

Seminar: How do I lie with statistics?

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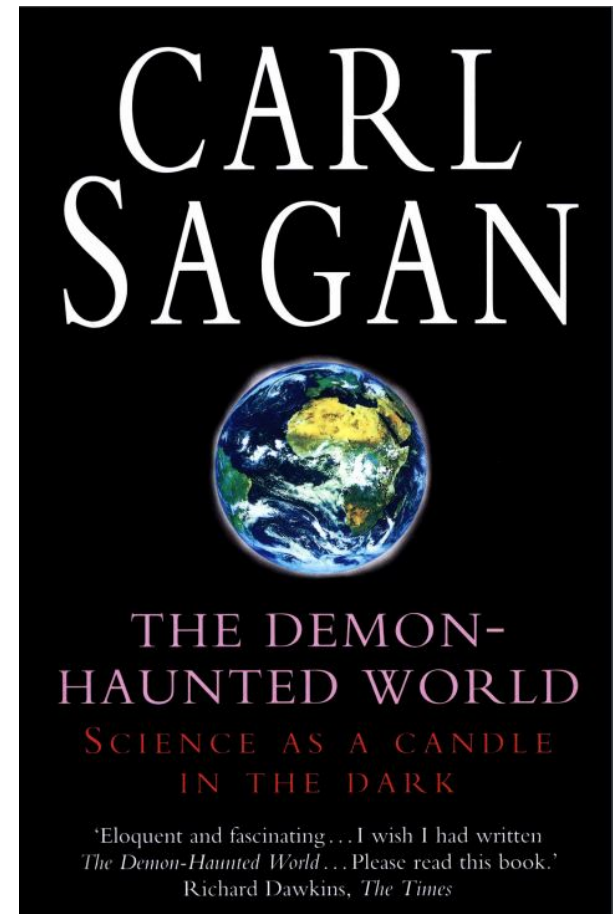
Topic 3: The Limits of Knowledge and the Power of Bullshit

Based on „The Demon-Haunted World“ - Carl Sagan (1996)

Julius Drück – Heidelberg, 31.10.2019

Outline

- 1) The Limits of Knowledge
- 2) The Demon-Haunted World
 - 2.1) Witch-hunts
 - 2.2) Aliens
- 3) Baloney detection
- 4) Conclusion



1) The Limits of Knowledge

- “Science is far from a perfect instrument of knowledge, it’s just the best we have.”
- Scientist has idea / hypothesis
- Hypothesis is abstraction from real world phenomena
- It needs to be testable
- Compare results of experiment with observations
- Hypothesis needs improvement based on results

1) The Limits of Knowledge

- Experiment needs to be repeated
- Hypothesis needs proof based on experimental results
- Experiments need to be repeatable independently with same results
- Discard hypothesis when results don't match with observations
- Limits of hypothesis also need to be tested

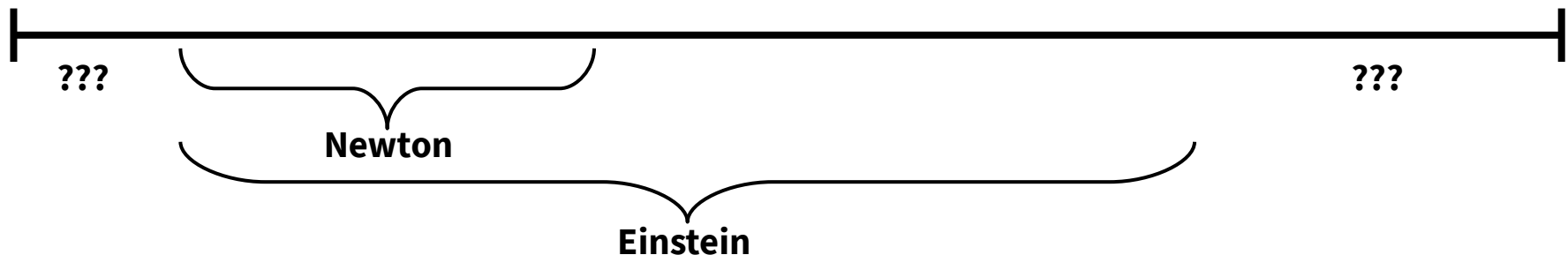
1) The Limits of Knowledge

- Range of validity (Under which circumstances does the hypothesis no longer work?)
- How precise is the hypothesis compared to observations?
- Improvements to hypothesis need to achieve better precision / increased range of validity
- Hypotheses usually involve abstraction, so infinite precision / range of validity is not obtainable

