

Aristotle and Avicenna's Solution to Overcome the Limitation of Syllogism

Gholamreza Zakiani 

Associate Professor of Philosophy Department, Allameh Tabataba'i University, Tehran, Iran. E-mail: zakiani@atu.ac.ir

Article Info

ABSTRACT

Article type:

Research Article

Article history:

Received 11 November
2025

Received in revised form
01 May 2026

Accepted 10 May 2026

Published online 25
October 2026

Keywords:

Syllogism, the limitation
of syllogism, Aristotle,
Avicenna, Belonging,
Exceptive syllogism

Understanding syllogism requires recognizing its limitations and the First Teacher's strategies for overcoming them. Aristotle's syllogism, due to its conceptual focus, cannot address relational propositions. To escape this constraint, Aristotle resorted to the relational context (sīāq-e ta'alloqī), whereas Avicenna, due to his formalist perspective, could not adopt this approach. Therefore, he expanded the very concept of syllogism. Aristotle's '*Organon*' and Avicenna's 'The Book of Healing' (*al-Shifā'*) form the two primary texts of this study. Our method for analyzing these texts is critical and hermeneutic; that is, we directly examined the *Organon* and asked through a critical reading: Why does the First Teacher rely solely on relational context to present his three types of syllogism? With the same approach, we turned to Avicenna's syllogism and found that he, too, recognized the limitations of syllogism but could not utilize relational context because, influenced by Porphyry, he leaned toward formal syllogism. Thus, to overcome its limitations, he adopted Galen's method - expanding the definition of syllogism to include Stoic conditional reasoning. To escape the constraints of syllogism, Aristotle turned to relational context, while Avicenna expanded the meaning of syllogism and introduced the exceptional syllogism. Students of Aristotelian logic may become familiar with the different methods of these two great teachers for overcoming the limitations of syllogism and the reasons behind their divergence.

Cite this article: Zakiani, G. (2026). Aristotle and Avicenna's Solution to Overcome the Limitation of Syllogism. *Journal of Philosophical Investigations*, 20(56), 617-640. <https://doi.org/10.22034/jpiut.2026.70185.4327>



© The Author(s).

Publisher: University of Tabriz.

Introudoction

In all fields of research and science, reasoning plays a central role; that is, every science and research endeavor must utilize reasoning for its emergence, growth, and flourishing. Undoubtedly, one of the oldest foundations of reasoning is Aristotelian logic, which was established 23 centuries ago by the great Greek thinker Aristotle. Aristotle's logic holds universal credibility, to the extent that Kant in the eighteenth century considered it a complete science that requires no reform (kant, 1980, B VII).

Aristotle himself initially provides a general definition of syllogism, which encompasses any argument: "A syllogism is a discourse such that, if it is accepted, another proposition must be accepted due to the acceptance of that discourse." He also defined syllogism as a logical argument that applies deductive reasoning to make conclusions based on two or more propositions. Aristotle presented syllogism based on terms and concepts. This limited the realm of syllogism to its concepts and terms, depriving it of support from arguments containing relations (the constraint of syllogism). To address such an issue, the First Teacher employed the verb "to belong" and attempted to expand the scope of arguments encompassed by syllogism. This strategy of Aristotle has not only been scrutinized throughout history but has also failed to attract the attention of his students in both the East and West over time.

Avicenna, a prominent commentator on Aristotle, engaged with Aristotelian logic after 14 centuries in the Islamic world and wrote several books commenting on Aristotle's syllogism. He recognized the limited scope of syllogism but could not utilize the First Teacher's strategy - using the verb "to belong." Therefore, he resorted to Aristotle's original definition of syllogism (the general definition) and categorized conditional arguments under the title of exceptional syllogism in order to extend the realm of syllogism beyond terms and concepts. Taking the same approach, the author in this study believes that syllogism, due to its limited concepts and terms, cannot deal with the numerous arguments about existing relations. Such limitations have created predicaments in conceptualizing syllogism as well. Regarding solutions, Avicenna's tactic is proved to be more successful than that of Aristotle, yet this strategy also encountered problems. Interestingly, these same issues did not attract the attention of Aristotelian logicians. Therefore, the core problem that encouraged this study is that it is unclear how Aristotelian syllogism is limited in its capacity to produce new knowledge and how Avicenna attempted to address such constraint. Accordingly, in this article, the strategies of Aristotle and Avicenna for overcoming the constraints of syllogism will be discussed.

