Philosophy of Science Survey

Week 5

PHIL 2160. Ohio University. Spring 2021.

Chapter 7: Falsifiability

Philosophical Issues

Theories of truth

Problems of induction

Structure of Scientific Beliefs

Worldviews

Core beliefs
Peripheral beliefs

Facts

Evidence and Methods

Direct evidence
Indirect evidence

Confirmation
Disconfirmation

Quine-Duhem Thesis

Axiomatic method
Falsificationism
HD method

Attitudes Towards Theories (Worldviews)

Falsifiability
(This chapter)

Instrumentalism
Realism
(Next chapter)

Falsifiability: Two Approaches

1. Falsifiability as a property of a theory
   - Popper's original approach
2. Falsifiability as a person's attitude toward a theory
   - DeWitt's favored approach

- We'll look at Popper's approach first and then discuss DeWitt's approach.

Falsifiability: Popper's Approach

- Review Chapter 5 ("Popper's falsificationism")
- Popper's question:

"When should a theory be ranked as scientific? or "Is there a criterion for the scientific character or status of a theory?"

–Karl Popper, "Science: Conjectures and Refutations" (1962)

Falsifiability: Popper's Approach

"When should a theory be ranked as scientific? or "Is there a criterion for the scientific character or status of a theory?"

–Karl Popper, "Science: Conjectures and Refutations" (1962)

- Popper answers this question by comparing theories he deemed most scientific and theories he deemed less scientific.
  - Note that he *started* with what he took to be clear examples of scientific and unscientific theories.
  - The question is how to explain the difference between the two sets of examples.

Falsifiability: Popper's Approach

- Most scientific theories (Popper's examples):
  - Newtonian physics
  - Relativistic physics
- Less scientific theories (Popper's examples):
  - Astrology
  - Marxist theory of history
  - Freudian psychoanalytic theory
  - Adlerian psychoanalytic theory
- What differentiates the two groups?
  - We'll not discuss all examples – if interested, see the short Popper reading on Perusall.

Falsifiability: Popper's Approach

- According to Popper, the second (less scientific) group of theories share one characteristic: they are confirmed by every piece of evidence, or they can explain any evidence.
- In other words, these theories are so well confirmed and can handle any potential disconfirming evidence.

for treatment.

The most characteristic element in this situation seemed to me the incessant stream of confirmations, of observations which 'verified' the theories in question; and this point was constantly emphasized by their adherents. A Marxist could not open a newspaper without finding on every page confirming evidence for his interpretation of history; not only in the news, but also in its presentation—which revealed the class bias of the paper—and especially of course in what the paper did *not* say. The Freudian analysts emphasized that their theories were constantly verified by their 'clinical observations'. As for Adler, I was much impressed by a personal experience. Once, in 1919, I reported to him a case which to me did not seem particularly Adlerian, but which he found no difficulty in analysing in terms of his theory of inferiority feelings, although he had not even seen the child. Slightly shocked, I asked him how he could be so sure. 'Because of my thousandfold experience,' he replied; whereupon I could not help saying: 'And with this new case, I suppose, your experience has become thousand-and-one-fold.'

–Karl Popper, "Science: Conjectures and Refutations" (1962)

could be interpreted in the light of the theory. But this meant very little, I reflected, since every conceivable case could be interpreted in the light of Adler's theory, or equally of Freud's. I may illustrate this by two very different examples of human behaviour: that of a man who pushes a child into the water with the intention of drowning it; and that of a man who sacrifices his life in an attempt to save the child. Each of these two cases can be explained with equal ease in Freudian and in Adlerian terms. According to Freud the first man suffered from repression (say, of some component of his Oedipus complex), while the second man had achieved sublimation. According to Adler the first man suffered from feelings of inferiority (producing perhaps the need to prove to himself that he dared to commit some crime), and so did the second man (whose need was to prove to himself that he dared to rescue the child). I could not think of any human behaviour which could not be interpreted in terms of either theory. It was precisely this fact—that they always fitted, that they were always confirmed—which in the eyes of their admirers constituted the strongest argument in favour of these theories. It began to dawn on me that this apparent strength was in fact their weakness.

–Karl Popper, "Science: Conjectures and Refutations" (1962)

Falsifiability: Popper's Approach

- According to Popper, Newtonian physics and relativistic physics are not theories that are confirmed by every piece of evidence. Why not?
- Because they make *risky* predictions.
- What does he mean by *risky*?

Falsifiability: Popper's Approach

- Recall the light bending example from Chapter 4. Einstein's theory predicted that the light bends twice more than predicted by Newton's theory.
- Referring to this prediction and Eddington's eclipse expedition, Popper says:

"Now the impressive thing about this case is the *risk* involved in a prediction of this kind. If observation shows that the predicted effect is definitely absent, then the theory is simply refuted. The theory is *incompatible with certain possible results of observation*."

