

Epistemology and Philosophy of Science

The Demarcation of Science from Non-Science

**What is the beginning of
"modern philosophy"?**

What things exist in the world?

What is the ultimate reality behind appearances?

What is the good and the beautiful?

Pre-Modern

Modern

~1600 AD

Copernicus

Kepler

Bacon

Galileo

Descartes

John Locke

Leibniz

Newton

How is knowledge possible?

What role do sensations play in obtaining knowledge?

What is the role of the reasoning faculty in obtaining knowledge?

Epistemological Turn!

Two answers to the question

Rationalists

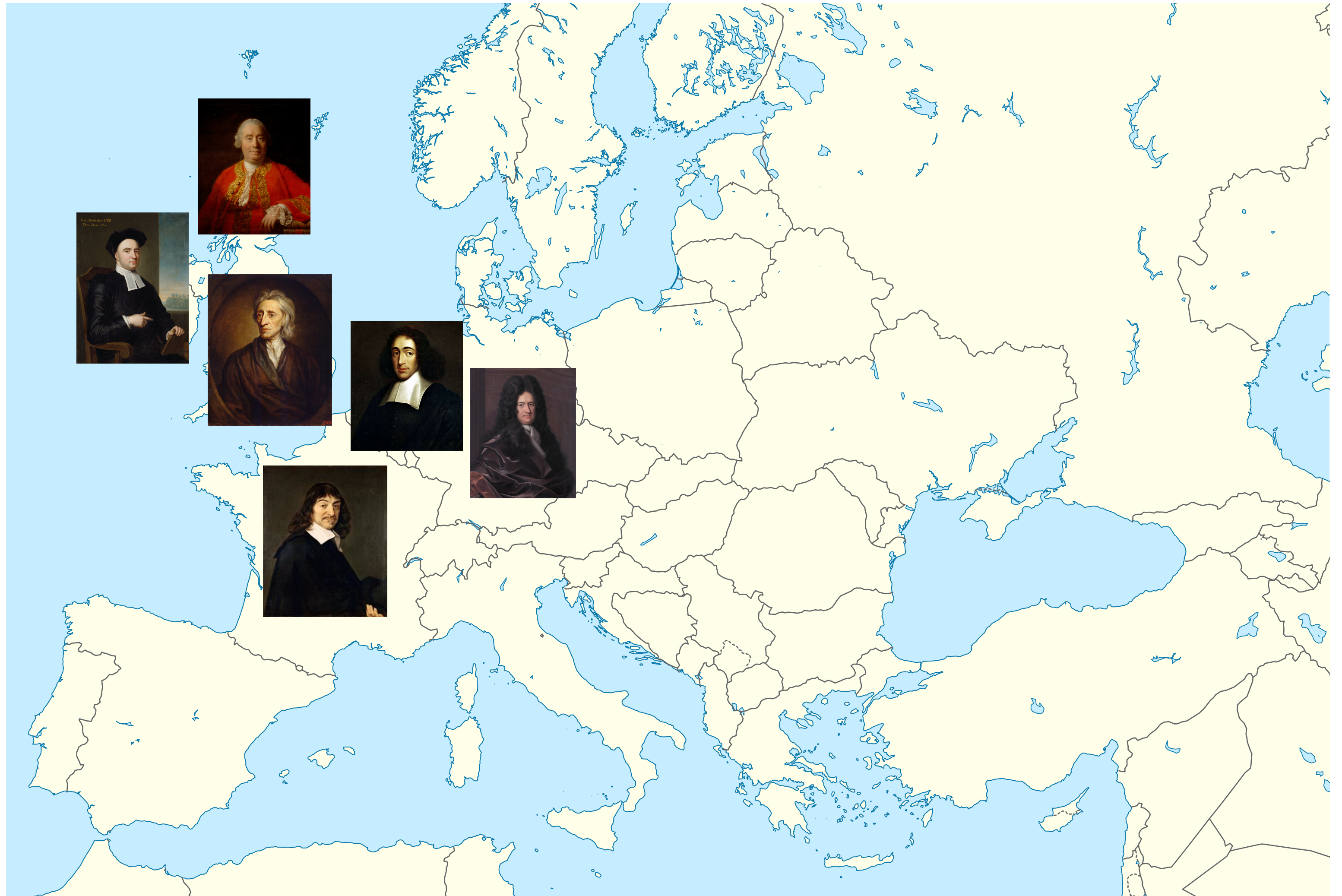
- Descartes
- Spinoza
- Leibniz

Reason is source of knowledge

Empiricists

- Hume
- Locke
- Berkeley

Sensations are source of knowledge



A Typical Rationalist Argument

Descartes' Radical Doubt

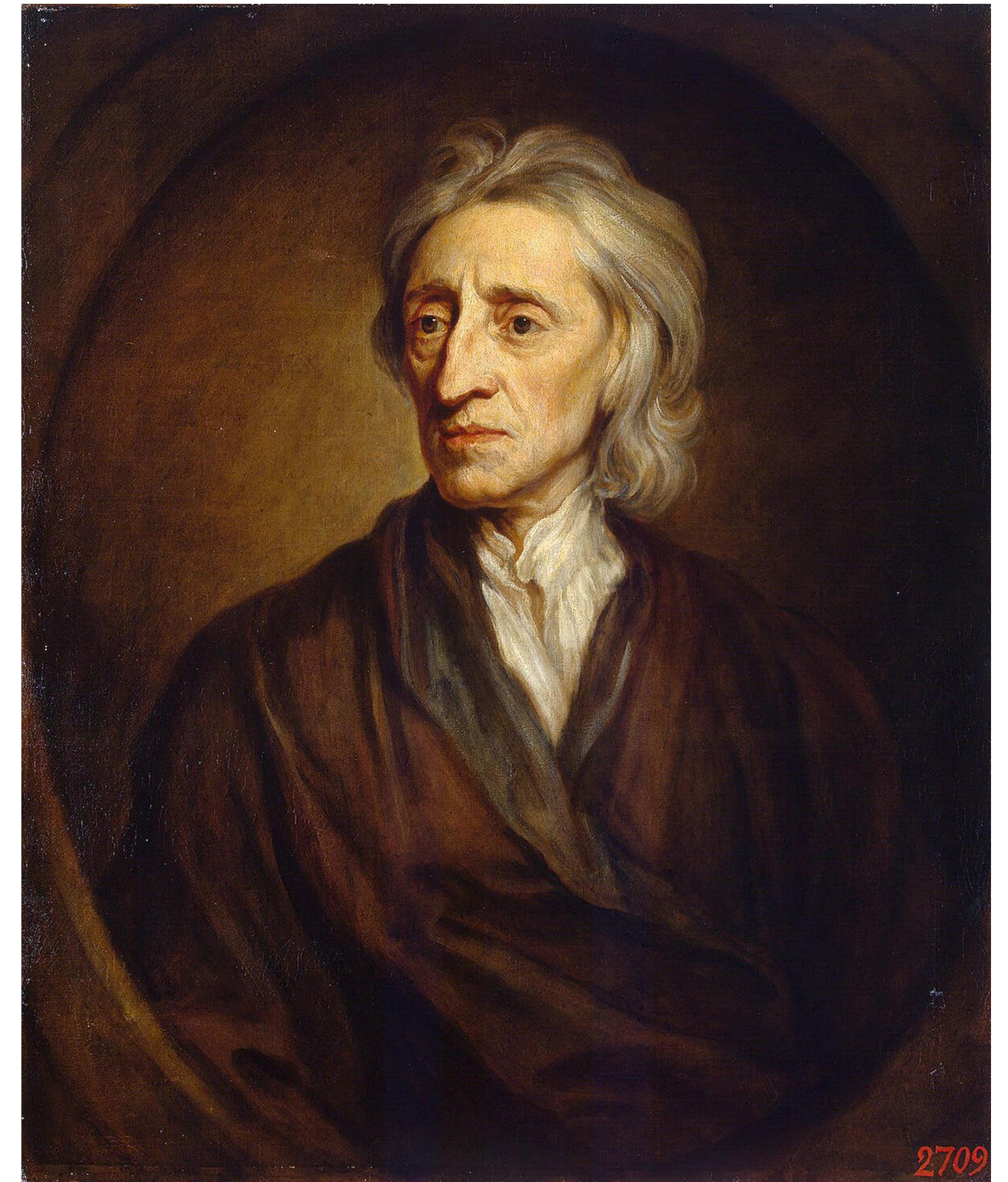
- We are sometimes misled by our senses, for example by optical illusions.
- It is possible that we are always misled in this way, and knowledge derived from our sensations can therefore never be certain.
- On the other hand, I can deduce with absolute certainty that, since I think, I must exist. (Cogito ergo sum)
- If we want our system of knowledge to be certain then it must be founded on reason, not sensations.



A Typical Empiricist Argument

Locke's Tabula Rasa

- Children are born with a mind that is like a blank wax slate or a white sheet of paper. There are no innate ideas, and no universally accepted truths.
- Over time experiences and sensations leave a mark on this blank slate. These sensations lead to **simple ideas**, where the mind is purely receptive.
- The active mind then combines these simple ideas to **complex ideas** of various kinds.
- Therefore, there is nothing in the mind which was not previously in the senses.

