

A notorious limitation of Aristotelian demonstration

Syllogistic certainty → truth of the premises

How can we assert the truth of the premises?

(All men are mortal; All amphibians can survive in water)

Premises as ‘first principles’

they express the essence of all the objects that belong to the various classes of objects in different scientific domains, but they cannot be accounted by any of these objects

(first principle can be used to demonstrate but are themselves indemonstrable)

- ‘human beings are rational animals’
- ‘planets are celestial bodies near the earth’
- ‘men are biped’

A challenge

- If we only understand (in a correct, valid way) the things we can demonstrate, we won't be able to understand (in an equally correct, valid way) first principles which by their very nature are indemonstrable
- And if we don't understand them how can we understand what is demonstrated by means of them?

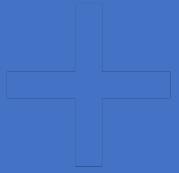
Marc Gasser-Wingate, 'Aristotle on Induction and First Principles', *Philosopher's Imprint*, volume 16, no. 4 February 2016.

How first principles come to be known

Not a procedure but a *cognitive development*

not an innate understanding but a *perceptual capacity*

we do not perceive first principles directly, we can only perceive particular things that eventually lead us to formulate those principles



Aristotle's answer

We can achieve a non-demonstrative understanding of these principles:

ἐπαγωγή (epagogé)

“Thus it is clear that we must get to know the primary premises by induction; for the method by which even sense-perception implants the universal is inductive. [...] it follows that there will be no scientific knowledge of the primary premises, and since except intuition nothing can be truer than scientific knowledge, it will be intuition that apprehends the primary premises. [...] If, therefore, it is the only other kind of true thinking except scientific knowing, intuition will be the originative source of scientific knowledge.”

(Posterior Analytics)

From particulars to universal

What guarantees the procedure:

Noūç (nous)

'So from perception there comes memory, as we say, and from repeated memories of the same thing [there comes] experience (*έμπειρία*); for many memories constitute a single experience. And from experience, or rather from the whole universal which has come to rest in the soul, the one apart from the many, that which is one and the same in all these things, [comes] a principle of craft or understanding [i.e. *νοῦς*] — of craft if it concerns coming to-be, of understanding if it concerns what is'. (100a3–9)

