

When we think of traditional logic, **Aristotle** is the first name that comes to mind.

In his philosophy, logic is important for two key reasons:

- it gives a structure to both scientific reasoning and its content
- Science's structure reproduces the syllogistic one.

## **Analytics**

In his works, the term “logic” doesn't appear as such, it's called **analytics**: the analysis of reasoning through the form of **syllogism**.

### **Prior Analytics**

Prior Analytics is the analysis of the real essence of logic: syllogistic inference, therefore deductive reasoning. Aristotle deals with logic in its meaning for the first time in history.

### **Posterior Analytics**

In *Posterior Analytics* it's studied how syllogistic knowledge can lead to scientific knowledge, or demonstration.

Science is a demonstrative type. It starts from a series of **axioms**, from which we deduce the whole architecture of scientific knowledge

## **Syllogism**

An example:

**All men are mortal    major premise**

Socrates is a man    minor premise

Socrates is mortal    conclusion

**men            medium term    M**

<b>men</b>	<b>medium term</b>	<b>M</b>
mortal	Major term	<b>Predicate</b>
Socrates	minor term	<b>Subject</b>

- The major premise connects the major term and the medium term.
- The minor premise will connect the minor term with the medium term.
- The conclusion connect the minor term with the major term.

The basic units of a syllogism are sentences with a particular grammatical form:

**subject** + **copula** + **predicate**

**Propositions** or statements: something is proposed, not commanded. We assert something of something else.

By stating "all men are human" we're saying something about the humanity of men. "human" and "men" are **categories**.

We may therefore affirm that Aristotelian logic is:

- a **categorical logic**: it is about sentences that predicate things about classes of objects and objects belonging to those classes;
- a **binary logic**: propositions are either true or false.

12<sup>th</sup> November 2020

## Limits

Syllogisms only deal with **properties**: they put in connection or separation two categories.

Consequently, this type of logic excludes many sentences used in everyday language. Relations such as "Oedipus loves Jocasta" or "The Greeks won against the Persians" can't be used. +++ EXAMPLES 2020.11.12 FROM SLIDES.

We are "constrained" by grammatical rules that may not be optimal in logic. For example: a problem emerges when we make the subject of a sentence

its object, by transforming the sentence in passive. Grammatically the meaning is perfectly the same; nonetheless, logically it becomes a problem.

“ The Greek defeated the Persian

has exactly the same meaning but logically it is not at all the same as:

“ The Persian were defeated by the Greek

These limits and constraints became a motive for criticism, particularly by [Gottlob Frege](#) in the 19<sup>th</sup> century.

## Types of propositions

Propositions can be

- **Universal:** concerning everything  
e.g.: “all **S** are **P**” or “all **S** are not **P**”
- **Particular:** concerning a subset of entities  
e.g.: “some **S** are **P**” or “some **S** are not **P**”

## Inferences

In a syllogism sentences are linked by particular rules, **inferences**:

An inference is the process of reasoning which correlates one type of sentence (the premise), with another type of sentence (the conclusion), on the basis of a series of rules (rules of deduction or rules of logical derivation)

## Rules

- In a syllogism there can only be its three characterizing terms: **major**, **medium**, **minor**
- The medium term must not 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

and more (see [Aristotelian logic > Limits](#)).

## Logical principles

General principles of logical derivation:

- **Identity**
- **Non-contradiction**
- **Excluded middle**

The “truth table” allows us to understand these

## Validity and truth

By relying on rules and principles we understand the inferences in analysis are valid or not valid: **fallacies** are the “errors” that make an inference invalid.

### Note

A valid inference isn't necessarily true: we can say the correlation between sentences is correct, but we can't use inferences to prove the truth of the former statement.

A valid reasoning guarantees that a certain correlation of sentences is correct by virtue of its inferential form, independently of the truthfulness of the sentences in analysis.

## Syllogism in sciences

In *Posterior Analytics* Aristotle focuses on demonstrations: the applications of the rules of syllogistic logic to scientific knowledge.

Aristotle marks a distinction between **doxa** (opinions) and **episteme** (true knowledge, science).

Aristotle conceives all the sciences as **deductive structures** which move from a series of general principles (the premises on the demonstrations) on the model of syllogistic inference. Then can be drawn conclusions on specific entities.

The truth of the conclusions necessarily depends on the truth of the premises.

# Geometry

Geometry is the underlying architecture behind every reasoning, it's the basis of every rule.

Fast-forwarding to [René 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.