Background of the Study

Aristotle's logic has experienced extensive development among scholars in the East and West over the past 24 centuries. However, it has also confronted strong criticism from harsh critics. The criticisms concerning the limitations of syllogism became more serious when mathematical

logic, which was founded with Frege's *concept-script* book in 1879, developed in the twentieth century. The advanced language of mathematical logic was capable of analyzing formulas that had multi-place predicates and multiple quantifiers. In this logic, connectives such as conjunction, disjunction, and condition were well analyzed, and an argument could have more than two premises. The limitations of syllogism have always attracted the attention of logicians as listed below:

- 1) David Cycleback (2024), in his article entitled '*The Limitations of Human Logic*', discusses limitations such as binary thinking, detachment from social and cultural contexts, distancing from life experiences, and a lack of engagement with human feelings and emotions. (David cycleback, the-limits-of-human-logic <https://davidcycleback.com/2024/12/30>)
- 2) Mohammad Thabit Al-Fandi outlines the main limitations of Aristotelian syllogism in the fourth section of his book '*Principles of Mathematical Logic*' (Beirut, 1972) as what follows: Aristotelian syllogism does not encompass the conventional inferences found in mathematics. Aristotle assumed that all propositions have a subject-predicate form. He only encoded variables, not logical constants; the failure to utilize the method of the subject-predicate principle restricts him to demonstrative sciences. Due to the limitations of syllogism, Aristotle was unable to cover all the reasoning and rules used in the sciences. (Mohammed Thabit al-Fandi, *Principles of Mathematical Logic*, Dar al-Nahdhat al-Arabiya, Beirut, 1972)
- 3) Khalaf Nouria, in his article '*The Shortcomings of Aristotle's Logic from the Perspective of Symbolic Logic*', refers to the disregard for empty concepts and personal limits as among the shortcomings of Aristotle's logic. (Khalef Nouria, Alla Mokhtar, *Deficiencies of Aristotelian Logic from the Perspective of Symbolic Logic*, 2024. <https://psychologyandeducation.net/pae/index.php/pae/article/view/8264>)
- 4) Irving Copi and Carl Cohen, in their book '*Introduction to Logic*', describe the limitation of Aristotelian syllogism being confined to categorical propositions and its incapability to analyze conditional propositions. (Irving Copi & Carl Cohen, *Introduction to Logic*, Pearson Education Limited 2014)
- 5) Ibn Khaldun (808 AH) in his famous *Introduction* points out the failure of analogy in physics and theology. [*Introduction to Ibn Khaldun*, translated by Mohammad Parvin Gonabadi, Scientific and Cultural Publishing Company, 2014, pp. 1092-1096]

As can be seen, almost none of those who have pinpointed the limitations of Aristotelian syllogism have mentioned Aristotle's solution to escape such limitations. Also, no one has addressed why Avicenna could not use Aristotle's method to escape the limitation of syllogism. Moreover, nothing is said about why Avicenna had used Galen's method to escape the limitations of syllogism.

Methodology: Critical and Hermeneutic Approach

Aristotle's logic has often been regarded simply as the science of logic and has not been considered to require a deep and philosophical understanding. This has led to the negligence of some important aspects of logic in the works of the "First Teacher". The author has attempted, through a critical approach to the history of Aristotelian logic, to break free from common interpretations and to re-examine Aristotle's text closely. In this process, the following question became prominent:

- "Why does the First Teacher, in his introduction to the syllogism - chapters 4 to 6 of the first book of *Prior Analytics* - use only the verb 'to belong'?"

This is where a deep understanding of Aristotle's logic arose. The key to the matter for Aristotle was the "syllogism limitation". Since syllogism deals with terms and concepts, it could not address relations and conditionals. Hence, the First Teacher used the verb "to belong" in order to partly escape this limitation (B belongs to every A). To clarify further, he maintained "if M belongs to all N, but to no O, then N will belong to no O. For if M belongs to no O, O belongs to no M: but M (as was said) belongs to all N" (*Prior Analytics*, 27^a 10).

