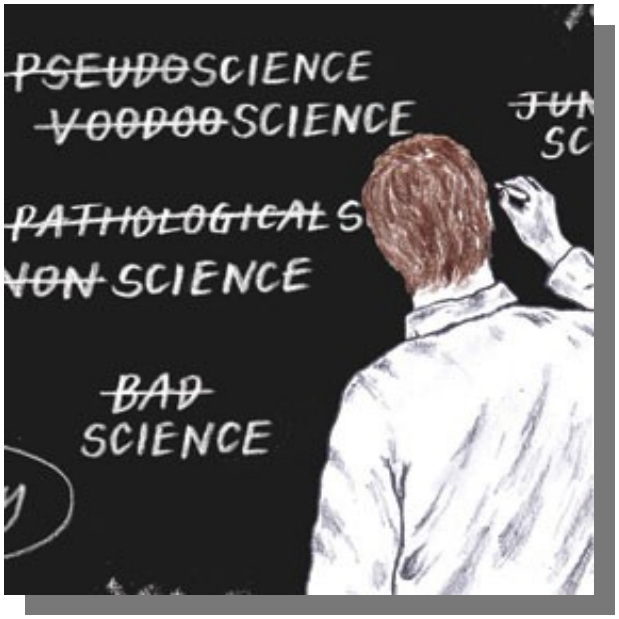


Pseudoscience Methods

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Topics

What is science?

What is Pseudoscience?

Popper's demarcation criterion's: falsifiability

Example from the book Neurotribes

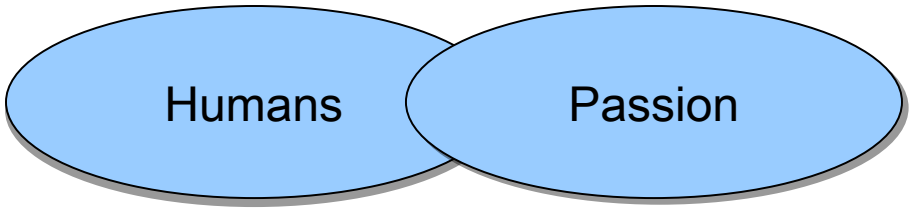
Is falsifiability enough?

Criteria of adequacy

Examples

What is Science?

- intellectual activity done by humans
- satisfies a human desire for knowledge and truth
- stems from need to overcome ignorance & fear



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The Amazing Power of Science

- Influences every aspect of our lives tremendously.
- Changes the world with an exceedingly fast pace.
- Produces scientific knowledge with astounding breath and depth.



What is Science?

1. Immediate solution to practical problem?
2. Objective search for the truth?
3. Grows continuously?
4. Collection of facts?
5. Finished Product?
6. Technology?

What is Science?

Science is the *systematic study* of natural events and conditions.

In general, all scientific subjects can be broken down into three areas—life science, Earth science, and physical science.

What is Science?

Life science, or biology, is the study of living things.

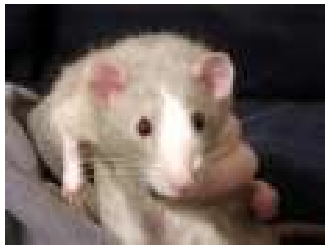
Earth science, or geology, is the study of the surface and interior of Earth.

Physical science includes physics and chemistry, which involve the study of nonliving matter and energy.

What is Science?

Psychology: the science of human & non human animal behavior





Goal: gather an organized body of knowledge

Psychological research seeks <u>scientific</u> explanation for behavior

What is Science?

All branches of science have some characteristics in common.

The study of science requires **openness** and **review**. Whatever information one scientist collects, others must be able to see and comment upon.

All scientific ideas must be testable and reproducible.

What is Science?

Scientific evidence must be **open for all to observe**. It must be measurable and not just one person's opinion or guess.

Empirical evidence includes observations and measurements. It includes the data people gather and test to evaluate scientific explanations.

The scientist may use specialized tools to make observations and take measurements.

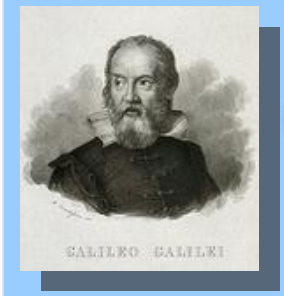
Science may be dangerous…

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	Questioned	Outcome
Socrates	Moral & Ethics	Hemlock
Galileo	*Church Dogma/Geocentrism*	*(~~torture~~) House Arrest*
Darwin	Evolution Natural Selection Creation	Ridicule

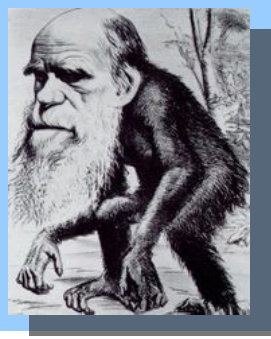












Vatican admits Galileo correct

Los Angeles Times, October 31, 1992

VATICAN CITY -- It's official: The Earth revolves around the sun, even for the Vatican.

The Roman Catholic Church has admitted erring these past 359 years in formally condemning Galileo for entertaining scientific truths it long denounced as anti-scriptural heresy.

Science



A 19th century artist, Nicolo Barabino, depicts the questioning of Italian Physicist and Astronomer Galileo before a tribunal of th

Rehabilitating Galileo's Image

Pope John Paul II moves to correct a 350-year-old wrong

During the often stormy relationship between science and religion, no other event has proved so troublesome as the Roman Catholic Church's denunciation of Galileo Galilei. In 1633, at the age of 69, the noted Italian scientist was judged by the Inquisition to have violated a church edict against espousing the controversial Copernican view that the sun, not the earth, was at the center of the universe. For the last nine years of his life, Galileo lived under house arrest.

In an age when heretics were sometimes burned at the stake, Galileo was treated relatively leniently. Still, he became widely regarded as a martyr of science who had been humbled by backward churchmen. Despite some tributes to Galileo by later church leaders, including several Popes, his condemnation has continued to taint relations between the Vatican—indeed, perhaps all religious authority—and scientists.



Galileo: flawed hero

The division has been a matter of special concern to Pope John Paul II. In public statements, beginning with a speech in 1979 before the Pontifical Academy of Sciences, he has said that there are no irreconcilable differences between science and faith. As a symbol of comity, he has made the rehabilitation of Galileo a major goal. In 1980 John Paul appointed a commission of scientists, historians and theologians to re-examine the evidence and verdict.

The panel's initial findings have now been made public. In a series of essays titled *Galileo Galilei: 350 Years of History*, published in Italian and French editions, nine Catholic scholars, including one American, acknowledge that the church was wrong in silencing Galileo. Writes Archbishop Paul Poupard, head of the Pontifical Council for Culture and editor of the collection: "The judges who condemned Galileo committed an error."

Indeed, the essayists argue that his condemnation was something of an aberration by the church's own standards. They point out that the church's attitude toward science then was not as backward as it is now sometimes perceived. As early as the 13th century, French Physicist George Bene notes, theologians like Thomas Aquinas had warned against the danger of literal interpretation of the Bible.

Galileo, however, seemed to court his own difficulties. His discoveries with the newly invented telescope—the mountains of the moon, the phases of Venus, the moons of Jupiter—made him known throughout Europe. But he was a flawed hero. He could be acerbic, arrogant and vain. He claimed discoveries that were not uniquely his: for example, the finding of sunspots, which were also seen by other 17th century observers. He wrote in a highly flamboyant style, scorning a scholarly Latin for vernacular Italian in order to reach a broader public. Among those who felt the bite of his pen were Jesuit astronomers. Some members of their order had originally supported Galileo, but by the time of his trial, they had died off and their hostile successors sharply attacked him as he faced the Inquisition.

Galileo's first brush with the authorities came in 1616, when he received a warning from Robert Cardinal Bellarmine, the leading theologian of the time. Bellarmine cautioned Galileo that the new Copernican view of the heavens should be treated as no more than a hypothesis. For a while the scientist heeded that advice. But when an old friend, Maffeo Cardinal Barberini, became Pope Urban VIII in 1623, Galileo felt confident enough to write his most controversial and, ultimately, self-ruinous work: *Dialogue on the Two Great World Systems*.

