Realism and antirealism

Two things we might want science to do:

- 1- Help us to predict and control the world around us.
  - The ancient astronomers wanted a good 'natural clock' on which to base a calendar.
  - Modern science helps us to design effective building structures, cell phones, airplanes, drugs, ...
- 2- Tell us what the world is like: "the reality beyond the appearances".
  - What shape is the universe we live in, and what is our place in the big picture?
  - Is the physical world ultimately made of atoms, or fields, or something else again?
- Everyone agrees that science can do (1). But only *scientific realism* (SR) thinks that science can also do (2) → is SR true?

Scientific Realism

- It is the common-sensical view that, subject to the recognition that scientific method is fallible and that scientific knowledge is always approximate:
  - we are justified in accepting the most secure findings of science at face value
  - we have good reason to believe that the phenomena described by science have properties that are independent of our theories bout them

Scientific Realism

- The puzzle:
- Why is it a philosophical position?
- Compare with 'polar bear realism:' the doctrine that there are polar bears –
  - The books we buy about them tend to get things about them right and
  - These animals have properties independent of our theories about them.

Scientific Realism

- Why is SR a philosophical position and 'polar bear realism' is not?
- Because SR has been challenged by powerful arguments:
  - Underdetermination argument
  - Pessimistic meta induction argument

Scientific Realism

- Four (consecutive) challenges to SR:
  - 1- empirical challenge (logical empiricism)
    - A challenge regarding the knowledge of unobservable entities → udnerdetermination argument
  - 2-Neo-Kantian challenge, first version (Hanson 1958, Kuhn 1970)
    - Semantic and methodological incommensurability used to argue that SR is impossible
  - 3-Neo-Kantian challenge, second version (Fine's NOA, Putnam's internal realism)
    - Critiques of 'metaphysical versions' of realism
  - 4-Post-modern challenge (sociolocigal and political studies)
    - Arguments to show that science is a social construction, thus we should reject the idea that it achieves an approximate fit between theory and reality

Two possible attitudes

- **Scientific realism**: The theory, say Copernican astronomy, is a true description of the way the Earth, planets and stars move. This is *why* its predictions are accurate.
  - Copernicus himself was a *realist* about Copernican astronomy.
  - In the Copernican Revolution, the distinction between realism and instrumentalism was important because: it is only if we are *realists* that the theory will seem to be in tension with the religious worldview.

Two possible attitudes

- **Instrumentalism**: the theory (say, Copernican astronomy) is *just* a mathematical system that is very good at generating accurate predictions for the apparent positions, sizes and shapes of stars and planets. There is **no** reason to think that it is a true description of the way the planets really are.
  - Osiander's foreword urges an *instrumentalist* attitude to Copernican astronomy
  - "Nor is it necessary that these hypotheses should be true, nor indeed even probable, but it is sufficient if they merely produce calculations which agree with the observations."

Scientific Realism

- According to standard scientific realism:
  - (semantic) (i) Scientific theories *are the right kinds of things* to be true or false;
    - Truth conditions are objective, depend on how the world is
  - (metaphysical) (ii) The truth of a scientific theory *goes beyond its empirical adequacy*;
    - Entities exist independent on our minds
  - (epistemological) (iii) We are (sometimes) *justified in believing* that our best theories are (at least approximately) true.

Scientific Realism

- Instrumentalists (like logical positivists) deny (i) (Scientific theories *are NOT the right kinds of things* to be true or false).
- Neo-kantians accept (i) but deny (ii) (The truth of a scientific theory DOES NOT *go beyond its empirical adequacy*).
- Constructive empiricists accept (i) and (ii), but are less than entirely comfortable with (iii) (We are NOT *justified in believing* that our best theories are at least approximately true)

Scientific Realism

- Two arguments against scientific realism
  - The underdetermination argument
  - The pessimistic meta-induction
- An argument for realism
  - The no-miracles argument (a.k.a. 'ultimate argument' or 'cosmic coincidence argument')

Scientific Realism

- Two qualifications:
  - What counts as 'best theory' we should be realist about? Varieties of realism:
    - Explanationist realism: realist commitments with respect of those parts of science that are indispensable or important to explain empirical success (Kitcher)
    - Entity realism: one is justified in believing in those unobservable entities they an use to do things in the world (Hacking)
    - Kind realism: one should be realist with respect to the natural kinds postulated by a theory (Carrier)
    - Structural realism: one should be realist not about the nature of things described in a theory, but about their structure (Worrall)
  - What is the notion of approximate truth? See later

The underdetermination argument

- An argument against scientific realism.
- Underdetermination:
- When more than one theory is compatible with the evidence, we say that *the evidence underdetermines the theory*.

The underdetermination argument

- Examples:
  - 1-Why is the train late?
    - The data: The timetable says that the train is supposed to arrive at 3.10pm. My watch now says 3.30pm. The train hasn't arrived yet.
    - Possible explanations:
      - There is a problem with the engine.
      - There is a problem with the track.
      - There has been a signal failure.
      - The driver called in sick; the train has actually been cancelled, but I haven't seen the announcement.
      - My watch is running fast; actually it's only 3.05pm.

The underdetermination argument

- All of these hypotheses are compatible with the appearances.
- We say that the appearances (of the timetable, the empty platform, the face of my watch, etc.) *underdetermine* the correct explanation.

The underdetermination argument

- Some radical cases of underdetermination
  - The dream
  - The Evil Demon
  - The Brain in a Vat
  - The Matrix
  - Solipsism
  - The Very Young Earth theory (The world came into existence five minutes ago).
  - The Common Sense theory: All of the above are false, and the world is pretty much the way common sense says it is

The underdetermination argument

- None of your present experiences is enough, all by itself, to prove that any of the theories is false.
  - i.e. Your present experiences *underdetermine* the truth about the 'reality beyond the appearances'

The underdetermination argument

- Underdetermination in science
  - in science, it is far less obvious which theory is the most plausible – we have cases in which the data fails to distinguish between two or more theories that seem to be about as plausible as one another.
  - When this happens, underdetermination becomes a *serious* problem for would-be realists.
  - Examples of underdetermination in science:
    - Ptolemaic and Copernican astronomy, c.1600
    - Three versions of quantum mechanics (now)

The underdetermination argument

- Examples of underdetermination in science:
  - Ptolemaic and Copernican astronomy, c.1600
  - Three versions of quantum mechanics (now)

The underdetermination argument

- Using the idea of underdetermination to construct an argument against scientific realism:
- Definition:
- Two theories T1 and T2 are *empirically equivalent* iff T1 and T2 make all the same predictions for observable events.

The underdetermination argument

- P1. For every scientific theory T1, there is an empirically equivalent but incompatible theory T2
  - Two theories T1 and T2 are *empirically equivalent* iff T1 and T2 make all the same predictions for observable events.
- P2. If theories T1 and T2 are empirically equivalent, there cannot be any reason to believe T1 rather than T2.
- C. There cannot be any reason to believe any scientific theory.