–Karl Popper, "Science: Conjectures and Refutations" (1962)

Falsifiability: Popper's Approach

- Now Popper has identified the distinguishing features of the two groups of theories.

More Scientific Theories

Newtonian physics
Einsteinian physics
Etc…

Incompatible with certain possible results of observation: They are *falsifiable*.

Less Scientific Theories

Astrology
Marxist theory of history
Psychoanalysis

Compatible with every possible results of observation: they are *unfalsifiable*.

Falsifiability: Popper's Approach

"The criterion of the scientific status of a theory is its falsifiability, or refutability, or testability."

–Karl Popper, "Science: Conjectures and Refutations" (1962)

More Scientific Theories

Newtonian physics
Einsteinian physics
Etc…

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Falsifiability: DeWitt's Approach

- Popper understands falsifiability *as a property of a theory itself*.
  - He says that *a theory is or is not falsifiable.*
- But DeWitt points out that there is nothing in unscientific theories that make them inherently unfalsifiable. (See the last paragraph of the section on "Basic Ideas"). We'll see an example shortly.

Falsifiability: DeWitt's Approach

- Rather, DeWitt suggests that we understand falsifiability *as a person's attitude toward theories*.
- Consider two people, Sara and Joe, who believe theory T, and assume that T is currently well supported by evidence.
  - Sara holds the attitude of falsifiability toward T: she is *willing to give up T if enough disconfirming evidence becomes available*.
  - Joe does not hold this attitude: he is *unwilling to give up T regardless of what evidence becomes available*.
- Falsifiability in this sense is related to dogmatism.
  - Sara is undogmatic.
  - Joe is dogmatic.

Falsifiability: DeWitt's Approach

- DeWitt is right that it's better to understand falsifiability as a person's attitude toward theories.
  - Recall Popper's experience with Adler.
  - Popper showed Adler potential disconfirming evidence. That is, for Popper, Adler's theory was falsifiable.
  - But Adler responded by accommodating the evidence without even studying the evidence carefully.
  - What impressed Popper was Adler's attitude toward his theory.

Falsifiability: DeWitt's Approach

- Another example: Astrology.
- The central claim of astrology:

  [A] The positions of planets at your birth have influences on your behaviors, personality, and fate.

- There is nothing inherently unfalsifiable about this claim. (see next)

Falsifiability: DeWitt's Approach

- If **[A]** is true, then it predicts that people who share birthdays or are born under certain signs should have similar personality and fate.
  - Studies of twins do not show any similarities of personality and fate.
  - So astrology *is* falsifiable.
- If **[A]** is true, then it also predicts that Mars tends to produce soldiers or athletes, and Venus tends to produce artists.
  - The Mars effect has been studied in population studies. See: https://en.wikipedia.org/wiki/Mars_effect
  - Regardless of whether the Mars effect is real, this case shows that astrology *is* falsifiable.

Falsifiability: DeWitt's Approach

- What makes astrology unscientific instead is *the attitude of its practitioners toward their theory*.
- Notably, astrologers are unconcerned about
  - potential disconfirming evidence,
  - internal problems of their theory (e.g., there are more planets than their theory acknowledges), and
  - the lack of comparison with the success of other theories that also explain behavior, personality, and fate (e.g., psychology, sociology, statistics, etc.)
- Their attitude is that of unfalsifiability. (Compare with DeWitt's example of supporters of cold fusion.)

Falsifiability: DeWitt's Approach

- So far we discussed falsifiability in the context of distinguishing between science and non-science.
- DeWitt's examples also belong to the same context.
  - Modern Astronomy (Sara) vs Flat Earth (Joe)
  - Cold fusion, Vedic scriptures (Steve)
- But DeWitt's discussion of Steve illustrates important points about the historically sophisticated understanding of science.

Falsifiability: DeWitt's Approach

- Steve is dogmatic about the literal interpretations of Vedic scriptures.
  - His attitude to his theory is that of unfalsifiability.
- Presented with contrary evidence, Steve rejects all of them in favor of evidence from the scriptures.
- Now DeWitt asks us to look at the matter from Steve's point of view.
  - This exercise gives us two pairs of views (see next)

Falsifiability: DeWitt's Approach

From our point of view, Part I:

- Steve is dogmatic about the literal interpretations of Vedic scriptures.
  - His attitude to his theory is that of unfalsifiability.
- Presented with contrary evidence, Steve rejects all of them in favor of evidence from the scriptures.