~ René Descartes, *Discourse on the Method*

Aristotle didn't mean to reduce all sciences to one nor to unify everything in one general group. Each science is autonomous, but it's a reality of a whole, and the basis of such whole is Geometry.

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## First principles

In order to guarantee the production of true scientific knowledge, the syllogistic procedure should infer its conclusions only from **true premises**. The syllogistic system can't deal with this issue alone. Premises have to be assumed as true. The premises themselves can't be demonstrated with the same method, or, if we try to do so by using syllogisms, we'd go back infinite times.

Since in science nothing can be assumed as true, there needs to be a tool to prove the premises.

The premises from which a demonstration begins, are taken as primitive: they explain all the truths, but they're not explained by any of these.

They're the called **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 principles can be used to demonstrate, but they aren't demonstrable themselves. They are defined following an inductive process, but not by a demonstrative explanation.

“ 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, n.4, February 2016.

It becomes quite natural to ask what kind of knowledge can we get of these first principles. So:

- How can it be trusted that what is derived from the premises is true, since the truthfulness of the premises themselves can't be demonstrated?
- How can the premises be proven as correct, in a non-demonstrative way, hence not by using a syllogism?

Aristotle has an answer to these two questions: **a cognitive development** needs to be applied, not a procedure.

From [Gasser-Wingate - Aristotle on induction and first principles.pdf](#):

Induction (ἐπαγωγή):

“ a form of cognitive development that begins with perception and progresses through a series of increasingly sophisticated states in which various universal concepts come to be formed in our souls

Doubts:

1. First principles are propositions, while in Aristotle knowledge of these ultimately takes the universal form of concepts
2. It's not sufficient to know and understand these fundamental propositions, they are to be studied as "the necessary explanatorily primitive truths from which all of our scientific understanding is derived".

Explanations:

2. two possible explanations:
  - *Noûs* as both the **state** of the mind and the **faculty** of reaching first principles
  - Aristotle is offering "a highly elliptical explanation of our acquisition of first principles", and his explanation lacks important steps to be accomplished after the inductive process

**footnote 10**: The necessity of recognizing attributes a subject has as *necessary* qualities to make it such, as seen later on in [Natural kinds](#).

Requiring to prove first principles would make scientific understanding impossible: an "explanatory regress" would take place; we must possess scientific understanding and get to it in an alternative, non-demonstrative, way.

6<sup>th</sup> November 2020

Syllogism is a type of logical inference.

A scientific demonstration is the application of the syllogism procedure in order to acquire knowledge, which is the goal of science.

It's possible achieve a non-demonstrative understanding of first principles and at the same time prove these to be certain enough to make their derivation demonstratively true.

Aristotle that first principles will be demonstrated on the basis of a sort of mental state. According to Aristotle, man isn't born with innate ideas: we have to develop a capability to perceive particular phenomena within a particular science and upon those we can generalize everything else, by drawing a general principle.

This capability is called *epagogé*.

## ἐπαγωγή (epagogé)

The capacity of knowing first principles by generalizing.

“ 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.

~ Aristotle, *Posterior Analytics*

Obviously, merely generalizing what has been observed isn't enough. An intuitive sensibility has to be developed, it takes the name of *νοῦς*.

## Νοῦς

*Noûs* is the “intuition,, which leads to *epagogé*.

“ So from perception there comes memory, as we say, and from repeated memories of the same thing [there comes] experience (ἐμπειρία); 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. *voũς*] — of craft if it concerns coming to-be, of understanding if it concerns what is

~ Aristotle, (100a3–9)

## Criticisms

This solution will be criticized by both rationalists (such as [René Descartes](#)) and experimentalists (such as [Francis Bacon](#)):

### Rationalist criticisms

Descartes criticizes the idea of mind as a “clean slate”, which acquires knowledge by experience only. It should be assumed instead that man is generated with a “pack” of innate ideas. Induction plays a marginal role. According to Descartes, the justification of the premises of scientific demonstration come from an already rule driven mind which necessarily has innate ideas.

### Experimentalist criticisms

The first experimentalists state that the understanding of phenomena by the mind shouldn't be taken for granted.

Epagogé needs a different, more adequate, non-deductive approach to credible premises. It needs to be tested and it should allow a greater control on the process of induction.

Induction is the right way, but not in Aristotle's way.

### Nominalism

A branch of Experimentalism, supported by William of Ockham, among the others. It was the first modern philosophy, approaching induction in a different way from the Aristotelian philosophy.

Next topic: [Francis Bacon](#)