The underdetermination argument

- P2: If theories T1 and T2 are empirically equivalent, there cannot be any reason to believe T1 rather than T2.
  - Aka: knowledge empiricism = there can be no evidence which rationally distinguishes between two empirically equivalent theories
    - Evidential indistinguishability

The underdetermination argument

- It is part of a selectively sceptical program of anti-metaphysical 'rational reconstruction'
  - The aim was to solve the demarcation problem: scientific claims are meaningful, 'metaphysical' claims are not because they are unobservable

The underdetermination argument

- How to accept theoretical terms (=terms referring to the unobservable)?
  - Project of 'rational reconstruction' of actual scientific practices → not easy to do
  - Operationalism:
    - treat theoretical terms as being completely defined in terms of particular operational procedures, eliminating the reference to the unobservable

The underdetermination argument

- E.g.: (*) electron density in a region R=(true by linguistic stipulation)it is given by the value x, iff E applied to R the value x, where E is an instrument such that, prior to the rational reconstruction (but not after), scientists would have thought of it as process to measure electron density

The underdetermination argument

- Problem: (*) is analytic and not revisable, thus there is nothing that can measure electron density better than E, but scientists replace instruments all the time!

Ways for a realist to (attempt to!) respond to this argument

- Ways to deny P1 ("For every scientific theory T1, there is an empirically equivalent but incompatible theory T2.")
  - 1-Claim that the alternatives aren't really empirically equivalent.
    - weak empirical equivalence iff both theories make all the same predictions for *observations and experiments that have been carried out so far.*
    - strong empirical equivalence iff they make all the same predictions for *all possible observations and experiments.*

Ways for a realist to (attempt to!) respond to this argument

- The problem with this response:
  - *weak* empirical equivalence is *relevant* to figure out whether or not we should believe in our best scientific theories *now*

Ways for a realist to (attempt to!) respond to this argument

- Ways to deny P1 ("For every scientific theory T1, there is an empirically equivalent but incompatible theory T2.")
  - 2-Claim that empirically equivalent alternatives "aren't really theories".
    - Examples
      - brains in vats + crazy theories

Two problems with this response

- 1-Ptolemaic and Copernican astronomy, say, are surely both genuine theories.
- 2-unclear how to distinguish between 'theories' and 'pseudo-theories'

Ways for a realist to (attempt to!) respond to this argument

- Ways to deny P1 ("For every scientific theory T1, there is an empirically equivalent but incompatible theory T2.")
  - 3-Claim that the alternatives aren't really distinct

Ways for a realist to (attempt to!) respond to this argument

- Problem: difficult to defend.
  - E.g. Ptolemaic and Copernican astronomy certainly *look* like distinct alternatives...

Ways for a realist to (attempt to!) respond to this argument

- Ways to deny P1 ("For every scientific theory T1, there is an empirically equivalent but incompatible theory T2.")
  - 4-Claim that the notion of empirical equivalence is incoherent or ill-defined
  - Attempt 1:
    - No non-arbitrary distinction between observable and unobservable entities
    - Such distinction is necessary in order to make sense of empirical equivalence
    - Therefore empirical equivalence is ill-defined

Ways for a realist to (attempt to!) respond to this argument

- Problem: we can define as observable the terms that are understood independently from the theory
  - CED: velocity, temperature are observable; potential and charge are not

Ways for a realist to (attempt to!) respond to this argument

- Ways to deny P1 ("For every scientific theory T1, there is an empirically equivalent but incompatible theory T2.")
  - 4-Claim that the notion of empirical equivalence is incoherent or ill-defined
  - attempt 2 (Laudan, Leplin):
    - the distinction between observable and unobservable entities varies over time (since it depends on the language an that changes as we gather more data)
    - so theories that now are empirically equivalent may not be at a later time

Ways for a realist to (attempt to!) respond to this argument

- Problem: one can rephrase the underdetermination argument such that it mentions theories at a given time

Ways for a realist to (attempt to!) respond to this argument

- A way to deny P2 ("If theories T1 and T2 are empirically equivalent, there cannot be any reason to believe T1 rather than T2.")
  - Two theories are *evidentially equivalent* [definition] iff there cannot be any reason to believe either more than the other.
  - A realist can deny P2 by claiming that *empirical equivalence does **not** entail evidential equivalence*.
  - This requires an account of 'super-empirical virtues'.

The underdetermination argument

- **'Empirical virtues':**
  - *correct* predictions (= empirical adequacy)
  - *lots of* predictions (= empirical strength) & wide scope
- **'Super-empirical virtues':** things that can make one theory better (= more worthy of belief) than another, *other* than getting the predictions right.
  - Simplicity, non-ad-hoc-ness, having made *novel* predictions, elegance/beauty/harmony, external consistency, ...

The underdetermination argument

- Evidential Indistinguishability Thesis (EIT):
  - Local explanationism (McMullin, Miller, Lipton): explanatory power can adjudicate between empirically equivalent theories
  - Abductive strategies (Boyd, Psillos): it treats SR as an hypothesis itself, claiming that it is supported by the fact that it is the only viable explanation for the success of science)
    - See later non miracle arguments

The underdetermination argument

- Problems for the realist:
  - 1-No agreement on how to rank these features
    - see Kuhn
  - 2-Why are theories with 'super-empirical virtues' *more likely to be **true*** than theories that do not have such virtues?

The underdetermination argument

- If this questions cannot be answered:
- the super-empirical virtues seem to be *pragmatic virtues* (they give us a reason to use the theory for making predictions),
- But they are not *epistemic virtues* (they don't give us a reason to believe the theory).
- "Pragmatic virtues do not give us any reason over and above the evidence of empirical data for thinking that a theory is true" (Van Fraassen)"

The underdetermination argument

- A possibility for the SR: reject that evidence for belief in a theory is exhausted by empirical data; rather, the explanatory power play an evidential role
  - Lipton 2004: "we infer what would, if true, provide the best explanation"
  - Harman 1965: "one infers, from the premise that a given hypothesis would provide a 'better' explanation for the evidence than would any other theory, to the conclusion that the given hypothesis is true"

The underdetermination argument

- Problems:
- 1) How do we judge 'better'?
- Simplicity, consistency, coherence, scope, unity,… can these virtues be precisely and uniquely and objectively defined? Can they be ranked objectively? What if they're not enough to favour one theory? Are they just pragmatic virtues? If so, why should they matter as indicators of truth?

The underdetermination argument

- 2) even if we can rank these theories, it does not mean much: we may just have a bad lot of theories and simply have identified the best of this bad lot (van Fraassen)
  - Reply: this is better than nothing

The pessimistic meta-induction

- PMI-1: The 'disaster' argument (Larry Laudan 1981) against scientific realism
  - P1. In the history of science, the vast majority of theories that were seriously believed at one time have later turned out to be false.
  - P2. There is no reason to think that current theories are different.
  - C. It is overwhelmingly likely that the majority of current scientific theories are false.

