Rationality and Revolutions

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Cognitive values

- Discover interesting truths:
  - Explanatory power
  - Predictive power
  - Generality
  - Simplicity
  - …

2

Contextual values

- Norms, beliefs, interests, preferences…
- Contextual:
  - They vary with time and across cultures

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Standard view

- The Value-Neutrality Thesis:
  - Only cognitive values have (and should have) place in science
  - Contextual values have (and should have) no role whatsoever in science decision making
    - Theory appraisal/theory choice are **not** (and should not be) **contextual**
      - See Longino and Okruhlik's papers for a criticism of this

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Rationality in science

- '**The rationality thesis**': theory choice is *rational*
- claim about theory *assessment* (justification), not theory *creation* (discovery)
- Two components:
  - 1-There is a logic of confirmation or falsification
  - 2-That logic is independent of values and subjective opinions.

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Rationality in science

- Differing attitudes to the rationality thesis
  - Inductivists and falsificationists think it is true
    - Even if you reject inductivism and falsificationism, you might still think that the rationality thesis is true
  - Kuhn *(The structure of scientific revolutions)* disagrees with both components of the rationality thesis

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Rationality in science

- A spectrum of reactions to Kuhn (the 'culture wars'/'science wars')
  - From rationalism...
    - Try to refute Kuhn's arguments
  - ...to relativism, constructivism, postmodernism, ...
    - Go towards the denial of the objectivity and/or rationality of science

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Extreme Rationalism

- There is a **fact** about which theory is better supported by the evidence available at the time in question
- This fact is independent of any subjective feelings, values, or social group
- The **rational theory** to choose is the one that is better supported
- It is (in principle) possible to write down a **precise *logic* or *algorithm* for theory choice**
- The reasoning of responsible scientists approximates the ideal of this logic
- [Something like this seems to be the view Kuhn took himself to be attacking]

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Weak Rationalism

- Theory choice necessarily involves assessments or value judgements about which rational people can **disagree to *some* extent**
- But there are (probably vague) **limits to** the extent of such **disagreement** (i.e. some assessments and value judgements are clearly *un*reasonable, even if it is unclear exactly where unreasonableness begins)
- This means that there is **no *precise* algorithm** for theory choice, **but** there will generally be **significant agreement** among reasonable scientists
- [Something like this seems to be Kuhn's considered view, in 'Objectivity, Value Judgment, and Theory Choice]

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A-Rationalism

- There is **not even approximately** any such thing as the **objective** degree to which a given body of evidence supports a given theory
- Theory choice necessarily involves assessments or value judgements that are **not susceptible to rational evaluation** at all
- Therefore, the process of theory choice is **a-rational**

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Relativism

- There are **no theory-neutral criteria** for theory choice, and every scientific theory is better than its competitors from its own point of view
- Therefore, rational debate among proponents of competing theories is impossible, and a 'switch of allegiance' from one theory to another has more in common with a **religious conversion** than a reasoning process
- [Something like this seems to have been Kuhn's original view, although he later resisted this reading of his work]

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Social Constructivism

- There is **no** such thing as a **theory-independent reality.** Rather, physical reality is literally **constructed by scientists** when they accept a new theory
- Therefore, it makes no sense even to *ask* (e.g.) whether scientific theories are objectively true, or whether 'the scientific method' is objectively likely to lead to truth; and **theory choice is just a choice of which world to live in**

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Kuhn's notion of paradigm

- Two meanings:
- 1-Exemplars:
  - Examples/schemas on how to use the theory to solve problems
    - Ex: Lab exercises…
- 2-Disciplinary Matrices:
  - Exemplars + symbolic generalizations + metaphysical commitments + heuristic models + values
  - A notion much more general that `theory'

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Kuhn's notion of paradigm

- Paradigm:
  - Epistemological, metaphysical, methodological, axiological elements that guide the scientists in:
    - What experiment to perform
    - Which observation to make
    - How to modify the theories
    - How to make choices among alternatives
    - …

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Kuhn's three stages

- Science does not progress linearly
  - stage 1: immature science
  - stage 2: normal science (first paradigm acquired)
  - stage 3: revolutionary science (paradigm shift)
- Kuhn's claims about normal science (NS):
  - NS is based on a paradigm
  - NS is dogmatic
  - NS is objectively progressive

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Kuhn's revolutionary science

- Kuhn's claims about scientific revolutions (SR):
  - SR are paradigm shifts
  - SR are total (paradigms are mutually excusive)
  - SR are relatively sudden and unstructured events
    - gestalt switch, religious conversion
  - Revolutionary science is not dogmatic
  - SR cannot be decided by rational debate
    - arguments in favour of a paradigm end up being circular
  - SR are not objectively progressive
    - Changes in paradigm cannot be said to bring us closer to the truth