From Steve's point of view, Part I:

- We are dogmatic about modern science.
  - Our attitude to contemporary scientific theories is that of unfalsifiability.
- Presented with contrary evidence from the scriptures, we reject all of them in favor of evidence from the sciences.

Falsifiability: DeWitt's Approach

From our point of view, Part II:

- We are undogmatic about modern science and are willing to give up any contemporary theories if sufficient and convincing evidence becomes available.
  - Our attitude is that of falsifiability.

From Steve's point of view, Part II:

- He is undogmatic about his theory and is willing to give up any part of it if sufficient and convincing evidence from the scriptures becomes available.
  - His attitude is that of falsifiability.

Falsifiability: DeWitt's Approach

- Our point of view and Steve's point of view are symmetrical.
- But note that DeWitt is not endorsing Steve's point of view.
- The more important lesson of this exercise is that *it is possible to disagree about what counts as relevant evidence* (or sufficient, convincing evidence).
  - We don't count the scriptures as relevant evidence, whereas Steve does. And Steve in turn doesn't count scientific observations as relevant evidence, whereas we do.

Falsifiability: DeWitt's Approach

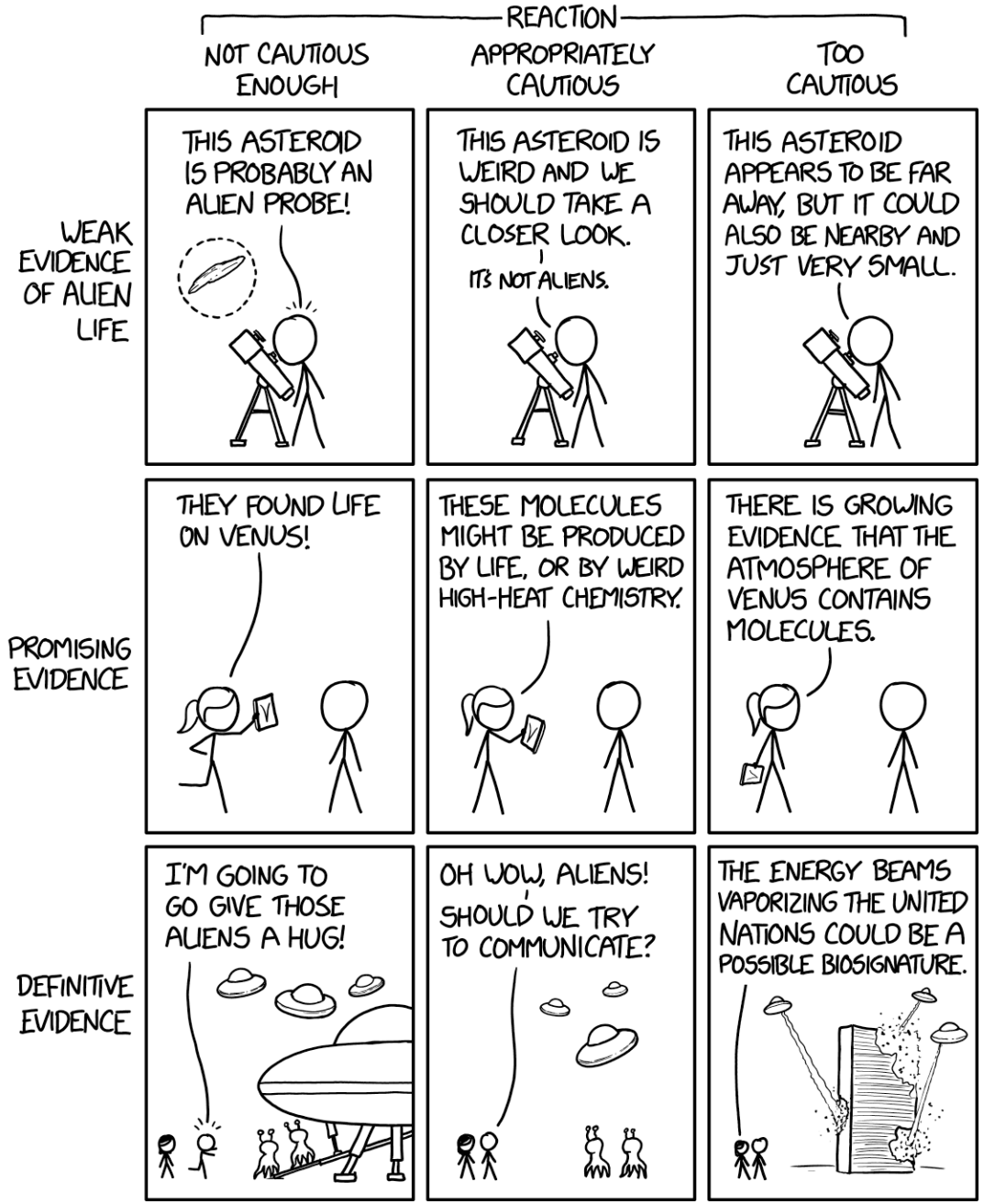
- In other words, it's possible to disagree about ***standards of evidence***, including:
  - What counts as admissible or credible evidence
  - How much evidence is sufficient
- Note that a disagreement over standards of evidence cannot be resolved simply by collecting more evidence!