The pessimistic meta-induction

- Justifying P1: Error in the history of science
  - Over the course of history, thousands of respectable scientists have believed theories that we now think are false.
  - Examples
    - 1-The theory of crystalline spheres (Aristotle/Eudoxus)
    - 2-Ptolemaic astronomy
    - 3-Aristotelian physics
    - 4-The humoral theory of medicine
    - 5-Separate creation for each species (as opposed to the theory of evolution)
    - 6-The phlogiston theory of combustion
    - 7-Newtonian physics
    - …

The pessimistic meta-induction

- Phlogiston theory of combustion: popular in chemistry in the 18th century.
  - Unburnt (but burnable) substances contain phlogiston.
  - When the substance is burnt, phlogiston is released.
  - Non-burnable substances are substances that do not contain phlogiston.

The pessimistic meta-induction

- Oxygen theory:
  - Unburnt (but burnable) substances have a capacity to combine with oxygen.
  - When the substance is burnt, (part of) it combines with oxygen.
    - Usually the part that combines with oxygen is released as a gas. (This is the oxygen-theorist's explanation of why most substances lose weight when burnt.)
  - Non-burnable substances are not able to combine with oxygen (in a suitable way).
- Modern scientists believe that there isn't (and never was) any such thing as phlogiston; phlogiston theory was just false.

ways for a realist to respond to the disaster argument

- 1-Deny P1 ("In the history of science, the vast majority of theories that were seriously believed at one time have later turned out to be false.")
  - Something wrong with characterizing some rejected theories as being *just false*.
  - The rejected theories were
    - approximately true, and/or
    - partially true, and/or
    - close to the truth,
  - If so, then something very close to realism can be maintained

Problems with that sort of response

- 1- this response is relatively plausible for the case of Newtonian physics, but it's far less plausible for e.g. phlogiston theory:
  - If phlogiston does not even exist, and nothing like it exists, how can a theory that explains combustion in terms of phlogiston be (e.g.) 'approximately true'?
- 2- difficult to characterize 'approximate truth' or 'partial truth' or 'closeness to the truth'.

The notion of approximate truth

- Motivations:
  - Abstraction (incorporate only some relevant parameters) + idealization (distorting the nature of certain parameters) → models and theories are not, strictly speaking, true
  - The idea of convergent realism: theories get closer to the truth as scientific inquiry progresses

The notion of approximate truth

- Two routes:
- 1a) formal (Popper 1972)
- Relative orders of verisimilitude (=likeness to the truth) between theories over time in terms of comparison between their true and false consequences
- Problem: it has been shown that in order to make sense of A having a greater verisimilitude than B, A would have to be true

The notion of approximate truth

- 1b) possible worlds (i.e.) similarity approach
- Truth conditions of a theory are identified by the set of possible worlds in which it is true
- Truth-likeness is calculated by means of a function that measures the average, or some distance, between the actual world and the worlds in that set

The notion of approximate truth

- 1c) type hierarchy approach
- Truth likeness is analysed in terms of similarity relationship between nodes in a tree structured graph of types representing scientific concepts on the one hand and entities, properties and relations on the other

The notion of approximate truth

- 2) qualitative approach
- 2a) limiting case approach:
- One theory T1 is closer to the truth than T2 if T2 is a limiting case of T1
- …

Problems with that sort of response

- 3- An argument that scientific theories cannot be approximately true because its theoretical terms fail to refer
- A term successfully refer if it picks out something in the world
  - 'horse' vs 'the present king of France'
  - sense: ideas and descriptions associated with the term
  - reference: the thing picked out by the term
- The sense changes over time, the reference is determined by the pointing
  - ex: 'whale' - sense before: fish; sense now: mammal

Problems with that sort of response

- 3- An argument that scientific theories cannot be approximately true because its theoretical terms fail to refer
  - Theoretical terms refer to unobserved entities, so we cannot determine its reference by (physical, direct) pointing
  - Rather, the **reference is determined by the theory** (i.e. the sense determines the reference)
  - Since senses change over time also references change over time
  - So either the world changes when we change the theory, or theoretical terms do not refer
  - If theoretical terms do not refer, then the theory cannot be approximately true

Problems with that sort of response

- Neo-Kantian challenge, first version
- Kuhn challenged SR arguing from theory dependence of methods to the conclusion that a realist conception of the growth of approximate scientific knowledge cannot be obtained
- During scientific revolutions, there are no rational methods to compare alternative theories
- Ex: Newtonian and relativistic mechanics" they do not share a common subject, the term 'mass' does not mean the same (in one theory it is independent of velocity, in the other it is not; in one theory it doesn't transform into energy, in the other it does…) → reference failure

Problems with that sort of response

- There is commitment to a 'descritptivist' conception that the referent of a term is picked out by a description which constitutes the analytic definition of the term in question

Problems with that sort of response


- Saul Kripke (1975), Hilary Putnam (1976): causal and naturalistic conception of referent
  - The relation between a term and its referent is a matter of there being the right sort of causal relation between uses of the term and instances of the referent
  - If so, then we can have a posteriori, non-analytical definitions of kinds to which scientific terms refer
  - Scientific kinds are real, rather than nominal essences
  - Ex: the essence of water is H20
  - Scientific kinds are natural kinds, defined in terms of their essence → connection with projectibiliy of predicates

ways for a realist to respond to the disaster argument

- 2-Deny P2 ("There is no reason to think that current theories are different")
- Our examples of now-thought-false theories were empirically successful and explanatory.
- But perhaps we can find other respects in which they are different from other theories, and hence deny P2.

ways for a realist to respond to the disaster argument

- Ways to deny P2
  - 2A-Restrict realism to 'mature' theories
    - Problem: how to give a noncircular explication of what 'mature' means.
    - If 'science X is mature' just means 'science X has been going on for long enough that it's reached the stage of being approximately true', then our problem recurs, in the form: *why should we believe that our current sciences are mature?*

ways for a realist to respond to the disaster argument

- Mature: unification, coherence, mathematical sophistication…
- ex: all parts of modern physics share:
  - law of conservation of energy
  - basic theory of matter
  - same units
  - same concepts
- is this a good definition?

ways for a realist to respond to the disaster argument

- Another definition of mature:
  - Well established (survived many tests for a very long time),
  - not ad hoc (not precisely posited to account for observations)
- Problem: too vague  
  - Add novel predictions? (Alan Musgarve, Peter Lipton,…)

ways for a realist to respond to the disaster argument

- Ways to deny P2
  - 2B-Restrict realism to theories enjoying novel predictive success
    - Problem:
    - 1-make precise "novelty" is not straightforward
      - temporal novelty
      - epistemic novelty
      - …
    - 2-there have been (at least some) *false* theories that "enjoyed novel predictive success".

