



Why does science work?

Is science compatible with naturalism?

The human mind and reality

- Plantinga says that science requires there to be a happy fit between how our minds work and how reality works.
 - Also, he says that theism is the best explanation for this.
- “The medievals had a phrase for it: *adequatio intellectus ad rem* (the adequation of the intellect to reality).”

- Plantinga quotes Noam Chomsky:

“This partial congruence between the truth about the world and what the human science-forming capacity produces at a given moment yields science. Notice that **it is just blind luck** if the human science-forming capacity, a particular component of the human biological endowment, happens to yield a result that conforms more or less to the truth about the world.”

Plantinga comments: “From the point of view of theistic religion, this is not blind luck. It is only to be expected.”

Why can cavemen do differential geometry?

“Current physics with its ubiquitous partial differential equations ... involves mathematics of great depth, requiring cognitive powers going enormously beyond what is required for survival and reproduction. ... These abilities far surpass what is required for reproductive fitness now, and even further beyond what would have been required for reproductive fitness back there on the plains of Serengeti.

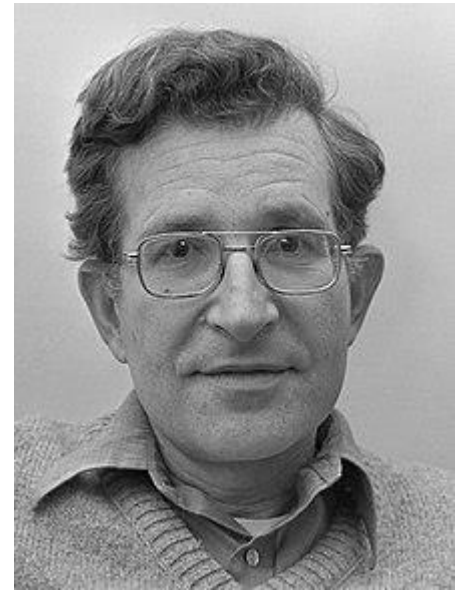
- (Plantinga, p. 12)

“... the mental requirements of the lowest savages, such as the Australians or the Andaman Islanders, are very little above those of many animals. **How then was an organ developed far beyond the needs of its possessor?** Natural Selection could only have endowed the savage with a brain a little superior to that of an ape, whereas he actually possesses one but very little inferior to that of the average members of our learned societies.”

Alfred R. Wallace *The Quarterly Review*,
April 1869.



It is possible to imagine that chimpanzees have an innate fear of snakes because those who lacked this genetically determined property did not survive to reproduce, but one can hardly argue that humans have the capacity to discover quantum theory for similar reasons.



The experience that shaped the course of evolution offers no hint of the problems to be faced in the sciences, and ability to solve these problems could hardly have been a factor in evolution. We cannot appeal to this *deus ex machina* to explain the convergence of our ideas and the truth about the world.

Chomsky, *Language and Problems of Knowledge*, MIT Press (1988), p. 158.

Scientific ability is a ‘spandrel’?

“Of course it is always possible to maintain that these mathematical powers are a sort of spandrel, of no adaptive use in themselves, but an inevitable accompaniment of other powers that do promote reproductive fitness. ... Well, perhaps; but it sounds pretty flimsy, and the easy and universal availability of such explanations makes them wholly implausible. It’s like giving an evolutionary explanation of the music of Mozart and Bach in terms of the adaptiveness, the usefulness, in the Pleistocene, of rhythmical movement in walking or running long distances.”

(Plantinga, p. 12)

N.B. evolutionary “spandrels”



A “spandrel” is a biological feature that isn’t itself adaptive (selected for), but is a by-product of other features that were selected for. (E.g. thumping sound of heart, redness of blood.)

How is math “real” anyway?

... numbers and sets themselves make a great deal more sense from the point of view of theism than from that of naturalism. ...

... most people who have thought about the question, think it incredible that these abstract objects should just exist, just be there, whether or not they are ever thought of by anyone. ...

...It is therefore extremely tempting to think of abstract objects as ontologically dependent upon mental or intellectual activity ...

...But if it is human thinkers that are at issue, then there are far too many abstract objects.

