Aristotles work on logic and theory philosophy essay

Aristotle was born in 384BC, in a small town called Stageria which was situated in northern Greece. The king at that time was King Amyntas of Macedon and Aristotle's father, Nicomachus, was the kings doctor and physician [4]. Aristotle's mother was called Phaestis. He moved to Athens in 367BC, where he became a student of Plato's academy which was called the Platonic circle. Plato was the student of Socrates. Along with his predecessors, Plato and Socrates, Aristotle is still recognised as one of the most important figures in logic and philosophy.

In the 20 years he spent in Athens, Aristotle listened to the philosophers and scientists in the Platonic circle and this enabled him to teach himself. At the time of Plato's death in 347BC Aristotle left Athens, for a place called Atarneus, with another student of Plato called Xenocrates. Aristotle found his friend Hermias of Atarneus, who had studied philosophy in Plato's Academy, and married his niece Pythias.

Together Aristotle and Pythias had a daughter, also named Pythias.[4] Aristotle then travelled to Lesbos where he met his most famous pupil Theophrastus.

It was not until 335BC that Aristotle returned to Athens after tutoring Alexander the Great [4] and another future king Ptolemy. Upon his return to Athens, Aristotle began teaching regularly in the morning in the Lyceum and founded an official school [2, p. 92]. Aristotle then left Athens in 322BC after the death of Alexander the Great. He retired to his mother's family estate in Chalcis, which was situated on the island of Euboea and he stayed there until

his death in the same year. Theophrastus then took over from Aristotle and became head of The Lyceum.

Aristotle wrote on many subjects other than logic including physics, metaphysics, poetry, theatre, music, rhetoric, politics, government, philosophy, ethics, biology, and zoology [4]. It is his work on logic, documented in six texts (the Organon) which will be the focus of my project report.

The Organon

Aristotle's logical works were made into six texts " called the Organon, or instrument of science" [7, p. 23] in the early 1st century AD. It was named by the Peripatetics, who were Aristotle's followers. The six texts are given below:

Categories

On Interpretation

Prior Analytics

Posterior Analytics

Topics

On Sophistical Refutations

The order of these six texts is not chronological because Aristotle's famous pupil, Theophrastus chose the order to make the Organon more structured.

Categories aims to enumerate all the possible kinds of thing which exist. On Interpretation introduces Aristotle’s work on propositions i. e. assertions or denials. Prior Analytics describes his work on deductive reasoning, particularly the syllogism, which is an argument in which one proposition follows directly from two other propositions i. e. the conclusion follows from two premises. Posterior Analytics talks about demonstration, definition and scientific knowledge. Topics deals with the construction of valid arguments and in On Sophistical Refutations, Aristotle discusses the flaws in logic.

In the following chapters I will describe the categories Aristotle used in logical arguments, introduce induction and deduction, which are the two basic types of arguments, show how Aristotle built logical arguments from syllogisms (the syllogistic) and how he used modal logic to qualify the truth of his arguments.

Although Aristotle’s work on logic was only accepted by mathematicians until the 19th century, it is the earliest known formal study of logic and therefore provided the foundation for the development of this important field of mathematics.

Chapter 2: The Categories

Categories is the first text in the Organon, which aims to identify any possible thing that could be either the subject or the predicate of a proposition in an argument. A proposition is a statement that asserts that something is true or false. An argument is a group of statements, where one of these statements supposedly follows from the others.

The Categories are very useful in helping to understand arguments and syllogisms, which are discussed in later chapters. The categories may have been the most discussed part of Aristotle’s work and many logicians have disagreed over how they are to be interpreted. There are ten categories, which are described below. The greek word for them is in brackets.

Substance (Ousia) – Substance is the most fundamental category and a substance is defined as something that can’t be predicated on anything or said to be in anything. Aristotle distinguishes between primary and secondary substances in Categories. Primary substances are individual objects such as a particular tree, with tree being a secondary substance, which is attributable to or an attribute of the primary. Hence, Aristotle is a primary substance, while man is a secondary substance. The other nine categories must relate to the substance [6].

Quantity (Poson) – The second category Aristotle discusses in Categories is quantity, which is defined as an extension of an object i. e. the physical size of the object. This can be expressed as “ How much?” [6].

Quality (Poion) – Quality characterizes the nature of an object. It can include physical descriptions but not those that can be measured numerically, as they would fall under the quantity category. This can be expressed as “ What Kind?”.

Relation (Pros ti) – Relation can be defined as the way in which one object may be related to another. This can be expressed as “ In relation to what”. Objects can be related physically i. e. one being larger than the other. They

can also be related with respect to time i. e. one object was made after another.