- In everyday life Newtonian physics are valid
- No longer the case when approaching speed of light

1) The Limits of Knowledge

- Limitations of Newtonian physics not necessarily known in Newtons age
- Theory of Special and General Relativity was an improvement in precision and range of validity
- Indistinguishable from Newtonian physics in its realm of validity
- Limits of Special and General Relativity are being tested



1) The Limits of Knowledge

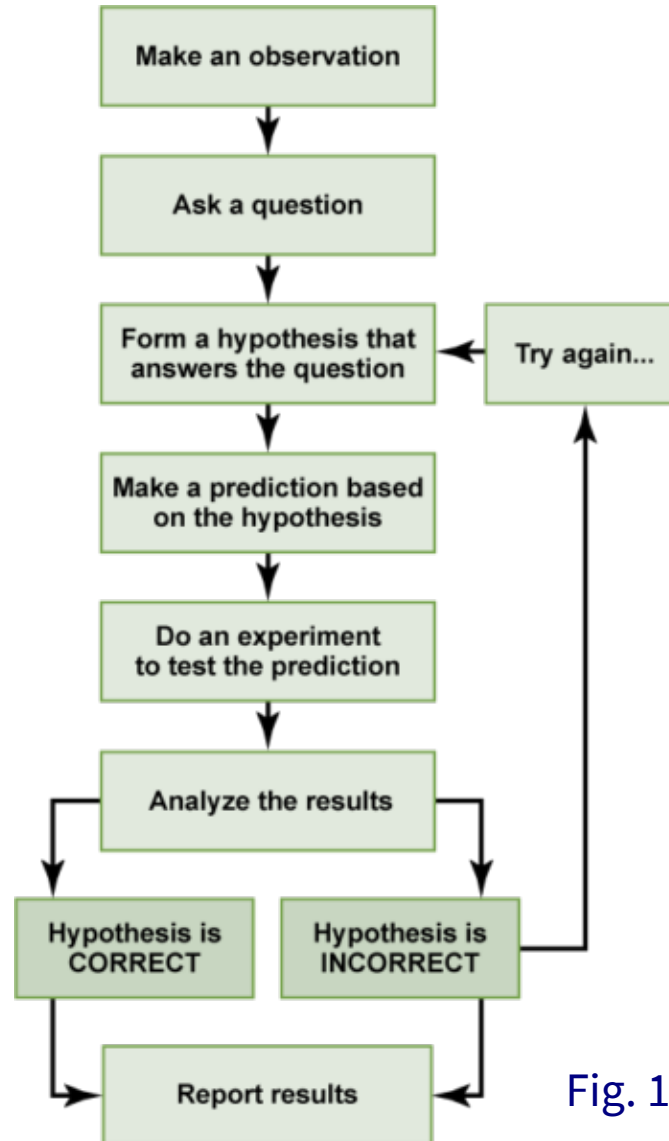


Fig. 1

The Burden of Proof

Conventional Logic



Shifting the Burden of Proof



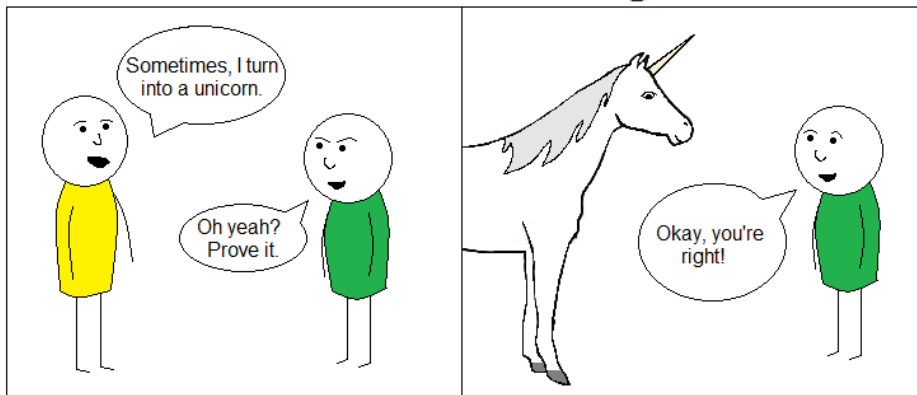
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Fig.2