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Kuhn's incommensurability

- Theories in different paradigms are incommensurable (= lack a common measure)
- Observational incommensurability:
  - Scientists in different paradigms differ about the observational data
- Semantic incommensurability:
  - Theories in different paradigms are not translatable
- Methodological incommensurability:
  - There is no universal method for making inferences form data

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Kuhn's six arguments

- For observational incommensurability:
  - 1-theory-ladeness of observation
- For semantic incommensurability
  - 2-meaning variance
- For Methodological incommensurability:
  - 3-problem weighting
  - 4-shifting standards
  - 5-ambiguity of shared standards
  - 6-collective inconsistency of rules

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Doctrines underlying Kuhn's arguments

- The holistic character of paradigm
- The theory-ladenness of observation
  - the theory that the scientists accept influences what they observe
- The theory-dependence of meaning
  - the theory that the scientists accept determines the meaning of the theoretical terms
- Meaning holism
  - Meanings of terms are interconnected so that changing the meaning of one term will change the meaning of all other terms

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1-Theory-ladenness of observation

- The basic idea
  - The rationalist accounts all presuppose that the *results of observation* **can act** as an objective, *neutral* arbiter between theories
  - This requires that proponents of competing theories can **agree** on what the observational data is

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1-Theory-ladenness of observation

- Example:
  - Ptolemaics and Copernicans should agree that observation had established that:
    - Mars started retrogression on May 3
    - Galileo's telescope had shown Venus' phases
  - If not, then they **could not have a meaningful discussion** about which theory did a better job
  - The claim that 'observation is theory-laden' is sometimes taken to undermine this presupposition

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1-Theory-ladenness of observation

- Theory-ladenness of observation, version 1
  - Slogan: **'What you see (or hear, etc.) depends on what you already believe.'**
  - Kuhn: "[T]he proponents of competing paradigms ... see different things when they look from the same point in the same direction." (SSR, p.150; *emphasis* added)

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1-Theory-ladenness of observation

- Intuitive version :
  - Scientists who accept theory A will see only things that confirm theory A, while scientists who accept theory B will see only things that confirm theory B **(Literally!)**
  - So, the proponents of rival theories **cannot agree** on *what the observational evidence is*.
  - If there is **no theory-neutral way of agreeing** on what the evidence is, then **observations cannot serve as neutral arbiters between theories**

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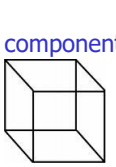
1-Theory-ladenness of observation

- Why the worry is not completely implausible
  - Perception has an 'active' component
  - Toy examples
    - The Necker cube
    - The duck-rabbit
    - The old/young woman



- Examples from science
  - A radiologist and a layman viewing a photograph of a diseased lung

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1-Theory-ladenness of observation

- What seems to be going on:
  - *Some* sense in which we 'see the same thing'
    - We are seeing the same drawing
    - We are seeing the same X-ray photograph
  - But some sense in which we do *not* 'see the same thing'
    - You see the bottom face of a cube; I don't
    - The radiologist sees a diseased lung; I just see a bunch of bones and tissue

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1-Theory-ladenness of observation

- Three stages of perception
  - External stimulus (physical description)
  - Processing to generate an experience
  - Perceptual experience determined by *processing*, as well as by *stimulus*
- Precisification of the senses in which what's seen by two agents is the same/different
  - same external stimulus but we have different visual experiences

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1-Theory-ladenness of observation

- Relevance (or otherwise) to the objectivity of science
  - Experimenters record a judgment based on the experience they had
  - They do not, and cannot, record a description of the external stimulus itself
- The worry: perhaps the 'processing' phase is infected by the theory that the perceiver believes

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1-Theory-ladenness of observation

Kuhn's example

- A Ptolemaic and a Copernican watching the dawn
  - If Kepler sees 'Kepler's sun' and Ptolemy sees 'Ptolemy's sun', but Kepler's sun is (by definition) at rest and Ptolemy's sun is (by definition) moving, then Kepler and Ptolemy *cannot be observing the same thing as one another*
    - No object can be *both* at rest and moving

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1-Theory-ladenness of observation

Kuhn's examples

- A Galilean and an Aristotelian, looking at the same swinging stone
  - The Aristotelian sees a stone seeking the centre of the Universe
  - The Galilean sees a pendulum
- A Ptolemaic and a Copernican watching the dawn
  - If Kepler sees 'Kepler's sun' and Ptolemy sees 'Ptolemy's sun', but Kepler's sun is (by definition) at rest and Ptolemy's sun is (by definition) moving, then Kepler and Ptolemy *cannot be observing the same thing as one another*
    - No object can be *both* at rest and moving

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1-Theory-ladenness of observation