Falsifiability: DeWitt's Approach

- Most importantly, disagreements about standards of evidence do occur in science, and they are reasonable disagreements.
- There are also no general criteria to resolve these disagreements.
- But scientists do resolve these disagreements on a case-by-case basis, and to better understand how this resolution occurs, we will study a specific historical case.

Falsifiability: DeWitt's Approach

- Many of you noted that DeWitt's approach to falsifiability applies to cases beyond science.
- And that is one advantage of understanding falsifiability as a person's attitude towards theories.
- It also allows us to remember that disagreements about confirmation or disconfirmation of a theory can involve deeper disagreements over standards of evidence.
- So when you disagree with a friend who is unwilling to give up his or her theory despite the disconfirming evidence *you* present, you and your friend may be disagreeing over standards of evidence.



Standards of Evidence

Chapter 8: Instrumentalism and Realism

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Attitudes Towards Theories (Worldviews)

Falsifiability
(last chapter)

Instrumentalism
Realism
(this chapter)

Instrumentalism and Realism as Attitudes

- Attitudes about what?
- Instrumentalism and realism are ***attitudes toward the aim of scientific theories***.
  - That is, what we should demand of a scientific theory in order for it to count as adequate.
- What do we use scientific theories for?

Instrumentalism and Realism as Attitudes

- We use theories to do many things, but for our purpose, it's sufficient to focus on three broad categories:

1. Prediction
2. Explanation (in the minimal sense)
3. Understanding

Instrumentalism and Realism as Attitudes

Prediction

- We use scientific theories to make predictions about the future states of affairs.

Explanation (in the minimal sense)

- We use scientific theories to explain the available data.
- Explanation in this sense is not fundamentally different from prediction.
  - The difference is only that we are "predicting" something that is already observed (the available data). (Sometimes, this is called retrodiction.)

Instrumentalism and Realism as Attitudes

Understanding

- We use scientific theories to understand *why* the observable parts of the world are as they are.
- Example:
  - Observation: starlight bends around the sun.
  - Why does light bend around the sun?
  - *Because space (gravitational field) is curved around a massive body like the sun, and light follows this curved space.*
    - The italicized sentence describes what the unobservable parts of world are like.

Instrumentalism and Realism as Attitudes

Explanation vs Understanding

- Consider observation: starlight bends around the sun by amount X.

Explaining the data

- *If* space (gravitational field) is curved around a massive body like the sun, and light follows this curved space, then light should bend by amount X.

Understanding why

- *Because* space (gravitational field) is curved around a massive body like the sun, and light follows this curved space.
- The green parts are the theory, and note how they function differently in explanation and understanding (see next).

Instrumentalism and Realism as Attitudes

Explanation vs Understanding

- Consider observation: starlight bends around the sun by amount X.

Explaining the data

- *If* space (gravitational field) is curved around a massive body like the sun, and light follows this curved space, then light should bend by amount X.
- Here, the theory (green) is only assumed to be true (it's in the *if* part). To use a theory to explain the data, we just need some evidence (e.g., from past confirmation) to motivate our assumption.
- And the theory of course needs to predict the data accurately.