- "Extraordinary claims require extraordinary evidence." (Sagan Standard)
- E.g. claiming to have eaten ice cream requires substantially less proof
- Burden of Proof lies with the one making a claim
- Science is based on having proof for a hypothesis / claim

The Burden of Proof

Conventional Logic



Shifting the Burden of Proof



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Fig.2

- A claim needs to be testable with scientific methods, otherwise holds no value
- Having doubts towards a claim doesn't require proof against said claim
- Shifting the burden of proof makes nearly any claim "viable" based only on the fact that the opposite can't be proven

2) The Demon-Haunted World

2.1) Witch-hunts

- “ Microbiology and meteorology now explain what only a few centuries ago was considered sufficient cause to burn women to death.”
- Church had much control, was an authority, what they said was generally believed by the public
- Demons were said to have come to earth to have sexual relationships with women
- Offspring were called witches
- They are thought to have caused (at the time) inexplicable phenomena

2) The Demon-Haunted World

2.1) Witch-hunts

- Bull of 1484 from Pope Innocent VIII initiated systematic persecution of “witches”
- Women were persecuted and tortured before being burned to death in public
- Confessions were being forced out of them by torture
- Torture also brought out confessions about other witches, which caused even more women to be persecuted and tortured
- As a result the amount of people who claimed of seeing someone ‘performing witchcraft’ increased over time

2) The Demon-Haunted World

2.1) Witch-hunts

- 1486: Creation of the Malleus Maleficarum ('Hammer of Witches')
- 'Research' done, to document what a witch is and how to identify them
- Document which has helped institutionalize witch-hunts
- Bottom line: If accused of witchcraft, you're a witch
- Soon, persecution started out of personal interest of accuser
- Defendant had no rights, proof of innocence nearly impossible
- Burden of Proof was shifted towards the accused

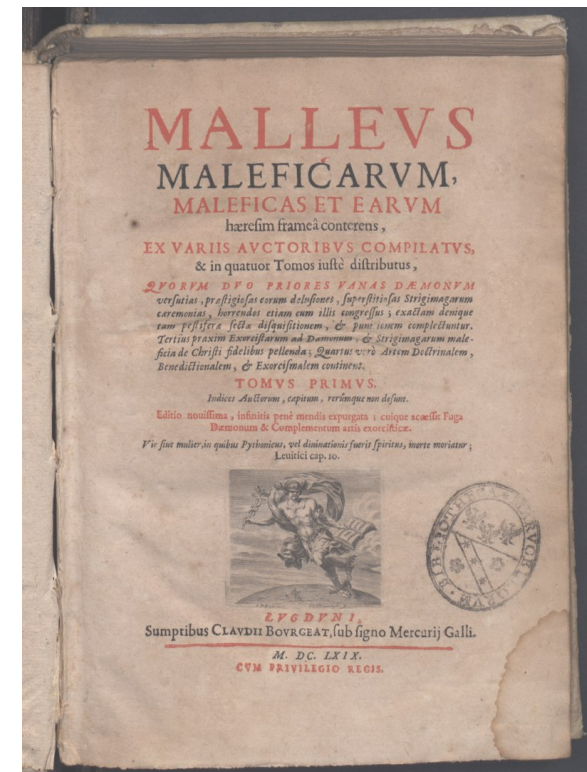


Fig.3

2) The Demon-Haunted World

2.2) Aliens

- “So in an age when traditional religions have been under withering fire from science, is it not natural to wrap up the old gods and demons in scientific raiment and call them aliens?”
- Not unusual to experience hallucinations / dreams where you might later recall them being real
- Science Fiction got very popular in the 20th century
- Some people reported their experiences as abductions
- Through influence of Science Fiction, aliens were the ones ‘abducting’ those people
- Possible that people really believed their own stories
- Over time more attention was being given to those stories through the media