A possible (pro-rationalist) response

- For 'theory-ladenness' to undermine the rationality of theory choice:
  - 1-(not only) what a scientist observes depends on what theories she believes, **(but also)**
  - 2-scientists generally tend to be unable to observe things that would be unfavorable to the theory they currently believe
- Even if we grant (1), **(2) seems to be false.**
  - Lots of Ptolemaics *did* see the full range of phases of Venus through Galileo's telescope

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2-Meaning variance

- Theory-ladenness of observation, version 2
  - Slogan: **'There is no theory-neutral observation language'**
    - Examples of 'observation reports' in science
      - The current was measured to be 1A
      - The phases of Venus were observed to include the whole range, from New to Gibbous
    - These reports are clearly not free of all theory:
      - You don't even *have the concepts of* 'current', 'ampere', 'phase', 'Venus', 'gibbous', until you've learned the relevant theory

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2-Meaning variance

- Intuitive version of the worry
  - If an experiment is to discriminate between two theories, then the result of the experiment has to be described in a language that competitors both speak
  - Worry: competing theories do ***not*** share enough common language

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2-Meaning variance

- 'Meaning holism': The meaning of a term depends in part on the theory in which it appears
  - So, scientists advocating rival paradigms mean different things by key terms like 'mass','planet', 'Sun' etc.
- This makes it impossible for scientists to have a rational discussion of which paradigm is better: they are not even talking about the same things as one another

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2-Meaning variance

- People committed to different theories speak different languages
  - these languages are incommensurable (= have no common measure)
  - translation does not preserve meaning

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2-Meaning variance

- Replies:
  - 1- If this were right, it would mean that the scientists advocating 'rival' paradigms **could not be disagreeing with one another**, either!
    - Brahe's meaning of planet= satellite of Earth
    - Kepler's meaning of planet=satellite of the Sun
    - Sb="all planets go around the Earth"
    - Sk="all planets go around the Sun"
    - Sb and Sk do not contradict each other

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2-Meaning variance

- Replies
- 2- If we focus on the referent, not on the meaning, semantic incommensurability evaporates
- **Referent:** the set of things the term picks out in the world
  - ex: Ptolemaics and Copernicans *were* talking about the same object (*the Sun*) when they disagreed about whether or not the Sun was the centre of the Universe

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3-Problem Weighting

- How do we assess theories? Puzzle solving
- But: we cannot decide ***which theory is better at puzzle-solving*** unless we have a way of deciding which puzzles are more important
- Different paradigms can agree that solving puzzles is a virtue, while disagreeing about **which puzzles are important**

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4-Paradigm-relative standards

- Paradigm: *also* standards for assessing theories
  - i.e. answers to the question 'what must a good theory be like?'
- These standards vary from paradigm to paradigm
- proponents of each paradigm are 'rational' (according to their own standards) in hanging onto their own paradigm

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4-Paradigm-relative standards

- The structure of Kuhn's suggestion
  - Paradigm A: Theory A + A-standards
  - Paradigm B: Theory B + B-standards
  - If Theory A scores better on the scorecard of A-standards, and Theory B scores better on the scorecard of B-standards, then no-one can be talked out of the paradigm he currently accepts

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4-Paradigm-relative standards

- "To the extent... that two scientific schools disagree about what is a problem and what a solution, they will inevitably talk through each other when debating the relative merits of their respective paradigms. In the partially circular arguments that regularly result, *each paradigm will be shown to satisfy more or less the criteria that it dictates for itself and to fall short of a few of those dictated by its opponent.*"

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4-Paradigm-relative standards

- Example: Aristotelian vs. Newtonian physics
  - EXPLANATION:
    - Aristotelians objected to Newtonian physics since they could not *explain why* massive bodies attract each other
    - Newtonians countered that
      - such explanation was not required; and
      - the Aristotelian 'explanations' (in terms of natural tendencies of objects) had never been *explanations* anyway
  - IMPORTANCE OF QUANTITATIVE vs QUALITATIVE
    - Newtonians objected to Aristotelians that they made only qualitative predictions, not *quantitative* ones
    - Aristotelians countered that quantitative predictions were not a criterion of adequacy of terrestrial (as opposed to celestial) physics

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5-Ambiguity of Shared Standards

- Kuhn (in 'Objectivity, Value Judgment, and Theory Choice'):
  - **there are *some* 'shared standards'**
  - **But:**
    - 1-there is no rational justification for those standards
    - 2-different paradigms disagree about:
      - **how to interpret**
      - **how to apply**
      - **How to rank** those standards

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5-Ambiguity of Shared Standards