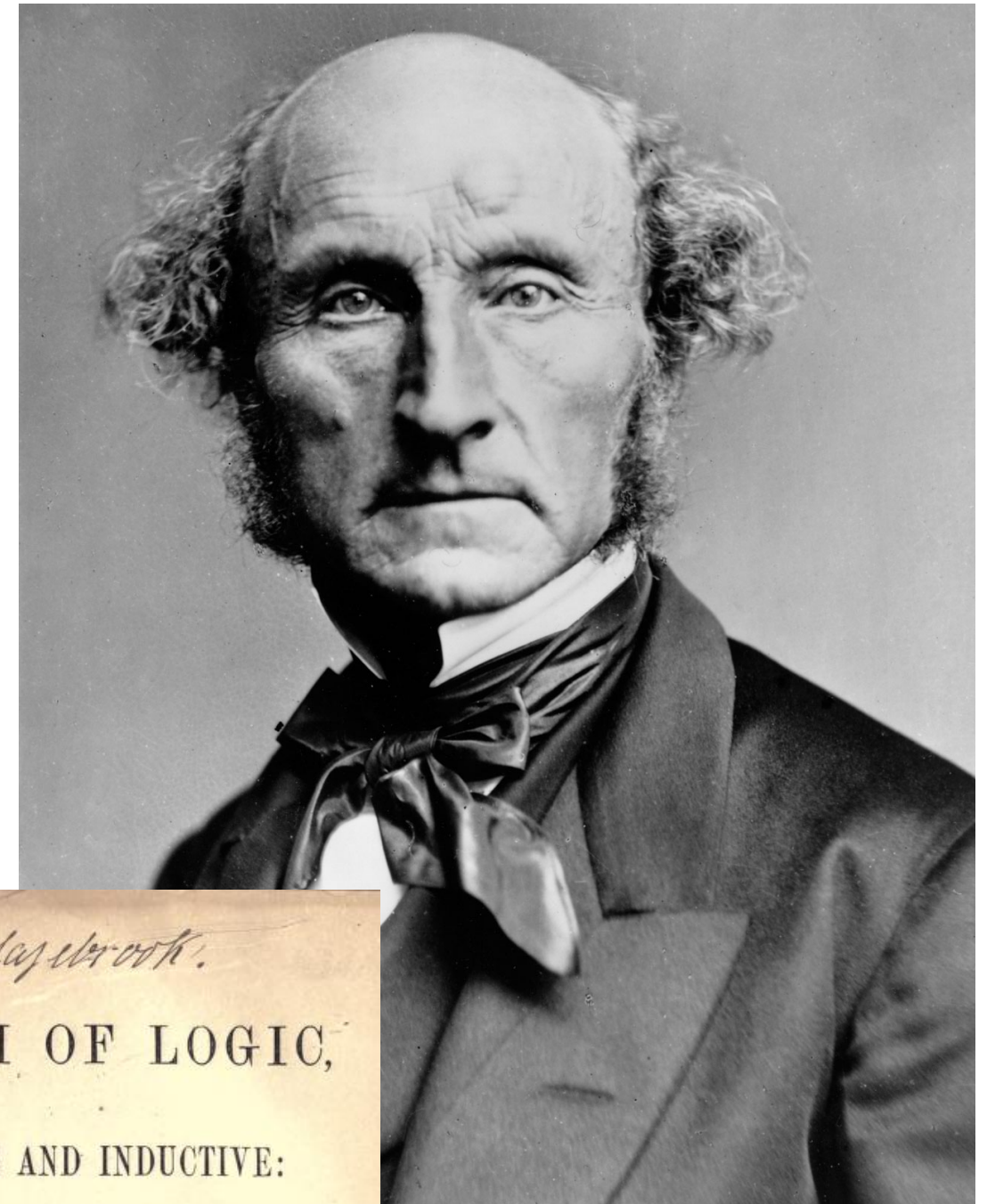
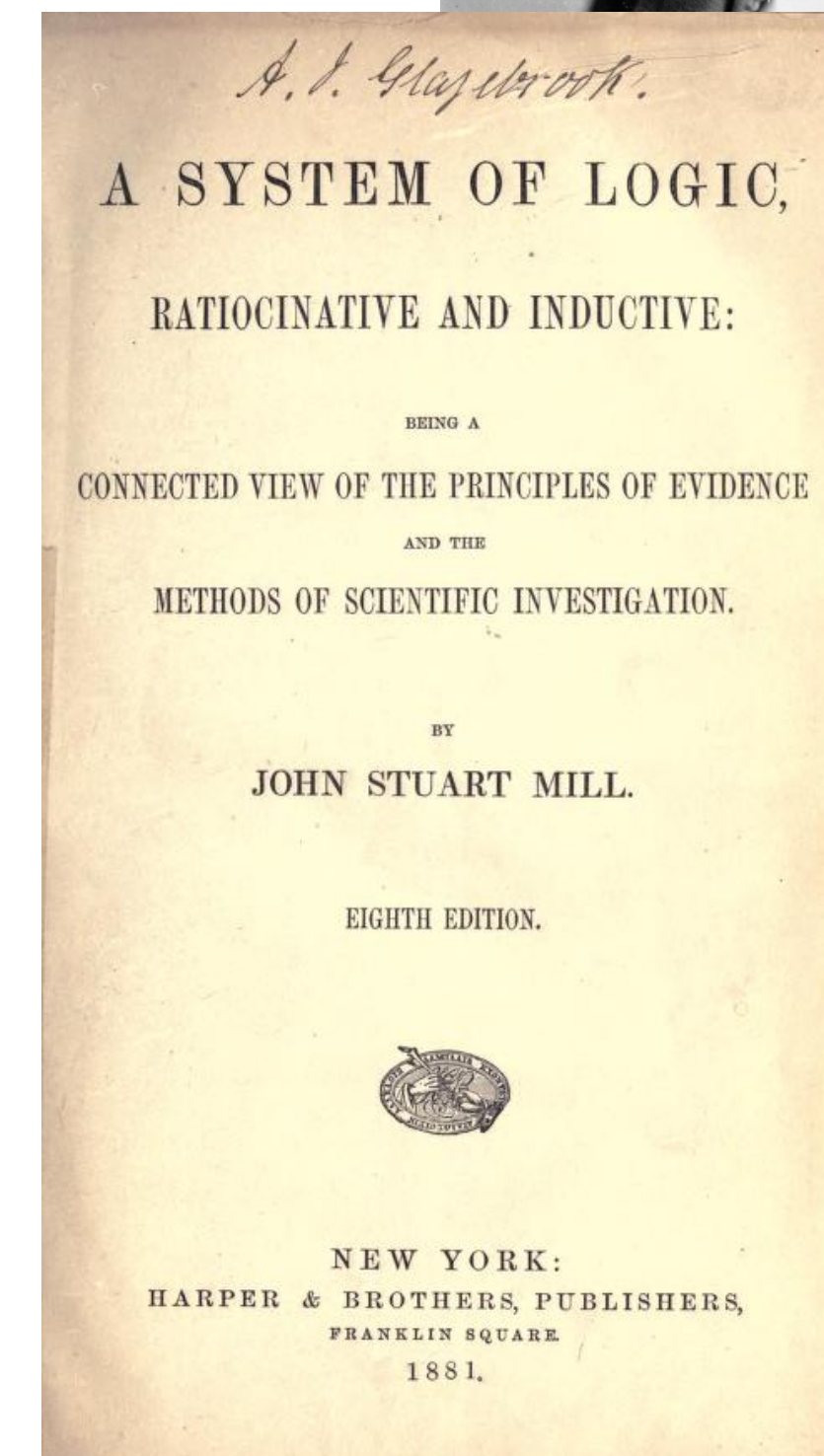