2) The Demon-Haunted World

2.2) Aliens

- Often described as small grey beings, less than four feet tall: “ Their heads are pear-shaped, bald, and large for their bodies. Their eyes are enormous, their faces expressionless and identical.”
- Typical description of aliens in the 20th century (Sci-Fi, magazines, etc.)
- Through media attention, the number of reported alien abductions rose significantly
- UFO sightings had to be real “[...] and there is no other explanation than the object being an advanced piece of alien technology that is well beyond our comprehension.” [Source]
- People tend to see what they want to see
- Denying other, easier explanations

2) The Demon-Haunted World

2.2) Aliens

The screenshot shows a Google search for "aliens". The search bar is at the top left, and the results are displayed in a grid. Each result includes a thumbnail image and a short title. The images depict various types of aliens, UFOs, and scenes related to alien contact. The titles are as follows:

- Aliens may be more like us than we think | Uni... ox.ac.uk
- Storm Area 51: US Air Force warns over Fac... bbc.com
- How Will We Make First Contact With Aliens: ... thedailybeast.com
- Aliens are HERE and they're breeding with h... express.co.uk
- Simple math shows how many s... nbcnews.com
- How Dead Aliens Could Help Save... space.com
- 1.5 million people have signed up to stor... theguardian.com
- Space Entrepreneur Thinks Alien... nbcnews.com
- Auf der Suche nach Aliens - Aktuell | SWR3 swr3.de
- Area 51: Over 1m sign up to storm base, 'see t... newshub.co.nz
- Evidence That Aliens Have Made Contact - YouTube youtube.com
- Why Aren't The Aliens Here Already? : 1... npr.org
- Alien research breakthrough as 1,000 t... metro.co.uk
- Gorilla-Effekt: Vielleicht leben ... welt.de
- What evolutionary theory can tea... theconversation.com
- Ferne Welten: Aliens in Film und Literatur - "Pr... deutschlandfunkkultur.de
- Dojo lässt Aluhutträger und Aliens für Ebay Klei... wuv.de
- What Happens Next If We Find Proof... nbcnews.com
- Außerirdisches Leben im Universum: U... stuttgarter-zeitung.de
- Ancient Aliens history.com
- UFO seekers flock to Thai hilltop in search... cnn.com

Screenshot taken: 29.10.2019 18:23

2) The Demon-Haunted World

2.2) Aliens

- No real evidence for any abductions / aliens exists
- Many other possible explanations: hallucinations, mental-illnesses, pranks, etc.
- “Boring” explanations for UFOs: aircraft (e.g. unusual lighting patterns, high-altitude balloons, etc.)
- If aliens have visited us: Why no first contact? Why visit in secret? Why can we detect their aircraft when they are much more technologically advanced than us? ...
- Simple answer: We haven't been visited by aliens (yet).

3) Baloney detection

Tools for skeptical thinking

- Independent confirmation of the ‘facts’
- Encourage debates
- “In science there are no authorities; at most, there are experts.”
- Think of multiple explanations for what has to be explained, then think of tests to disprove each alternative: Surviving hypothesis has good chance of being the correct one
- Choose the simpler hypothesis when different alternatives explain data equally well
- Hypotheses need to be testable

3) Baloney detection

What not to do: Common fallacies

- Correlation does not equal causation
- Absence of evidence is not evidence of absence
- Observational selection
- Misunderstanding of the nature of statistics: “Roughly half the population of country X has below average intelligence.”
- Excluded middle (only considering the two extremes in a continuum)
- Attacking the arguer and not the argument

4) Conclusion

- Not everyone needs to pursue science, it is unrealistic and not necessary
- However, the scientific method of thinking is key to be able to distinguish between fact and baloney
- Knowing how to avoid common fallacies is equally important
- The scientific method needs to be applied judiciously
- Science itself is not perfect and has its limitations, it needs verifiable evidence
- “In every country, we should be teaching our children the scientific method and the reasons for a Bill of Rights. With it comes a certain decency, humility and community spirit. In the demon-haunted world that we inhabit by virtue of being human, this may be all that stands between us and the enveloping darkness.”

Thank you for your attention!