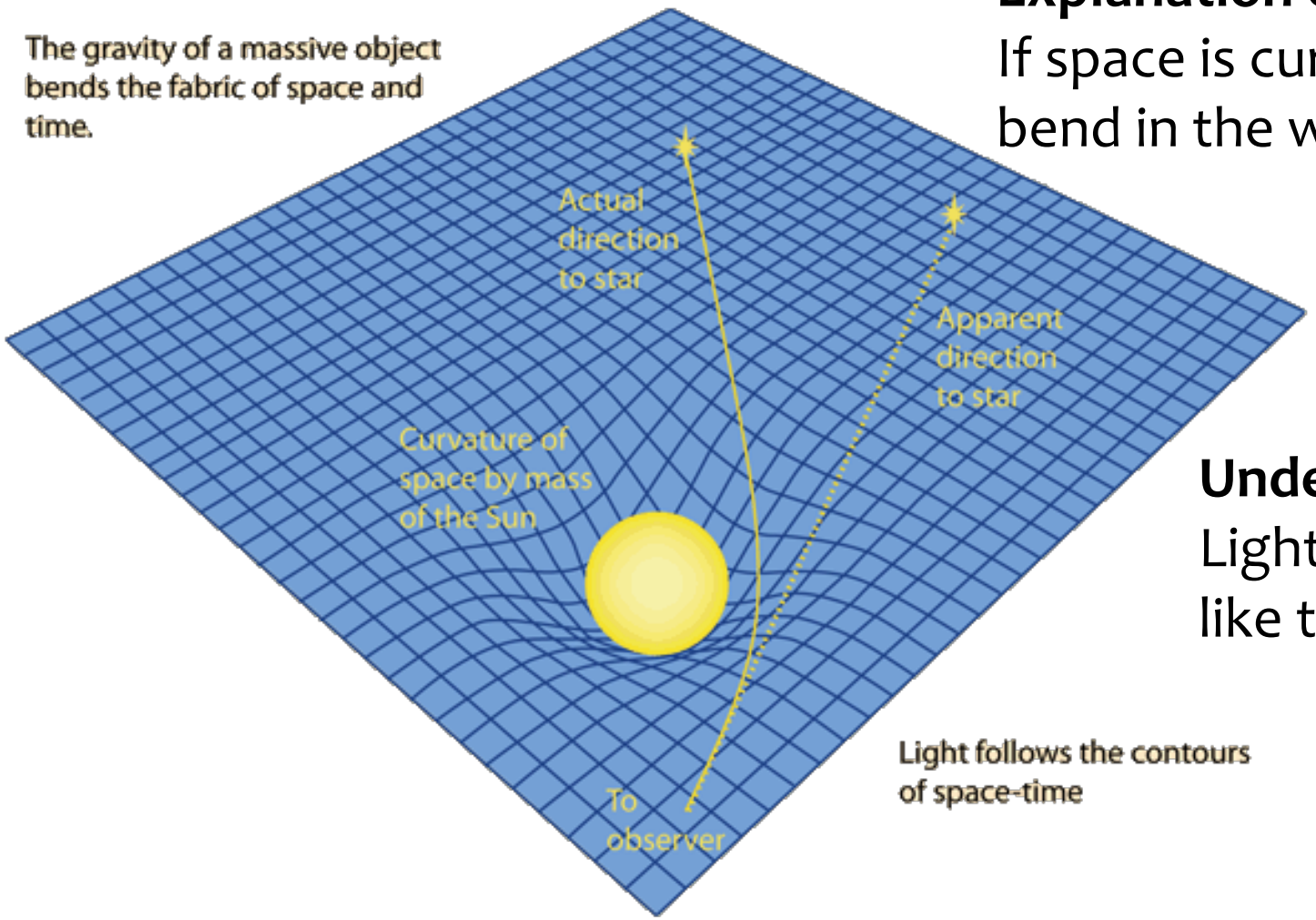
Instrumentalism and Realism as Attitudes

Explanation vs Understanding

- Consider observation: starlight bends around the sun by amount X.

Understanding why

- *Because* space (gravitational field) is curved around a massive body like the sun, and light follows this curved space.
- Here, the theory must be true in the correspondence sense.
  - What the theory says about the unobservable parts of the world must correspond to the way those parts really are independently of our beliefs.



Explanation of data

If space is curved like this, then light should bend in the way we observed.

Understanding why

Light bends because space is curved like this.

Instrumentalism and Realism as Attitudes

- We use scientific theories for:

1. Prediction of the future states
2. Explanation of the data (“explanation” in the minimal sense)
3. Understanding why

- Instrumentalism are realism are attitudes about which of these activities should be the most important aim of scientific theories.

Instrumentalism and Realism as Attitudes

- We use scientific theories for:

1. Prediction of the future states
2. Explanation of the data ("explanation" in the minimal sense)
3. Understanding why

- **Instrumentalism:** Theories should aim at prediction (1) and explanation (2), and they are adequate without providing understanding (3).
- **Realism:** Theories should aim at providing understanding (3), so theories should describe what the mind-independent reality is like, including both the observable and unobservable parts of it.

Instrumentalism and Realism as Attitudes

- **Instrumentalism:** Theories should aim at prediction and explanation, and they are adequate without providing understanding.
  - Following DeWitt, we also say that someone is an instrumentalist about a given theory, if she believes that the theory only meets the instrumentalist demand.
- **Realism:** Theories should aim at providing understanding, so theories should describe what the mind-independent reality is like, including both the observable and unobservable parts of it.
  - Following DeWitt, we also say that someone is a realist about a given theory, if she believes that the theory meets the realist demand.

