# The Argument (for rationalism) from Induction

More than observation is needed

# Summary of argument for rationalism

- "... if the conclusions of the inferences genuinely go beyond the content of direct experience, then it is impossible that those inferences could be entirely justified by appeal to that same experience. In this way, *a priori* justification may be seen to be essential if extremely severe forms of scepticism are to be avoided. …"
- Laurence BonJour, *In Defense of Pure Reason*, p. 3

- N.B. "… The argument for this conclusion is extremely straightforward and obvious, so much so that it is very hard to understand **the widespread failure to acknowledge** it."

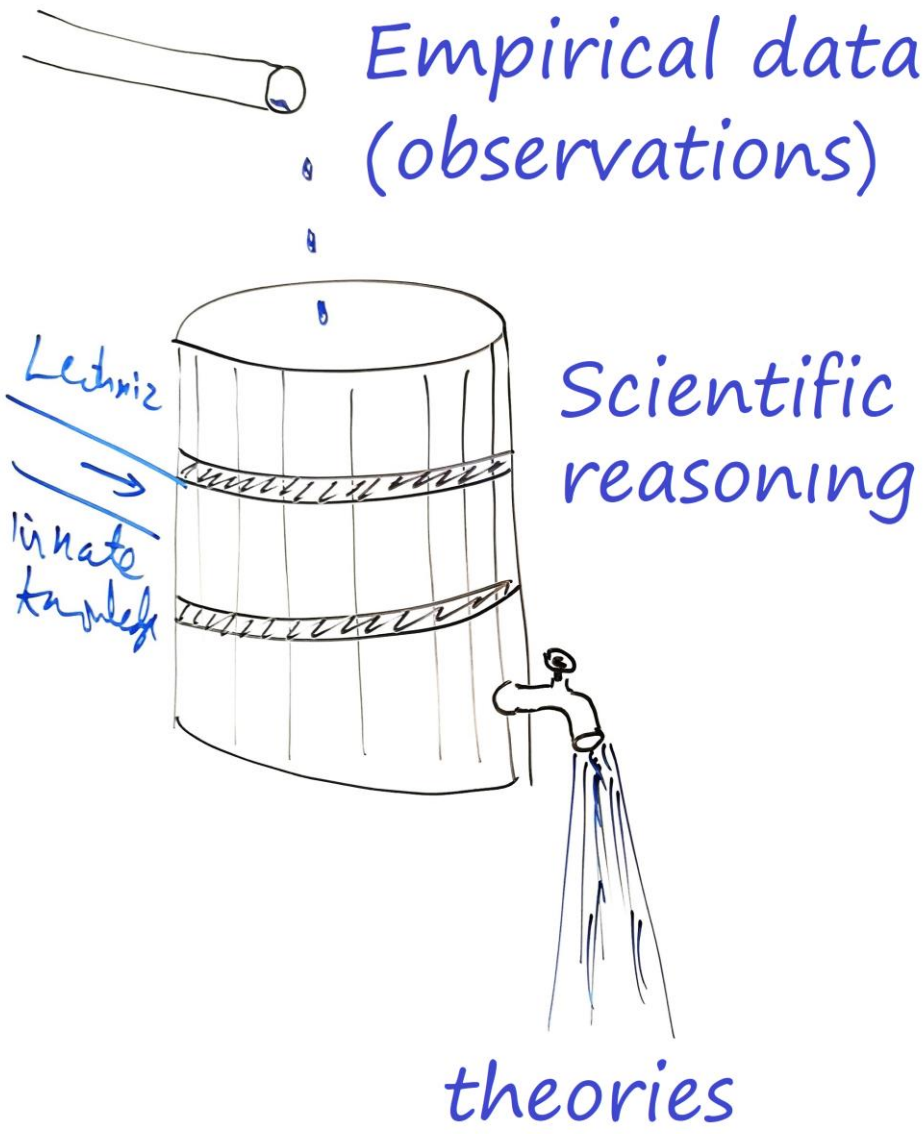
# In standard form:

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.


Empirical data
(observations)
Scientific
reasoning
theories

# Leibniz's summary

"... it is obvious that if some events can be foreseen before any test has been made of them, we must be contributing something from our side".

*New Essays*, Preface, p. 2

# What is a scientific inference?

- The basic format of an “inductive argument” is:

  Evidence (data, premises)

  ---

  ∴ Hypothesis (conclusion)

- The puzzle comes from the fact that the hypothesis has a lot more information than the data.

- E.g.

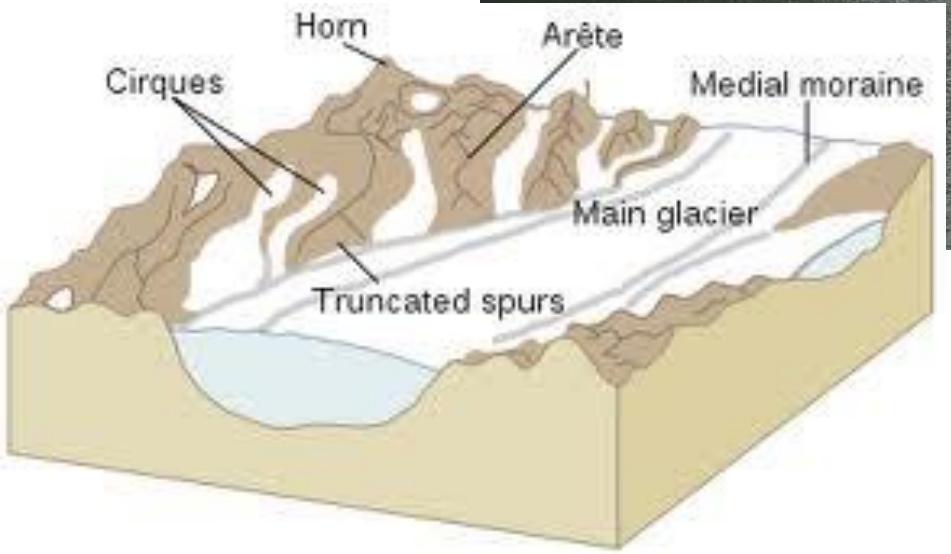
This valley has a U-shape

---

$\therefore$ This valley was formed by a glacier

Typically, an inductive inference makes a judgement about the most likely (hidden) cause of an (observed) effect, as in this case.