The book, written in the form of a conversation between three fictional characters, argued the relative merits of the Copernican universe and the older Ptolemaic system, which held that the sun and planets revolved around the earth. Galileo made it plain that his sympathies were with the character upholding the Copernican view, a know-it-all who disdainfully dismissed his opponents. He made Ptolemy's advocate sound like a simpleton, even giving him the name Simplicio. Into Simplicio's mouth went some of the arguments made by Pope Urban against the Copernican world.

Convinced that the wily scientist had made a fool of him, Urban signaled the Inquisition to proceed against Galileo. The tangled record is far from clear, but Galileo appears to have been found guilty on two charges: he had defied the order to treat the Copernican system only as a hypothesis and, in espousing that view, he was "vehemently suspect of heresy."

As John Paul once noted, the case created in the minds of many religious people doubts about the possibility of "fruitful harmony between science and faith, between church and the world." But arguing that such harmony can in fact exist, the Pope says that the church has now paid a suitable tribute to Galileo by accepting a major contention of the pioneering astronomer: that the Bible does not contain specific scientific truths, but speaks metaphorically about such events as the creation or the movement of the sun. As Galileo said, quoting a churchman of his day, "The intention of the Holy Spirit is to teach how to go to heaven and not how go the heavens." That is surely a credo any contemporary astronomer, indeed any 20th century scientist, can accept. —*By Frederic Golden. Reported by Wilton Wynn/Rome*

Some Examples of Pseudoscience?

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Homeopathy

- Magic water pretending to be medicine

“Energy” pseudoscience

- New-age mumbo jumbo

“Quantum” pseudoscience

- Wave functions and Chopra

Health Fads

- Magical diets and cancer cures

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What is Pseudoscience?

Something that looks like science and pretends to be science …
but isn't!

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What is Pseudoscience?

Something that looks like science and pretends to be science … but isn't!

- Proto-science

RUTGERS

What is Pseudoscience?

Something that looks like science and pretends to be science … but isn't!

- Proto-science

- Speculative science

RUTGERS

What is Pseudoscience?

Something that looks like science and pretends to be science … but isn't!

- Proto-science
- Speculative science
- Pseudoscience

RUTGERS

What is Pseudoscience?

Something that looks like science and pretends to be science … but isn't!

- Proto-science

- Speculative science

- Pseudoscience relies on …

1. Scientific language
2. Appeal to authority
3. Forceful arguments
4. Appeal to intuition
5. Popular media

1) Scientific Language

Complex language is persuasive

- Science is complex, therefore “complex” must imply “scientific”

Taking advantage of the use of *Mental heuristics*

- Short-cut rules
- Make decisions quickly
- Not entirely accurate
- Inaccuracies can be exploited
- E.g. optical illusions

2) Appeal to Authority

"You should believe me because *<respected person>* says I'm right"

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Science is *not* a hierarchy

- Truth is not decided by rank

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"You should believe me because *<respected person>* says I'm right"

Science is *not* a hierarchy

- Truth is not decided by rank

Also, science is *not* a democracy!

- Truth is not decided by a majority vote

2) Appeal to Authority

"You should believe me because <*respected person*> says I'm right"

Science is *not* a hierarchy

- Truth is not decided by rank

Also, science is *not* a democracy!

- Truth is not decided by a majority vote

These heuristics are useful, but…

- Experts can be wrong
- Expertise rarely transfers between disciplines
- Even certain theories often have dissenters

3) Forceful Arguments

Certainty is a red flag!

- Scientists usually appear cautious
- Pseudoscientists appear confident

“This is the way it is”

- Subconsciously accept the idea

“This is what the evidence shows”

- (so far)
- (but we might be wrong)
- Subconsciously doubt the idea

4) Appeal to Intuition

"I mean, it's obvious, right?"

Intuition is an evolved sense

- Good for working on "Human scales"
- Useful *on the whole*
- Employs heuristics
- Highly susceptible to errors when applied to unfamiliar environments
- Science is not (always) intuitive

Don't trust your gut

- That's why we have experiments!

5) Popular Media

Scientific accuracy is not a priority

- Most science journalists are not scientists
- Sensationalism sells!

Peer review is vital

- Beware of those taking shortcuts
  - E.g. Pons & Fleischmann

Truth is not related to volume

- Only evidence counts

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Some Examples

Homeopathy

- Magic water pretending to be medicine

“Energy” pseudoscience

- New-age mumbo jumbo

“Quantum” pseudoscience

- Wave functions and Chopra

Health Fads

- Magical diets and cancer cures

More Examples!

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Pseudoscience Related to Space and Astronomy
2012 Phenomenon - end of the world
Crop Circles - made by aliens
Face on Mars - A rock formation: evidence of life
Pseudoscience Related to the Earth
Cryptozoology - search for Bigfoot (Yeti), Loch Ness monster, El Chupacabra
Pseudoscience Related to the Paranormal
Channeling - Involves communicating with a spirit through a person
Electronic Voice Phenomenon (EVP) - Used by ghost hunters to record messages from spirits
Extra-sensory Perception (ESP) - clairvoyance, telepathy, levitation
Numerology - A belief in a relationship between certain numbers and people or events
Pseudoscience Related to Psychology
Conversion Therapy - change a person's sexual preference (homosexual to heterosexual)
Hypnosis - method of deep relaxation where the subject is open to suggestions
Psychoanalysis – Freud
Other Pseudoscience Examples
Feng Shui - A Chinese method of arranging objects and living spaces in a certain way
Handwriting Analysis - A belief that a person's personality can be seen in their handwriting

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Science & Pseudoscience – Popper's Demarcation Criterion

About 100 yrs ago, people were deeply interested in theories like:

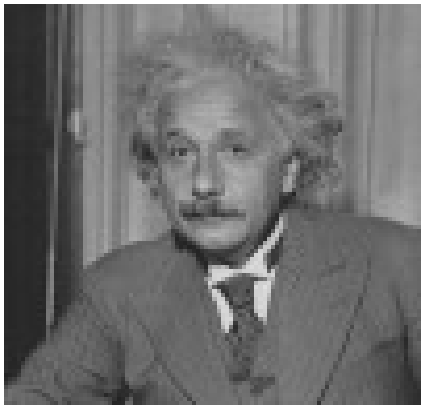


Alfred Adler's (1870-1937) *individual psychology*:

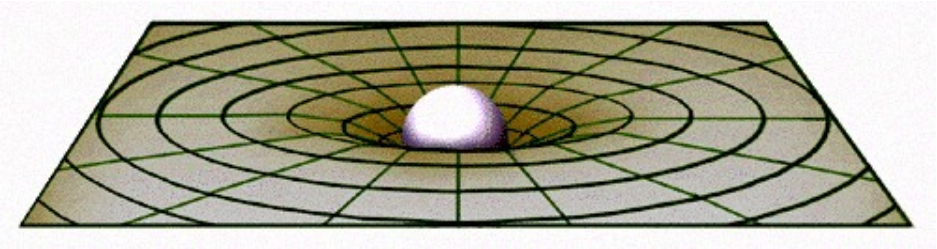
- An inborn sense of inferiority
- Strive for superiority
- Seemed to be able to explain *everything* within its field of inquiry!

Popper's Demarcation Criterion

Albert Einstein's (1879-1955) *theory of relativity*:



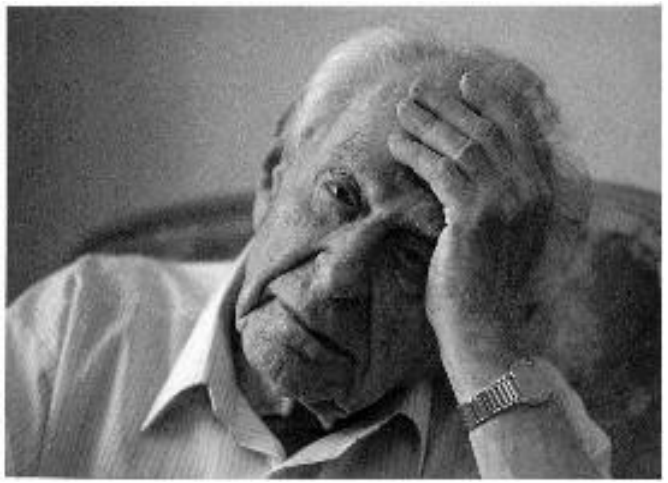
- Relativistic spacetime e.g. simultaneity is relative.
- $E = mc^2$
- One of the two pillars of modern physics.



Popper's Demarcation Criterion

Both claimed to be "scientific".

Yet, Karl Popper (1902-1994) held that theories like Alder's is actually *not* scientific.