Place (Pou) – Place may be defined as the position of an object in relation to the surrounding environment i. e. its location. This can be expressed as “ Where”.

Time (Pote) – Time may be defined as the position of an object in relation to the occurrence of events. This can be expressed as “ When”.

Position (keisthai) – From studying Aristotle’s examples on this category it can be interpreted that he meant a condition of rest resulting from an action: “ Lying, sitting, standing”. Therefore position can be defined as the end point as a result of a corresponding action. i. e. posture.

State (Echein) – From studying Aristotle’s examples on this category it can be interpreted that he meant a condition of rest resulting from an affection: “ Sleeping”. Therefore state can be defined as the end point as a result of a corresponding affection.

Action (Poiein) – Action can be defined as how changes to an object affects something else.

Affection (Paschein) – Affection can be defined as the changes that something else has on the object.

Affection and action are closely related with action being the production of change in some other object and affection being the reception of change from some other object.

According to Aristotle, every part of a statement can be identified by one of the above categories as shown in the following example:

The six foot (Quantity) Spanish (Quality) tennis player (Substance) sat (Position) in his chair (Place) next to his opponent (Relation) feeling pleased (Affection) with his smash (Action) in the last game (Time).

Throughout the Organon we find Aristotle uses the categories in many ways in arguments. In Posterior Analytics he uses them “ to support the thesis that demonstrative science must rest on indemonstrable first premises.” [1, p. 57] According to Aristotle, every part of a verifiable statement, or proposition, falls into one, and only one, of these categories.

Chapter 3: The two types of argument: Deduction and Induction

In logic, an argument is a group of sentences, known as premises, which try to prove that an initial proposition is true. The idea of argument is to get from the proposition to a conclusion [8, p. 1]. A deductive argument is when the conclusion is proved from a logical consequence of the premises. An inductive argument involves moving from a set of specific facts to a general conclusion.

Deductive arguments

Prior analytics is the third of the six texts that make up the Organon which contains Aristotle’s work on deductive reasoning. A deduction is an argument where the conclusion follows necessarily from the premises. In particular if the premises are true, then the conclusion must also be true. Aristotle defines deductive arguments as follows:

“ A deduction is an argument in which, certain things being supposed, something else different from the things supposed follows of necessity because of their being so” [1, p. 29]

Deductive arguments are said to be valid or invalid. A deductive argument is valid if and only if the truth of the conclusion is a logical consequence of the premises [8, p. 1]. If the conclusion is false, then at least one of the premises must be false. An example of a deductive argument is given below:

All apples are fruit.

All fruit grows on trees.

Therefore all apples grow on trees.

This argument is valid because the conclusion follows as a logical consequence of the premises. Now consider the example below:

Everyone who plays tennis is Spanish.

John plays tennis.

Therefore John is Spanish.

In this argument the conclusion also follows as a logical consequence of the premises, therefore it is also valid. However the premise that everyone who plays tennis is Spanish is false. For a valid deductive argument to be sound then all the premises must be true. A deductive argument which is invalid or has one or more false premises or both is not sound. Therefore the above example is valid but not sound.

Inductive arguments

In addition to deductive arguments, Aristotle also noted the existence of inductive arguments. An inductive argument is one that reaches a general conclusion based on a specific set of facts [9, p. 46].

An example of an inductive argument is given below:

Of one hundred snooker balls struck with a cue, all of them moved

Therefore all snooker balls move when struck with a cue.

These inductive arguments have one major difference that separates them from deductive arguments, which is the fact that a single counter example is enough to block the inductive argument from a set of specific facts to a general conclusion.

Now consider the following example:

“ Socrates has two legs.

Plato has two legs.

Aristotle has two legs.

Therefore all humans have two legs.” [1, p. 31]

Now if we add the premise:

“ Monosceles is human and does not have two legs.” [1, p. 31]

then we have a counterexample which does not allow us to arrive at the conclusion that all humans have two legs.

Inductive logic has been criticised many times and it has been questioned how the truth of the general conclusion can be established from a set of specific facts. An inductive argument cannot give a conclusion which is certain but can only tell us how probable the conclusion is from the premises. Deductive arguments are therefore more powerful and can be used as the basis for proofs in mathematics.

Mathematical Proofs

Aristotle’s work on demonstrations is contained in the fourth text of the Organon, Posterior Analytics. Aristotle defines a demonstration as “ a deduction that makes us know”, which means that a demonstration is a type of deduction. Aristotle believed that if the premises of a deductive argument are true then the conclusion is true, therefore if you know the premises are true, then knowledge of the conclusion follows.