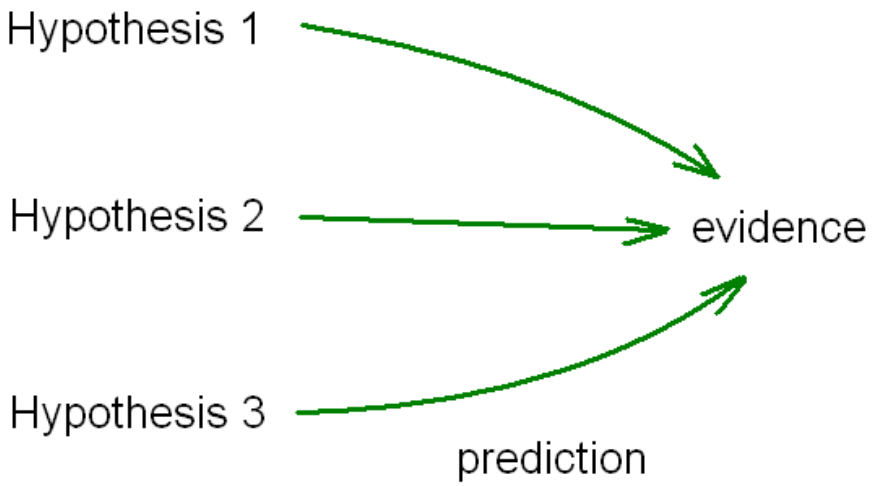
hypothesis




evidence

# The many possible causes problem

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



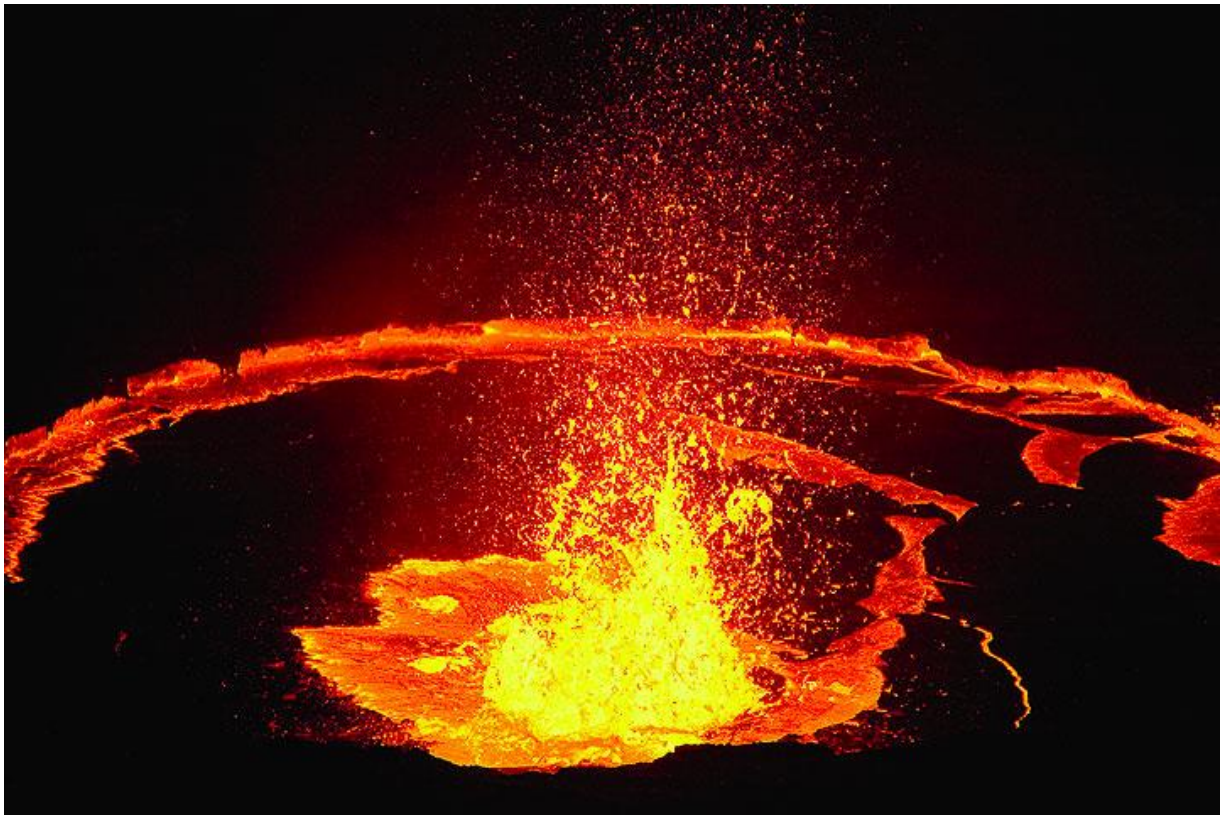

**Problem**: If (say) three hypothesis all predict the observed data, then which hypothesis do you (inductively) infer *from* the data?

# Example: Why did the dinosaurs die out?

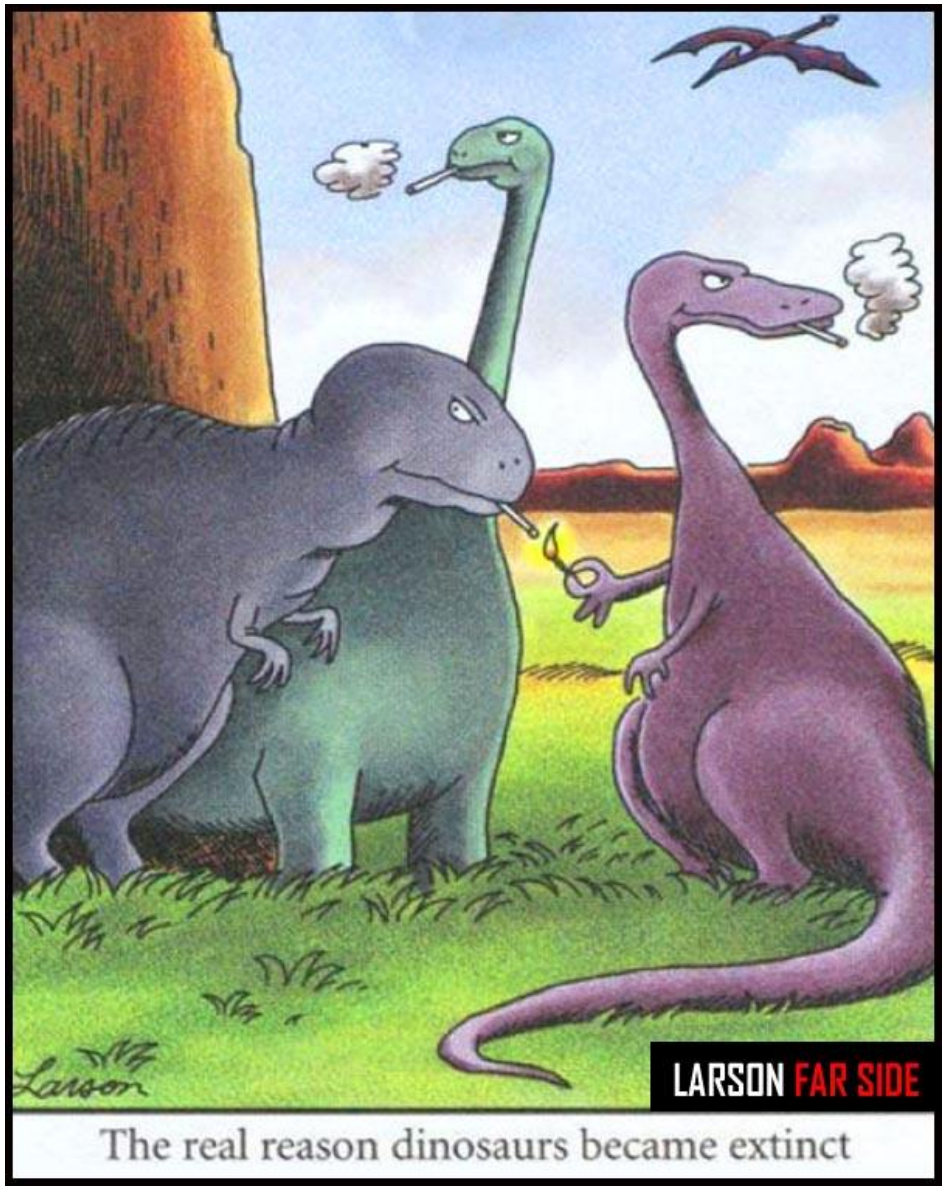
**Data**: in Cretaceous rocks, there are dinosaur fossils. In Tertiary rocks (the next layer up) there are no dinosaur fossils.