Popper's Demarcation Criterion

He raised the *demarcation problem*:

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

Scientific / Pseudoscientific

Popper's Demarcation Criterion

His criticism of theories like Adler's:

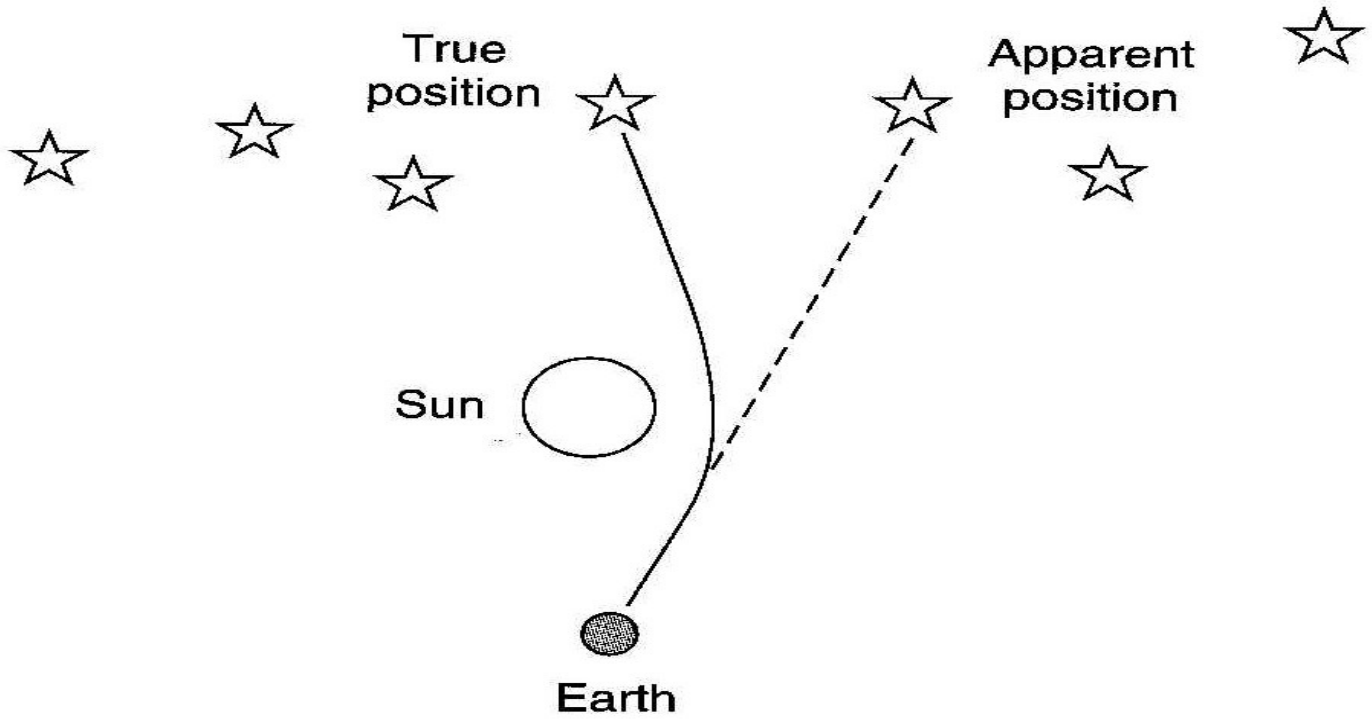
- Adler's theory could easily "explain" two "diametrically opposite" cases, e.g.:
  - A man pushes a child into the water with the intention of drowning it.
  - A man sacrifices his life in an attempt to save the child.
- How?
  - By appealing to the idea of inferiority feeling, . . .

Interpretation Vs Explanation

- Its “explanatory power” is just a disguise of its “interpreting power”.

This **apparent strength** - capable of explaining everything - is in fact a **weakness**.

- Arthur Eddington's confirmation (1919) of Einstein's theory was different:
  - The light-bending prediction
  - Might be refuted — not always confirmatory!



Popper's Demarcation Criterion: Falsifiability

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Consequently, Popper proposed:

- The criterion of the scientific status of a theory is its

  falsifiability,

  or *refutability*,

  or *testability*.

Is this criterion adequate?

Pseudoscience and Falsifiability

Pseudoscience theories refuse falsifiability

(beware of certainty…)

“Is there any way we could prove this to be false?”

”No” --> Pseudoscience

As Popper said: “not only these pseudoscience theories are not right… *they are not even wrong*!”

Pseudoscience and Falsifiability: Autism's therapy

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"Is there any way we could prove this to be false?"

"No" --> Pseudoscience

"Is there any way this therapy could be not the best one for the case at hand?"

"No" --> Pseudoscience

Neurotribes by Steve Silberman

"Soon, samples of Leo's blood, hair, stool, and urine were dispatched to a network of labs for analysis, including "Doctor's Data" in Illinois and the "Great Plains Laboratory" in Kansas, which acted as central testing hubs for the whole "DAN! Network". **Unlike most conventional medical testing outfits, these labs provide not only quantified results directly to doctors but printouts for patients with interpretive commentary** and suggested baseline "reference ranges" for individual tests. The Great Plains Laboratory, for example, suggested that children with "abnormal" levels of peptides in their urine be put on the GFCF diet and be tested for food allergies."

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Neurotribes by Steve Silberman

"Leo's doctor happened to know of a skilled BioSET practitioner who had an office just down the block and said that he would provide the Rosas with a referral. He also furnished them with a list of vitamin and mineral supplements that he offered to sell them directly from his office. **This one-stop-shopping approach is common in the biomed community**."

Neurotribes by Steve Silberman

"The Rosas walked out of the doctor's office reeling but resolved—out with the gluten-infested Goldfish, the hyperallergenic peanut butter, and the yeast producing jellies; in with the rice bread, almond butter, GFCF pancake mix, cod liver oil, K-Mag Aspartate, probiotics, CoQ10, B-12, zinc, selenium, digestive enzymes, glutathione cream, folic acid, antifungals, and immune-boosting mushroom extract. **The monthly bill for these foods and supplements was enormous**, on top of the thousands that the Rosas paid each month for ABA and other therapies. But they saw these expenses as crucial investments in Leo'sfuture."

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Neurotribes by Steve Silberman

"On the Rosas' next pilgrimage to Los Altos, the doctor inevitably brought up chelation. But this time Craig challenged him. "Wait a second," he told the doctor. "You're telling me that the recommended course of action for a low reading of mercury toxicity is chelation?" "Yes," the doctor replied. "And the recommended course of action for high mercury toxicity is chelation?" The doctor nodded yes again. **Finally Craig asked him, "Is there any sort of outcome that would contraindicate chelation?" And the doctor said, "No."** At that point, Craig and Shannon said, "Thank you very much," walked out of the doctor's office, and never went back to Los Altos to see him again."

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Popper's Demarcation Criterion: Falsifiability

Consequently, Popper proposed:

- The criterion of the scientific status of a theory is its

falsifiability,

or *refutability*,

or *testability*.

Is this criterion always adequate?

Comments on Popper's Falsificationism

Two senses of falsifiability:

Falsifiability as a **logical property** of statement:

- Falsifiable, e.g.:

  "It never rains on Wednesdays."

  "All substances expand when heated."

- Unfalsifiable, e.g.:

  "Luck is possible in sporting speculation."

  "There is a ghost in this room which cannot be sensed, directly or indirectly."

Falsifiability as a **methodological prescription** of how scientists should act

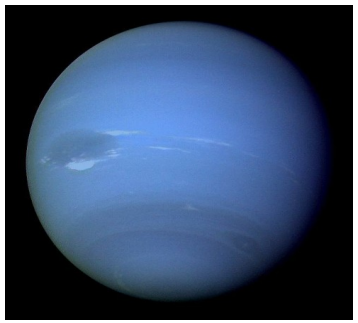
- E.g. try to make "all substances expand when heated" unfalsifiable in this sense.

But both these senses are problematic!

1. The logical sense

- May be too broad – too easily fooled
- Suppose T is a theory having testable predictions.
- Let C be, say, “there is a ghost in this room which cannot be sensed, directly or indirectly”.
- Then T & C have testable predictions and thus are scientific in the logical sense!

2. The methodological sense



- Too restrictive

- E.g. the discovery of Neptune
  - Newton's theory of gravitation wrongly predicted the orbit of Uranus – abandoned it?
  - In fact, some scientists tried to rescue Newton's theory by postulating the existence of an unknown planet.
  - Neptune was finally discovered at almost the exact place and time as predicted.