**How do you think these arguments
fare in the eyes of scientists?**

John Stuart Mill

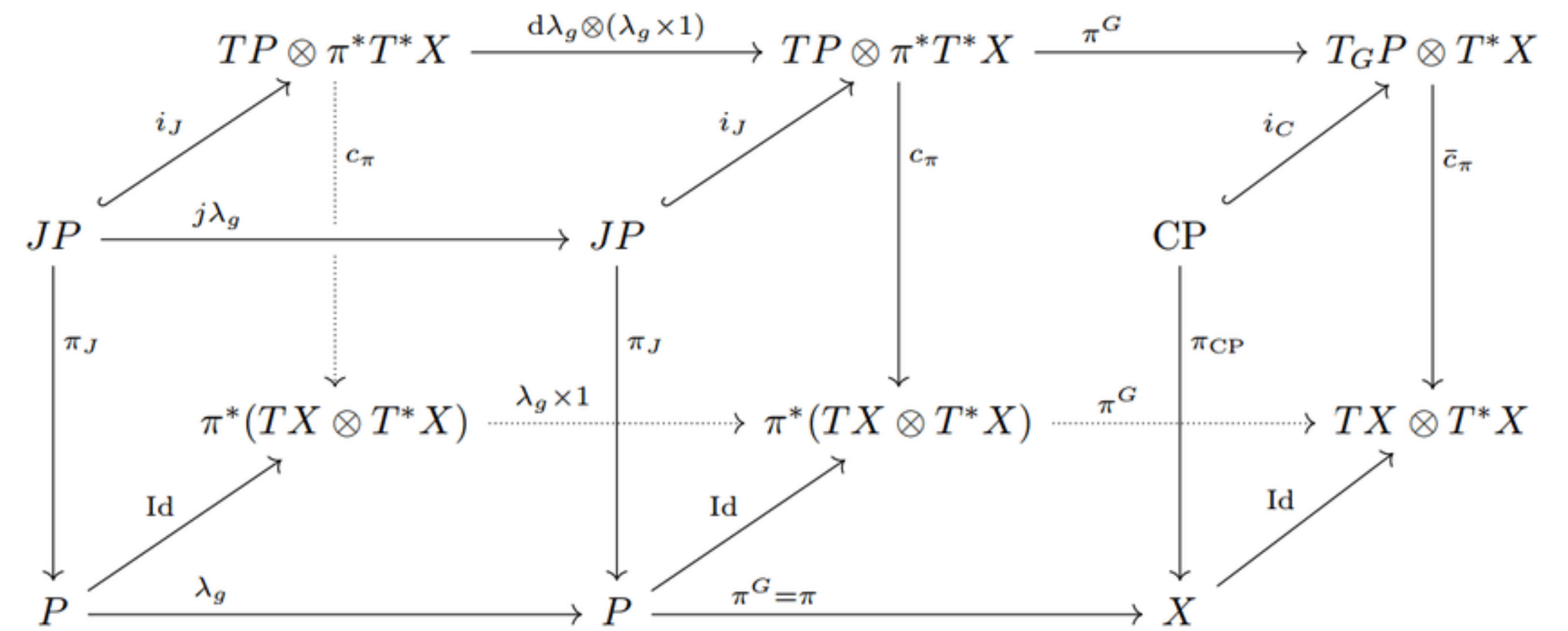
An Empiricist Reconstruction of Mathematics

- We frequently observe 2 pebbles, 2 plates, 2 horses.
- We form the complex idea of the number 2.
- From the physical process of putting 2 pebbles next to 2 other pebbles we form the idea of addition.
- Mathematical laws are complex ideas which regulate our observations of such simple operations.
- This shows that an empiricist foundation of mathematics and logic is possible.





???