Modern mathematical proofs are convincing demonstrations that a particular mathematical statement is true. Proofs are found using deductive arguments rather than using inductive arguments. A proof must demonstrate that the mathematical statement is true for every case and there cannot exist a single counter example. A proposition which has not been proved but mathematicians believe is true, is called a conjecture. If a statement is proved it can be called a theorem and may be used in other proofs. Mathematical proofs use logic and there can be some ambiguity in them, much like Aristotle’s logical works.

Chapter 4: Aristotle's syllogistic

Syllogisms

Aristotle believed that logical arguments, which were discussed in chapter three, should be built from syllogisms. Syllogisms are logical arguments which consist of two premises and the conclusion [8, p. 9], which must follow from the two premises. Aristotle's definition of a syllogism can be found in Prior Analytics, the third text of the Organon. He defined a syllogism as " a discourse in which, certain things having been supposed, something different from the things supposed results of necessity because these things are so." [1]

The two premises and the conclusion in a syllogism are propositions which contain either ' every', ' some', or ' none'. Below are a few examples of syllogisms:

No reptiles have fur; Every snake is a reptile. Therefore no snakes have fur.

No lazy people pass exams; Some students pass exams. Therefore some students are not lazy.

Some cats have no tails; Every cat is a mammal. Therefore some mammals have no tails.

Every horse has hooves; No humans have hooves. Therefore no humans are horses.

Every kitten is playful; Some pets are kittens. Therefore some pets are playful.

Contradictions

There is an important relationship between propositions used in syllogisms called contradiction. To have a contradiction one of the propositions must be true and the other must be false. Aristotle illustrates this relationship in the following examples:

“” Every A is B” and “ some A is not B” are contradictories.

“ No A is B” and “ Some A is B” are contradictories.

Note further that “ Every A is B” and “ No A is B” are not contradictories because although they cannot both be true, they can both be false.” [1, p. 34]

Such sentences are called categorical sentences. We can assign each sentence type with a vowel as follows:

“ AaB = A belongs to every B (Every B is A)

AeB = A belongs to no B (No B is A)

AiB = A belongs to some B (Some B is A)

AoB = A does not belong to some B (Some B is not A)” [1, p. 34]

Aristotle did not invent this notation, however it is still very useful in simplifying the categorical sentences. This notation dates from the middle ages. Aristotle believed that every declarable sentence can be analysed in terms of these categorical sentences, however modern logicians disagree and regard them as only one type of proposition.

Problems with Aristotle's syllogistic

We are able to view the syllogistic as a small part of a more general logical theory such as predicate logic. We can do this by translating the categorical sentences into predicate logic notation as shown below:

" AaB = For any x, if x is a B then x is an A

AiB = For some x, if x is a B then x is an A

The translations of Aeb and AoB are then the negations of these:

AeB = For any x, if x is a B then x is not an A

AoB = For some x, if x is a B then x is not an A" [1, p. 43]

After completing these translations we can see that Aristotle's conversion rules leave ambiguities and therefore do not work. " This is because the translations of AiB and AoB imply the existence of some object, but the translations of AaB and AeB do not. However, even if nothing is a B or an A it can be true of everything that if it is a B then it is an A" [1, p. 43] or if it is a B then it is not an A.

In order to preserve his results Aristotle made assumptions about the existence of objects. For example: The sentence " John's sons play golf" implies that John has sons. If he had no sons the sentence would be meaningless. Therefore " the syllogistic can be interpreted as a theory of relations of non-empty classes"[1, p. 43] as they convey no knowledge otherwise.

Later mathematicians rarely used syllogisms, partially due to the problems discussed above. They often used logic founded by the stoics in the early third century BC. The traditional rules of inference used by the stoics are as follows:

“ Modus ponens (literally: mood that affirms): If p, then q; and p. Therefore q.

Modus tollens (literally: mood that denies): If p, then q; and not-q. Therefore not-p.

Hypothetical syllogism: If p, then q; then r. Therefore If p, then r.

Disjunctive syllogism: p or q; and not-p. Therefore q.” [3]

Syllogisms are not used by modern mathematicians either and have been replaced by first-order predicate logic after work done by Friedrich Ludwig Gottlob Frege. Frege was born on the 8th November 1848 in Germany and died on the 26th July 1925. He was originally a mathematician and then developed an interest in logic and philosophy. He is recognised as one of the founders of modern logic [11p. 1], and also contributed to other areas of mathematics.