The “failure” of Popper's criterion throws up an important question:

- Is it possible to find some common features shared by all the sciences, but not shared by anything else?
- Has science “essential features”?

Popper assumed that the answer was yes.

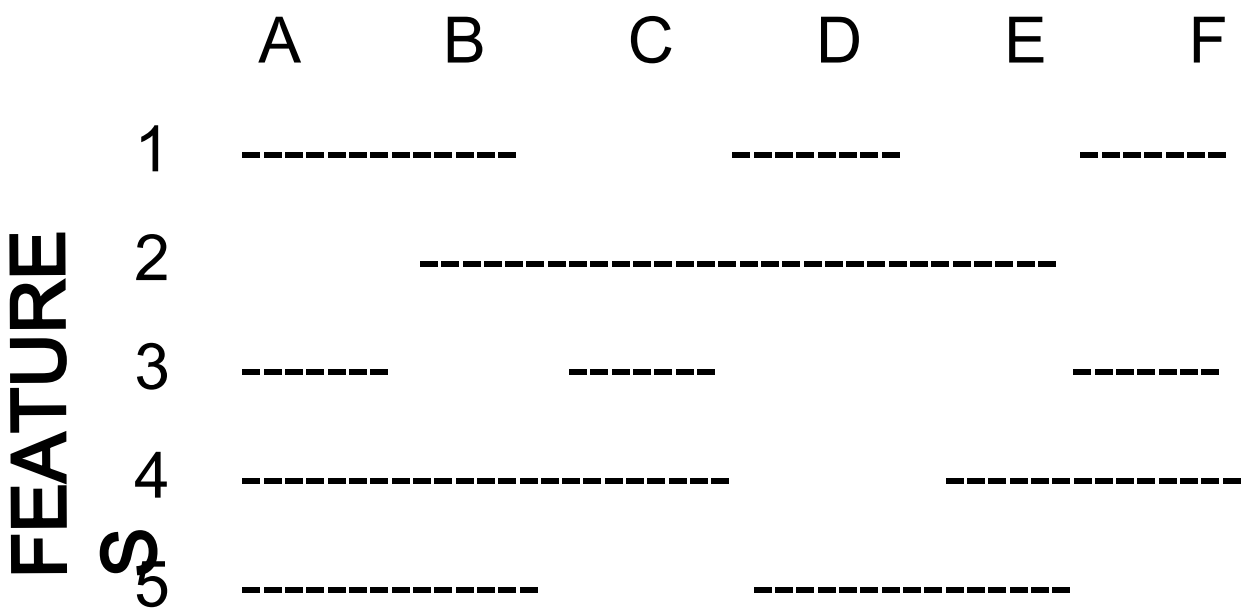
Ludwig Wittgenstein (1889-1951) argued against essentialism.

- Family resemblance concepts like "game" have no essential features.
- Cf. His *Philosophical Investigations*, sections 66-7.



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GAMES



The same may be true of “science”.

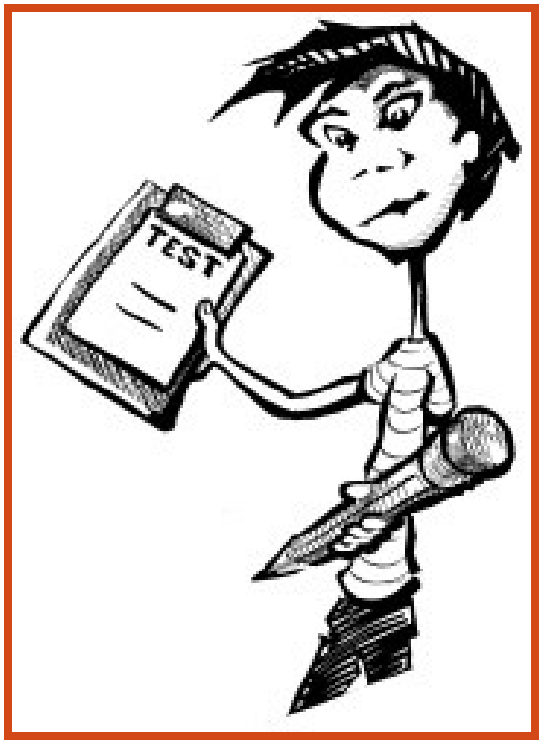
- Note the heterogeneity of science.

If so, no simple criterion for demarcating science from pseudoscience!?

How actually should we choose among hypotheses – scientific or pseudoscientific?

Criteria of Adequacy

- Testability
- Scope
- Fruitfulness
- Conservatism
- Simplicity



What are their significance?

Testability

- Necessary condition for being scientific
- Possible candidate for knowledge
- Minimal condition for further study

Scope, Fruitfulness, Conservatism, Simplicity

- Involved in systematizing, unifying & developing scientific knowledge.

Testability

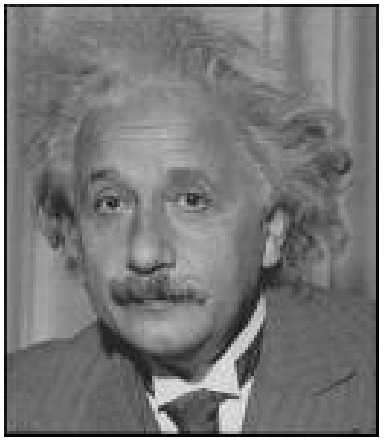
- A hypothesis is scientific only if it is testable, that is, only if it predicts something more than what is predicted by the background theory alone.
- E.g. what makes fluorescent lights work?
- The little fairy hypothesis
  - Non-testable version
  - Testable version



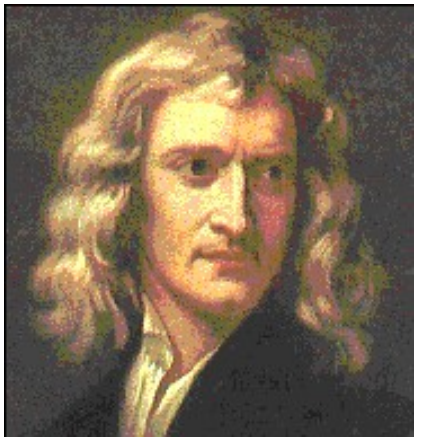
- *Ad hoc* hypothesis
  - A common type of non-testable hypotheses

Scope

- Other things being equal, the best hypothesis is the one that has the greatest scope, that is, that explains and predicts successfully the most diverse phenomena.
- Einstein's theory has greater scope than Newton's.



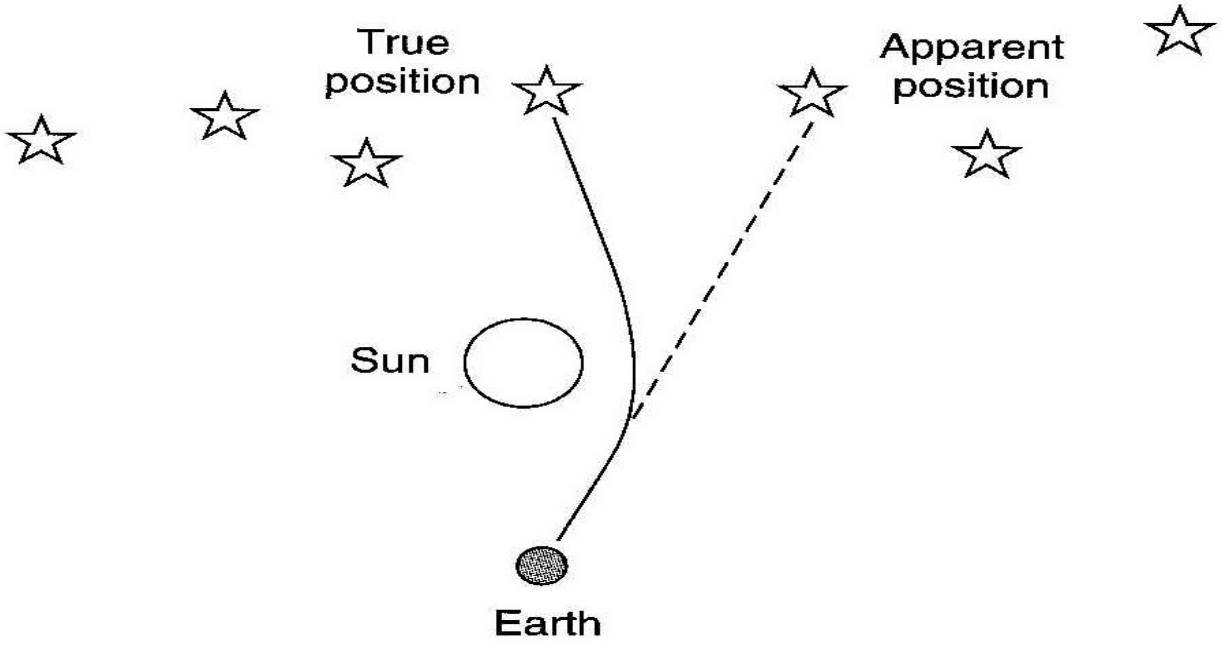
1879 - 1955



1642 - 1727

Fruitfulness

- Other things being equal, the best hypothesis is the one that is the most fruitful, that is, makes the most successful novel predictions.
- Einstein's theory's novel prediction



Conservatism

- Other things being equal, the best hypothesis is the one that is the most conservative, that is, the one that fits best with established beliefs.
- E.g. hypothesis: a crime is committed by aliens.