How is math “real” anyway?

- Theism is thus able to reconcile (apparently) contrary views about mathematical objects (and universals, possible states of affairs, etc.)
 1. Numbers exist necessarily, and “objectively” in the sense of being independent of human thought.
 2. Numbers are conceptual, intellectual entities of some sort.
- (Theism also explains human knowledge of mathematics.)

Inductive inference and innate knowledge

- “Scientific theories, so we are told, are underdetermined by the evidence. This just means that **these theories go beyond the evidence**; they are not merely compendious ways of stating the evidence.” (p. 18)
- If scientific theories ‘go beyond the evidence’, then doing science requires more than just empirical knowledge.
 - (Leibniz and Bonjour make this argument.)

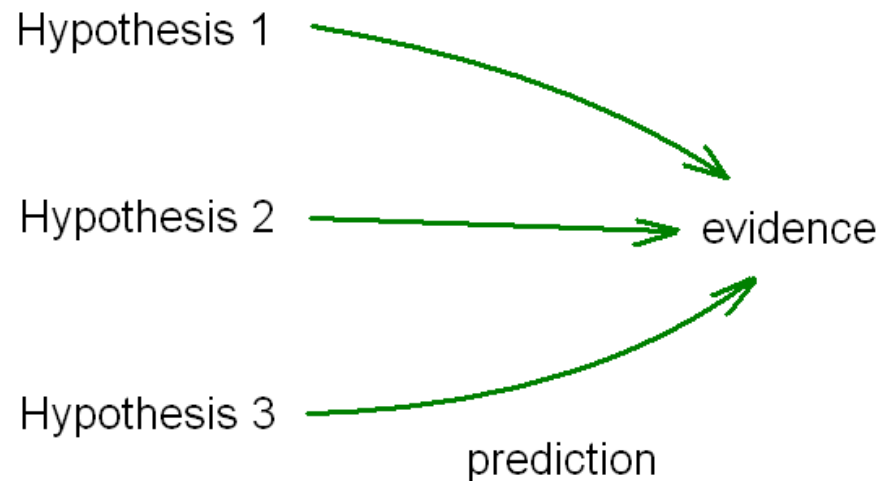
Argument for innate knowledge

1. In a scientific inference, the conclusion “goes beyond” the information provided to us by sense experience.
2. In any rational inference, the information in the conclusion cannot go beyond the premises.
3. Scientific inferences are rational

- ∴ Scientific inferences requires extra premises, in addition to experience.
- ∴ Scientific inferences require *a priori* knowledge.

The “underdetermination” problem

- For any observed data, we can imagine many possible causes of it.



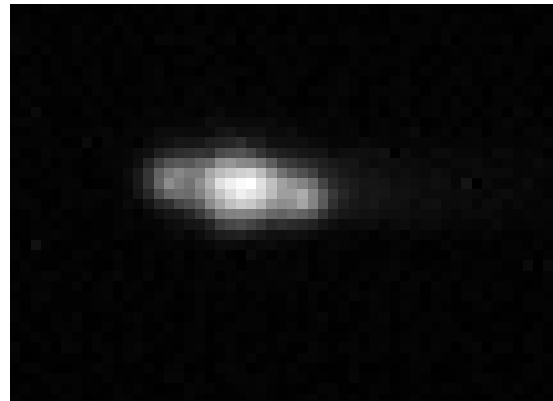
Problem: If (say) three hypothesis all predict the observed data, then which hypothesis do you (inductively) infer *from* the data?

Example: A Theory of Saturn

On 30 July 1610 Galileo wrote to his Medici patron:

“. . . the star of Saturn is not a single star, but is a composite of three, which almost touch each other, never change or move relative to each other, and are arranged in a row along the zodiac, the middle one being three times larger than the lateral ones, and they are situated in this form: oOo.”

(roughly what Galileo saw)



- But why a composite of three spheres? Why not a *giant soup tureen*?