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C- restrict realism in other ways:
  - Structural realism
  - Entity realism
  - Explanationist realism

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-1 John Worrall's structural realism on approximate truth

- The most serious departures from the truth in scientific theories tend to be errors about the nature of their basic entities rather than on the nature of their relations:
  - We should accept claims about (observable and unobservable) structures posited by theories only

ways for a realist to respond to the disaster argument

- Two main kinds of structural realism:
  - Epistemic structural realism: our best theories successfully describe relations between entities, not entities themselves (Worrall)
  - Ontic structural realism: the very concept of entities is problematical; there are no such things, or if there are, they are just emergent from relations (French and Ladyman)

ways for a realist to respond to the disaster argument

- A problem for Epistemic structural realism:
  - How can they articulate a concept of structure which makes the knowledge of it effectively different from that of the nature of entities?
- A problem for Ontic structural realism:
  - Clarify the emergence relation change extremely challenging

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-2 Ian Hacking's entity realism (also Cartwright and Giere)

- We are justified in believing in unobservable entities that we can manipulate, not theories
  - Theories are not literally true
  - Justification from experimental (and not theoretical) practice of science

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-2 Hacking's entity realism (also Cartwright and Giere)
- We are justified in believing in unobservable entities that we can manipulate, not theories
  - Compatible with the causal theory of reference (Kripke Putnam): one can refer to an entity despite significant changes in the theory's description of its properties

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-2 Hacking's entity realism (also Cartwright and Giere)
  - The argument:
  - 1-We are entitled to believe that a theoretical entity is real iff we can use it to do things
  - 2-We can use certain theoretical entities (e.g. electrons) to do things
  - C- Thus, we are entitled to believe them to be real

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-2 Hacking's entity realism
- David B. Resnik's objections to entity realism:
  - 1) Resist 2: what is our justification to believe we can use electrons to do things?

    - Not deductive nor inductive (H doesn't believes in laws)
    - So it has to be abductive (IBE arg): the explanation for the success of experiments is that there are electrons
    - But H rejects abduction

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-2 Hacking's entity realism
- Resnik's objections to entity realism:
  - 2) the position is unreasonable:
  - We grant belief in unobservable without justification (so we have no knowledge): one can believe in entities theory-free because only if it is a natural kind, but we do not know that it is one! (contrast with the realist: she can know, since natural kinds are picked out by the theory)

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-2 Hacking's entity realism
- Resnik's objections to entity realism:
  - 3) experiments are loaded with theory!

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-3 Kitcher's explanationist realism (Stathis Psillos)

- We are justified in believing in indispensable unobservable entities
  - The ones that play a distinctive role in explanation
  - The success of past theories didn't depend on their false components
  - It is sufficient to show that what generated the success have been retained in current theories

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-3 Kitcher's explanationist realism
- Objection:
  - Provide a method to identify which aspects of theories are required for their success without being regarded as 'post-hoc' rationalizations

ways for a realist to respond to the disaster argument

- Ways to deny P2
- 2C-4 Martin Carrier's kind realism

- …
- 2C-5 Arthur Fine Natural Ontological Attitude
  - A distinct proposal:
    - Core non realist position shared by both realist and antirealist
    - …

ways for a realist to respond to the disaster argument

- The argument is not cogent
- Marc Lange 2002: turnover fallacy
  - It is fallacious to infer the chances that a current successful theory will be replaced in the future by looking at history and noting the percentage of theories that were false:
    - We should expect to find more false theories than true ones because false theories are more likely to be replaced
      - Baseball example

The pessimistic meta-induction

- PMI-2: the meta-level argument to the conclusion that success of science is not an indicator of truth (against the no-miracle argument, see later)

The 'no-miracle argument'

- The main argument for realism
- Hilary Putnam 1975: 'Realism is the only philosophy that doesn't make the success of science a miracle'
- Different varieties:
  - Local defence: to argue realism about specific theories
  - Global defence: to argue realism about all theories (the ultimate argument, the cosmic coincidence argument)

The 'no-miracles argument'

- The *basic idea* of no-miracles arguments:
  - Our best scientific theories are successful in lots of ways.
  - One possible explanation for this success is that the theories are actually *true*.
  - The only alternative seems to involve believing in 'miracles'/'cosmic coincidences': the theory isn't actually true, but somehow all the observable phenomena conspire to make it *look to us as if* the theory is true.
  - This alternative is implausible. Therefore we should be realists.

The 'no-miracles argument'

- Different varieties of no-miracle arguments:
- 1-Smart's argument for realism:
  - Only scientific realism can account for the difference between correct and merely useful theories
    - Ex: Copernican (C) vs Ptolemaic astronomy (P)
      - Realists accept C and reject P. They explain the usefulness of C by saying it is true AND they explain the usefulness of P saying that it is instrumentally useful.
      - Antirealists don't accept either C or P as true, so how can they explain their usefulness?

The 'no-miracles argument'

- Van Fraassen criticism:
  - Empirical adequacy can do the trick: both are empirically adequate, so they're both useful
- Reply: This just postpone the issue one step further
  - What explains the descriptive accuracy of C?
  - Without observable regularities being explained in terms of a deeper (unobservable) structure it seems that we have to believe in lucky accidents and coincidences

The 'no-miracles argument'

- Van Fraassen's reply to this reply:
- This is unreasonable
  - At some point you have to stop and posit some primitives

The 'no-miracles argument'

- 2- Wilfrid Sellars thought experiment for realism

- Two empirically indistinguishable samples of gold dissolute in acqua regia at different rates
  - No empirical regularity can explain this result
  - Only if we postulate that the two samples have (unobservable) different molecular structure we can explain this result
  - The aim of science is to explain
  - If so, science requires the belief in unobservables entities (even if they have no further observable consequence)

The 'no-miracles argument'

- Van Fraassen criticisms:
  - 1) it is not true that the microstructures do not have any observable consequence:
    - If A and B have different dissolution rates, Ra and Rb, then all gold samples will dissolves at rates between these two values, and any value in between can be observed: this was not implied by the original data

The 'no-miracles argument'

- Van Fraassen criticisms:
  - 2) it is not true that science has to explain in every case:
    - If quantum mechanics is incompatible with classical mechanics, no attempt to reduce QM to CM will work
  - 3) perhaps similar microstructures can be posited for other materials, and they will give rise to experimental/observational consequences

The 'no-miracles argument'

- 3) Puntam's ultimate argument
- Realism is the only adequate explanation for the success of science. Otherwise it is a miracle

The 'no-miracles argument'

- 4) Hacking's corroboration argument
- If some abstract entity can be detected using not one, but several instruments, then this is a basis for believing that this entity exists
  - Ex: dense bodies in red blood platelets can be detected by different kinds of microscopes (light and transmission microscopes)

The 'no-miracles argument'