People are not convinced

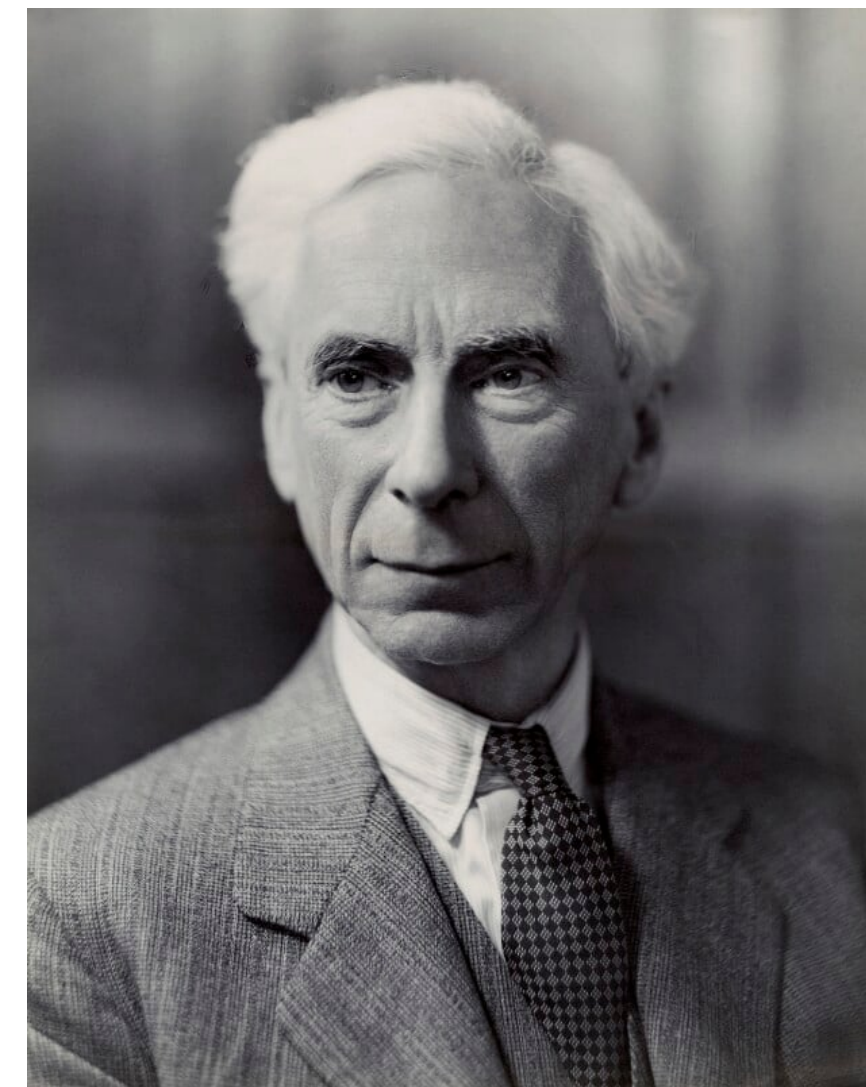
Another Revolution in Philosophy: The Linguistic Turn



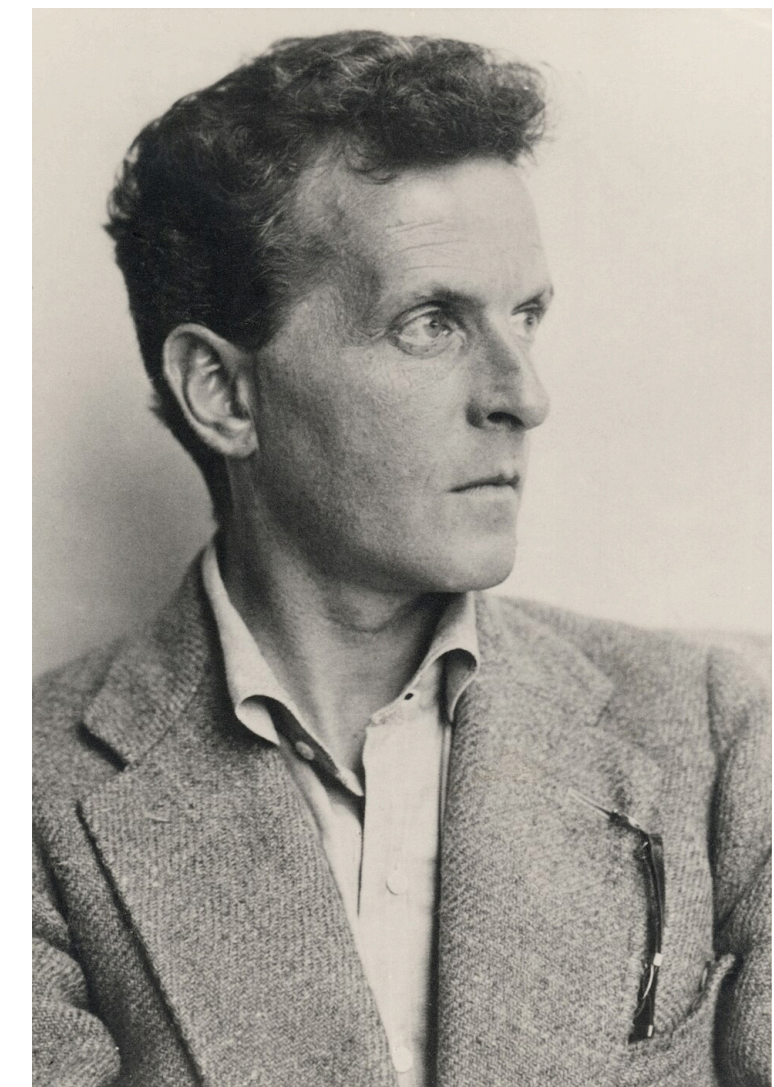
Frege



Peirce



Russell



Wittgenstein

- They are all important logicians or mathematicians
- They all identify the problem of how language works as the central problem of philosophy

This gives rise to analytical philosophy

A typical Analytical Argument

Frege's Analysis of Identity Statements

- We either know or don't know that
$$(a + b)^2 = a^2 + 2ab + b^2$$
- Everyone knows that $(a + b)^2 = (a + b)^2$
- We can substitute equals for equals, therefore everyone knows that
$$(a + b)^2 = a^2 + 2ab + b^2$$
- This conclusion is absurd.
- How do we solve this philosophical puzzle?



