LOGIC&PHILOSOPHY OF SCIENCE MODULE 1

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Logic **AND** Philosophy of Science

- Learning logical tools: not an end in itself
  - Importance of contexts of use

Logic **AND** Philosophy of Science

- Logic, the original idea → method to reason correctly
- Context where reasoning correctly is of essence → science

- Scientific reasoning → logical reasoning at its best

Logic AND Philosophy of Science

- Philosophy of science at the time of "logical positivism" (1930s onwards)

Vienna circle *Manifesto*:

'the scientific world conception is marked by the application of a certain method, namely *logical analysis*'

Logic **AND** Philosophy of Science

- Learning about scientific reasoning (its 'logic') → learning about the s*cientific credentials* of any discipline

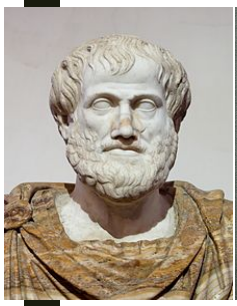
STRUCTURE OF THE MODULE

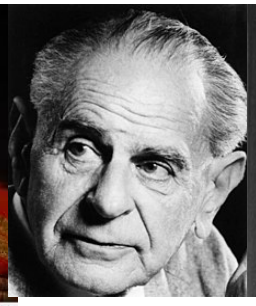
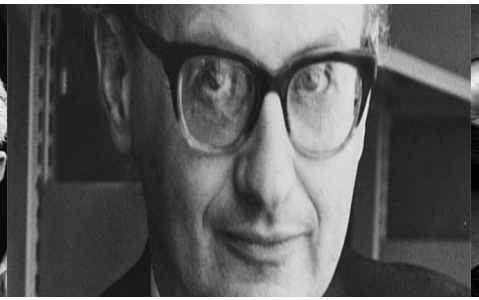
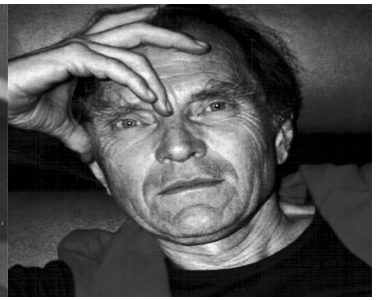
THREE TOPICS:

- scientific method
- scientific explanation
- natural and social kinds

Topic 1: scientific method

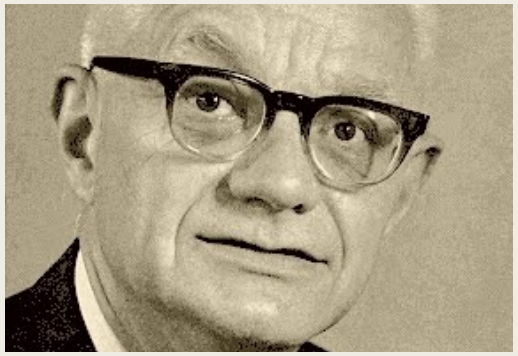
- **Deduction/demonstration** (Aristotle)
- **Induction** (Hume, critics, solutions)
- **Falsification/hypothetico-deductivism** (Popper and criticism)



Topic 2: scientific explanation

- The **deductive-nomological model** (Hempel)
- **Inference to the best explanation**/ abduction (Pierce, Lipton)



Topic 3: natural and social kinds

- Categorizing the world
- Necessary properties
- Modalities (necessary/possible)
- Essentialism

- Social kinds
- Natural and social ontologies

Objectives of Module 1

- knowledge of some basic logical terminology and of some basic philosophy of science terminology
- acquaintance with some of the main epistemological debates in the philosophy of science and of some of the logical problems and challenges they pose
- understanding the limits of logical reasoning vis a vis the aims of science.

First exam date:
18 Dec 2020, 10-12pm

Reading material

Phil Sci manual:

- Ladyman, J., *Understanding Philosophy of Science* (chapters in Moodle)

Weekly sessions:

- Articles/chapters/extracts from primary sources (in Moodle)

One word on ....

- STUDENT QUESTIONNAIRES!