- P1: some unobservable entities cab be detected by different means by different instruments
- P2: it would be an extraordinary coincidence if these entities did not exist
- C: therefore, we are justified in believing that they exist

The 'no-miracles argument'

- Objections:
- 1) detectors are constructed and calibrated precisely with the intent of reproducing the outputs of others
- 2) (vF) we can explain these findings without assuming explanations are true
  - See pragmatics of explanation

The 'no-miracles argument'

- Van Fraassen criticism:
  - If we demand science to explain, the success of science needs an explanation
  - Realists say it's the case because they believe in the correspondence between theories and truth: how could theories fail to refer if they successfully predict?
  - Van Fraassen goes with a Darwinian explanation:
    - As organism struggle for survival, so do theories: empirically inadequate theories die out

The local IBE defence of realism

- P1. It would be unreasonable to reject IBE in common sense reasoning.
- P2. There is no relevant difference between everyday reasoning and scientific reasoning.
- C1. It would be unreasonable to reject IBE in scientific reasoning. [from P1, P2]
- P3. If we accept IBE in cases of scientific reasoning, we accept the *truth* of our best physical theories, i.e. we are realists about our best physical theories.
- C2. It would be unreasonable to reject scientific realism. [from C1, P3]

The local IBE defence of realism

- A *preliminary* assessment of the local IBE defense of realism
  - P1 (It would be unreasonable to reject IBE in common sense reasoning) seems compelling.
    - Anyone who rejected inferences like the common sense one sketched above would be regarded as crazy.
  - P2 (There is no relevant difference between everyday reasoning and scientific reasoning.) seems compelling.
    - What could the difference be??
  - C1 does follow from P1 and P2.
  - C2 clearly follows from P3 and C1.

The local IBE defence of realism

- Justifying P3 (If we accept IBE in cases of scientific reasoning, we accept the *truth* of our best physical theories)
  - An example of IBE reasoning in science would be:
    - P1. We observe tracks in a cloud chamber, dots on a television screen and electrical phenomena.
    - P2. The best explanation of these phenomena is that there are electrons (obeying a particular set of laws).
    - Therefore,
    - There are electrons.
  - If we accept this IBE argument, then we accept that there are electrons. This is something that only the scientific realist will agree with. So P3 seems to be correct.

The local IBE defence of realism

- This is a 'local' defence of scientific realism because we have to run a separate IBE argument for each scientific theory that we want to be realists about.
  - One IBE argument will lead to the conclusion that the theory of evolution is (probably/approximately/etc) true.
  - Another IBE argument will lead to the conclusion that quantum mechanics is (probably/approximately/etc) true.
  - And so on, for each successful scientific theory.

Objection to the local IBE defence of scientific realism

- The pessimistic meta-induction (again)
  - P2 (There is no relevant difference between everyday reasoning and scientific reasoning.) is false:
  - The pessimistic meta-induction shows us that scientific IBEs very often go wrong. This is not true of everyday IBEs.

Objections to the local IBE defence of scientific realism

- 2-The objection from ambiguity (van Fraassen)
- What does it mean we follow a rule?
  - That we are willing to believe what follows the rule (and unwilling to believe what conflict with it)
    - Realists: they always follow IBE, so they are willing to believe theories to be true
    - Van Fraassen: he follows a different rule, and thus he is willing to believe the theory to be true empirically adequate

Objections to the local IBE defence of scientific realism

- 2-The objection from ambiguity (van Fraassen)
  - The notion of 'inference to the best explanation' is ambiguous, and when it is disambiguated the argument becomes either unsound or circular.
  - There are two senses of 'inference to the best explanation':
    - A-Inference to the *truth* of the explanans.
    - B-Inference to the *empirical adequacy* of the explanans.

Objection to the local IBE defence of scientific realism

- VF: What does it mean to follow a rule?
  - We are willing to believe anything that follows from that rule and unwilling to believe anything that conflicts with what follows from it
  - As such, the claim that we follow the rule that we are willing to believe that the theory that best explains the evidence is true is an empirical hypothesis that should be compared to the alternative, VF's CE: we are willing to believe that the theory that best explains the evidence is empirically adequate

Objections to the local IBE defence of scientific realism

- Constructive empiricists accept (empirical adequacy) but reject (truth).
  - Van Fraassen's example: Inferring that there is a mouse in the wainscoting vs. inferring that "there is a mouse in the wainscoting" is empirically adequate.
- So, if the realist means 'IBE' in sense (a), then P1 begs the question against the constructive empiricist.
- If the realist means 'IBE' in sense (b), P3 (If we accept IBE in cases of scientific reasoning, we accept the *truth* of our best physical theories) is false.
- Either way, the argument is unpersuasive

Objections to the local IBE defence of scientific realism

- Terminology:
- We say that an argument *begs the question* iff it is circular, i.e. if the defense of one or more of its premises requires already assuming that the argument's conclusion is true.

Objections to the local IBE defence of scientific realism

- The Darwinian objection (vF)
  - The success of our best scientific theories can be explained just by noting that we have thrown out all the unsuccessful theories. This is a perfectly good explanation, and does not involve postulating that the theory is *true*.

Objections to the local IBE defence of scientific realism

- Van Fraassen: "[T]he success of current scientific theories is no miracle. It is not even surprising to the scientific (Darwinist) mind. For any scientific theory is born into a life of fierce competition, a jungle red in tooth and claw. Only the successful theories survive – the ones which *in fact* latched onto actual regularities in nature."
  - Analogy: Why does the mouse run from the cat?

Objections to the local IBE defence of scientific realism

- Assessing the Darwinian objection
  - We need to distinguish between two questions:
    - How did the running-from-cats behavior evolve?
    - What is it about the mouse that explains why the mouse runs from the cat?
  - The Darwinian explanation answers the first of these. But answering the second question requires giving some details of mouse psychology.

Objections to the local IBE defence of scientific realism

- Assessing the Darwinian objection
  - We need to distinguish the questions:
    - How did successful theories come to be accepted?
    - What is it about theory T that explains why theory T is successful?
  - Van Fraassen's Darwinian explanation answers the first of these. But scientific realism is (allegedly) required to answer the second.

The global IBE defence of realism

- The "ultimate argument"/the "cosmic coincidence argument".
- This argument requires that we first formulate 'scientific realism' as a *single global claim* (rather than a large collection of realist claims about particular sciences: quantum mechanics is true, the theory of evolution is true, etc.), and then find an IBE argument for that global claim.