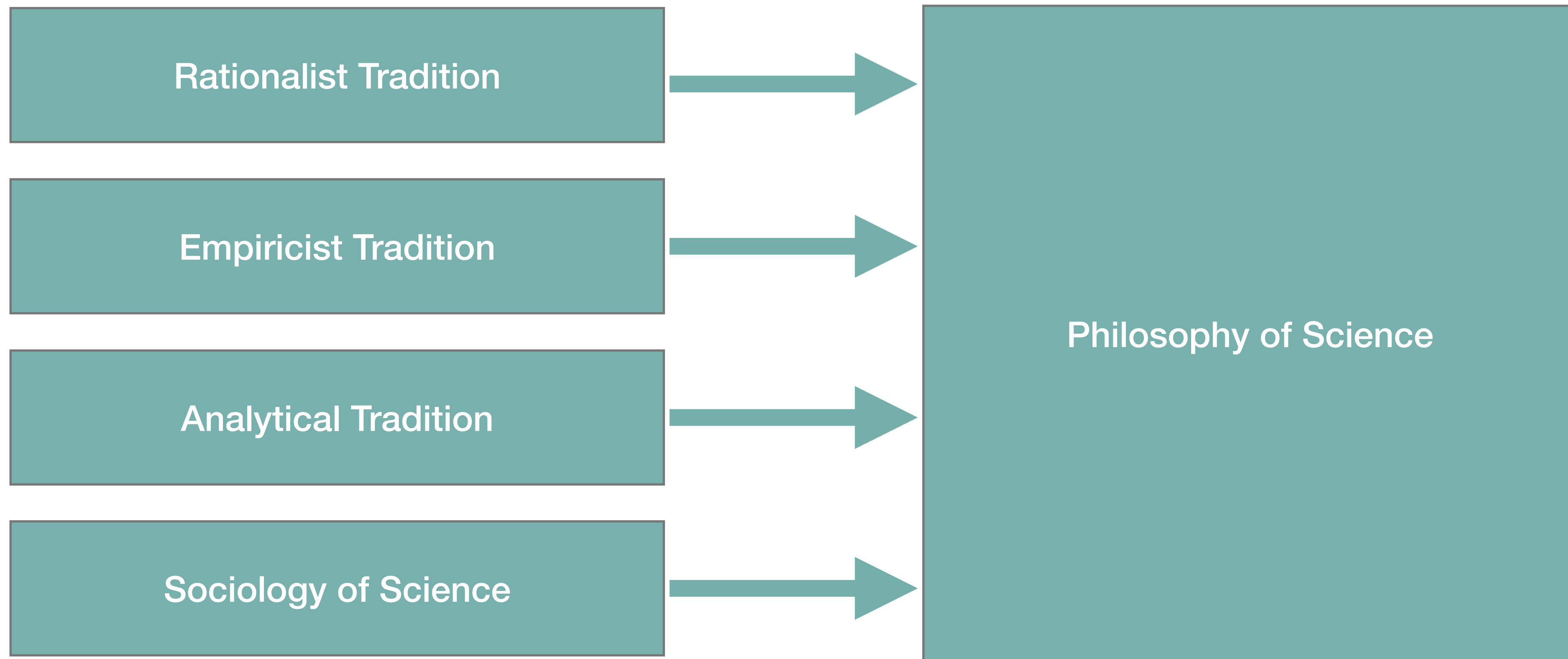
A typical Analytical Argument

Frege's Solution to the Problem

- There are two levels of meaning: Every expression has both **sense** and **denotation**.
- The **denotation** is what object the expression "points to". $2 + 2$ and $3 + 1$ both denote the number 4.
- The sense describes how the expression denotes: "The morning star" and "the evening star" are two expressions with different senses but the same denotation.
- In some contexts we cannot replace expressions with the same denotation but different senses.