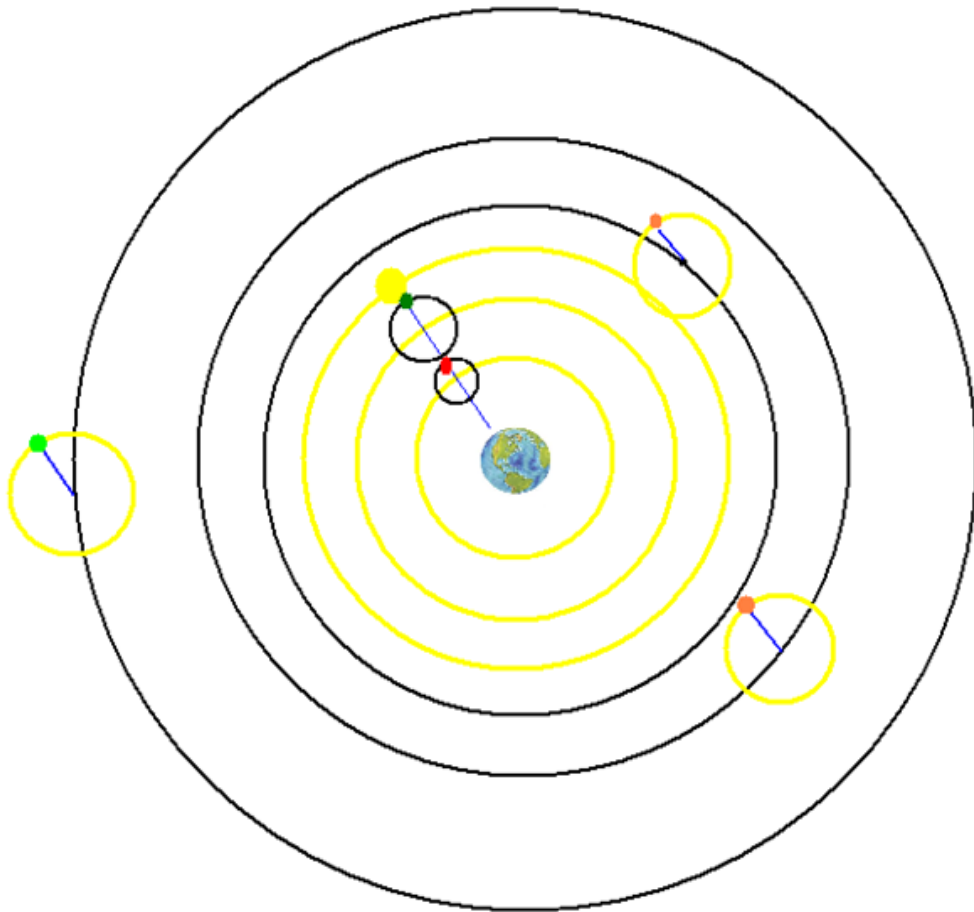


Does this hypothesis not predict the data?

Background knowledge

- I guess we just assume that there isn't going to be any enormous dishware floating around in space. That's ridiculous!
- Inductive inference requires *background knowledge* some sort, to tell us which of the possible theories are 'plausible', or 'physically sensible'.