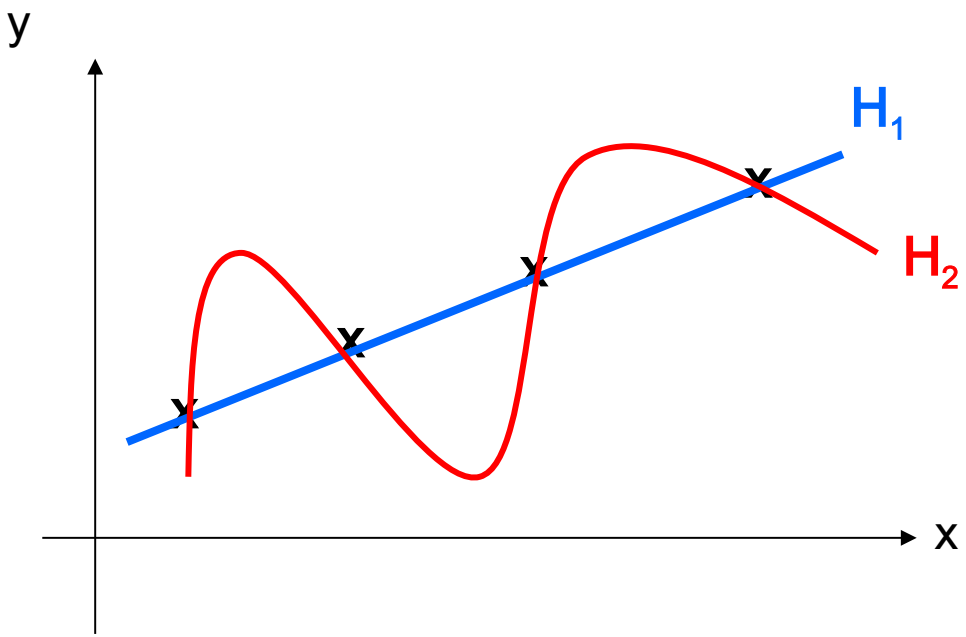


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Simplicity

- Other things being equal, the best hypothesis is the simplest one.
- Curve-fitting for experimental data:



The Copernican Revolution

- Ptolemy's geocentric theory vs. Copernicus's heliocentric theory

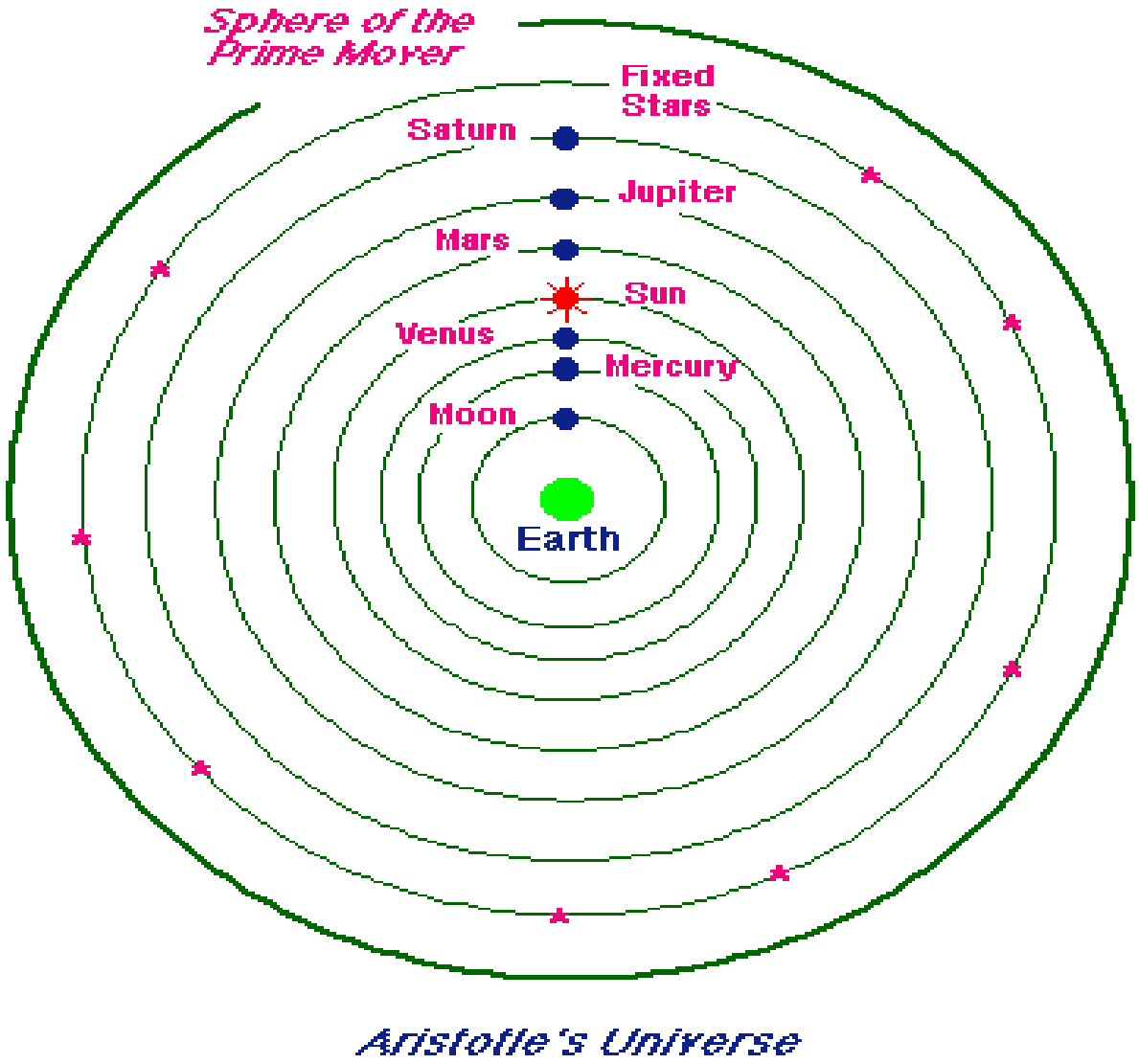
Ptolemy (c.87-150)



Copernicus (1473-1543)



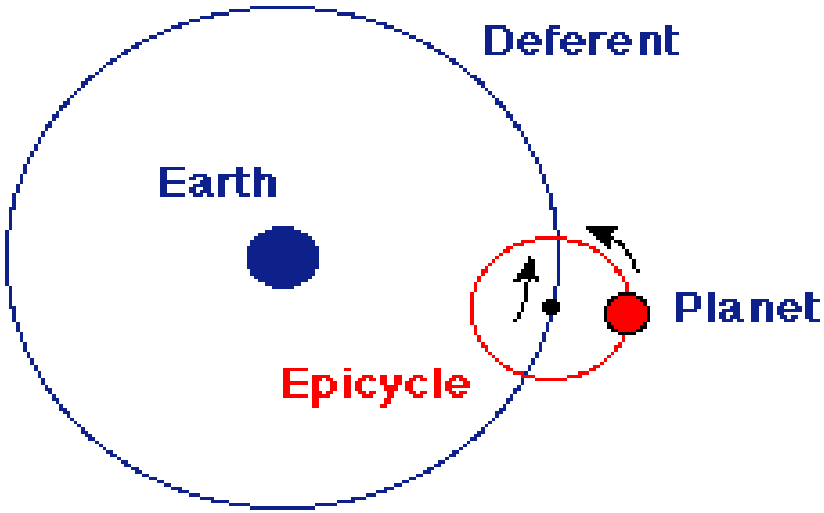
The geocentric model of the Universe:

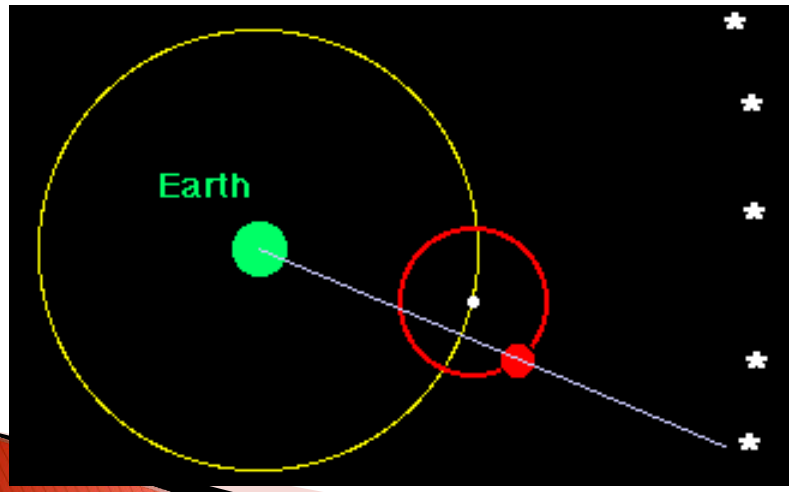


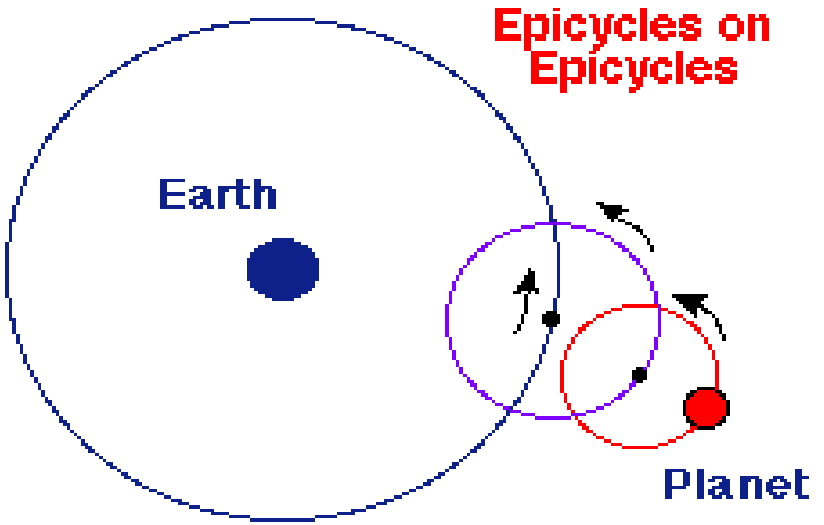
The problem - explaining the retrograde motion of the planets.

Ptolemy's solution:

- Epicycles

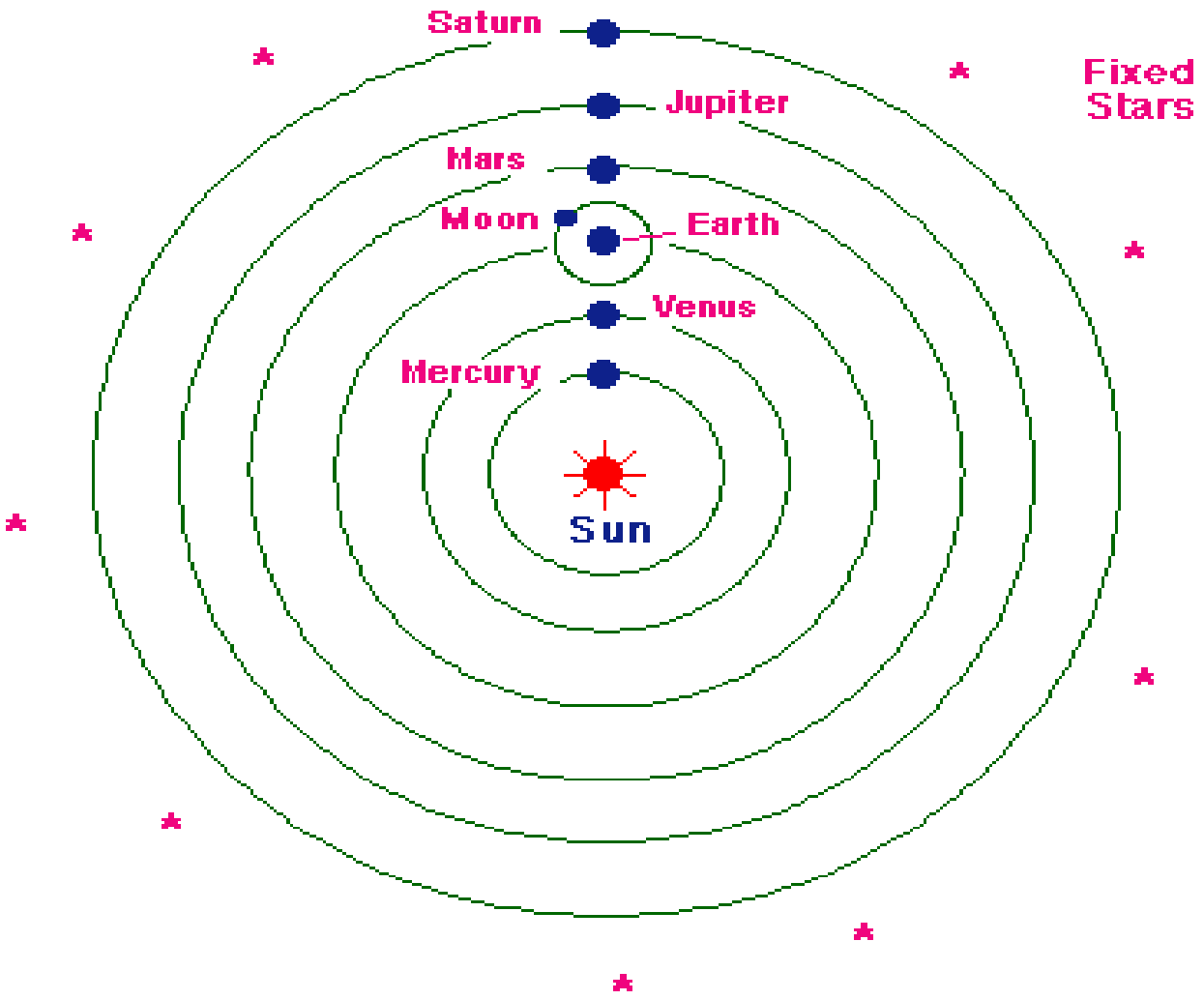






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The heliocentric model of the Universe:



Occam's Razor

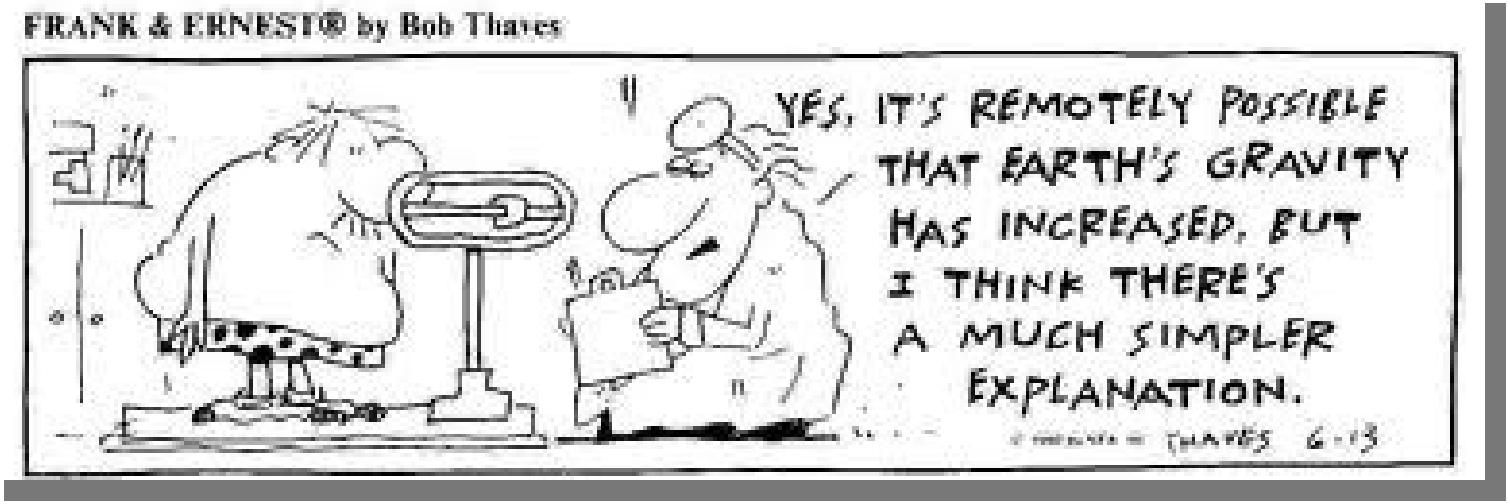
- Do not multiply entities beyond necessity.
- Laplace (1749-1827) & Napoleon