- Shared standards:
  - Accuracy
    - no disagreement with experiment ('matching') + explanation ('account for')
  - Consistency
    - No internal inconsistence (no logical contradictions), or inconsistence with other currently accepted theories
      - e.g. Copernican astronomy's inconsistency with Aristotelian physics
  - Scope
    - successful novel predictions
  - Simplicity
    - unifying power (K's official def); parsimony
  - Fruitfulness
    - How promising the theory is: will it lead to new discoveries/technologies and/or unexpected unifications ?
      - e.g. the Newtonians' discovery of Neptune and unification of celestial and terrestrial physics

5-Ambiguity of shared standards

- 'Shared standards' are not precise enough
- Example: 'simplicity'
  - how are we supposed to measure 'simplicity'?
  - In practice, 'common sense and intuition'

5-Ambiguity of shared standards

- Scientists in different traditions can have different 'senses' of what counts as simple
  - The Ptolemaic could argue that Copernican astronomy is no simpler than Ptolemaic astronomy, since the Copernican needs just as many circles as the Ptolemaic does
  - The Copernican could argue that Copernican astronomy 'is simpler', because it provides a simpler explanation of e.g. the existence of retrograde motion
  - **No fact of the matter as to which is 'right'**

6-Collective inconsistency of rules

- Different criteria could pull in different directions
  - Example: Consistency vs. simplicity
    - Copernican astronomy was simpler than Ptolemaic. But Ptolemaic astronomy was consistent with the terrestrial physics of the time
- Which criterion is *more important*: consistency or simplicity?
  - No a unique rational answer ?
  - Different paradigms can disagree on the *ranking*

Criticism of Kuhn - Ernan McMullin

- "Rationality and Paradigm Change in Science"
- Disagreement about standards can happen even in periods of normal science
  - So why one should think that some values are immune to change?
- Revolutions can differ in depth
  - from X-ray to Copernican revolution
  - Division between normal science and revolutionary science is more a matter of degree rather than a difference in kind

Criticism of Kuhn

- Some values (simplicity and fruitfulness) can be given (contra K) rational justification:
- They are not valued on their own but depend on others:
  - Predictive accuracy and explanatory power
  - ex: even if we cannot prove accuracy and explanatory power are an indicator of the truth, it's interesting that theories that are simpler and more fertile are more reliable predictors and better explainers

Criticism of Kuhn

- Can Kuhn consistently be an instrumentalist?
- K: if two theories have the same predictive accuracy (Copernicanism and Ptolemaic astronomy) then they have the same explanatory power, and thus theory choice was just a matter of taste
  - This seems totally wrong!
  - Explanatory power (rather than predictive accuracy) is an indicator of the truth
    - It's not an accident that the theory explains so much!!!!

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Criticism of Kuhn

- it cannot be an accident that Copernicanism was able to explain that much: it uncovered the true causes of the observed motions
- Copernicanism was preferred because they believed it to be true (because of its explanatory power and not because it was a better predictor)

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Criticism of Kuhn-Larry Laudan

- "Dissecting the Holistic Picture of Scientific Change"
- two accounts of scientific rationality:
  - hierarchical model
  - reticulational model
- Laudan: Kuhn is mistaken because he uses the hierarchical model, which is fundamentally flawed

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Criticism of Kuhn

- Hierarchical model
- paradigms have 3 components:
  - factual level (conceptual framework, ontology)
  - methodological level (rule for choosing among theories, values)
  - axiological level (aims of science)
- hierarchical in the sense that if the disagreement is at one level, it is resolved one level up
  - the justification is top-down
  - at the axiological level the justification ceases

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Criticism of Kuhn

- Reticulational model
  - Anti-holism
  - Non-linear conception of justification
- single components of a paradigm can be discussed, accepted, or rejected piecemeal
- changes at one level do not have to be accompanied to changes at another level
  - ex: methodological rules can change after the discovery that the old rules are not the best to realize the aims of science

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Criticism of Kuhn

- Laudan argues that Kuhn's last three arguments are unsound: each have at least one false premise
  - (shifting standards) standards do not always change from one paradigm to another
  - (ambiguity of shared standards) some shared standards (ex: consistency and novel predictions) are not ambiguous
  - (inconsistency of rules) not all sets of methodological rules give conflicting advice

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Criticism of Kuhn

- Problem weighting: which problems are most important?
- "important" can mean two different things
  - important for **social or economic reasons** or because a particular scientist is interested in solving the problem
    - non-epistemic sense
  - important because its solution would confirm the theory (**probative significance**)
    - epistemic sense

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Criticism of Kuhn

- Probative significance is an objective matter and claims about it will be defended or attacked by appealing to methodological and epistemic rules
- So, in the second sense of importance disputes about which problem is important will not necessarily end with a matter of disputable opinion
- that is, when focusing on the epistemic sense of important it does not follow that proponents of different paradigms **must** disagree about what problem is more important

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The Quine-Duhem Thesis and Underdetermination

Pierre Duhem (1861 – 1916)

Willard Van Orman Quine (1908-2000)

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Pierre Duhem's "Physical Theory and Experiment"

- Claude Bernard (1813-1878): father of experimental physiology
  - Free our mind when we make experiments!
    - (Francis Bacon)

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Duhem against Bernard

- This is impossible, especially in physics:
- we rely on physics in using each measurements apparatuses
- "The physicist is obliged to trust his own theoretical ideas or those of his fellow physicists. [...] The statement of the result of an experiment implies, in general, an act of faith in a whole group pf theories."