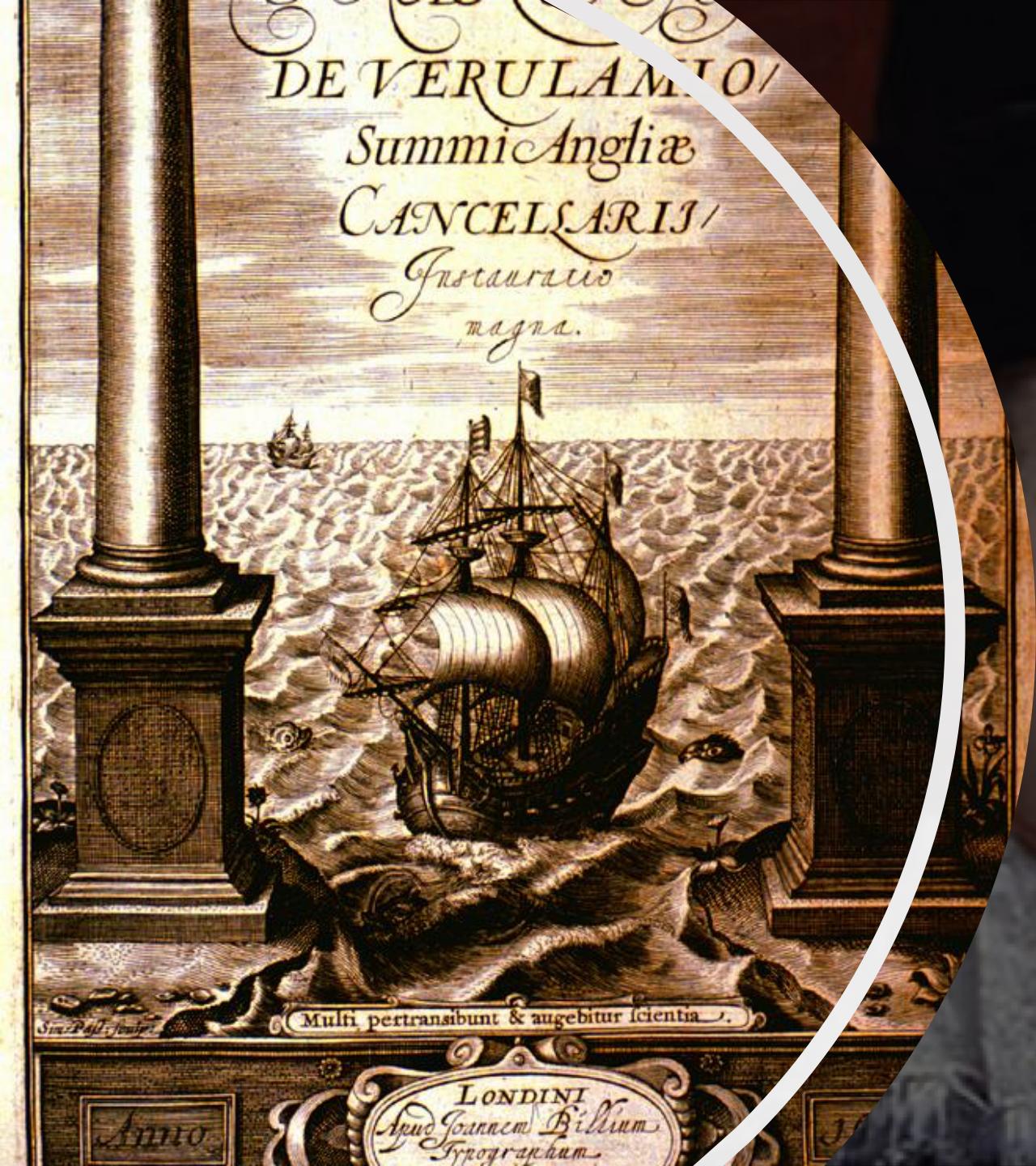


Against Aristotle's *epagogé*

- *The rationalists*: the mind is not a 'clean slate'; the mind is rule driven, it has innate ideas (Descartes)
- *The first experimentalists*: Aristotelian epagoge is a shortcut, first principles should be objects of discovery, led not by rational intuition but by a reliable procedure (F. Bacon)



Against Aristotelian demonstrative method



What's wrong with the use of induction in demonstrative science

It “flies from the senses and particulars to the most general axioms, and from these principles proceeds to judgment and the discovery of the middle axioms.” [Ahp.19]

It “cursorily skims experience and particulars” [Aph. 22]

Baconian ‘idols’ (Aph.s 38-62)

- I. of **tribe**
- I. of **cave**
- I. of **marketplace**
- I. of **theatre**

Wrong methods

- ‘Anticipation of nature’
(Aristotelian induction)
- Induction ‘by enumeration’
‘it is bad induction to infer principles of science through simple enumeration’ [Aph. 69] or by ‘simple experience’ [Aph. 82]



Ants, spiders and bees

Aph 95:

'Those who have handled the sciences have been either Empiricists or Rationalists. Empiricists, like ants, merely collect things and use them. The Rationalists, like spiders, spin webs out of themselves. The middle way is that of the bee, which gathers its materials from the flowers of the garden and field, but then transforms and digests it by a power of its own.'

Good induction: the ‘Interpretation of Nature’

it ‘first lights the candle, and then by means of the candle shows the way; commencing as it does with experience duly ordered and digested, not bungling and erratic, and from it educating axioms, and from the established axioms again new experiments.’



Gradual induction

“it shall analyse experience and take it to pieces, and by a due process of exclusion and rejection lead it to an inevitable conclusion”

Good induction proceeds by “rejections and exclusions, and then after a sufficient number of negatives, come to a conclusion on the affirmative instances”

(Aph 105)

Baconian
method

Experience + gradual induction

experience

Facts are particulars, various, diffuse.

They must be arranged in a suitable order

[Aph 10. Bk II]

tables:

- Tables of absence and presence
- Tables of deviation
- Tables of degrees or comparison

histories :

records of instances of facts

(either natural occurrences or artificial
creations of experiments)

gradual induction

1

First vintage: produces a hypothesis

2

Second vintage: further testing to establish results with more certainty

- in order to bring forward “not elegant and probable conjectures, but **certain** and **demonstrable** knowledge.” (Preface to NO, p.40)

Baconian induction

Certainty of results

- a) the ‘fruits’ which the new method might be able to deliver.
- b) the belief that a conclusion well supported by evidence commands a high degree of confidence

Certainty → not logical infallibility but empirical indubitability

J. Glanville, *Essays on Several Important Subjects in Philosophy and Religion*, 1676 (quoted in Urbach, *Francis Bacon's Philosophy of Science*, p.45)



IS INDUCTION SO
RELIABLE?

The story so
far...

P1. All Italian eat pasta

P2. E is Italian

C. E eats pasta

Truth of the premises

How do we know that:

- All Italian eat pasta?
- $F=Gm$ (Newton's law of universal gravitation)

All Italian eat pasta ??

- E eats pasta
- F eats pasta
- A eats pasta
-
-
- -----
- **All Italian eat pasta**

generalization

from a finite list of instances to a universal statement, *given certain conditions*.