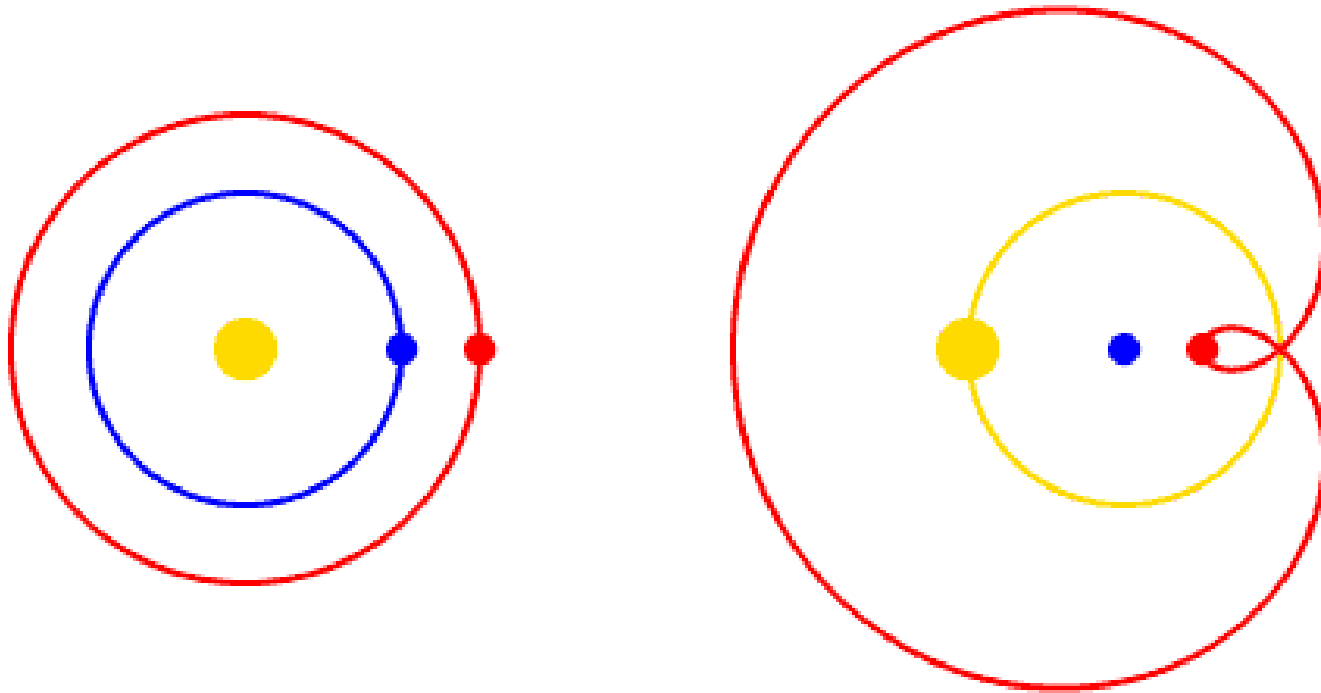
Example: Copernicus's argument



The diagram shows Ptolemy's geocentric model.

The solar orbit, and all its duplicates, are shown in yellow.

Predicting “retrograde” motion



- The orbit of Mars according to Copernicus (left) vs. Ptolemy (right). (Image: Wikipedia)

Less *ad hoc*

- A heliocentric universe, viewed from a central planet, *must* generate these appearances (data):
 - Retrograde motions for *some* planets.
 - These planets move retrograde when in opposition
 - The other planets stay close to the sun
- Copernicus's theory was much less *ad hoc* than Ptolemy's.
- *Ad hoc* = features of a theory driven by empirical data rather than theoretical virtues.

Copernicus's key insight

- “We thus follow Nature, who producing nothing in vain or superfluous often prefers to endow one cause with many effects.”

Copernicus, *De Revolutionibus Orbium Coelestium*.

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“The world is rational”

- Scientists have always assumed (and continue to assume) that the world is rational. Science is not possible without this assumption.

“What led me to my science and what fascinated me from a young age was the, by no means self-evident, fact that our laws of thought agree with the regularities found in the succession of impressions we receive from the natural world, that it is thus possible for the human being to gain enlightenment regarding these regularities by means of pure thought ...”

Max Planck, *A Scientific Autobiography* (1948)

Common Rationalist Principles

Objective reality has a rational structure, so that reality is comprehensible.