Instrumentalism and Realism as Attitudes

- **Realism:** Theories should aim at providing understanding, so theories should describe what the mind-independent reality is like, including both the observable and unobservable parts of it.
- Realism is a common attitude among ordinary people and some scientists.
- "It seems to be a fairly widespread belief that the accumulation of facts is a relatively straightforward process, and that science is, in large part at least, geared toward generating **true theories** that account for such facts" (DeWitt, Ch. 2).
  - Read "true" in the correspondence sense

Instrumentalism and Realism as Attitudes

- **Instrumentalism:** Theories should aim at prediction and explanation, and they are adequate without providing understanding.
- Instrumentalism can seem puzzling at first.
  - Many of you rightly felt so.
- Many ask:
  - Isn't realism obviously more attractive than instrumentalism?
  - Could theories be successful at prediction and explanation without being true of the unobservable parts of the world?

Realism

- **Realism:** Theories should aim at providing understanding, so theories should describe what the mind-independent reality is like, including both the observable and unobservable parts of it.
- Isn’t realism obviously more attractive than instrumentalism?
- Not obviously!

Realism

- Recall our discussion of the correspondence theory of truth. This notion of truth makes the *epistemological* question really difficult.
- Epistemological question: How can we know if a theory corresponds to the mind-independent, objective reality?
- It would require that we step outside the theory and have a theory-independent access to the unobservable parts of reality and compare them to the theory. But we don't know how this could be done.
  - What we *can* compare is a theory's prediction about possible observations and our actual observation.
  - This comparison enters confirmation reasoning, but since it's inductive, we cannot conclude that a well-confirmed theory is true, in the sense demanded by realism.

Realism

- This consideration suggests that realism makes a strong, seemingly unachievable demand.
- Or at least the realists need to show how we can answer the epistemological question.
  - This is an ongoing debate in philosophy of science.

Realism

- On the other hand, instrumentalism does not face this difficulty.
  - Confirmation and disconfirmation reasoning, together with common scientific methods, have been successful at showing whether a theory makes accurate predictions or accurately explains the available data.
- So the instrumentalist aim is achievable and reflects what scientific methods can achieve.
  - This is not to say that it's easy!
- Is realism obviously more attractive than instrumentalism?

Instrumentalism

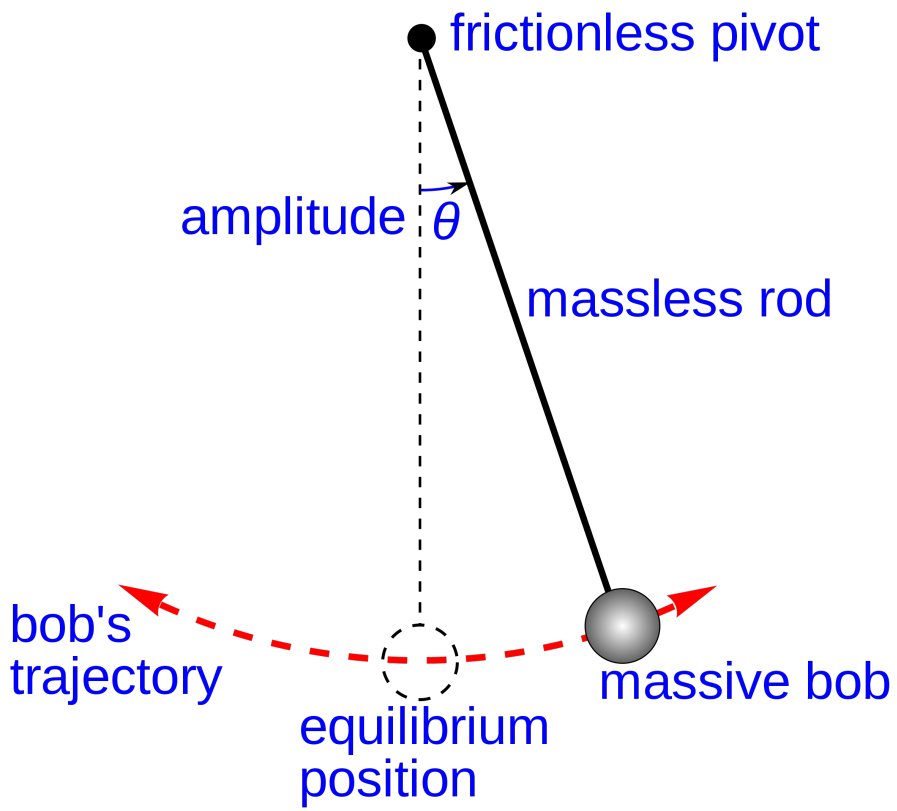
- **Instrumentalism:** Theories should aim at prediction and explanation, and they are adequate without providing understanding.
- Could theories be successful at prediction and explanation without being true of the unobservable parts of the world?
- Yes!
- DeWitt refers to Ptolemaic astronomy as an example, but we'll look at this more in later chapters. So let's look at different examples.
  - These examples also illustrate how the instrumentalist aim can be distinct from the realist aim.