William of Occam (c.1285-1349)



Discussion:

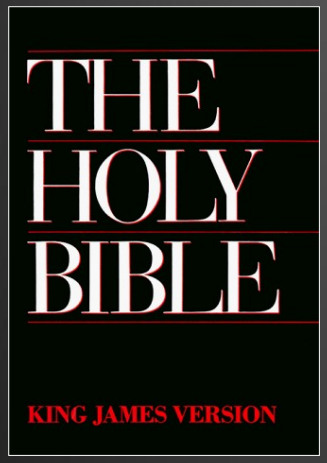
- There may have conflicts when applying the criteria.
- E.g., conflict between simplicity & conservatism in the case of Copernican vs. Ptolemaic theory.
- In which ways are Ptolemaic theory more conservative?

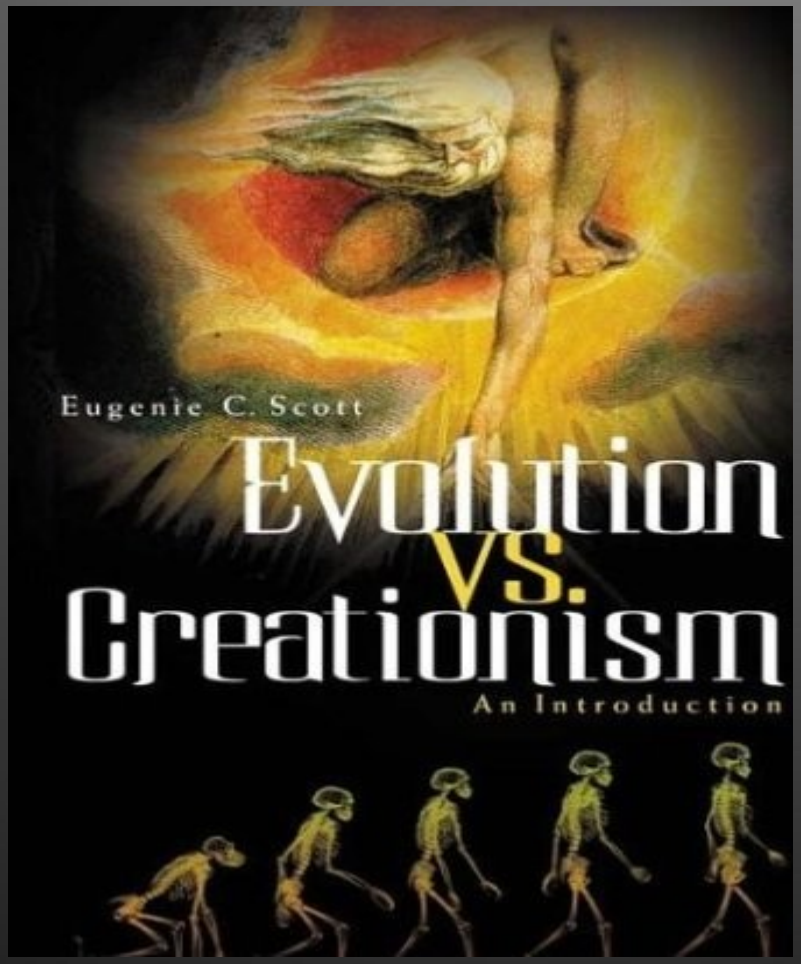


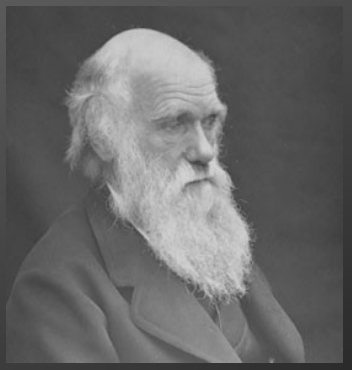
Occam's Razor: "Do not multiply hypotheses unduly"

Choose the simplest explanation!!!!

Further Example: Evolution vs. Creationism





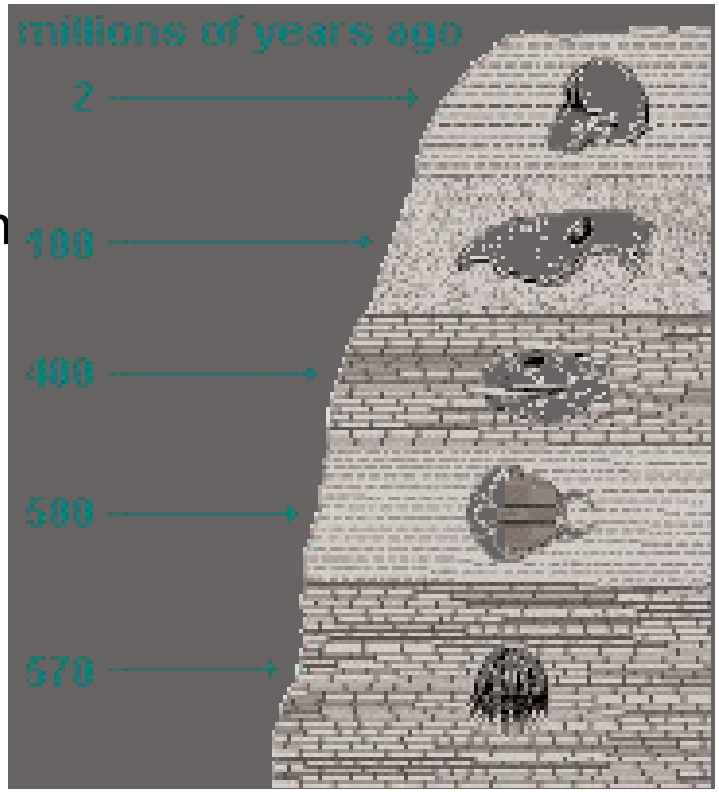


Charles Darwin
1809-1882

Testability & Conservatism

Evolution

- Testable claims, e.g.:
  - About the fossil record of change in earlier species
- Fits well with current established beliefs, e.g.:
  - The Earth's history is much longer than several thousands years.



Creationism

- Testable claims, e.g.:
  - About the fossil record
- Conflicts with well-established beliefs, e.g.:
  - Age of the universe
  - Buoyancy of earlier species
  - Types of fossil
  - Noah's Ark and the great flood



Fruitfulness

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Evolution

- Has predicted novel facts, e.g.:
  - Organisms should adapt to changing environments.
  - Mechanisms for modifying features and passing them from generation to generation – genes and mutation!

Creationism

- Has only made non-conservative novel claims, e.g. about buoyancy.

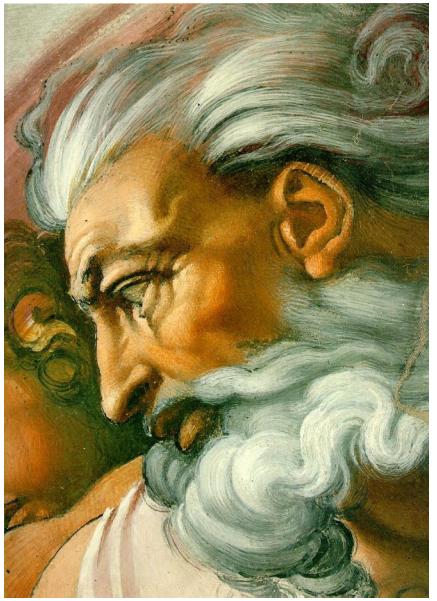
Simplicity

Evolution

- Without postulating a supernatural being with supernatural powers, but natural mechanisms involved.