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Holism thesis in physics

- When a physical theory is tested by an experiment, it is not the theory alone that is tested, but a large collection of theory, auxiliary hypotheses, and assumptions that are being put to the test
- T (theory), A_1,..., A_N (auxiliary hypotheses), O_1 (observable prediction)
- D1: ~(T --> O_1)
- D2: (T&A_1&A_2&A_3...&A_N)-->O_1

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The ambiguity of falsificationism thesis

- We perform an experiment and find out O_1 is false
- Since T alone does not entail O_1, we cannot conclude that T is false
- All that follows is that at least one of the T, A_1, ..., A_N is false and logic alone does not tell us which
- D3: $\sim(\sim O_1 \dashrightarrow \sim T)$
- D4: $\sim O_1 \dashrightarrow \sim(T \& A_1 \& A_2 \& A_3 ... \& A_N)$

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Holism thesis in physics

- Why agree on holism?
- example:
  - Newton's law of motion and the need of: initial conditions, forces, masses, distances, ..., instruments,..., other theories,...
- But this single example does not prove holism to be true for all physical theories
  - Is there a general argument?
    - Theory-ladennes of observation, again

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The theory ladenness of observation

- Theory-ladenness of observation gives a general argument for holism in physics:
  - The physicist, in order to connect the predictions of the theory with direct observation, needs to **translate** from the everyday language to the theoretical language
  - (theory-ladenness of observation) This translation is affected by using theories about how the measuring apparatus works
  - Therefore: (holism) when a physical theory is tested by an experiment, it is not the theory alone that is tested, but a large collection of theory, auxiliary hypotheses, and assumptions that are being put to the test

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Why crucial experiments in physics are impossible

- E is a crucial experiment between T_1 and T_2 if T_1 predicts that E will give the result O and T_2 predicts that E will have the result not-O:
  - If we perform E and obtain O, T_2 is eliminated
  - If we perform E and obtain not-O, T_1 is eliminated
  - (examples)
- Duhem: we cannot derive O from T_1 alone

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Why crucial experiments in physics are impossible

- if holism is true, then no experiment can conclusively refute a theory
- if it is impossible to conclusively refute a theory then, a fortiori, there cannot be crucial experiments

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Clarifications about Duhem's view

- His view was restricted to physics
- He attacked just the extreme view that experiments can refute with certainty theories as a matter of logic
- He left open the possibility that experiments (in conjunction with other considerations) could lead rationally to the rejection of theories as false and that successful experiments could confirm theories

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Clarifications about Duhem's view

- He never denied that *in fact* theories get refuted in science
- He described how scientists could protect their theory from refutation by modifying some of the assumptions
  - substitute ($T\&A_1\&...\&A_N$) with ($T\&B\&A_2...\&A_N$)
- but he never said that any modification is reasonable
  - the new system must be consistent
  - B cannot be false
  - B cannot be ad hoc
  - …

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Poincare's conventionalism: the argument

- Many (mutually incompatible) theories can cope with the same data
- If that is true, then there is no way to find out which theory is correct
- If there is no way to find out which theory is correct, then there is no fact of the matter whether one theory is true or not
- If there is no fact of the matter that a theory is true or false, a theory cannot really explain

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Poincare's Conventionalism

- Theories, theoretical terms and theoretical statements are neither true or false, they do not refer to anything
- They can only be classified as useful or not
  - Ex: "when a gamma ray hits a photographic places it leaves a mark" is neither T nor F
- They are instruments
  - Ex: a thermometer is neither true or false, but it is useful

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Duhem's rejection of Poincare's conventionalism

- Logical alone cannot force you to abandon a theory
- But "good sense" in science can
- Scientist A and scientist B can logically adopt different strategies wrt to T when experiments contradict it:
  - A: modifies the fundamentals of the theory
  - B: modifies some auxiliary hypotheses
- Good sense is telling when an experiment is crucial

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Duhem's rejection of Poincare's conventionalism

- Example of good-sense at work: Jean Biot (1774-1862)
- defender of the particle theory of light
- more and more difficult to defend after the work of Thomas Young (1773-1829) and August Fresnel (1788-1827)