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Commissione Paritetica

What is ‘logic’?

logos – ‘discourse’, ‘rule’, ‘reason’

- the study of correct reasoning, or valid arguments
- the study of rules/principles for reasoning correctly

Not an *empirical* discipline

- Logic is a *normative* discipline: it tells us how we ***ought to*** reason

Logic as a *normative* discipline

1) logic has to do primarily with the **form** of our reasoning and arguments

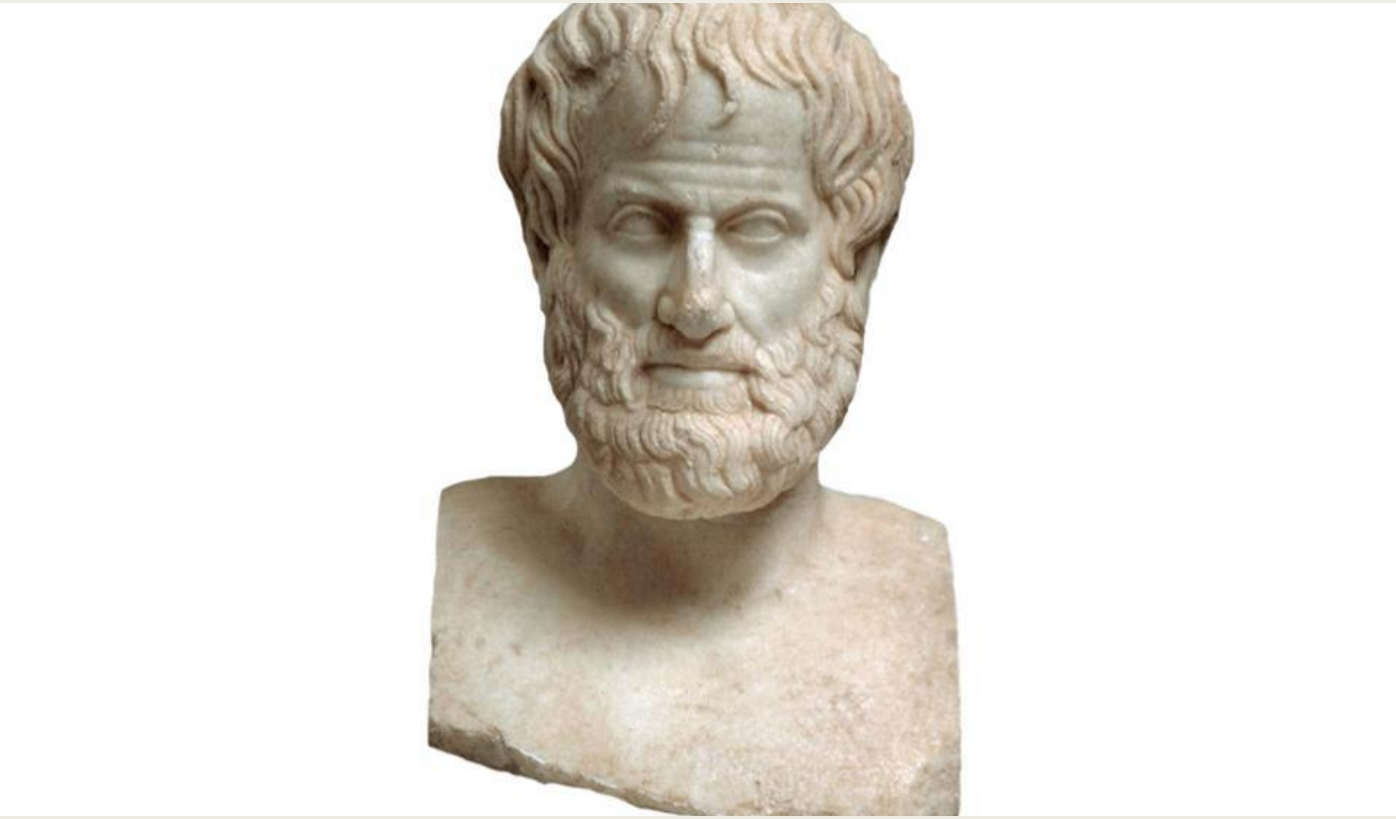
- *x is y*
- *y is z*
- *x is z*

Logic as a normative discipline

2) the principles of logic are not contingent but **necessary**

- *If a then a*

Where did all this start?



Aristotelian (traditional) LOGIC

domain of logic → 'analytics' (the analysis of reasoning through the form of syllogism)

- *Prior Analytics*: work on syllogistic reasoning
- *Posterior Analytics*: work on demonstration

Importance of logic for Aristotle

- It gives structure to scientific content and reasoning
- The edifice of science reproduces the structure of syllogism

What is a syllogism?