Instrumentalism

Example 1: Scientific Models

- Scientific theories and their models contain *idealizations.*
  - Idealizations = known and deliberate simplifications of reality
- But these theories and models are successful at prediction and explanation.
- See an example next.

Instrumentalism

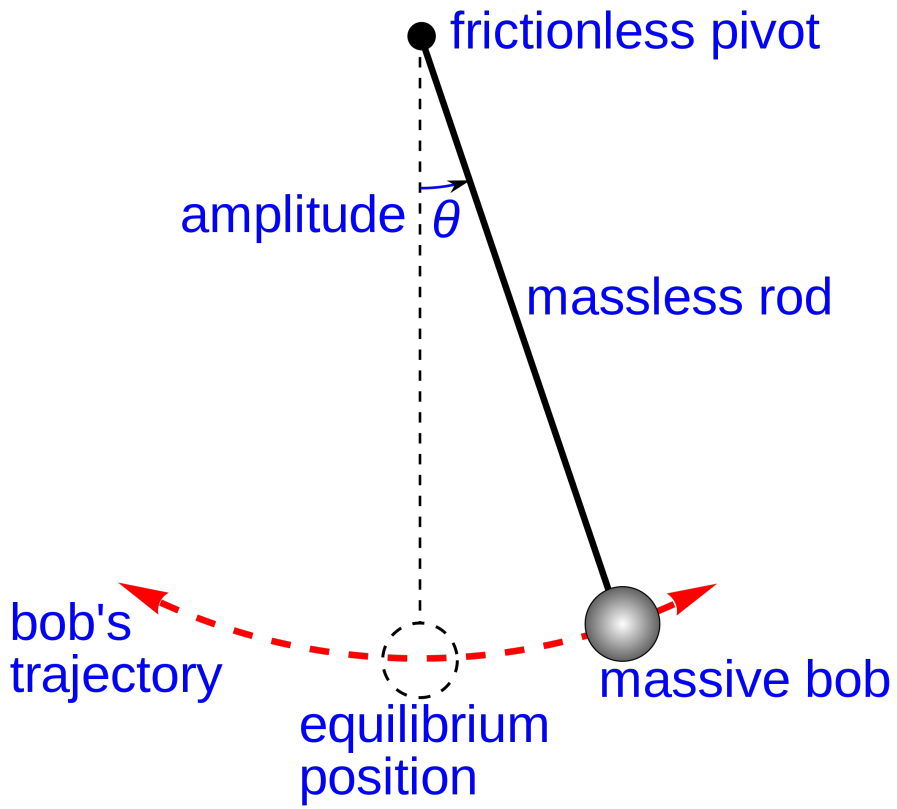


https://en.wikipedia.org/wiki/Pendulum

The pendulum model is very successful at prediction and explanation.

But does it describe reality in the way realism demands?

Instrumentalism



https://en.wikipedia.org/wiki/Pendulum

Of course not!

No real-world system can fit this description of the pendulum.

For example, in the model, the rod is infinitely light and perfectly rigid. The pivot has no friction. And the bob is a point mass.