Creationism

- Postulating a supernatural being with supernatural powers, but less natural mechanisms involved.



Difficult to judge, but creationism seems to be simpler under "commonsense".

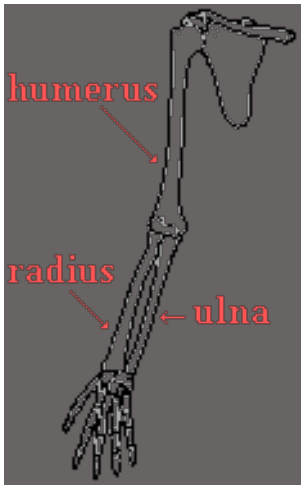
Scope

Evolution explains diverse phenomena, e.g.:

- The fossil record of change in earlier species
- The chemical and anatomical similarities of related life forms



DNA

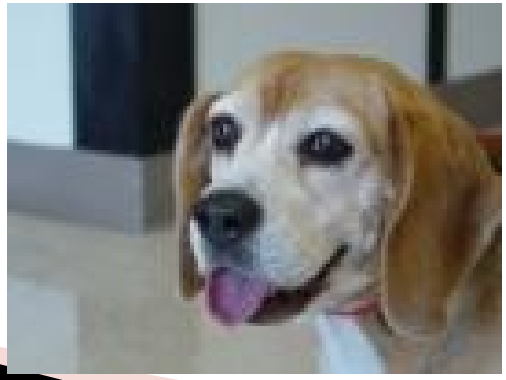


Human arm bones
(typical vertebrate pattern)

- The geographic distribution of related species
  - E.g. the existence of Australia's, New Zealand's, and Hawaii's mostly unique biotic environments









Creationism's scope is zero!

- Creationism's explanations are either failed explanations (e.g. about the fossil record) or *pseudo-explanations*.

- Pseudo-explanation
  - Appealing to "an incomprehensible being with incomprehensible powers" – a notion that does not allow any predictions!

Conclusion: It's much much more reasonable to accept evolution than creationism.

Method section

Sections of a lab report

Title

Abstract

Introduction

Method

- *Design*
- *Participants*
- *Apparatus & Materials (optional)*
- *Procedure*
- *Scoring (optional)*

Results

Discussion

References

Appendix (optional)

In which order … ?

Title

Abstract 6.

Introduction 4. (outlined in advance)

Method 1.

- *Design*
- *Participants*
- *Apparatus & Materials (optional)*
- *Procedure*
- *Scoring (optional)*

Results 2.

Discussion 5.

References automatic

Appendix (optional) 3.

Method

Someone should be able to repeat your experiment by reading this section!

Include **enough information for replication** of the study, but avoid superfluous information



- E.g. 'A pencil and paper were used to record the participant's gender'.
- The Method always has clearly labelled sub-sections, but these do vary according to the type of experiment and the Journal type
  - E.g. You may not always need an apparatus section (unless, for example, you used a MRI scanner and wanted to report the details about it)

Method –sub–sections

Design

Participants

Apparatus and/or Materials (optional)

Procedure

Scoring (optional)

Sometimes the order of these sub-sections will be different if you pick up an academic paper. Try to stick with the order above.

Design sub-section

Here you should **formally describe** the type of design being used (using psychological design language)

- This is more often the case for an experimental design where IVs are manipulated and DVs measured. Not all designs (e.g. correlational) have IVs!

Directly **mention and define all IV(s)/DV(s)**.

- Remember to report units of measurement for DVs!

Conditions of the design should be mentioned and how they were manipulated

- E.g. Design type might be a between-subjects design

Design sub-section

You start mentioning the participants in the design sub-section.

You want to explain how the participants "relate" to the design.

That is, how many participants were tested under each condition?

Any design controls should be mentioned here.

- E.g. If the design counterbalanced for the ordering of two conditions, then say so.

How did you assign participants to conditions (or orders of conditions)?

Design sub-section

Example:

'A repeated measures design was used. There were two independent variables: the lighting used in the nightclub (bright or dim) and the level of alcohol consumed (none or 6 pints). There were two dependent variables that were analysed separately: the participant's ratings of physical attractiveness (the COAR scale) and their ratings of the attractiveness of personality (the CRAPS scale). Participants took part in all four conditions of the experiment.'

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Participants sub-section

So who were tested in your experiment?

What age and gender were they?

How did you select them?

- A random sample?
- A snowball sample?
- A convenience sample?

How many of them were there?

Were there specific characteristics (selection criteria) of the people you tested that should be mentioned?

- E.g. All participants were right handed and bilingual.
- Only mention such things if they are important to your study

Participants sub-section

Example:

‘Fifty participants completed all conditions of this study: 25 were male and 25 female. Ages ranged from 18 to 39 years (M = 24.26, SD = 3.52 years). Participants were all undergraduate students at the University of Sussex who took part in return for free admission to the nightclub. All participants were naive to the purpose of the experiment.’

Apparatus / Materials sub-section

This section describes the apparatus and materials used in testing the participants

Apparatus includes specialist equipment e.g. An Apple computer running E-Prime.

Clear **sentences** should be used to describe apparatus/materials and *not bulleted lists*!

Sometimes a Stimuli section is used to describe the stimulus materials that participants responded to

- E.g. Stimuli were four geometric shapes, each containing the letter A-D. Shapes were approximately 2cm wide by 2cm high and were presented in red.
- Sometimes you might find it easier to give some visual examples of stimuli if relevant within a figure, which you can make reference to in your write-up.

An Example Figure

Title (in italics)

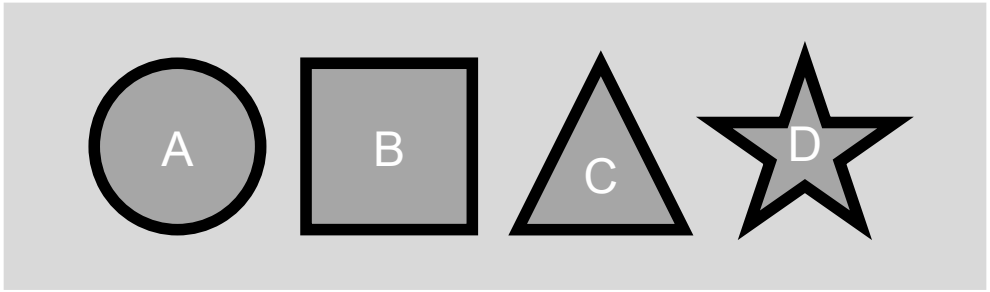


Figure 1: Examples of the four geometric shape stimuli used in the procedure (not to scale).

Caption

Reports can contain *figures* and/or tables and reference to any figure/table should be made in the main text of your report.

A figure can be a graph, charts, drawings, a photograph, a diagram, etc. and these elements are always referred to as a **'figure'** and numbered consecutively. The figure should have a title/caption **below** it (as in the example at the top!)

Just to be awkward, tables have the title and caption **above** the table!!

More on presenting Figures/Tables

RUTGERS

Figures/Tables often help explain things in fewer words

The reader should not have to refer to the text to understand your tables and figures: there should be explanatory figure/table captions

Figures and tables are labeled independently

- E.g. Figure 1 then later Table 1 (not Figure 1 then later Table 2!)

Axes on graphs should be clearly labeled

Units of measurement should be clear



Don't refer to 'graphs', 'diagrams', 'pictures', photographs' etc. in your main report text; use the terms 'Figure' and/or 'Table'

Procedure sub-section

This section should state how the design was implemented with the pre-mentioned participants, using the pre-mentioned design and apparatus/stimuli.

So when participants took part, what happened to them, and in what order, from the moment they began?

Mention important **timings** (especially important in many cognitive tasks).

Need enough detail to be able to replicate the procedure.

- Only include relevant detail!
- TOO DETAILED: E.g. Participants arrived 10 minutes before the start of the experiment. They were permitted, but not required, to sit. The wind was coming from the West…

Procedure sub-section

Very long instructions that were given to participants can be put into an **appendix** (but must be referred to e.g. 'For a full transcript of the instructions, see appendix 1.')

- Shorter instructions can be included in the main procedure section.

Any emphasis within instructions about how to respond should be made clear

- E.g. Participants were asked to respond as quickly as possible but were also reminded to be as accurate as they could be.