Conditions:

- Wide enough number of repeated cases
- No conflict among the cases
- The properties we generalise about should refer to the same objects
-

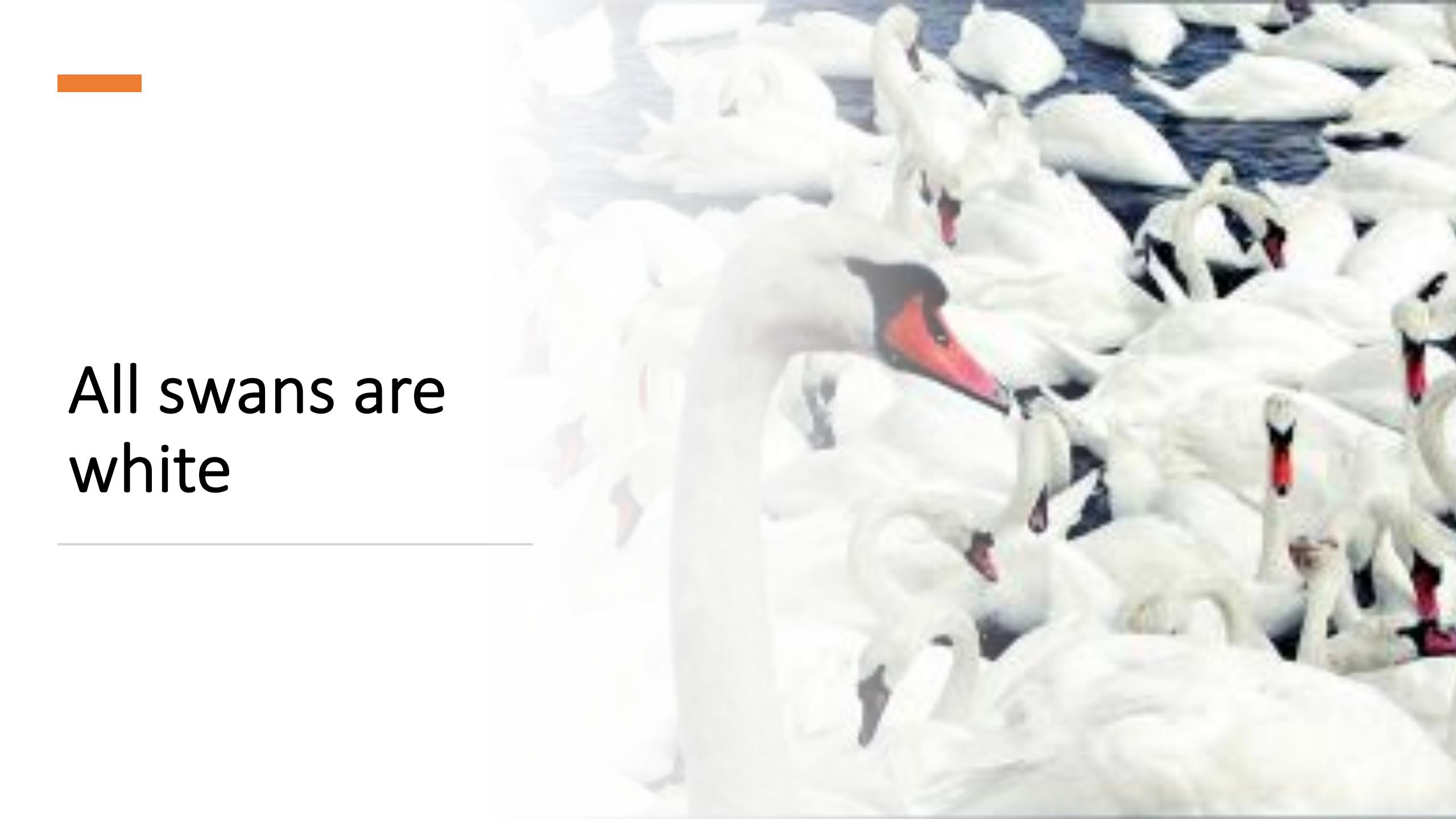
The principle of Induction

If

a large number of As have been observed under a *wide variety of conditions*, and if all those observed As without exceptions possessed the property b

Then

All As have b



All swans are
white

Swans are observed to be white (up to time t)

- 1) *The next swan* that will be observed will be white
- 2) *All swans* that will be observed will be white'

Logical problem

P – true

C – false

no logical contradiction

Deduction and Induction

- Deduction is safer (logically speaking)
- Induction is better for science ('ampliative' reasoning) but much less safe....

A leap into the future

- How well grounded?
- How justified?



How risky?....



David Hume (1711-1776)

OUR NEXT STEP

- Hume's problem with induction
- Dealing with the problem:
 - probability
 - pragmatic justification
- Using induction in science

How can we formulate
the **problem of**
induction?



*An Enquiry Concerning Human
Understanding (1748)*

- Sect. IV ‘Sceptical Doubts Concerning the Operations of the Understanding’
- Sect. V ‘Sceptical Solutions to the Doubts’
- Sect. VI ‘Of Probability’
- Sect. VII ‘Of the Idea of Necessary Connexion’