Science & Pseudoscience

What distinguishes science from pseudoscience?

Specifically:
What distinguishes a scientific theory from a pseudoscientific theory?

The "Demarcation Problem" → elicit discussion

Why Important?

① science literacy & science policy
external to science:
- creationism in public schools
- technological progress (math/sci education) } pragmatic reasons
- social welfare (lottery, psychic readings, etc) } moral reasons

② Internal to science = what are the characteristics of good scientific theories?

Why a topic in philosophy?

① philosophy of science:
- methodology of science
- what is science?
- what is scientific explanation?
- what is a sci. theory?
- what is sci. knowledge?
- etc.

② epistemology:
- what is knowledge?
- How is it obtained?

2 Ways to approach Demarcation Problem:

① Attempt to determine fixed set of criteria that once & for all define science & set it apart from pseudoscience.
("global" approach)

② Attempt to determine, for any given claim, whether we are justified in believing it.
("local" approach)

→ Is there a method that we can employ to do this?

Can we identify this method as the "scientific method"?

(If so, then we can say:
Products of this method are "scientific" claims)

Let's look at #2:

Hypothesis - claim/assertion

we restrict our attention to claims about natural phenomena :

egs: The Earth is the center of the Solar System
The Sun is the center of the Solar system
New species of plants & animals evolve over time from previous ones.
All species were created at some finite time in the past.

How should we determine which hypotheses to believe?

One criteria: Testability

(Intuition: we should believe claims that are supported by evidence → claims that can be tested

→ How can we characterized this feature?

One proposal:

Some claim This is the sci. method

Hypothetico-deductive (HD) method of testing hypotheses

3 Steps: ① Given hypothesis H, deduce a prediction P.
② Check if P is true or false.
③ If P is true, then H is confirmed
If P is false, then H is disconfirmed

Simple Confirmation (general argument pattern)

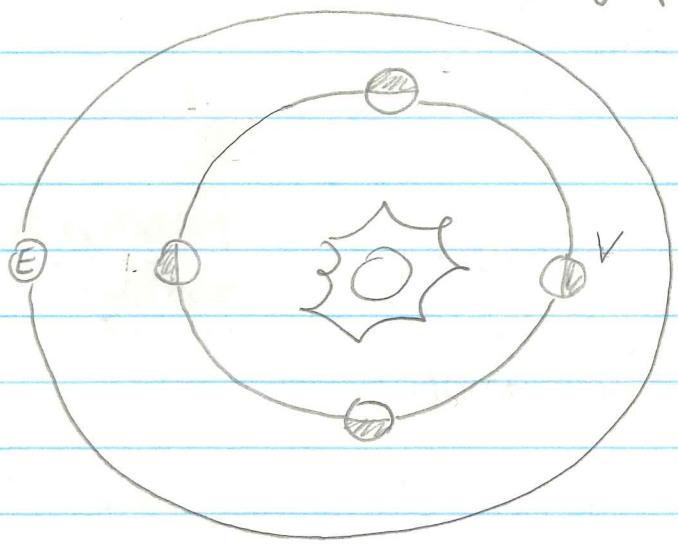
If H is true, then P is true.
P is true

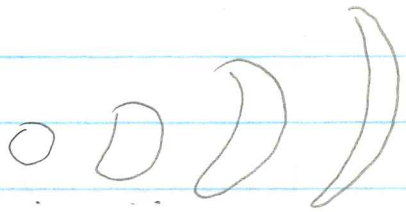
H is "confirmed" ← what does "confirmed" mean?
"true"? No.
"well-supported"?

Some problems:

Ex: Galileo and the telescope

H = The sun is the center of the solar system (Copernicus' Heliocentric theory)
P = Venus will display phases





phases of Venus as seen from Earth

G. observes these phases through his telescope.
"Confirmation" of Copernicus' Theory?

If Copernicus' theory is true, then Venus will display phases.
Venus displays phases.
Cop. theory is "confirmed"

Earth is center of Solar System

Aristotelian Response: Telescope is unreliable

- very reasonable at the time

G.'s implicit assumption: Telescope is reliable.

- needed in order to test H.

Modified Confirmation

If $(H \& A_1 \& A_2 \& \ldots)$ are true, Then P is true.

P is true.