Philosophy of Science

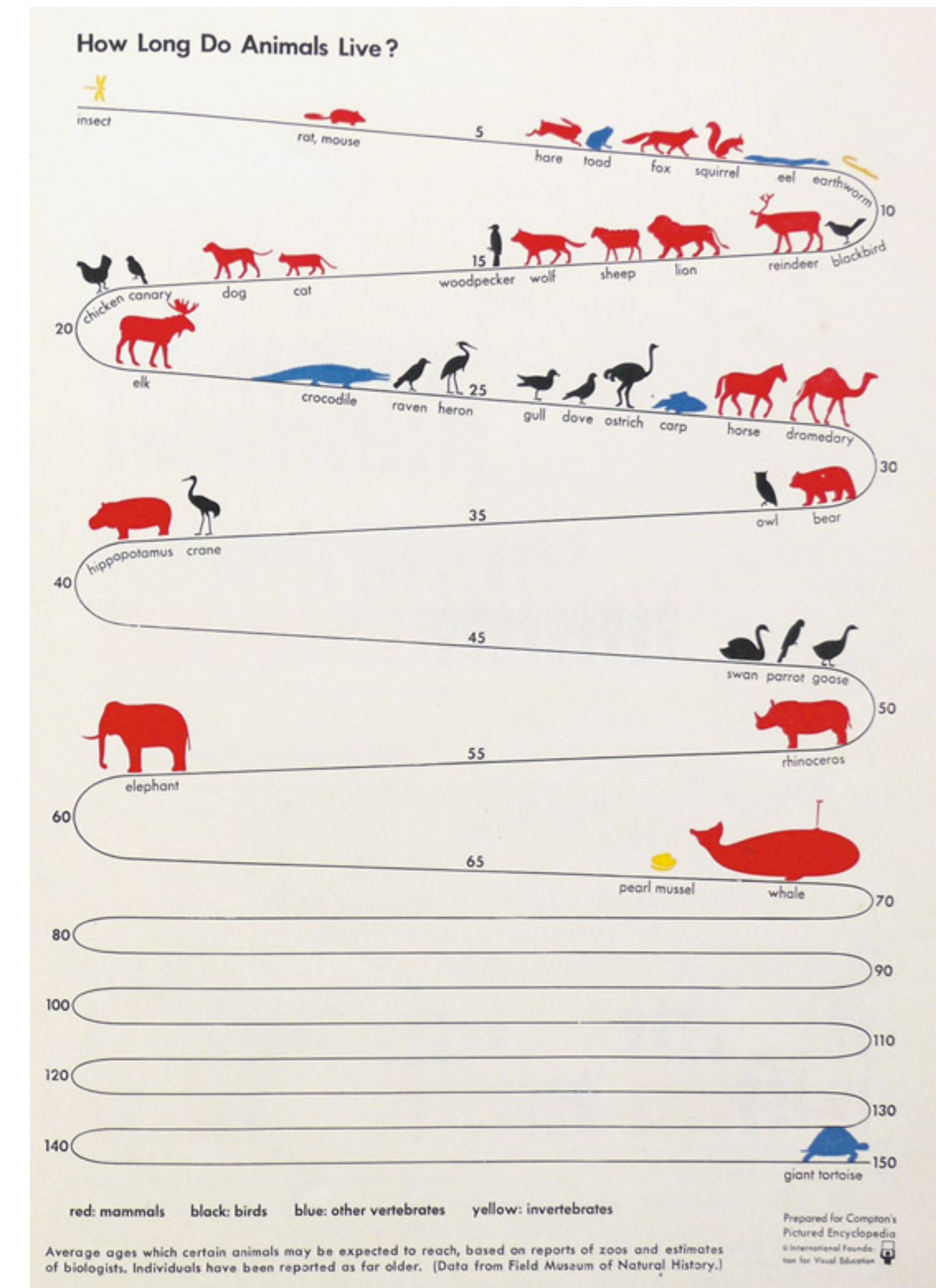


Logical Empiricism, Falsificationism, Puzzle Solving

The Vienna Circle

The Relationship to Interwar Vienna

- Part of the general cultural movement of modernism in interwar Vienna
- A group of philosophers, physicists, mathematicians and social reformers that share a scientific worldview and are opposed to irrationalist tendencies.
- A group which shares a common worldview but with a wide diversity of philosophical ideas and answers.
- Rudolf Carnap, Kurt Gödel, Hans Hahn, Olga Hahn-Neurath, Richard von Mises, Otto Neurath, Rose Rand, Moritz Schlick, Friedrich Waismann, Edgar Zilsel...



The Vienna Circle

The development of Logical Empiricism

- **Logical Empiricism:** Combine the empiricism of physicists like Ernst Mach with fresh ideas from analytic philosophy and logicians like Frege, Russell and Wittgenstein.
- **Unified Science:** There is only one common scientific endeavor which encompasses formal sciences, empirical sciences and the humanities.
- **Rejection of Metaphysics:** Metaphysics is a part of irrational discourse that, when analyzed, turns out to be empty, meaningless verbiage.
- **Verificationist Meaning Theory:** The meaning of a sentence is the method of its verification.