The global IBE defence of realism

- The "ultimate argument"/the "cosmic coincidence argument"
- We first need to formulate 'scientific realism' as a *single global claim*, and then find an IBE argument for that
  - Laudan's proposal: (R1) "Scientific theories (at least in the 'mature sciences') are typically approximately true and more recent theories are closer to the truth than older theories in the same domain." (Laudan)

The global IBE defence of realism

- It is not entirely clear *exactly* what the best way to formulate the claim of 'scientific realism' is (because it's not entirely clear what is the best way for realists to avoid objections like the pessimistic meta-induction).
- However, we can usefully start by discussing a typical formulation of realism:
  - (R1) "Scientific theories (at least in the 'mature sciences') are typically approximately true and more recent theories are closer to the truth than older theories in the same domain." (Laudan)

The global IBE defence of realism

- The explanandum
- The idea of the no-miracles argument is to argue that something like (R1) is required in order to explain several features of science.
- So the first thing we need to do is identify the features that [allegedly] require explanation

The global IBE defence of realism

- What are the features that we need to explain?
  - i-Science successfully predicts new and surprising phenomena.
  - ii-Science enables us to develop new technologies.
  - iii- Induction based on scientific theories is reliable
  - …

The global IBE defence of realism

- iv - When we test scientific theories, we rely on other theories as 'auxiliary hypotheses', and science has made progress by doing this.
  - E.g. in confirming microbe theory with microscopes, we rely on theories of optics to assure us that the microscopes are generally reliable image-generators.
- v - When we unify two theories that previously treated different domains of phenomena, the resulting unified theory is often successful.
  - E.g. Newtonian mechanics unified terrestrial and celestial physics, and went on to give a successful new explanation of the correlation between the tides and the position of the moon.

The global IBE defence of realism

- The global IBE defense of realism
  - P1. Scientific realism can *explain* features of science like (i)—(v) above.
  - P2. The only alternative is to postulate a large number of 'miracles'/'cosmic coincidences'. This is not an *explanation*.
  - C1. Scientific realism is the only explanation of features of science like (i)—(v). [from P1, P2, by deductive inference]
  - C2. Scientific realism is true. [from C1, by IBE]

Objections to the global IBE defence of realism

- 1-The circularity objection
  - "It is little short of remarkable that realists would imagine that their critics would find [the no-miracles argument] compelling. ...[E]ver since antiquity critics of epistemic realism have based their scepticism upon a deep-rooted conviction that the fallacy of affirming the consequent is indeed fallacious. ... Now enters the new breed of realist... who wants to argue that... realism can reasonably be presumed to be true by virtue of the fact that it has true consequences. But this is a monumental case of begging the question." (Laudan)

Objections to the global IBE defence of realism

- The point here is that:
  - realists accept inference to the truth of the best explanation, and hence are already convinced by a *local* IBE defence of realism, so for them the global defence is superfluous
  - non-realists regard IBE as just a special case of 'affirming the consequent' (which is a logical fallacy), and so an IBE 'defence of realism' will do nothing to convince them.

Objections to the global IBE defence of realism

- 'Affirming the consequent:'
  - P1. If X, then Y
  - P2. Y
  - Therefore
  - C. X

Objections to the global IBE defence of realism

- This argument begs the question because it uses a principle that antirealists will explicitly deny
- Antirealists will deny that IBE gives us reasons to believe in the truth of theories it supports
  - vF: it just gives us reasons that these theories are empirically adequate

Objections to the global IBE defence of realism

- PM-2: the meta level argument (by reductio)
  - 1- empirical success is a reliable indicator of truth (from the no miracle arg. - reduction assumption)
  - 2-our most current theory is true (from 1)
  - 3- most past theories are false (they are incompatible with the current theory)
  - 4-many past theories were empirically successful
  - C- thus (1) is false

Ways to reply to the meta PMI

- 1) Deny P4: insist that success means more than agreement with the data
- Alan Musgrave - Novel predictions are crucial
  - This rules out many past successful false theories

Ways to reply to the meta PMI

- 2) Deny P3: insist that strong successful theories refer to unobservable entities even if past scientists had false beliefs about them
  - So there are some truths in false theories, and that is what makes them empirically successful
  - → restrict realism to what makes the theory successful…

Ways to reply to the meta PMI

- 3) maintain that the argument is fallacious (Peter Lewis) - Base rate fallacy:

  - Past success of false theories is not sufficient to show that success is not an indicator of truth because when true theories are rare and false theories common, most cases of success come from false theories
    - A much higher percentage of accepted theories are true now than in the past. Thus we should expect that in the past, success was a poor indicator of the truth not because true theories are not likely to be successful but because in the past there was a much higher fraction of false theories among successful ones

Ways to reply to the meta PMI

- 3) insist that theory can be (approximately) true even if they did not refer

(CL Hardin and Alexander Rosenberg)

Objections to the global IBE defence of realism

- 2- The pessimistic meta-induction (yet again)
  - In 1581, Clavius used a "no-miracles argument" to argue that Ptolemaic astronomy must be true. But he was wrong.

Objections to the global IBE defence of realism

- More generally:
  - The history of science shows that there have been lots of theories that exhibited features (i)---(v), but that were not true.
  - So there *must* be *some* alternative, non-realist, explanation for (i)---(v) in the case of past theories, even if we haven't yet found that explanation.
  - And then there's no reason to think that the same nonrealist explanation (whatever it is) won't work also for current theories.

Objections to the global IBE defence of realism

- Laudan: this explanation exists!
  - Suppose we accept IBE as a guide to truth
  - Realism isn't the best explanation unless antirealism lacks an equally plausible explanation
  - Antirealism has such an explanation:
    - scientific theories are selected because of their predictive success, enabling us to control nature, etc....
    - We dump less successful theories in favour if more successful ones
    - So no wonder the ones we're left with are highly successful

Possible replies

- Laudan thinks that this objection remains even if we weaken the realist claim as follows…
- a-Restricting realism to *theories enjoying novel predictive success*
  - Perhaps it is no miracle that a theory that was designed to account for a given set of data succeeds in accounting for that set of data.
  - But it would be a miracle if a theory that was designed to account for some existing body of data went on to make successful novel predictions, unless that theory was true.

Possible replies

- Laudan:
- But this won't help, because lots of theories have enjoyed novel predictive success and still not been true.
  - e.g. Copernican astronomy and the phases of Venus

Possible replies

- b-Weakening realism to claim only *approximate* truth
  - It's no miracle that a theory can have features (i)---(v) without being *exactly* true.
  - But it would be a miracle for a theory to have these features without being even *approximately* true.

Possible replies

- Laudan:
- But this won't help, because lots of theories have had features (i)—(v) and not even been *approximately* true.
  - e.g. the aether theory of light made successful novel predictions, unified electricity and magnetism, served as an auxiliary hypothesis in confirmations of theories tested using optical devices, etc. But we now think that *there is no aether*. So how can an aether theory possibly count as 'approximately true'?

The challenge for the realist

- The realist needs to find a *form of realism* (e.g. R1, or a replacement for R1) and a set *of features to be explained* (e.g. (i)---(v), or a replacement for that list) such that the resulting no-miracles argument is not vulnerable to a pessimistic meta-induction.
- This is (probably? hopefully?) not impossible, but it is not easy, either!
  - Structural realism? Next class!

