1953, 43)
- Conservatism and the web of belief:
  - Our beliefs constitute a network that is analogous to a web
  - Innermost beliefs are less likely to be revised; outermost beliefs are more likely to be revised
  - Example of Newtonian mechanics and Neptune

# Two Kinds of Underdetermination

- Holistic underdetermination:
  - Given some counter-evidence, there are different ways to revise theory
  - Example:
    - If the metal doesn't melt, either discard the belief that it is iron or that iron melts at that temperature
- Contrastive underdetermination
  - Given some evidence, there are different theories consistent with that evidence
  - Example:
    - Newtonian mechanics
- Relationship between the two:
  - Some think (e.g. Stanford) it is possible to endorse one but not the other

# Responses to holistic underdetermination

- Quine's defeasible principles of theory choice in "Posits and Reality" (1955):
  - Simplicity "a vague business" 254
  - Familiarity
  - Scope
  - Fecundity where "successful further extensions of theory are expedited" 253
  - Conformity to experience
  - Conservatism

# Responses to holistic underdetermination

- Social or political factors determine theory choice:
  - Examples of factors:
    - Career interests
    - Political affiliations
    - Intellectual allegiances
    - Gender biases
    - Pursuit of power and influence
  - Examples of claimants:
    - Feminists
    - Sociologists of scientific knowledge
  - Critical responses to this:
    - Single case studies don't justify generalizations

# Responses to holistic underdetermination

- Laudan's response in "Demystifying Underdetermination" (1990):
  - Distinction:
    - Underdetermination as a claim about what is psychologically possible, vs.
    - Underdetermination as a claim about normativity or rational defensibility
  - Arguments:
    - Claims that defenders have only supported first claim, but not the second
    - We have principles of ampliative inference that can respond to the problem
  - Critique from Stanford:
    - Principles themselves are open to change

# Responses to contrastive underdetermination

- Anti-realism:
  - Science aims only at empirically adequate theories:
    - Empirically adequate theory:
      - A theory whose observable implications are true
    - Argument:
      - “it is not an epistemic principle that one might as well hang for a sheep as a lamb” van Fraasen, *The Scientific Image* (1980, 72)
  - We should be agnostic because of unconceived alternatives:
    - “we should believe that there are well confirmed alternatives to our best scientific theories that are presently *unconceived* by us” – Kyle Stanford, “Underdetermination of Scientific Theory,” SEP.
    - Argument:
      - Appeals to “the long history of repeated transient underdetermination by *previously* unconceived alternatives across the course of scientific inquiry.”
      - “In the progression from Aristotelian to Cartesian to Newtonian to contemporary mechanical theories, for instance, the evidence available at the time each earlier theory dominated the practice of its day also offered compelling support for each of the later alternatives (unconceived at the time) that would ultimately come to displace it.”

# Responses to contrastive underdetermination

- Objections:
  - Single case studies don't justify generalizations
  - Cases studies tack on unnecessary auxiliary hypotheses
  - Laudan's response

What do you think?



COME NEXT TIME!!