**Hypothesis 1**: Asteroid impact, leading to dust cloud blocking the sun, massive fireball reducing oxygen levels, etc.

**Hypothesis 2**: Volcanic Activity. The Deccan Traps formed at the end of the Cretaceous period, erupting for thousands of years, and releasing poisonous gases that cooled the climate.



# Hypothesis 3 …



- In general, you pick the theory that best predicts the data. (I.e. it predicts *more* of the data, and with a greater degree of certainty.)

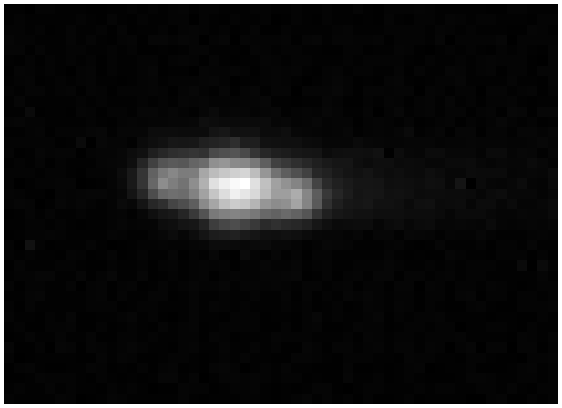
- But what if there are two or more theories that predict the data equally well?
  - N.B. This happens a lot!

# 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?

- I guess we just assume that there isn't going to be any enormous dishware floating around in space. That's ridiculous!

- Physicists today would say it isn't "physically sensible"

- Does inductive inference require *background knowledge* of what is physically sensible?

# Rationalism vs. Empiricism

- **Rationalists** say that the many causes problem (i.e. theories go beyond the data) shows that extra information is needed for science to be rational. This extra information is *a priori* (innate).

- **Empiricists** say that *there is no innate knowledge*. So either:
  i. Experience is enough for science (Bacon)
  ii. Scientific inferences are not rational (Hume)

## e.g. Leibniz argues for rationalism:

The senses, although they are necessary for all our actual knowledge, are not sufficient to give us the whole of it, since the senses never give anything but instances, that is to say particular or individual truths.

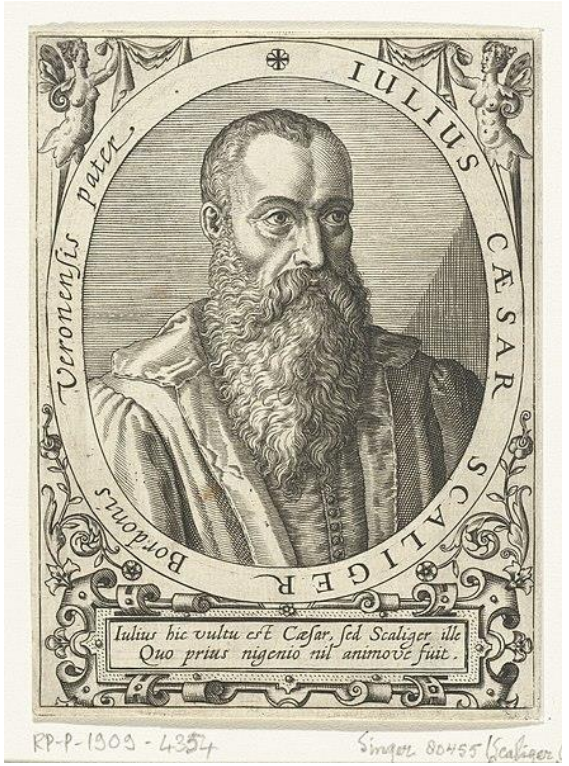
Now all the instances which confirm a general truth, however numerous they may be, are not sufficient to establish the universal necessity of this same truth, for it does not follow that what happened before will happen in the same way again. ...

. … From which it appears that necessary truths, such as we find in pure mathematics, and particularly in arithmetic and geometry, must have principles whose proof does not depend on instances, nor consequently on the testimony of the senses, although without the senses it would never have occurred to us to think of them…

(*New Essays on Human Understanding,* Preface)

"... Julius Scaliger used to call these sources 'living fires or flashes of light' hidden inside us but made visible by the stimulation of the senses, as sparks can be struck from a steel. We have reason to think that these flashes reveal something divine and eternal: this appears especially in the case of necessary truths."

(*New Essays on Human Understanding*, Preface)




Italian scholar and physician, 1484 – 1558

# Human knowledge vs. animal instinct

"This is how man's knowledge differs from that of beasts: beasts are sheer empirics and are guided entirely by instances. Men can come to know things by demonstrating them, whereas beasts, so far as we can tell, never manage to form necessary propositions. Their capacity to go from one thought to another is something lower than the reason that men have. The thought-to-thought sequences of beasts are just like those of simple empirics who maintain that what has happened once will happen again in a case that is similar in the respects that they have noticed, though that doesn't let them know whether the same reasons are at work."

- (Leibniz, *New Essays on Human Understanding*, Preface)

# Rationalism in physics

"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)

# Newtonian rationalism?

"It is inconceivable that inanimate Matter should, without the Mediation of something else, which is not material, operate upon, and affect other matter without mutual Contact…That Gravity should be innate, inherent and essential to Matter, so that **one body may act upon another at a distance thro' a Vacuum**, without the Mediation of any thing else, by and through which their Action and Force may be conveyed from one to another, is to me **so great an Absurdity** that I believe no Man who has in philosophical Matters a competent Faculty of thinking can ever fall into it."

—Isaac Newton, *Letters to Bentley,* 1692/3

- [TL;DR: The idea of gravity acting at a distance is *crazy*. There's no need to look at the empirical evidence.]

# Rationalism and science

- We have seen that rationalism includes *nativism*, the claim that humans have some innate (*a priori*) knowledge and concepts.

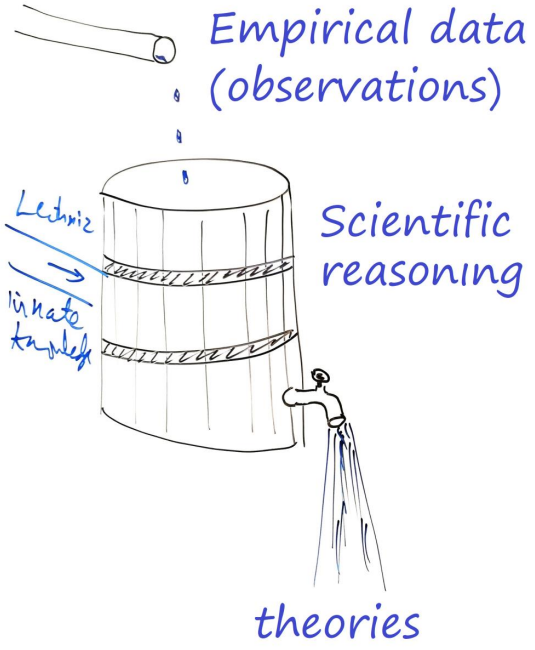
- More generally, rationalism is the view that the world has (in some sense) a "rational structure", so that it obeys principles that are rationally obvious.
  - Max Planck: "our laws of thought agree with [nature]."

- E.g. it seemed rationally obvious to Newton that no "body may act upon another at a distance thro' a Vacuum".

# Empiricism and science

- Thus rationalists have *two* sources of scientific information: empirical data, and innate knowledge.

- Empiricists have just *one* source of scientific information: observations/ empirical data.




- According to empiricism, **any belief that is not based on empirical data should be set aside as an unjustified prejudice that will distort scientific truth**.