- Inserire roba Laudan su truth and reference

Scientific Realism

- According to standard scientific realism:
  - (semantic) (i) Scientific theories *are the right kinds of things* to be true or false;
    - Truth conditions are objective, depend on how the world is
  - (metaphysical) (ii) The truth of a scientific theory *goes beyond its empirical adequacy*;
    - Entities exist independent on our minds
  - (epistemological) (iii) We are (sometimes) *justified in believing* that our best theories are (at least approximately) true.

Scientific Realism

- Instrumentalists deny (i) (Scientific theories *are NOT the right kinds of things* to be true or false).
- Logical positivists accept (i) but deny (ii) (The truth of a scientific theory DOES NOT *go beyond its empirical adequacy*).
- Constructive empiricists accept (i) and (ii), but are less than entirely comfortable with (iii) (We are NOT *justified in believing* that our best theories are at least approximately true)

Scientific Realism

- According to instrumentalism:
  - There is no question about whether or not we should believe that scientific theories are true.
  - Scientific theories are not even the right kind of thing to be true or false: they are just elaborate tools that scientists construct to help them to make predictions.
  - Scientific knowledge aims at anticipating successful predictions

Scientific Realism

- According to logical positivism:
  - If two theories are strongly empirically equivalent, they actually mean the same as one another.
  - This means there is no problem about which to believe – we can believe both at the same time

Scientific Realism

- Objections to instrumentalism and positivism/Observability
  - Instrumentalism and positivism both seem to require two things (either for their *coherence* or for their *motivation*):
  - 1-A sharp dividing line between
    - 'observable' and 'unobservable' entities, OR
    - 'observation terms' and 'theoretical terms';
  - 2-A theory-neutral concept of observation.
  - Critics argue that neither of these things is possible.

Why instrumentalism and positivism seem to need a sharp observable/unobservable dividing line for their coherence

- Instrumentalists say that all and only the ***empirical predictions*** are assertoric (= they are the right sorts of sentences to be true or false)
- But the 'empirical predictions' are (by definition) the things that the theory says about observable phenomena.
- If there's no sharp dividing line between statements about observables and statements about unobservables, then there's no sharp dividing line between statements that are 'empirical predictions' and those that aren't
- and therefore there's no sharp dividing line between assertoric and non-assertoric statements
  - It's unclear whether or not this consequence makes sense.
  - If it *doesn't* make sense, instrumentalism is untenable.

Why instrumentalism and positivism seem to need a sharp observable/unobservable dividing line for their coherence

- Similarly: Logical positivists say that two theories mean the same as one another iff they make the same empirical predictions. So (by the same line of argument):
  - If there's no sharp dividing line between statements about observables and statements about unobservables, then
  - logical positivism has the consequence that there's no precise **matter of fact** about whether or not two theories mean the same thing as one another.
  - Again, it's unclear whether or not this consequence makes sense.

- Inserire note su log empricisim

Constructive empiricism

- A non-realist account: one that is supposed to avoid the usual objections to instrumentalism and positivism

Baas Van Fraassen (1941)

Constructive empiricism

- VF's characterization of SR:
  - "science aims to give us, in its theories, a literally true story of what the world is like; and acceptance of a scientific theory involves the belief that it is true"
- Antirealism: the aim of science is not to tell a true story and to accept a theory is not to believe it is true
- VF's antirealism:
- "science aims to give us theories which are empirically adequate; an acceptance of a theory involves as beliefs only that it is empirically adequate"

Constructive empiricism

- The sentences of a scientific theory *are* "assertoric", i.e. they are the right sorts of sentences to be true or false (so: they are not just 'instruments for prediction', as the instrumentalist thinks; they are also claims about what the world is like).
- They *are* to be taken literally (so: they are not to be regarded as oblique talk about possible observations).

Constructive empiricism

- BUT
  - It is no part of the aim of science to find *true* theories; and acceptance of a scientific theory does not involve belief that the theory is true.
- INSTEAD:
  - Science aims to give us empirically adequate theories; and
  - Acceptance of a scientific theory involves as belief only that the theory is empirically adequate.

Constructive empiricism

- Agnosticism about the theoretical
- "to be an empiricist is to withhold belief in anything that goes beyond the actual, observable, phenomena … to develop an empiricist account of science is to depict it as involving a search for truth only about the empirical world, about what is actual and observable"

Constructive empiricism

- CE is a theory about what the aim of science is, not about what to believe
- CE is a descriptive enterprise on how an empiricist can regard the activity of science as consistent with his own empiricist standards

Constructive empiricism

- Empirical adequacy (definition): A theory is *empirically adequate* iff what the theory says about observable phenomena is true ('saves the phenomena').
  - Examples of 'observable phenomena':
    - Mars appeared to start retrogressing on June 3;
    - the photograph of the cloud chamber had a curved track across it;
    - the pointer on the voltmeter swung to '6'.

Constructive empiricism

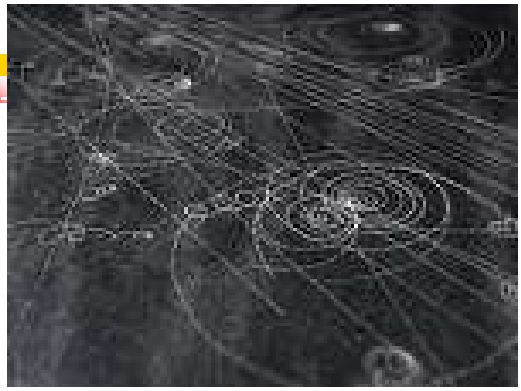
- Semantic vs syntactic view of theories
  - Syntactic view: a theory is an enumeration of theorems expressed in one language
  - Semantic view (vF's favorite): a theory is given by the specification of a class of structures (described in various languages) that are the theory's models

First specify the family of structures (the models) then select which parts directly represent observable phenomena

A theory is empirically adequate if appearances (=the structures which can be described as measurement reports) are hysomorphic to the empirical structures of some model of the theory; i.e. if observable phenomena can 'find home' with the structure described by the theory

Constructive empiricism

- X is observable if there are circumstances such that, if X is present to us under these circumstances, then we observe it
- NOTE: one observes something only when the observation is UNAIDED; one does not observe cells under the microscope, just sees an image



Constructive empiricism

- A phenomenon can be *observable* without being *observed*.
  - A tree falling in a forest is an observ*able* phenomenon, even if there's no-one around to observe it.
  - For a phenomenon to be observ*able*, it just has to be such that someone *could have* observed it *if* they were appropriately situated (in the right place at the right time, with their eyes open, etc.).