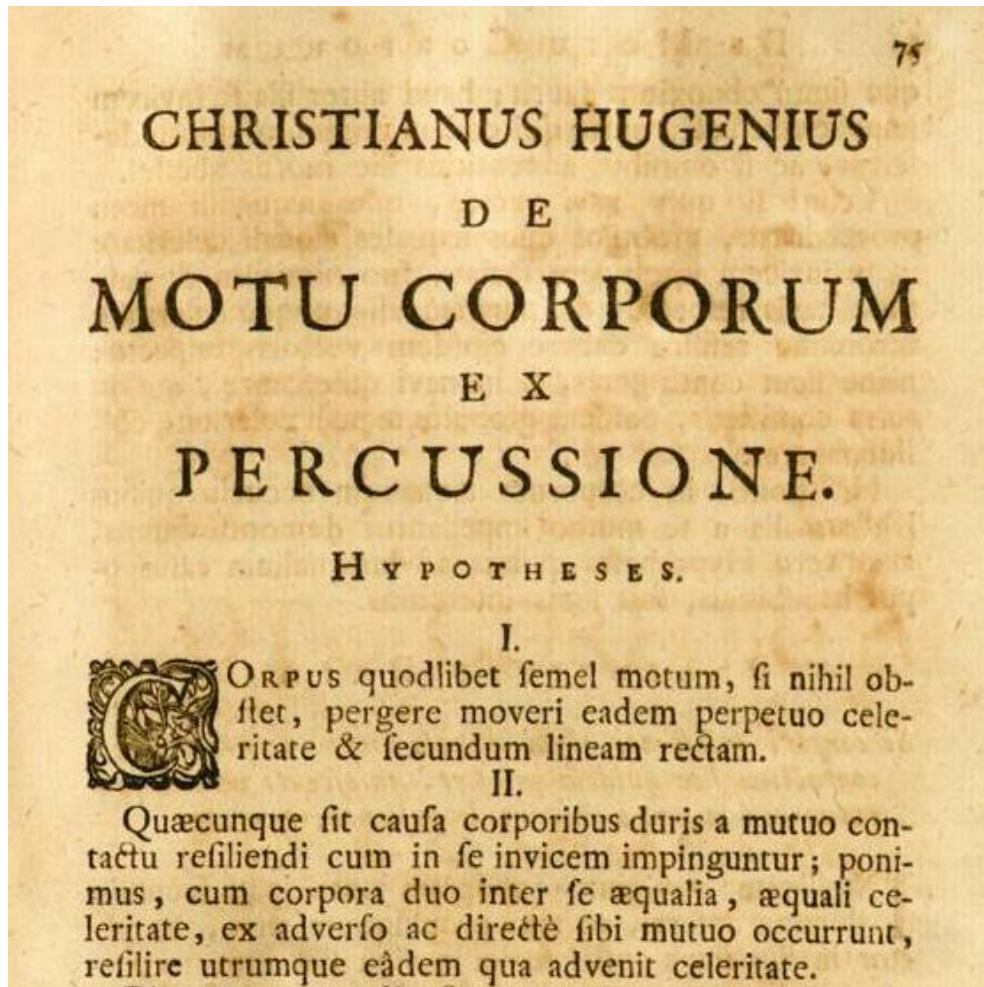
1. The relation of cause and effect mirrors the relation of logical consequence.

- Effects can be logically inferred from their causes, i.e. from suitably complete descriptions of the total cause. (Or, at least, the probability of an effect is logically determined by the causes.)
- Every event has a cause. (Objects and events don't appear "from nowhere", spontaneously, all by themselves.)
- Exactly similar causes always yield exactly similar effects (or the same probabilities of effects)
- If a cause is symmetric, in a certain respect, then its effects (or the probabilities of effects) must also be symmetric, in the same respect.

Common Rationalist Principles

- 2.The Separability Principle.** The spatial and temporal parts of a system can be considered as individuals, and will behave independently of each other, unless they exert forces upon each other.)
- 3.The Locality Principle.** Forces on a system can only be exerted by the immediate environment, not by distant objects, except indirectly via a chain of intermediaries.
- 4.The Markov principle.** The past states of a system cannot act directly on future states, but only indirectly via the states at intermediate times.
- 5.Relativity.** The laws of physics are the same in a uniformly-moving frame as in a stationary frame.

E.g. Huygens on collision



Huygens solved
Descartes' collision
problem:

“On the Motion of
Bodies Resulting
from Impact”.

He *deduced* the
rules from three
rationalist
principles.

Hume: science isn't rational

- Hume *agreed* with Leibniz that scientific theories cannot be logically derived from experience.
- But Hume was also convinced that *all* of our scientific knowledge (and concepts) are derived from experience.
- (So science isn't rational.)
 - “the conclusions we draw from that experience are not based on reasoning or on any process of the understanding.”