# e.g. Francis Bacon (1561-1626).

*Novum Organon*, or "New Tool", 1620.

**49.** The human intellect doesn't burn with a dry light, because what the person *wants* and *feels* gets pumped into it; and that is what gives rise to the 'please-yourself sciences'. For a man is more likely to believe something if he would like it to be true. ...

In short, there are countless ways in which, sometimes imperceptibly, a person's likings colour and infect his intellect.

# Summary of Bacon's empiricism

- To be a good scientist, you must force yourself to **set aside your preconceived ideas** (about how the world *ought* to be) and base your beliefs on the observations (which reveal how the world *actually is*).

- **Key question**: Is it really *possible* to do this?
  - The 'many possible causes' problem suggests otherwise.
  - I.e. theories "go beyond" the evidence
  - I.e. theories are "underdetermined by" the evidence

# Example:
# Background assumptions *needed*

At a certain bank, money has often gone missing, and the branch manager suspects that one of her employees is stealing it. She compiles the following table, showing which of her five employees were at work each day, and the amount of money that went missing that day.

| | March 4 | 5 | 6 | 7 | 8 | 11 | 12 |
|---|---|---|---|---|---|---|---|
| Jan | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| Mike | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Hazel | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| Curtis | ✓ | ✓ | | ✓ | ✓ | ✓ | |
| Dan | ✓ | | ✓ | | ✓ | ✓ | ✓ |
| | $210 | $0 | $0 | $90 | $130 | $0 | $75 |

The manager asks: “Which one of my employees is the thief?”

# Background Assumptions

- It looks like Hazel, since she's the only person who was present on every day when money went missing. (On March 5 Hazel didn't steal, for some unknown reason.)

- But here we're *assuming* that there's just one thief. What if two (or more) people are working together? Any other hypotheses?

# Background Assumptions

- If we assume that there are *two* thieves, then a decent hypothesis is that Jan and Dan are working together, and (rather cleverly) trying to make it look as if Hazel is the thief!

- According to most philosophers of science, a scientific hypothesis needs to be grounded upon some framework of prior beliefs, or *paradigm*.

# More than data are needed

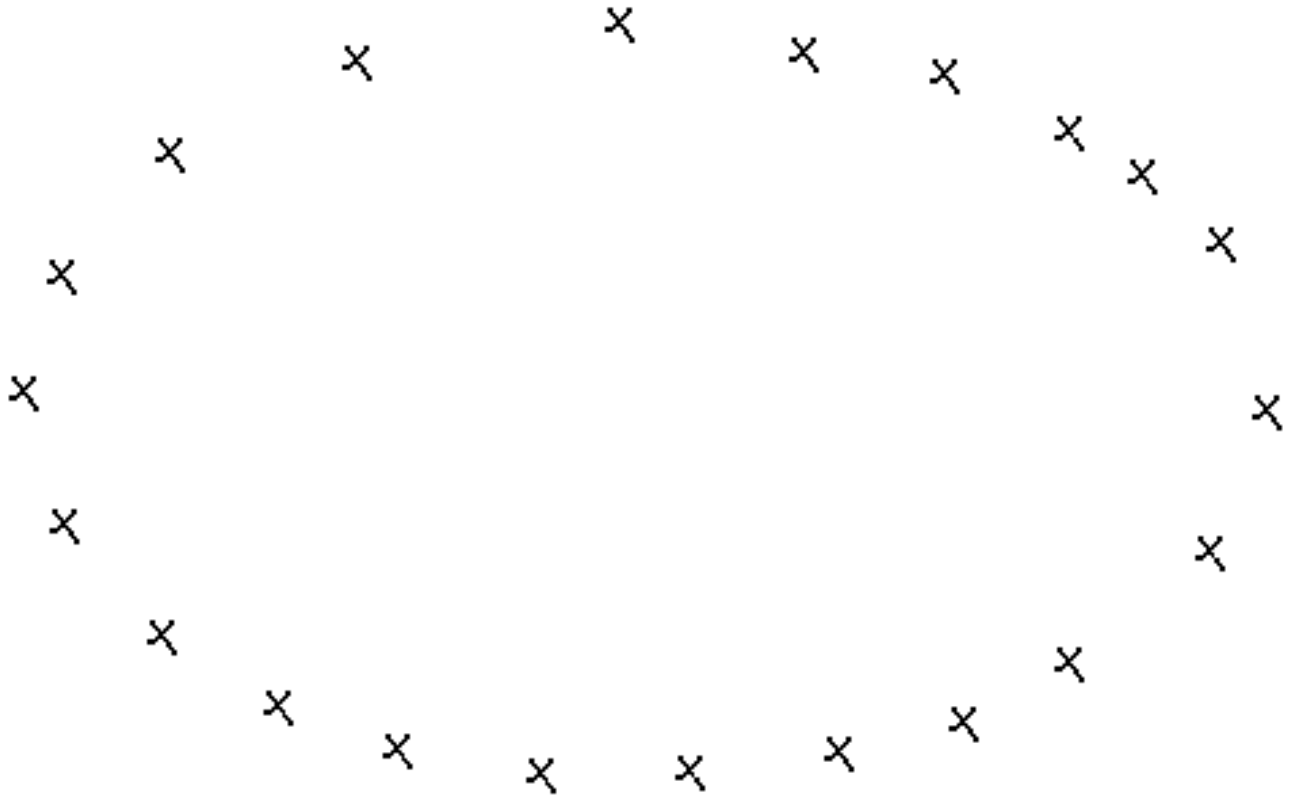
- For example, Kepler assumed that the orbit of Mars would be some kind of *simple* curve, such as a conic section.

- Isaac Newton assumed that nature is economical:

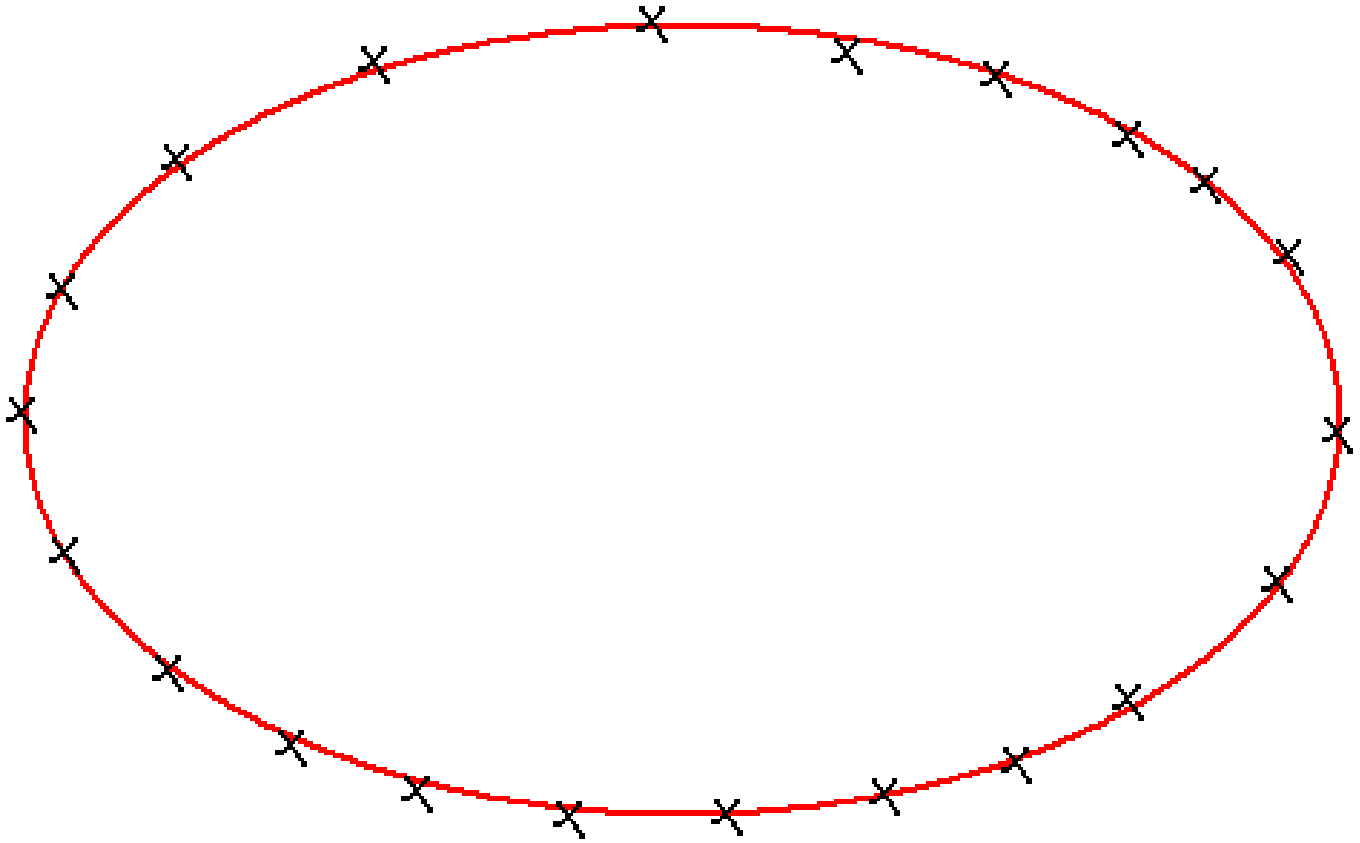
  "To this purpose the philosophers say that Nature does nothing in vain, and more is in vain when less will serve; for Nature is pleased with simplicity, and affects not the pomp of superfluous causes."

# Kepler's data

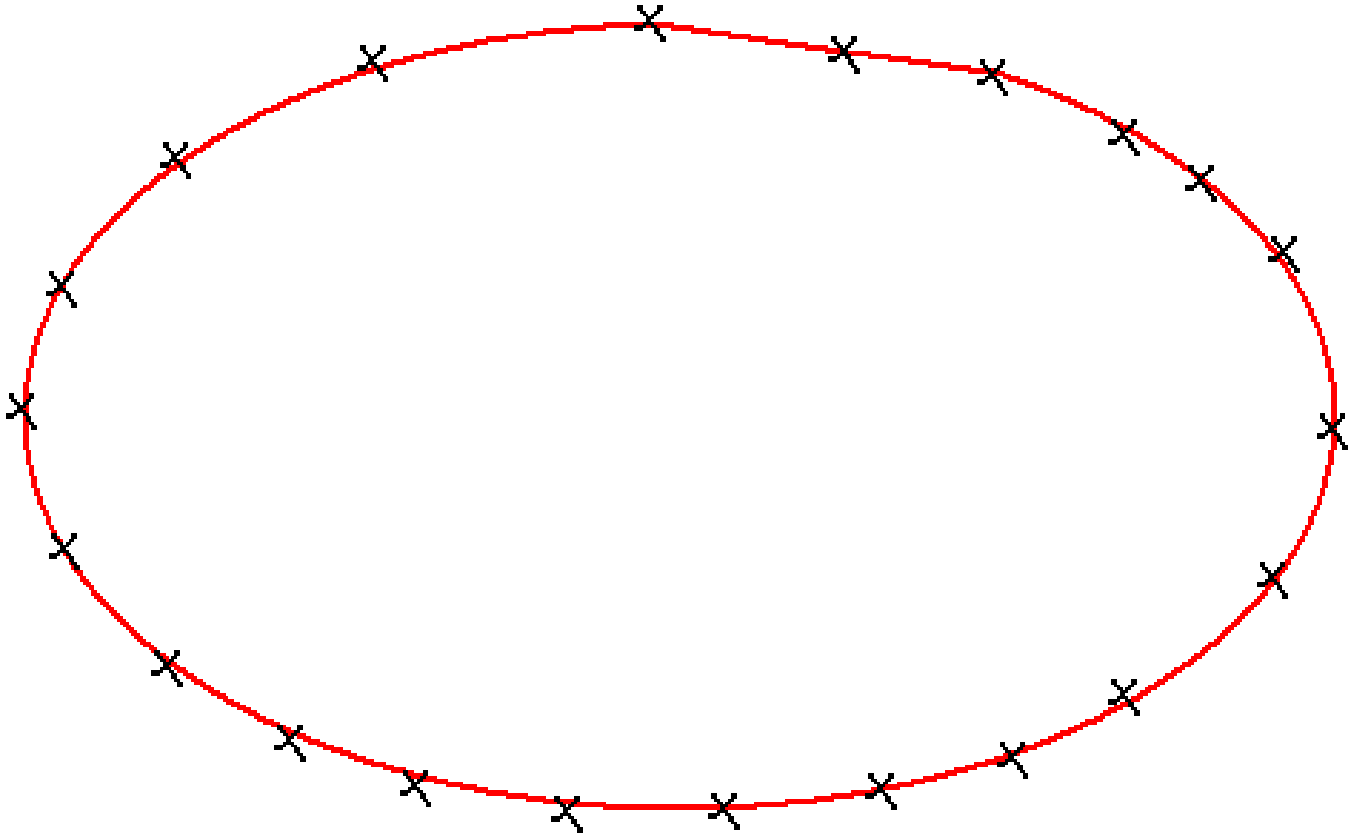
Which hypothesis *logically follows* from these data? (None!)