But why did Avicenna not use the verb "to belong" at all in his introduction to the syllogism? Ibn Sina could not use the verb "to belong" because, following Porphyry, he moved towards a form-based approach (every A is B). Therefore, the question arises: what strategy did Avicenna employ to overcome the problem of syllogism limitation? In this regard, Avicenna was influenced by Galen, who divided syllogism into three types: "conditional (Stoic), conjunctive (Aristotelian), and relational (mathematical)" (Buchenski, 105). Therefore, Avicenna categorized conditional syllogisms under the exceptional syllogism subclass within the division of syllogisms, thereby using this tactic to escape the constraint and limitation of the syllogism.

In conclusion, by adopting a critical perspective on the history of Aristotelian and Avicennian logic on one hand, and using an author-centered hermeneutic method and dialoguing with the text on the other, this hermeneutic understanding was achieved: both masters of logic employed different strategies to overcome the problem of the syllogism limitation; Aristotle used the strategy of the "verb to belong", while Avicenna used the strategy of "expanding the meaning of syllogism to include conditional reasoning".

The Origin of the Discussion of the Limitation of Syllogism

Is Logic a science or a tool? For Aristotle, the instrumental nature of logic was never in question, as he applied his syllogistic rules to various fields, including geometry, astronomy, as well as social and philosophical issues. Similarly, his followers in both the East and the West have made comparable efforts. Therefore, the more precise interpretation of the initial question is whether logic, beyond its instrumental function, also possesses a scientific function.

The importance of this question becomes clear when we want to determine the place of logic in the classification of sciences. Aristotle has two similar interpretations in his classification of sciences:

...all thought is either practical or productive or theoretical ([The Metaphysics, 1025^b25](#)).

...as in the case also of knowledge. This is classed as speculative, practical, and productive; and each of these denotes a relation: for it speculates upon something, and produces something and does something ([Topica, 145^a15-19](#)).

Evidently, Aristotle was concerned with the position of logic, using the term *constructive* or *productive* alongside *theoretical* and *practical* in both interpretations.

Al-Farabi also faced the same dilemma, as he wrote in his division of certain sciences:

Certain sciences are divided into three kinds: theoretical, practical, and logical. Theoretical science includes those things by which and through which true knowledge is obtained. Practical science includes happiness and everything that leads to the attainment of happiness... And logical science contains those things that use specific tools to extract the correct results from any science ([al-Mantiqiyyāt, Vol.1, 365, 414](#)).

He explicitly used the term "logical" instead of terms such as constructive or productive. This definition may remove the doubt that perhaps Aristotle did not mean logic by constructive or productive sciences! Al-Farabi writes elsewhere:

It may be thought by some that logic is a part of philosophy, because, after all, it deals with a kind of being. However, these objects are not discussed in terms of their existence, but rather in terms of their being tools for strengthening man's ability to know beings. ... Therefore, they are taken as something other than beings, namely as tools for knowing beings; hence it is not appropriate to consider logic as a part of philosophy but as an independent art and not as a part of another art; and it is neither a tool nor a part at the same time ([Utterances Employed in Logic, 107-108](#)).

Thus, Aristotle and al-Farabi explicitly emphasized the instrumentality of logic.

However, it seems that such a tripartite classification, theoretical, practical, and logical does not satisfy Avicenna. In *al-Šifā*, he endeavors to distinguish the existential and instrumental aspects of logic, thereby incorporating the existential aspect of logic into philosophy. He writes:

Also, you have been told in general terms how logic can be both a part of wisdom and a tool [of wisdom], and that there is no contradiction between counting it as a part and counting it as a tool. In fact, noting that the subject-

term of logic describes one kind of existing thing, and the name ‘philosophy’ applies to knowledge about any kind of existing thing, [it follows that] logic is a part of philosophy. It tells us the facts about some existing things, and how they are; its nature is to tell us how ideas that we didn’t know can be reached or specified by means of those existing things. Then to the extent that this status is specific to certain existing things, or is an essential accident or a constitutive feature of those things, logic is an investigation of certain kinds of fact about existing things, and hence it is one of the sciences. But in the second place this particular kind of knowledge about this particular kind of existing thing happens to be helpful for knowledge of other things; and so, this knowledge is not just a piece of knowledge, it is also a tool for [obtaining] another knowledge. In fact, one might say that the main purpose of logic is to be a helper towards another knowledge (*al-Šifā*, Logic, syllogism, 10-11).