- All *men* are mortal — *major premise*
- ***Socrates*** is a man — *minor premise*
- Socrates is *mortal* — *conclusion*

- Men → *medium term* (M)
- *Mortal → major term or extreme (P → Predicate)*
- *Socrates → minor term or extreme (S → Subject)*

Summary of syllogism

- Men → *medium term* (M)
- *Mortal* → *major term or extreme (P)*
- *Socrates* → *minor term or extreme (S)*

P1.	**MP**	mortal-men
P2.	**SM**	Socrates-men
C.	**SP**	Socrates-mortal

S is P (subject-copula-predicate)

- Propositions
- Sentences
- Statements

Categorical logic

- It is about sentences that predicate things about classes of objects (categories), or objects that belong to those classes.

Binary logic

- propositions admit only of two possibility, truth or falsity

- saying that something is the case: it is true/false that something is the case.

Types of propositions

- **Universal** – *affirmative* (All S are P) or *negative* (All S are not P)
- **Particular** – *affirmative* (Some S are P) or *negative* (Some S are not P).

‘inferences’

- process of reasoning that correlates one type of sentence (‘***premise***’), with another type of sentence (‘***conclusion***’), on the basis of a series of rules – (***rules of deduction***, or of logical derivation)

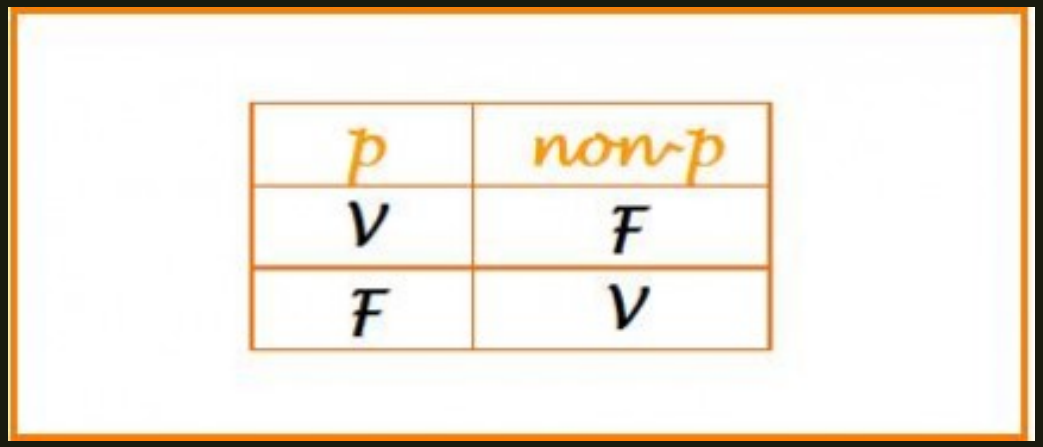
Rules of logical derivation

- In a syllogism there can be only three terms (major, medium, minor)
- The medium term can never be present in the conclusion
- From two affirmative premises we can only derive an affirmative conclusion
- From two particular premises we can never derive a general conclusion
- Etc.

General principles of logical derivation

- **Identity**: given A, A is A.
- **Non-contradiction:** it is not possible that ‘A is x’ e ‘A is not x’.
- **Excluded middle:** a sentence is either true or false. There is no other possibility.

Truth tables



p	non-p
V	F
F	V

P. of non contradiction

- p ¬p p&¬p
- V F F
- F V F

Rules+principles

- Valid/invalid inferences
- Invalid inference = fallacy

Validity and truth

A valid reasoning guarantees that a certain correlation of sentences is **correct by virtue of its inferential form**, independently of whether the sentences are actually true or not.

Correct correlation

- If man is an amphibian, then man can live under water
- If man is an amphibian, then man cannot live in water

The importance of logic for science in Aristotle

- Syllogistic logic leads to true scientific knowledge (from form to content)

syllogism and demonstration

Doxa – ***Episteme***

(opinion – knowledge)

Episteme → science

Logic: ‘organon’ that guarantees the validity of a scientific argument

Demonstrative science: from principles (premises of d.) to conclusions (ascribing a particular object to a general category)

Geometry as a model of method

- From Aristotle to Descartes:

"rules which are certain and easy and such that whomsoever will observe them accurately will never assume what is false as true, or uselessly waste his mental efforts, but gradually and steadily advancing in knowledge will attain to a true understanding of all those things which lie within his powers." (Descartes, *Discourse on Method*)

From 256 syllogisms....

..... down to 24!

what's left out:

<u>fallacies</u>

Aristotelian logic

A powerful tool!

and yet, not powerful enough.....