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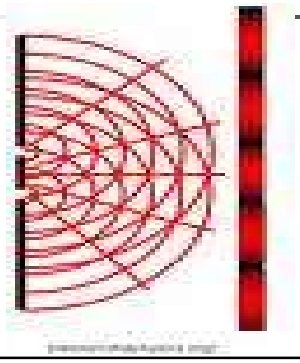
Duhem's rejection of Poincare's conventionalism



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Duhem's rejection of Poincare's conventionalism

- Even after most scientists opted for the wave theory of light, Biot kept modifying the assumption in the particle theory
- But then followed the Foucault experiment (light travelled more slowly in water than in air) and he abandoned it

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Duhem's rejection of Poincare's conventionalism

- " … it may be that we find it childish and unreasonable … to maintain obstinately at any cost, at the price of continual repairs and many tangled-up stay, the worn eaten columns of a building tottering in every part, when by razing these columns it would be possible to construct a simple, elegant, and solid system. "

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Quine's attack on the two dogmas of empiricism

- The two dogmas of empiricism:
  - Analyticity
    - The analytic /synthetic distinction
  - Reductionism
    - Every meaningful synthetic statement is logically equivalent to some sentence containing only observational terms (joined together with logical connectives)

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Quine's attack on the two dogmas of empiricism

- They are dogmas because:
  - 1=the analytic/synthetic distinction is an unsupported article of faith
  - 2=reductionism is also unsupported because it is based on the analytic /synthetic distinction

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Quine's attack on the two dogmas of empiricism

- Quine: the two dogmas are identical
  - A reductionist posits a class of statements (analytic statements) that have NO empirical meaning and that are confirmed no matter how the world is
  - Since they have no factual component, their truth depends on a linguistic component

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Analytic-synthetic distinction

- Basic idea (pre-Quine):
- Synthetic statements= observational statements
  - They are true or false depending on how the world is
- Analytic statements = they have no observational content; they are confirmed no matter what
  - So, their meaning comes from their linguistic component

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What does 'analytic' mean? Traditional answers

- Kant:
  - Analytic: iff the concept of the predicate is contained in the concept of the subject
  - Any statement that is not analytic is synthetic
- Geometry and mathematics:
  - synthetic a priori ("the straight line is the shortest distance between two points")
  - Empiricists (who believed that all synthetic statements must be a posteriori) were wrong

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Traditional answers

- Frege:
  - criticism of Kant (too strict and vague definition)
  - A statement is analytic iff it can be proved from definitions using only the laws of logic (reduction to a tautology)
  - Truth about geometry are synthetic a priori (like Kant)
  - But arithmetic is analytic
    - Logicism…

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Logicism: arithmetic is ultimately reducible to logic

- Frege:
  - Arithmetical truths are analytic because they are reducible to logical truths;
  - logical truths are immediately seen to be true by the use of our reason;
    - Platonism=the human mind has the ability to grasp by rational intuition necessary truths about abstract reality.
- Logical positivists liked logicism but could not accept Platonism
  - logical truths do not have any factual content and their truth is determined just by convention

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Geometry

- Kant and Frege: synthetic a priori
- Logical Positivists:
  - Einstein's GR: physical geometry is an empirical matter.
- Pure geometry (study of the logical consequences of various axioms) is analytic;
- Empirical Geometry (nature of physical space) is synthetic.

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Reductionism

- The meaning of a synthetic statement is given by its implications from experience
  - Verifiability criterion of meaning = Reductionism:
    - An individual statement has **meaning** only if it logically implies a group of statements that are about our immediate experience.

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Quine's rejection of the analytic-synthetic distinction

- Fregean definition of analyticity: a statement is analytic iff it is a tautology or can be reduced to it by means of definitions
  - No bachelor is unmarried→ No unmarried man is married
- Definitions are acceptable only when they preserve the existing meaning of the term in question
- So a satisfactory account of analyticity depends on a account of synonymy (sameness in meaning)

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Q's rejection of the analytic-synthetic distinction

- What is synonymy?
- Attempt 1: two terms, X and Y, are synonyms when they are interchangeable *salva veritate*:
  - Without changing the truth or falsity of the sentences in which they occur.
    - X=bachelor
    - Y=unmarried man
      - All bachelors are unmarried men → All unmarried men are unmarried men

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Q's rejection of the analytic-synthetic distinction

- But this does not guarantee the sameness in meaning:
  - X=creature with a heart
  - Y=creature with a kidney
    - All creatures with a heart are creatures with a heart → All creatures with a heart are creatures with a kidney
  - X and Y are interchangeable salva veritate because they the same extension (they refer to exactly the same objects) but they do not mean the same thing.
- For synonymy between X and Y we need more than just X iff Y

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Q's rejection of the analytic-synthetic distinction

- Attempt 2:
- X is a synonym of Y = necessarily, X iff Y
- But this just amounts to say that

"X iff Y" is analytic, and this is circular.