Unlike the tripartite classification of Aristotle and al-Farabi, Avicenna puts in practice a binary division. In Avicenna's approach, several points are noteworthy: First, he has not demonstrated that, from the instrumental perspective, logic falls under practical wisdom¹ as neither the definition of practical wisdom includes logic, nor is logic mentioned among the types of practical wisdom. Secondly, he has emphasized that “the main purpose of logic is to be a helper towards other knowledge.” Thirdly, Avicenna's argument does not differ significantly from that of al-Farabi, and it appears that al-Farabi's view is sounder.

Therefore, Avicenna's binary division of philosophy in the Syllogism chapter of *al-Šifā* can be interpreted as a response to those who denied that logic is a science. In doing so, he sought to clarify the scientific nature of logic. Conversely, in the First Method of *Išārāt* (Remarks) on Logic, he begins with the following statement "Logic is intended to give the human being a canonical tool which, if attended to, preserves him from error in his thought" (117-118). This straightforward definition, which has become the standard among Muslim logicians, exclusively emphasizes the instrumental purpose of logic.

Thus, it becomes evident that the eminent logicians Aristotle, al-Farabi, and Avicenna uniformly regarded logic as an instrumental science. This raises a central question: If logic serves as a tool for various sciences, why can't syllogism be readily applied to all scientific fields? In other words, if all sciences require such a tool, logic or Aristotelian syllogism, why is it that the arguments from other sciences cannot be effortlessly reformulated into the structure of Aristotelian syllogisms?

¹"The wisdom pertaining to theoretical matters, which we comprehend but do not enact, is termed theoretical wisdom. Conversely, the wisdom concerning practical matters, which we both comprehend and enact, is termed practical wisdom. Each of these two forms of wisdom is further categorized into three subdivisions: the subdivisions of practical wisdom encompass civil wisdom, household wisdom, and ethical wisdom. The origin and the ultimate perfection of these three categories are derived from divine law" (*Uyūn al-Ḥikmah*, 17)

Aristotle's Solution to the Limitation of Syllogism

Aristotelian syllogism has three figures and fourteen moods¹. The most important feature of Aristotelian syllogism is that it deals with the relationship between terms, so it is inevitably focused on the relationship of inclusion between terms. The relationship of inclusion between two terms encompasses the four fundamental relationships: equivalence (mutual inclusion), opposition (complete mutual exclusion), complete inclusion, and partial inclusion, which later became recognized as the four relational types. The method for reflecting the four relations in language is through the four categorical propositions (universal and particular affirmatives, universal and particular negatives). This means that all possible states between the four mental relations can be expressed using the four categorical linguistic propositions. For instance, if, subjectively, A is universally related to B and B is particularly related to A, linguistically, it can be said: 'Every B is A'; 'Some A is B'; and 'Some A is not B'.

Two Important Points about the Four Categorical Propositions

There are two important points about the four categorical propositions that are both relevant to the main topic of this paper. Firstly, consider the following two sets of sentences:

- Sentences with *action* verbs: John writes. Jane does not run, and so on.
- Sentences with *to-be* verbs: John is a writer. Jane is not a runner, and so on.

In Aristotelian logic, sentences with action verbs have no place and must be converted into sentences with copula (*to-be*) verbs to apply Aristotelian syllogism to them. Now the question is, why are sentences with *copula* the axis of Aristotelian syllogism?² To address this question, it is essential to elucidate the emergence of Aristotelian metaphysics and its intrinsic relationship with his logical framework.

The foundation of philosophical research in ancient Greece began with Thales, who proposed that water is the essence of all things, and included concepts such as hyle (matter), numbers, and atoms (indivisible particles). Heraclitus, however, rejected the idea of any constant entity, asserting that everything is in a state of flux and change. This perspective contrasted sharply with Parmenides, who denied the existence of change altogether, and Socrates, who focused on ethics and general definitions. In response to Heraclitus, Plato introduced the world of Forms, aiming to reconcile the conflicting views. However, Aristotle found Plato's theories unsatisfactory. Aristotle analyzed the objects of the world into matter (potentiality) and form (actuality). Matter and form were unpredictable because they were not mental. Up to this point, Aristotle's art, like that of others, was philosophical and metaphysical.

¹ Indeed, Aristotle instead of using the terms 'valid' and 'invalid,' exclusively employs the term 'syllogism' for valid moods and does not consider invalid moods as syllogisms at all.