Arguments for constructive empiricism

- 1) empirical adequacy is less audacious than truth
- 2) it makes better sense of science:
  - 2a-Scientists try to find empirical regularities rather than fundamental entities/structures
    - Ex: Millikan's experiment to measure the charge of electrons: he was finding a filling value for a quantity that was left open – he discovered a regularity in the world

Arguments for constructive empiricism

- 2b) scientists see pragmatic virtues in science: they look for other over and above truth
  - Simplicity, elegance, greater scope…
  - The realists see these virtues as epistemic, but there is no reason why they should:
    - Why believe the world is more likely to be simpler than complicated?

Arguments for constructive empiricism

- 2c) scientists sometimes accept their theories to a certain degree:
  - This is explained by constructive empiricism

Arguments for constructive empiricism

- 3) pragmatics of explanation
  - We can account for theories being explanatory without believing them to be true (they can explain even if they are false)
    - Explanation=information in response to contextually defined queries
- 4) avoid inflationary metaphysics
  - Who needs laws of nature, natural kinds, modality…???

Objections to constructive empiricism

- Grover Maxwell:
- 1-there are observable objects about which we must be realists
- 2- no nonarbitrary line can be drawn between observable and unobservable objects
- 3- therefore we are not warranted in claiming that there is a class of unobservable objects about which we may be antirealists

Objections to constructive empiricism

- VF:
- Grants the premises but denies that the conclusion follows:
  - Premise 2 shows that most observable terms are vague, from which nothing follows about SR
  - We can use vague predicates as long as there are clear cases of them
  - At best M's argument is a challenge to find some clear cases of observable and unobservable objects

Objections to constructive empiricism

- Here they are:
  - Moons of Jupiter are clearly observable
    - Astronauts can go and see
  - Electrons in a could chamber are clearly not
    - VF's example: Electrons vs jets
- So even if there must be observable objects about which we must be realist and even if the distinction obs/unobs is vague, it does not follow that we are never warranted in claiming that there are unobs about which we must be antirealist

Objections to constructive empiricism

- How constructive empiricism is supposed to avoid the objection based on the lack of a sharp theory/observation distinction:
  - Maxwell's continuum shows only that the observable/unobservable distinction is vague.
  - But:…

Objections to constructive empiricism

- Maxwell's continuum shows only that the observable/unobservable distinction is vague.
- But:…
- 1-Vague predicates still have clear cases.
- 'Bald' is a vague predicate.
  - There are some people with intermediate amounts of hair; perhaps there is no fact of the matter as to whether or not they are bald.
  - But being *vague* doesn't make a predicate *useless*. My grandfather is *clearly* bald, and I am *clearly not*.

Objections to constructive empiricism

- 2-The vagueness of the line between observable and unobservable shows only that the amount of belief that is involved in acceptance of a scientific theory is vague.
  - If Xs are *clearly observable*, then acceptance of a scientific theory *clearly* involves belief that the theory gets Xs right.
  - If Xs are *clearly unobservable*, then acceptance of a scientific theory *clearly does not* involve belief that the theory gets Xs right.

Objections to constructive empiricism

- If it's unclear whether or not Xs are observable, then it's unclear whether or not acceptance of the theory involves belief in Xs.
- But this isn't an *objection* to constructive empiricism.
  - Why *shouldn't* there be cases that are 'borderline' vis-a-vis the question of whether or not acceptance of the theory involves belief in it?

Objections to constructive empiricism

- Further objections based on the nature of the observable/unobservable distinction
  - 1-The line between observable and unobservable changes with time.

Objections to constructive empiricism

- Reply:
  - This doesn't stop the line from making sense at any given time.
  - This time-relativity of the location of the line shows only that the amount of belief that is involved in acceptance of a scientific theory changes with time…
    - Acceptance of a given theory *now* involves belief that what the theory says about things that are *now* observable is true.

Objections to constructive empiricism

- Further objections based on the nature of the observable/unobservable distinction
  - 2-The line between observable and unobservable is an artefact of human physiology. Other creatures (aliens?) might have had different perceptual faculties.

Objections to constructive empiricism

- Reply: This shows that the unobservable/observable distinction is not suitable to bear *ontological* weight.
  - We would be 'asking the observable/unobservable distinction to bear ontological weight' if we said (e.g.): "Only observable things exist. So-called theoretical entities *do not exist*."
- But it does not show that the distinction cannot bear *epistemic* weight.
  - Van Fraassen: 'Observable' means 'observable by us'. Acceptance of a theory *by us* involves as belief only that the things the theory says about phenomena that are *observable by us* are true.

Objections to constructive empiricism

- 3-Constructive empiricism is incoherent, since, for example:
  - Electrons are actually unobservable [by us]
    - that is only because of the way that light etc. happens to interact with them. Electrons *would be directly observable* if *the true laws of physics* made them reflect light in such a way that clear images of electrons formed on our retinas, the way that clear images of tables form on our retinas.
  - But it *also* says that only statements about observables should be accepted as true.
  - So, the constructive empiricist (apparently!) has to say that we should not accept "Electrons are unobservable" *as true*.
  - And this seem to contradict the initial claim.

Objections to constructive empiricism

- 4-T he 'tu quoque' objection:
- Constructive empiricism suffers from all the same objections as realism.

Objections to constructive empiricism

- 4a-Constructive empiricism and underdetermination:
  - The data not only underdetermine which theory is true; they also underdetermine which theory is (strongly) empirically adequate.
  - Prior to 1608, the data underdetermined which of Ptolemaic and Copernican astronomy was empirically adequate.
  - So, if scientific realism is untenable because of the underdetermination problem, so is constructive empiricism.

Objections to constructive empiricism

- 4b-Constructive empiricism and the pessimistic meta-induction:
  - Most of the theories in the history of science have turned out to be not only false, but even empirically inadequate.
  - Ptolemaic astronomy was shown to be empirically inadequate after the development of the telescope.
  - Newtonian mechanics was shown to be empirically inadequate once we learned how to accelerate masses to speeds close to the speed of light.

Objections to constructive empiricism

- Possible replies:
  - It's true that constructive empiricism suffers from the same objections as realism. But this shows, at most, that constructive empiricism is *no more* plausible than realism. It does not show that constructive empiricism is *less* plausible than realism.
  - Perhaps constructive empiricism is (furthermore) *better* than realism because, although both are risky, constructive empiricism is *less* risky than realism.
    - Van Fraassen: "It is not an epistemological principle that one might as well hang for a sheep as a lamb."

Objections to constructive empiricism

- 5-Horwich's objection:
- constructive empiricism is incoherent, because there is nothing more *to* believing a theory than 'the mental state responsible for using it'

Objections to constructive empiricism

- Reply: Several examples show that this must be false.
  - Engineers use Newtonian mechanics, even though they believe it to be false.
  - Chemists use an orbiting-electrons model of atoms, even though they don't believe that electrons orbit atoms.
  - Navigators use Ptolemaic astronomy, even though they don't believe that the Earth is the center of the universe or that planetary orbits are formed from deferents and epicycles.