Hume's account of induction

- It is *custom* or *habit*. When we are inclined to behave or think in some way, not because it can be justified by reasoning or some process of the understanding but just because we have behaved or thought like that so often in the past, we always say that this inclination is the effect of 'custom'. In using that word we don't claim to give the basic reason for the inclination. All we are doing is to point out a fundamental feature of human nature which everyone agrees is there, and which is well known by its effects.
- (Hume, *Enquiry*, Section 5, Part 1)

Plantinga's response

“Hume goes on to claim that there is no rational foundation for this sort of reasoning, and that inductive reasoning is not in fact rational. Is this correct?

Say that a kind of reasoning is rational, for us, just if a human being with properly functioning cognitive faculties (properly functioning ratio or reason) would engage this kind of reasoning; if so Hume is wrong. We human beings, including those among us with properly functioning cognitive faculties, are inveterately addicted to inductive reasoning. And this is another example of fit between our cognitive faculties and the world in which we find ourselves.”

Any good?

Evolutionary origin of innate knowledge?

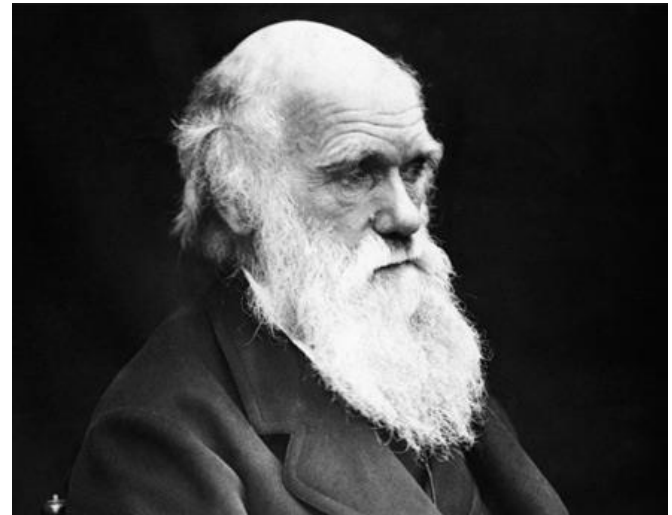
- On a selectionist (Darwinian) view of evolution, our minds have been shaped by forces of natural selection, over our evolutionary history.
- Some cognitive dispositions were no doubt more adaptive than others, in our remote ancestors. (We will have the more adaptive dispositions.)
- The innate (non-empirical) knowledge required for science arises in this way?

E.g. David Papineau in the SEP

- ... few philosophers since Hume have been prepared to appeal to God-given powers in accounting for the epistemological powers of the human mind. ...
Contemporary thought offers a biological alternative to God as a source of synthetic *a priori* knowledge. **Perhaps natural selection has structured our minds to make certain substantial truths accessible without experience, even if God hasn't.** ...
- ... Of course, 'innate ideas' of these kinds do not have the same truth-guaranteeing imprimatur as God-given ones, given that natural selection is rather more likely to be a deceiver than a benevolent god, instilling in us beliefs that are biologically advantageous though false.

... you have expressed my inward conviction, though far more vividly and clearly than I could have done, that the Universe is not the result of chance. But then with me the horrid doubt always arises whether the convictions of man's mind, which has been developed from the mind of lower animals, are of any value or at all trustworthy. Would any one trust in the convictions of a monkey's mind, if there are any convictions in such a mind?

-- Charles Darwin, letter of 1881.



- Recall one of Darwin's arguments in the *Origin*:

“the simplicity of the view that each species was first produced within a single region captivates the mind.”

- Is a theory that captivates the mind of a primate *thereby* likely to be true?)

Evolutionary origin of innate knowledge?

- If natural selection has shaped our minds, over long ages, then this just increases the amount of past “experience” we have.
- In effect, we carry in our brains faint echoes of the experiences of innumerable remote ancestors.
- But if past experience cannot logically justify beliefs about the future (or other non-experienced matters like the structure of the atom) then adding more of it won't help.

- Thus natural selection is incapable of giving us the innate *knowledge* that seems to be needed for science.
- At best, selection might provide us with dispositions to believe, which (by pure luck) happen to fit the world we're in. (But beliefs that are only true by luck don't count as knowledge.)