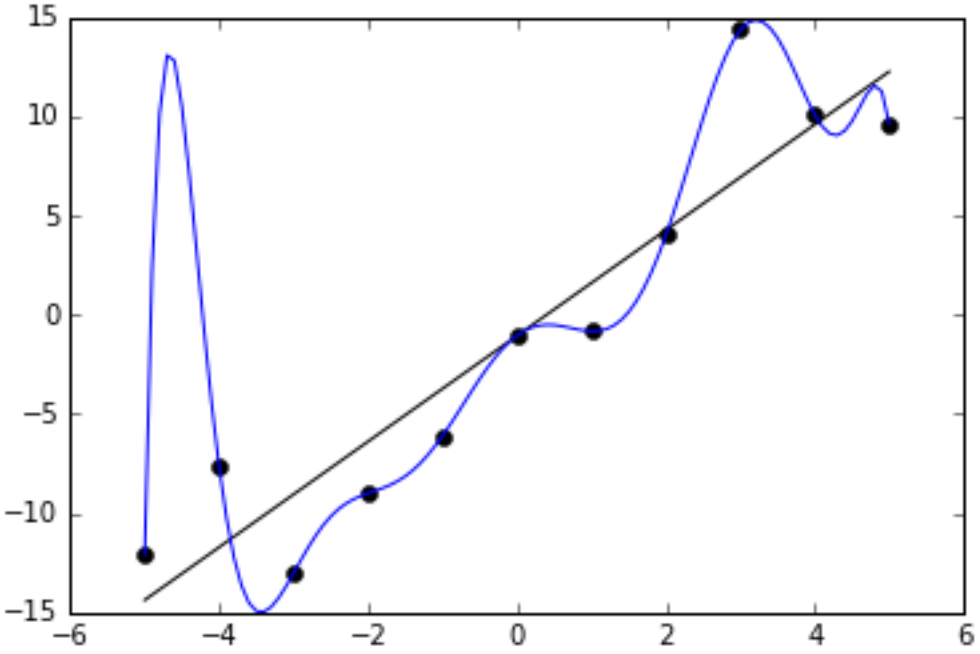
These are all *idealizations*.

Instrumentalism

Example 2: Overfitting

- Realism says that a theory should describe both the observable and unobservable parts of the world as they really are.
- But accurately describing all observations can lead to poor performance at prediction and explanation.

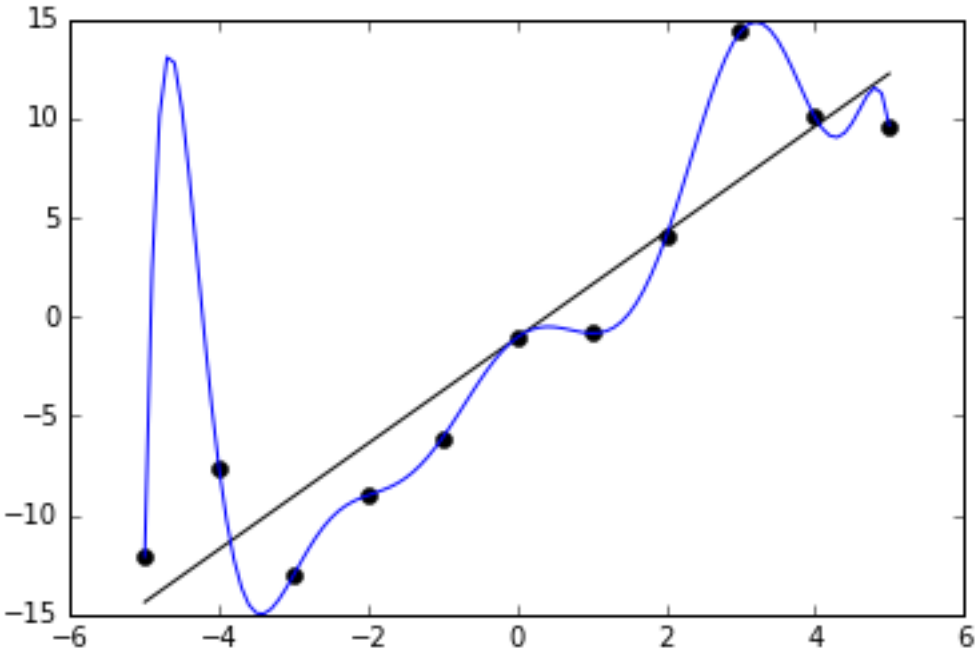
Instrumentalism



- Black dots are observed data.
- Blue is a mathematical model that accurately describes all the data.
- Black is an idealized model. It does not describe the observed data accurately.

https://en.wikipedia.org/wiki/Overfitting

Instrumentalism



- But the idealized model (black) will make better predictions of future observations.
- Statisticians call the blue model “overfitted.”
- In this case, if prediction is important, the realist demand is not helpful.

https://en.wikipedia.org/wiki/Overfitting

Instrumentalism

- **Instrumentalism:** Theories should aim at prediction and explanation, and they are adequate without providing understanding.
- Could theories be successful at prediction and explanation without being true of the unobservable parts of the world?
- Yes, as we saw.

Instrumentalism

- And in fact, we routinely use *older, superseded theories* (e.g., Newtonian mechanics) for prediction and explanation.
- We are instrumentalist about these theories.
- The instrumentalist attitude, then, is a familiar attitude.
- Contemporary instrumentalists suggest we adopt the same attitude toward the *current* theories.
  - This suggestion is also motivated by the underdetermination of theories by evidence. Evidence does not uniquely determine our current theories, so we are not warranted to be realist about them. But since our theories are successful at prediction and explanation, we are warranted to be instrumentalist about them.