² The significance of this question becomes apparent when we recognize that Mathematical logic does not emphasize connective sentences. Therefore, in the case of Natural Language propositions, one of the forms of conjunction, disjunction, or conditional arises, and Propositional Logic is formulated.

From that time onward, he considered the mental portability of matter and form, leading to the concepts of genus and difference. Genus and difference are mental substances and definitional states which refer to concepts with extension; for example, intentional human has extensions such as John, Jane, etc.

The emphasis on matter and form in metaphysics paved the way for Aristotle to shift his focus towards concepts in logic. The relationship between concepts is one of inclusion. By considering the ratio of inclusion of two terms in the mind, one can discern relationships such as equivalence, opposition, complete inclusion, and partial inclusion. Furthermore, all these mental states are supported by the four categorical propositions. That is to say, the relationship of a term with its extensions is a singular proposition (John is a human), and the relationship of two terms with their extensions forms a quantified proposition (every human is animal, no human is a cow, some humans are men, some humans are not men).

A syllogism arises when the relationship between two terms is unclear. To clarify this relationship, we introduce a third term, called the middle term, which establishes a connection - whether through opposition, equivalence, complete inclusion, or partial inclusion - with the two original terms. That is, in a syllogism, the relationships among the three terms are assumed, and the way the middle term relates to the other two can generate three or four different figures. For example, if we need to determine the connection between two terms, A and Γ, that do not have an established relationship, we identify a third term, B, that relates to both A and Γ. This term, B, acts as the middle term.

Due to the emphasis on matter (genus) and form (difference), Aristotle marginalized propositions that use the copula (is and is not) as well as those with action verbs (such as goes, wrote, etc.). Additionally, a syllogism is formed by connecting three terms, which, when expressed in language, results in the four categorical propositions. Secondly, in Greek, there were two modes for expressing propositions: using the *copulas* (is/are) and using *to belong to*. Aristotle used both modes to express the four categorical propositions (Table 1).

Table 1. Aristotle's categorical propositions

	Copula mode	reference	To belong to mode	reference
Universal affirmative	Every A is B.	17 ^a 7	B belongs to all A.	25 ^a 17
Universal negative	No A is B.	17 ^b 7	B belongs to no A	25 ^a 16
Particular affirmative	Some A is B.	17 ^b 21	B belongs to some A.	25 ^a 18
Particular negative	Not every A is B.	17 ^b 20	B doesn't belong to some A.	25 ^a 25

Aristotle willfully ignored the copula (*to be*) when introduced his triadic figures. That is, he mainly focused and used *to belong to* in explaining each figure and its moods. So, he does not use the structure (every A is B) at all when introducing different figures. Let's take a look at some examples.

- **Barbara:** If A belongs to all B and B belongs to all Γ , then necessarily A belongs to all Γ . (25^a41)
- **Camestres:** If M belongs to all N but to no Ξ , then N belongs to no Ξ . (27^a11)
- **Darapti:** when both Π and P belong to all Σ , then necessarily Π belongs to some P. (28^a20)

Belonging to in Prior and Posterior Analytics

In the following part, we will discuss some arguments from Aristotle's *Organon*, as well as the *Prior and Posterior Analytics*. In these arguments, the terms differ from traditional Aristotelian terms, and the premises do not resemble categorical propositions. Instead, Aristotle attempts to rewrite them into syllogisms by expanding the concept of belonging.