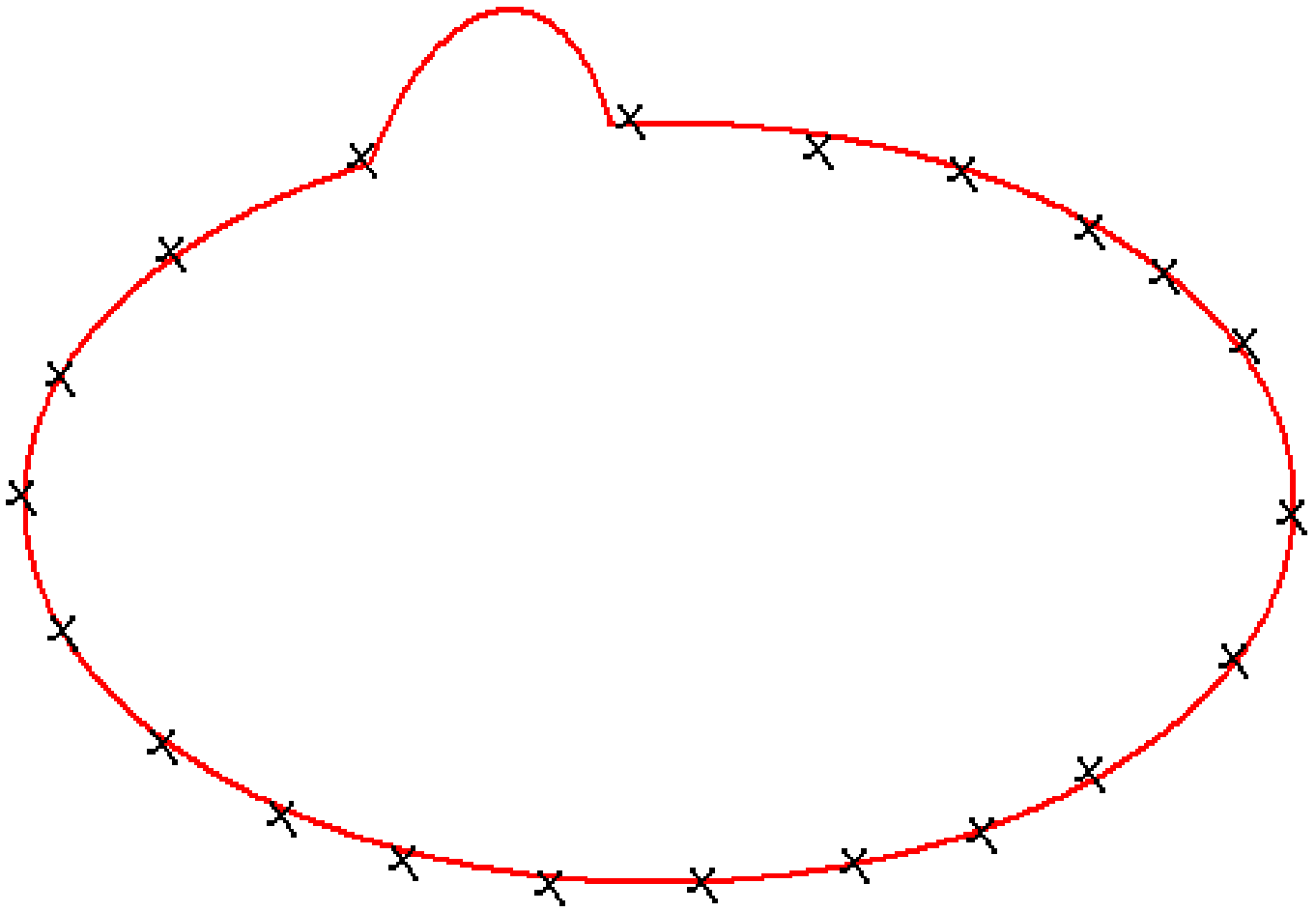
Kepler: the real orbit is the ellipse that *best* fits the data.



- But why not this hypothesis?



- Or this one?



# Appendix 2: 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.)
   - 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.
2. **The Separability Principle**. The spatial and temporal parts of a system can be considered as separate entities, 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.

# Why is extra information needed?

- Logically, you *cannot* infer what is going on in unobserved cases, purely from cases that have been observed.
  - E.g. suppose you're helping someone move, and initially have no idea what objects may be inside the cardboard box you're carrying.
  - You open the box, reach inside, and pull out a mug. *What else is inside the box?*
    - (If you think you do have a good idea about what else is in the box, what is your *reasoning* for this?)

# Inductive Inference

So, a more accurate scheme for inductive (scientific) inference is as follows:

Empirical evidence/data (observed)

(extra information)

---

∴ Hypothesis (not observed)

# Part 2

The empiricist strikes back

# David Hume (1711 – 1776)

- 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) come from experience.
- (So how can we have scientific knowledge?)

# “Relations of ideas” vs. “matters of fact”

- In discussing the origin of human knowledge, Hume distinguishes between math and logic (“relations of ideas”) and science (“matters of fact”).

1. Concerning arithmetic, geometry, logic, etc:
   - “Propositions of this kind can be discovered purely by thinking, with no need to attend to anything that actually exists anywhere in the universe.”
2. Concerning physics, chemistry, biology (etc.):
   - Pure rational thought cannot tell us anything at all. Only experience can give us knowledge of such things.

- Hume's argument for the second claim, that knowledge of "matters of fact" (even unobserved matters of fact) is entirely from experience, is lengthy and we will skip it for now.

- The main steps are:
  1. Matters of fact are not *logically* provable. The contrary of any matter of fact is logically possible.
  2. Knowledge of *unobserved* matters of fact is founded upon the relation of cause and effect.
  3. Knowledge of cause and effect comes only from experience.

All that past experience can tell us, directly and for sure, concerns the behaviour of the particular objects we observed, at the particular time when we observed them. My experience directly and certainly informs me that that **fire consumed coal then; but it's silent about the behaviour of the same fire a few minutes later, and about other fires at any time**.

The bread that I formerly ate nourished me; i.e. a body with such and such sensible qualities did at that time have such and such secret powers. **But does it follow that other bread must also nourish me at other times**, and that the same perceptible qualities must always be accompanied by the same secret powers? **It doesn't seem to follow necessarily** [i.e. logically].

- David Hume, *Enquiry Concerning Human Understanding*, Section 4 (Part 2)

- There is, in other words, no *logical* connection between observed and unobserved cases. (Exactly as Leibniz said.)

- Hence, there is no *logical* connection between observation and theory.
  - (Because theories tell us about unobserved cases.)

# Hume: Science isn't logical

- Nevertheless, Hume thinks that we *do* get scientific knowledge from experience.
- For example, Hume mentions the law of conservation of momentum and describes it as "something we know purely from experience".)
- **Hence, the mental process that takes us from experience to scientific theory *is not a logical one***.
- "the conclusions we draw from that experience are not based on reasoning or on any process of the understanding."

# In standard form

1. There is no *logical* connection between observed and unobserved matters of fact.
2. We have no source of knowledge other than observation.
3. Observation *does* provide some knowledge of unobserved matters of fact.

---

$\therefore$ Scientific inferences are not rational (i.e. they're not based on reasoning)

# How *does* induction work then?

"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)

# What is ‘custom’, or ‘habit’?

“… having found in many cases that two kinds of objects—flame and heat, snow and cold—have always gone together, and being presented with a new instance of flame or snow, the mind’s habits lead it to expect heat or cold and to believe that heat or cold exists now and will be experienced if one comes closer. This belief is the inevitable result of placing the mind in such circumstances.

That our minds should react in that way in those circumstances is as unavoidable as that we should feel love when we receive benefits, or hatred when we are deliberately harmed. These operations of the soul are a kind of **natural instinct**, which no reasoning or process of the thought and understanding can either produce or prevent.”

- ‘Custom’, or ‘habit’, is very much like the animal instinct that Leibniz referred to.
  - “beasts are sheer empirics and are guided entirely by instances.”

# Is Hume an ‘inductive sceptic’?

- See Extra Reading #5, Section 5.

LANGARA COLLEGE

Philosophy 1101 – Introduction to Philosophy

Richard Johns, February 2017

**The Argument from Induction for Rationalism**

**1. The logical gap between evidence and theory**

In our discussion of rationalism vs. empiricism, we have so far looked at one rationalist (Descartes) and one empiricist (Locke).

# Part 3

Hume’s argument and Kant’s response

# Hume's argument in more detail

- Hume noted that it's the *cause-effect relation* that connects what we observe with what our theories talk about.
  - For example, we can't see a glacier that melted thousands of years ago. But that glacier *caused* the valley to appear as it does today.
  - Most scientific (inductive) reasoning is reasoning from effect to cause.

# Hume's argument in more detail

- A less common kind of inductive reasoning is from cause to effect. In any case, when moving from matters we've observed (data) to matters that we have not observed (hypothesis) we use the cause-effect relation.

"All reasonings concerning matters of fact seem to be founded on the relation of C*ause* and *Effect*, which is the only relation that can take us beyond the evidence of our memory and senses."