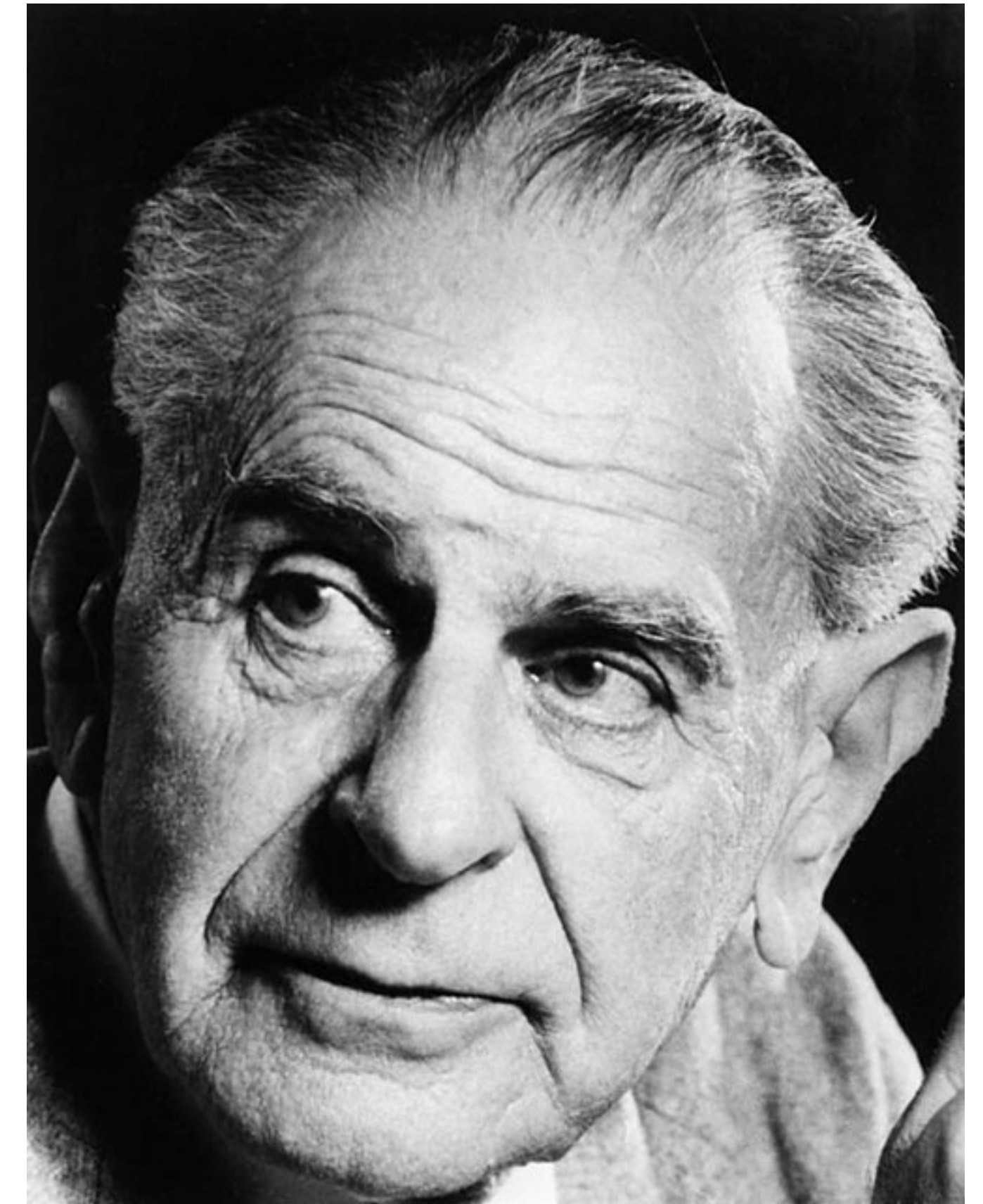
Immensely influential historically

Many concrete ideas rejected by mainstream today

Karl Popper

Falsificationism

- Most influential philosopher of science among scientists
- **Rejection of inductive verification:** Verification of empirical laws is impossible. Inductive logic doesn't work.
- **Falsificationism:** Scientific theories make predictions that can be falsified by empirical observations. They can be conclusively rejected.
- Any theory that makes falsifiable predictions is scientific.
- **Immunization Strategies:** Unscientific theories use immunization strategies which make it impossible to refute them.



Thomas Kuhn

Revolutionary Episodes and Normal Science

- **Falsification is the Exception:** Scientific theories are only rarely falsified. This happens in revolutionary phases
- The definition of science cannot be based on what happens during exceptional times: It must be defined on what happens during **normal science**.
- Normal science is characterized by **puzzle solving** within a paradigm.
- During scientific revolutions a **paradigm shift** happens.



What demarcates Science from Non-Science and Pseudoscience

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philosophy of science



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Hobbes' Philosophy of Science

Value of Using Scientia in Natural **Philosophy** 5. The Prospects for a **Science of Civil Philosophy** Bibliography... history of **science** and **philosophy**, there are several reasons why we may find these areas of Hobbes' thought...his political **philosophy**, or as he called it “civil **philosophy**”, to be a **science** capable of demonstration...

Marcus P. Adams

<https://plato.stanford.edu/entries/hobbes-science/>

The Philosophy of Computer Science

proper object of study of the discipline of computer **science**. The **philosophy of computer science** treats them...the **philosophy of computer science**”, in Floridi L. (ed.), The Routledge Handbook of **Philosophy of Information**...computer **science** have related ones in the **philosophy of mathematics**, the **philosophy of empirical sciences**...

Nicola Angius, Giuseppe Primiero, and Raymond Turner

<https://plato.stanford.edu/entries/computer-science/>

Science and Pseudo-Science

Kuipers (ed.) Handbook of the **Philosophy of Science**: General **Philosophy of Science** – Focal Issues, Amsterdam...Rationality of **Science**”, **Philosophy of Science**, 55: 435–441. Bartley III, W. W., 1968. “Theories of Demarcation...in the **Philosophy of Science**, Proceedings of the International Colloquium in the **Philosophy of Science**...

Sven Ove Hansson

<https://plato.stanford.edu/entries/pseudo-science/>

Science and Chinese Philosophy

History of **Science** in China The question of the relation of Chinese **philosophy** and **science** is