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Q's rejection of the analytic-synthetic distinction

- Perhaps the failure to give an independent characterization of synonymy can be traced to the vagueness of ordinary language
  - Artificial language in which the semantic rules are generating the analytic sentences

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Q's rejection of the analytic-synthetic distinction

- But this is circular again:
- what distinguishes these semantical rules (to generate analytic statements) from other semantical rules (such as those specifying all the truths of the language)?
- These are the ones that picks out all and only the analytic sentences

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Q's rejection of the analytic-synthetic distinction

- Quine's conclusion:
- the analytic-synthetic distinction is a dogma, an unsupported (and perhaps unsupportable) article of faith

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Q's rejection of the analytic-synthetic distinction

- Two dogmas →
- meanings are not independent of other statements that we accept →
- we cannot decide whether a given statement is analytic or synthetic **without** considering our entire web of beliefs →
- Q's holism

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Duhem and Quine: Differences

- Context
  - Quine: in the context of analytic/synthetic distinction
  - Duhem: nothing like that
- Type of holism
  - Quine's Semantic holism: any expression in a language cannot be understood in isolation
  - Duhem's Confirmation holism: a theory cannot be tested alone by experience

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Duhem and Quine: Differences

- Scope
  - Duhem: holism in physics; Quine: global holism – "the totality of our so-called knowledge or beliefs"
- Ways of saving a theory
  - Duhem: unreasonable and contrary to good sense to stick with a theory beyond a certain point
  - Quine: pragmatic factors are important (but no detail provided)
    - The only ground for choosing which explanation to believe is " the degree to which they expedite our dealings with sense experiences"

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Criticism of Duhem

- Quine seems right (and Duhem wrong) in thinking that the whole science, and not just physics, should be subjected to the holistic thesis
- Other sciences:
  - Ambiguity of falsificationism is avoided in them in using instruments because the chemist, say, accepts many auxiliary hypotheses as established truths on the presumed infallibility of physics
    - Just a difference in the psychology of testing, not in the logic

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Criticism of Duhem

- Geometry:
- Duhem was convinced that geometry had been conclusively established to be true by our common-sensical knowledge of the world
  - Only in Euclidean geometry there can be similar figures of different sizes. In non-E geometries instead two figures are similar iff they are equivalent, and this seemed absurd to D
  - Therefore, D rejected relativity as a purely formal theory with no application to the real world

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Criticism of Quine

- The claim that " the whole science" is the unit of empirical significance is implausible
  - When a physical theory is combined with other theories and assumptions to generate a prediction, theories from other sciences play no role in the derivation
  - Quine, later on, tones down his thesis in this respect
    - "little is gained by saying that the unit is in principle the whole science"

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A possible formulation of the Quine-Duhem thesis

- The holist thesis applies at any (high) level (contrary to Duhem, in light of Quine)
- The group of hypotheses under test in any given situation is in practice limited and does not extend to the whole human knowledge (contrary to Quine, in light of Duhem)
- Q's claim that "any statement can be held to be true come what may…" is true from a logical point of view but scientific good sense concludes in many situation that it would be perfectly unreasonable to hold to particular statements (addition to Quine, in light of Duhem)

- Donald Gillies

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Laudan's repudiation of underdetermination

- Laudan is critic of those that have used the Q-D thesis to bolster their view that science is governed to a large degree by sociological forces and can be understood only by taking these factors into consideration
- Purposes of the article:
  - Clarify different claims about underdetermination
  - Assert their plausibility
  - See what follows form each of them
- Conclusion:
  - once we distinguish that there are different versions of the underdetermination thesis, underdetermination shows to be either true but innocuous or dramatic and false.
  - Often philosophers take the underdetermination thesis for granted without giving any argument for it.

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Laudan's repudiation of underdetermination

- Two types of underdetermination
  - deductive
    - it limit itself to what can be established about the status of theories, given some evidence, through deductive logic
      - Hume
  - ampliative
    - it permits the use of non-deductive inferences as well
      - Quine, Goodman, Kuhn, Hesse, Bloor

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Laudan's repudiation of underdetermination

- HUD (Humean underdetermination): " for a finite body of evidence, there are indefinitely many mutually contrary theories, each of which logically entails that evidence" : (T→E) & E does not imply T
- (familiar) arguments for HUD:
  - T1=A&E; T2=B&E; T3=C&E,...E=evidence; A=all electrons have mass of 1 g; B=all electrons have mass of 2 g;…
- HUD is true but uninteresting: it concerns only what is logically possible

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Laudan's repudiation of underdetermination