# How do we know what causes what?

- If Hume is right (and he is) that all inductive reasoning is based on cause and effect (reasoning mostly from effects to causes), then we have to ask how we get knowledge of this relation. *How do we know what causes what?*
- Hume's answer is "by experience".

"The mind can never possibly find the effect in the supposed cause, by the most accurate scrutiny and examination. For the effect is totally different from the cause, and consequently can never be discovered in it."

"I venture to assert, as true without exception, that knowledge about causes is never acquired through a priori reasoning, and always comes from our experience of finding that particular objects are constantly associated with one other.

Present an object to a man whose skill and intelligence are as great as you like; if the object is of a kind that is entirely new to him, no amount of studying of its perceptible qualities will enable him to discover any of its causes or effects.

Adam, even if his reasoning abilities were perfect from the start, couldn't have inferred from the fluidity and transparency of water that it could drown him, or from the light and warmth of fire that it could burn him."

"Events that aren't much like the common course of nature are also readily agreed to be known only by experience; and nobody thinks that the explosion of gunpowder, or the attraction of a magnet, could ever be discovered by arguments a priori—i.e. by simply thinking about gunpowder and magnets, without bringing in anything known from experience."

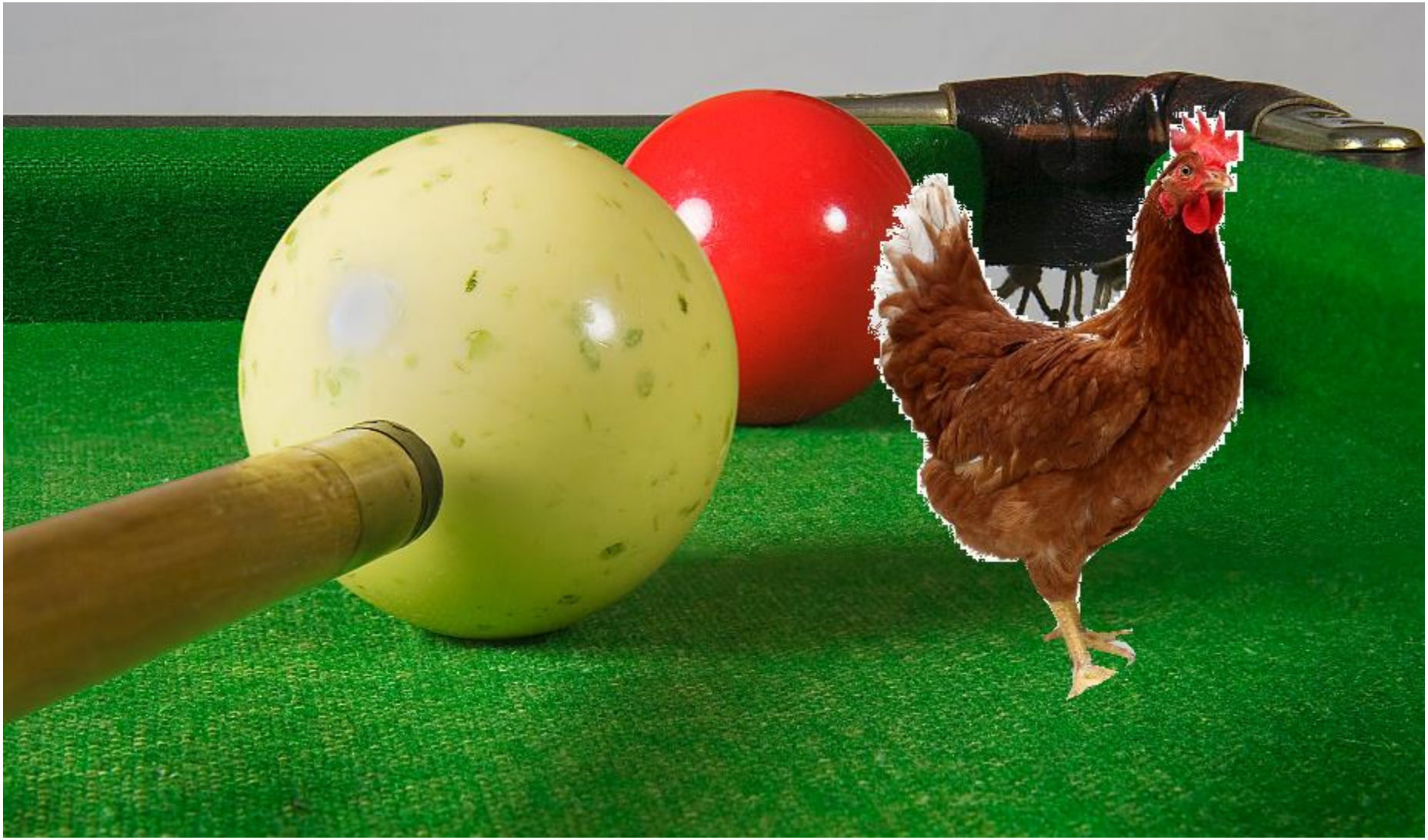
(Etc.)

# Example: colliding bodies

- Descartes argued, in the case of colliding bodies, that a symmetrical cause must have a symmetrical effect. Any symmetry breaking would be *irrational*.

  (Planck agrees: "our laws of thought agree with the regularities found in the succession of impressions we receive from the natural world")

- But Hume thinks that reasoning cannot tell us *anything at all* about cause and effect.
  - According to Hume (I suppose?) the next time the balls collide, they might turn into a chicken. (Why not?)



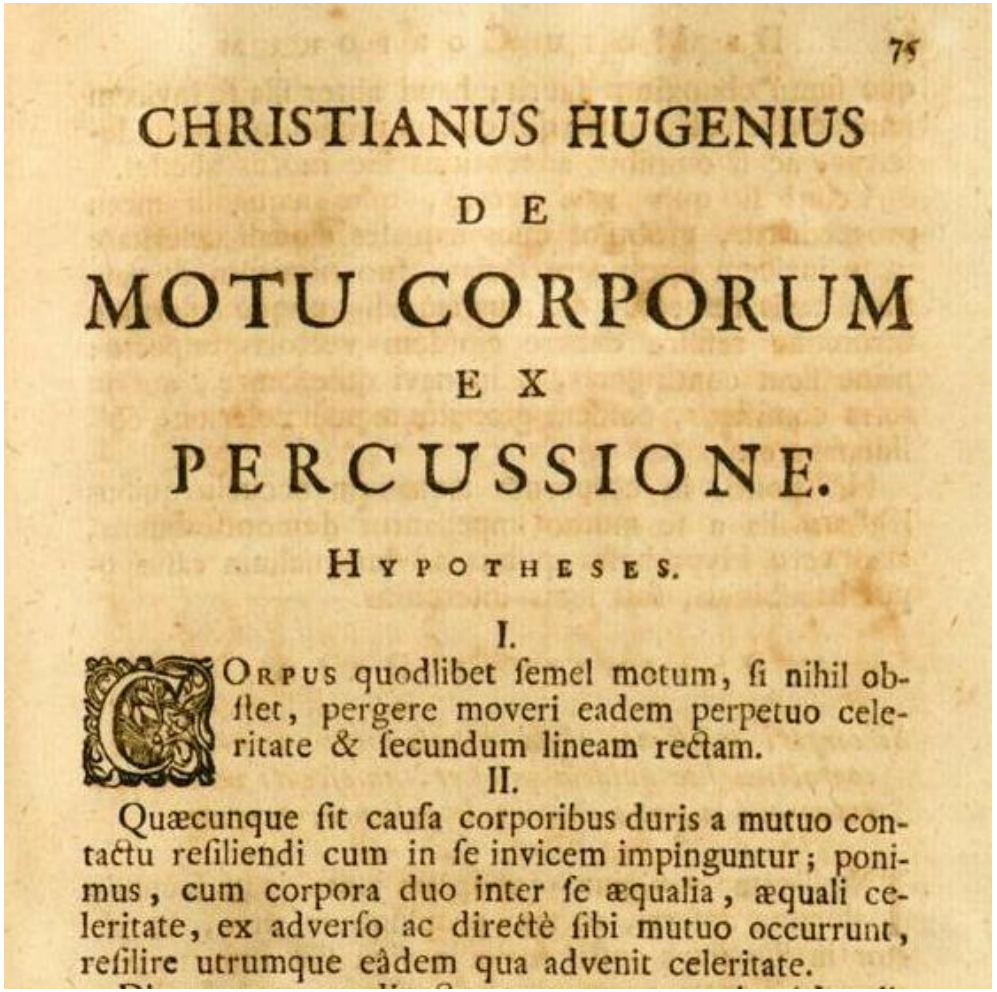
- Why not?