Chapter 5: Modal propositions and the modal syllogistic

In the second text of the Organon, On Interpretation Aristotle moves from contradictions to discuss modal propositions. Modal logic aims to qualify the truth of propositions by attaching words like “ possibly” and “ necessarily” [7, p. 81] to the categorical sentences, which were discussed in the previous

chapter. Modern logicians take “ possibly” and “ necessarily” to be related by:

“ possibly” = “ not necessarily not” and “ necessarily” = “ not possibly not”

Modern modal logic also states:

“” necessarily p” implies “ p” and “ p” implies “ possibly p”” [1, p. 44].

While Aristotle agrees with “ necessarily p” implies “ p” there are flaws, in his logic, when it comes to “ p” implies “ possibly p” as he distinguishes between two types of “ possibly p” [1, p. 44]. Some of his work on the modal syllogistic is hard to understand and many logicians have found more flaws. They say some of his work leads to contradictory results and all attempts at trying to interpret the modal syllogistic, in such a way that agrees with Aristotle’s previous results, have failed. Therefore his modal syllogistic is less impressive than his nonmodal syllogistic. This may be why the modal syllogistic does not make much of an appearance anywhere else in the Organon other than On Interpretation. Even Aristotle’s most famous pupil, Theophrastus had his reservations about Aristotle’s modal syllogistic and dropped some of Aristotle’s work [1, p. 45] in developing his own, simpler version of the modal syllogistic.

Modal logic then developed, informally, due to work done by William of Ockham and John Duns Scotus [10], in the 14th century. Modern formal logic was founded by C. I. Lewis [10] in his 1910 Harvard thesis. He also did some work on the subject in some articles in 1912. Then in 1932 Lewis released his book entitled Symbolic Logic, which was the culmination of his work on

modal logic. The next development in modal logic arrived in 1959 thanks to a 19 year old Harvard University undergraduate, called Saul Kripke, who invented the Kripke semantics for modal logics [10], which is still in use today. He had talked to A. N. Prior before inventing the Kripke semantics. Prior was the creator of another form of logic called temporal logic, which is closely related to modal logic.

In conclusion, Aristotle’s work on modal logic is not nearly as successful as his other logical works, however it does show that he was trying to develop a system of logic able to modally qualify propositions.

Chapter 6: Conclusion

Aristotle’s logical works, particularly his syllogistic, is the first serious attempt in history at an in depth theory of argumentation. Aristotle’s work on logic gives the impression that it still requires further study and logicians are still at work on it today. At the end of “ On Sophistical Refutations”, the final text of the Organon, Aristotle gives his own assessment of his work on logic and the Organon, which is given below:

“ And if it should seem to you after reflection that our study, arising out of these things from its beginning, compares well with our other inquiries which have been developed out of material handed down, then it remains incumbent on all of you our hearers to pardon its shortcomings and give much thanks for its discoveries.” [1, p. 65]

The above quote from Aristotle does seem to suggest that Aristotle himself knew that some parts of his work needed further exploration. However it was several centuries before his ideas were superseded.

Tradition logic, sometimes called term logic is the name for the type of logic which was influenced by Aristotle’s work. This traditional logic began to decline in Europe sometime between the 14th and 17th centuries. This was due mainly to the fact that Rodolphus Agricola Phrisius (1444-1485) and Petrus Ramus (1515-1572) began to promote their own ideas on logic, influenced by the stoics, called place logics [5]. However, traditional logic was still used in England until the 19th century.

During the 19th century, two mathematicians, George Boole and John Venn tried to make logic algebraic using many concepts of traditional logic [5]. Frege then introduced first-order predicate logic. Modern predicate logic then became the most influencial form of logic after Bertrand Russell and A. N. Whitehead, created Principia Mathematica (1910-1913), which is a comprehensive text on the foundations of mathematics inspired by Frege’s earlier work on predicate logic. Predicate logic was able to overcome problems such as explaining the inference from “ every cat is a mammal” to “ the owner of every cat is the owner of a mammal”. The above example is simple in predicate logic but cannot be explained in term logic, which is only able to use syllogistic arguments. As the popularity of predicate logic grew, the use of term logic declined.

However, predicate logic is not without its faults and some mathematicians have criticised it, saying that it is unnatural as its syntax is very different from the syntax we use in sentences that appear in our everyday language. They have also pointed out that it has theoretical problems, including empty names and identity statements. Therefore traditional logic, which was influenced by Aristotle’s logical works, still has quite a following today.