$(H \& A_1 \& A_2 \& \ldots)$ are "confirmed"

collection of H and "auxiliary hypotheses $A_1, A_2, \ldots$ is what is supported by evidence P (and not just H alone)

Auxiliary hypotheses = additional claims required in order to derive a prediction P from a given hypothesis.

Probs with HD confirmation:

Prob #1: Hypotheses cannot be tested in isolation

Prob #2: Structure of HD argument is inductive: even if premises are true, conclusion can be false (ie - what exactly does "confirmed" mean? Cannot mean "true")

Maybe Sci. method should be based on disconfirmation instead of HD confirmation:

Simple Disconfirmation

If H is true, then P is true.
P is not true.
H is not true

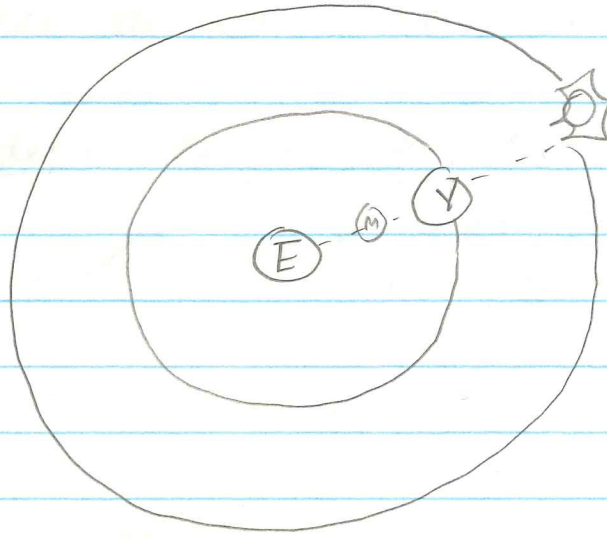
} Valid-deductive argument. If prems are true then conc. must be true.

Again: too simple: To derive P, need more than just H.

ex: Gal. & telescope again

H = the Earth is the center of the Solar System (Ptolemy's Geocentric theory)

P = Venus will not display phases



centers of epicycles of M & V fixed on line between E & S (Required to explain observation that M & V never seen at midnight.)

G. observes that P is false using telescope

Aristotelian response: telescope is unreliable!

Modified Disconfirmation

If $(H \& A_1 \& A_2 \& \ldots)$ are true, then P is true.

P is not true.

$(H \& A_1 \& A_2 \& \ldots)$ are not true

Problem: which claim is wrong? H? A_1? A_2?
Any combo?

Karl Popper (1950's): Scientific theories are falsifiable.

Claim: They can be proven to be false
(They make "risky" predictions that may turn out to be incorrect)

Pseudo-scientific theories are not falsifiable.
(They do not make risky predictions.)

Examples:

science → General relativity: predicts light rays will be bent by massive gravitational sources.
(very risky prediction!)
Turns out to be true! (Eddington Eclipse Expedition 1912)
GR passes "crucial test"

pseudo-sci → Astrological horoscopes: very vague, risk-free predictions. Can always be interpreted as being correct

Our analysis of Simple Disconfirmation shows Popper's account is inadequate

Duhem & Quine: Popper's account is based on simple disconfirmation model.
- scientists are not in the business of trying to disprove their theories.

Bottom Line: Hypotheses are not tested in isolation, but against a background of auxiliary hypotheses.

Moral: Testability is hard to characterize: what is Relation between theory & evidence?
Big field of study in Phil. of Science

BUT: Most philosophers will agree that testability is the essential characteristic of justified belief. Even if it is hard to characterize, we can and will, be able to rank hypotheses on how well they are supported by evidence.

In this class:
Look at a number of hypotheses.
Fundamental Question: Is there sufficient evidence to justify our belief in them?

main concern: what counts as good evidence?

(less important) ↓

Other "Criteria of Adequacy" for believing in hypotheses:

Fruitfulness - ability to make novel predictions.
- Velikovsky's novel prediction of temp of Venus
- Fresnel's whitespot

Scope - ability to account for as large a range of phenomena as possible

Simplicity - ability to account for phenomena using fewest number of assumptions (Occam's Razor)

Conservatism - ability to account for phenomena without deviating too far from established beliefs

creationism scores higher than evolution on these

Problem: By themselves, these criteria are neither sufficient nor necessary to distinguish "scientific" claims from "pseudosci" claims