# Hume on the collision problem

"We are apt to **imagine** that we could discover these effects purely through reason, without experience. We **fancy** that if we had been suddenly brought into this world, we could have known straight off that when one billiard ball strikes another it will make it move—knowing this for certain, without having to try it out on billiard balls. Custom has such a great influence!"

- Do you agree that this is an illusion?

# Huygens solved the collision problem!



75

CHRISTIANUS HUGENIUS

DE

MOTU CORPORUM

EX

PERCUSSIONE.

HYPOTHESES.

I.

CORPUS quodlibet ſemel motum, ſi nihil obſtet, pergere moveri eadem perpetuo celeritate & ſecundum lineam rectam.

II.

Quæcunque ſit cauſa corporibus duris a mutuo contactu reſiliendi cum in ſe invicem impinguntur; ponimus, cum corpora duo inter ſe æqualia, æquali celeritate, ex adverſo ac directè ſibi mutuo occurrunt, reſilire utrumque eâdem qua advenit celeritate.

Hume wrote the Enquiry in 1748, about 45 years *after* Huygens' (correct) solution to Descartes' collision problem, was published: "On the Motion of Bodies Resulting from Impact".

# What about Huygens?

- Huygens' solution was almost entirely *a priori*! Everything was mathematically derived from three highly intuitive principles, or "hypotheses":
  - Natural motion is in a straight line, at constant speed
  - Symmetry is conserved during collisions
  - The laws of collision are the same in all uniformly-moving reference frames ("Galilean relativity")

- Was Huygens just *lucky*?
- Is the intuition that nature will obey rational principles an *illusion*?

# Immanuel Kant

Introduction to the second edition of the *Critique* (B3–4)

> … experience never gives its judgments true or strict universality, but only assumed and comparative universality through induction, enabling us to say of this or that rule '*We haven't yet observed* any exception to it'.

- For example, if we know that the law of gravity *always* holds, then we didn't get this knowledge from experience *alone*.

...the proposition *Every alteration must have a cause* will serve the purpose. (Hume tried to get this proposition out of the experience of a frequent association of two kinds of event, first K1 then K2, and a habit of connecting the two event-kinds - a habit that arises from the association. This habit creates a *subjective* necessity - 'When I encounter a K1 event *I can't help expecting* a K2 event' - but this approach can't capture the causal proposition, because the very concept of *cause* so obviously contains the concepts of *necessary connection with an effect* and of *strict universality* of the relevant rule; this is objective, not subjective, necessity.)

(Bennett translation)

**(2)** Natural science contains within itself synthetic a priori [i.e. innate] judgments as principles. I'll offer only a couple of examples:

- In all alterations of the corporeal world, the quantity of matter remains unaltered.
- When bodies make other bodies move, action and reaction must always be equal.

It's clear that each of these is necessary (and thus *a priori* in its origin), and that they are synthetic propositions.

(p. 23 in Bennett's edition of the *Critique of Pure Reason*)

# The problem of induction solved?

- According to rationalists like Descartes, Kepler, Kant and Leibniz, inductive inference (science) requires that we know certain basic principles, prior to experience. Kant calls these *a priori* principles.

- ***Problem***: How would humans get *a priori* knowledge? Where would we get it from?

# Part 4

Where would humans get innate knowledge from?

- For Descartes, Kepler, Scaliger and Leibniz, God is the source.

  [Geometry] passed over to Man along with the image of God; and was not in fact taken in through the eyes." (Johannes Kepler)

- Is there another possible source?

# Kant's idealism

- Kant had a very different solution. What we take to be the "real world" is actually structured by our own minds! Thus the *a priori* knowledge used in science is ultimately **knowledge about ourselves**, and the way **we see** the world:

> "If our intuition has to conform to the constitution of the objects, I don't see how we can know anything about them a priori; but I can easily conceive of having a priori knowledge of objects if they (as objects of the senses) have to conform to the constitution of our faculty of intuition"
>
> Kant, *Critique of Pure Reason*, 1781, Preface (second edition) xvii.

- What do you think about that?

# Evolution to the rescue?

Was there (during the period of human evolution) any selective pressure toward ‘good sense’, as needed in contemporary science?

- The cognitive tasks faced by hunter-gatherers seem rather different from those posed by (e.g.) quantum cosmology. Do we trust the intuitions of a hunter gatherer about quantum cosmology?

# David Papineau in the *Stanford Encyclopedia of Philosophy*:

"How can we possibly discover substantial facts about our world without experience of that world?

The traditional answer would have been that God made this possible, by constructing our minds so as to make certain substantial truths accessible to us without the help of experience. Contemporary methodological naturalists are likely to reject any such God-given route to the synthetic *a priori*. Indeed, 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**. For example, the last section suggested that we may have such innate knowledge of certain aspects of human psychology, and there are other plausible examples of biologically innate knowledge. 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.

"But this possibility of error need not disqualify all biologically innate beliefs as knowledge—the truth of some such beliefs may be sufficiently non-accidental for them to count as knowledge."

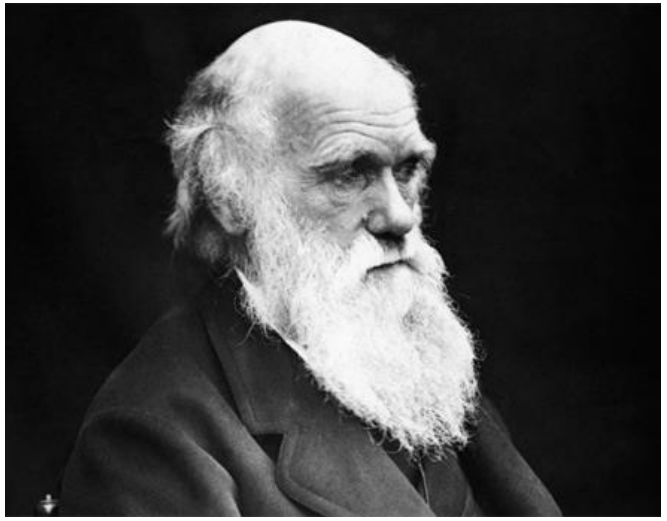
- Yet can the innate knowledge needed for induction (e.g. science) be a product of natural selection?

"... 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.

With me the horrid doubt always arises whether the convictions of man's mind, which has always 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.



- Another argument notes that 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.

- No wonder rationalism is a very unpopular view today.