- Quinean underdetermination
  - NUT (non-uniqueness thesis): "for any theory T, and any given body of evidence supporting T there is at least one rival (i.e. contrary) to T that is as well supported (by that evidence) as T"
  - EGAL (egalitarian thesis): "every theory is as well supported by evidence as any of its rivals" – implicitly assumed and not really argued for

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Laudan's repudiation of underdetermination

- Quine's explicit doctrine:
- (0) "one may hold onto any theory whatever in face of any evidence whatever" (Quine)
- Laudan:
  - (0) "presupposes EGAL ("every theory is as well supported by evidence as any of its rivals") and makes no sense without it"
  - Q has to show EGAL to be true

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Laudan's repudiation of underdetermination

- Quine's explicit doctrine:
- (0) "one may hold onto any theory whatever in face of any evidence whatever"
- In order for (0) to be interesting it has to be normative, not descriptive
- (0)→(1): "it is rational to hold onto any theory whatever in the face of any evidence whatever"

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Laudan's repudiation of underdetermination

- (1) (=it's rational to hold on to T) is supposed to follow from
- QUD (quinean underdetermination): "any theory can be reconciled with any recalcitrant evidence by making suitable adjustments in our other assumptions about nature "

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Laudan's repudiation of underdetermination

- In order for QUD to be relevant for (1) (=it's rational to hold on to T) it must concern ways in which we can rationally reconcile any theory with any evidence
- The notion of reconciliation is ambiguous:
  - T is logically compatible with E (→ QUD1)
  - T logically entails E (→QUD2)
  - (T explains E
  - T is empirically supported by E)

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Laudan's repudiation of underdetermination

- QUD1 (logical compatibility): any theory T can be rationally reconciled by any recalcitrant evidence E by deleting some of the original auxiliaries and perhaps adding a new auxiliary B such that the new group ($T\&B\&A_2\&A_3\ldots\ \&A_n$) does NOT entail anything that is inconsistent with E
- QUD2 (entailment): any theory T can be rationally reconciled with any recalcitrant evidence E by deleting some of the original auxiliaries and adding a new auxiliary B such that the new group ($T\&B\&A_2\&A_3\ldots\ \&A_n$) entails E

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Laudan's repudiation of underdetermination

- But:
- The shift from one group to the other is rational only if the new group:
- 1- has a significant degree of empirical support
- 2- is able to explain E
- Deleting hypothesis (presumably) will make T loose explanatory and predictive power

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Laudan's repudiation of underdetermination

- We need something like EGAL:
- EGAL: "every theory is as well supported by evidence as any of its rivals"
  - Because only if every theory enjoyed the same degree of empirical support any theory could be rationally retained in the face of any evidence whatever
- Laudal: Q does not argue for it, he assumes it

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Laudan's repudiation of underdetermination

- The strong programme in the sociology of science
  - Mary Hesse and David Bloor
  - underdetermination implies that scientists' decisions about theories are caused by social factors and processes rather than by reasoning and logic

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Laudan's repudiation of underdetermination

- Hesse:
- (1) HUD- scientific theories are deductively underdetermined by the data
- (2) so, scientists must adopt extra-empirical criteria for what counts as a good theory when deciding to accept one theory in preference to its empirically adequate rivals
- (3) these empirical criteria differ over time and between groups
- (4) hence, the adoption of these criteria should be explained by social rather than logical factors
- (5) thus, the decision to accept particular scientific theories on the basis of these criteria must also be explained by social rather than logical factors

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Laudan's repudiation of underdetermination

- Laudan: (4) – the conclusion that the adoption of the criteria must be socially constructed- does not follow: it presupposes that anything that cannot be determined by logic has to be determined by social factors.
  - why not say that the selection of the rule is the result of some reasoning (different Cs from different Ps)?

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Laudan's repudiation of underdetermination

- Bloor:
- sometimes scientists change their belief though there may no change in the evidence and that system of belief can be held stable in face of changing evidence
- Therefore, scientists are free to believe whatever they like, independently of evidence

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Laudan's repudiation of underdetermination

- Laudan:
- this just shows that:
  - theoretical preferences are influenced by factors other than empirical evidence
  - new evidence is sometimes not enough to cause scientists to change their minds
- the argument goes astray because it claims that because certain types of evidence are neither necessary nor sufficient to change in belief it follows that no evidence can ever compel a rational scientist to change his belief

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Laudan's repudiation of underdetermination

- Summary:
  - HUD (Deductive underdetermination aka Humean underdetermination: for a finite body of evidence, there are indefinitely many mutually contrary theories, each of which logically entails that evidence) -/-> ampliative underdetermination
  - NUT (non-uniqueness thesis: for any theory T, and any given body of evidence supporting T there is at least one rival, i.e. contrary, to T that is as well supported by that evidence as T) -/-> a theory cannot be rationally judged to be better than its rivals (strong underdetermination)

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