- I:** "For example, let A be evil, B making war against neighbors, C Athenians against Thebans, D Thebans against Phocians. If then we wish to prove that to fight with the Thebans is an evil, we must assume that to fight against neighbors is an evil. Evidence of this is obtained from similar cases, e.g. that the war against the Phocians was an evil to the Thebans. Since then to fight against neighbors is an evil, and to fight against the Thebans is to fight against neighbors, it is clear that to fight against the Thebans is an evil. Now it is clear that B **belongs to** C and to D (for both are cases of making war upon one's neighbors) and that A belongs to D (for the war against the Phocians did not turn out well for the Thebans): but that A **belongs to** B will be proved through D." (69^a1-11)
- II:** "Let C be the planets, B not twinkling, A proximity. Then B **belongs to** C; for the planets do not twinkle. But A also **belongs to** B, since that which does not twinkle is near" (78^a32-35).
- III:** "Let Γ be the moon, A eclipse, B the fact that the moon fails to produce shadows though she is full and though no visible body intervenes between us and her. Then if B, failure to produce shadows in spite of the absence of an intervening body, **belongs A to** Γ , and eclipse, **belongs to** B, it is clear that the moon is eclipsed" (93^a38-93^b3).
- IV:** "Why does it thunder?' 'Because fire is quenched in the cloud', are equivalent. Let C be cloud, A thunder, B the quenching of fire. Then B **belongs to** C, cloud, since fire is quenched in it; and A, noise, **belongs to** B; and B is assuredly the definition of the major term A." (93^b9-12)
- V:** "Why did the Athenians become involved in the Persian war?' means 'What cause originated the waging of war against the Athenians?' and the answer is, 'Because they raided Sardis with the Eretrians', since this originated the war. Let A be war, B unprovoked raiding, C the Athenians. Then B, unprovoked raiding, **belongs to** C, the Athenians, and A **belongs to** B, since men make war on the unjust aggressor. So A, having war waged upon them, **belongs to** B, the initial aggressors, and B **belongs to** C, the Athenians, who were the aggressors." (94^a36-94^b6)

VI: "To ask the reason why one must walk after supper is precisely to ask to what end one must do it. Let C be walking after supper, B the non-regurgitation of food, A health. Then let walking after supper possess the property of preventing food from rising to the orifice of the stomach, and let this condition be healthy; since it seems that B, the non-regurgitation of food, **belongs to** C, taking a walk, and that A, health, **belongs to** B" (94^b9-17)

VII: "Assuming that the definition of ice is solidified water, let C be water, A solidified, B the middle, which is the cause, namely total failure of heat. Then B **belongs to** C, and A, solidification, to B" (95^a18-20).

VIII: "Let A be deciduous character, B the possession of broad leaves, C vine. Now if A **belongs to** B (for every broad-leaved plant is deciduous), and B to C (every vine possessing broad leaves); then A **belongs to** C (every vine is deciduous), and the middle term B is the cause" (98^a7-10).

Non-syllogistic Analysis of the Given Examples

Before we examine and analyze the examples mentioned, it's important to highlight a key point. By comparing the original Greek text with English translations, we see that Aristotle's translators have utilized *copula* mode, and phrases such as "is predicated," along with *belong-to* mode to better express the nuances of syllogism and deductive reasoning as articulated by Aristotle. While we cannot provide a definitive reason for this linguistic shift by Aristotle's translators, it can be inferred that they recognized the challenges Aristotle faced in using copula structures.

The eight examples mentioned above show that not all terms are definitional states, and not all propositions are expressed as quantified propositions. As a result, these arguments cannot be analyzed using Aristotelian syllogism. However, Aristotle himself tries to interpret such arguments in a syllogistic manner. To better understand Aristotle's shortcomings, it is helpful to compare his analyses with the following analyses, which are presented in the form of simple/conditional propositions.

I: Why is the war between Athens and Thebes evil? Because it is a war with neighbors, and beginning war with neighbors (such as the war between the Thebans and Phocians) is evil.

II: Why are the planets close? It is because they do not twinkle.

III: What is a lunar eclipse? When there is no intermediary, such as a cloud, between us and the moon and yet a full moon is not seen, a lunar eclipse has occurred.

IV: Why does a cloud produce thunder? It is because fire is extinguished in clouds.

V: Why did the Persians engage in war with the Athenians? Because the Athenians had previously invaded the Persian satrapy of Sardis with the help of the Eretrians.

VI: Why do people walk after dinner? Walking aids digestion, which in turn promotes good health.

VII: What is ice? Ice is solidified water because ice is water without heat, and water without heat is solidified.

VIII: Why do the leaves of a vine fall off? It is because the vine is a broad-leaved plant.

If we want to adhere to the criteria of the First Teacher in introducing the syllogism, we cannot analyze such arguments in a syllogistic way unless we use Aristotle's trick of using "belonging mode"! And it goes without saying that this trick is ineffective to the extent that it is used to escape the limitation of syllogism.

Aristotle and the Explanation of "to belong to" mode

In Chapter 36 of the first book of *Prior Analytics*, Aristotle himself discusses the broad meanings of "to belong to" when explaining:

That the first term belongs to the middle, and the middle to the extreme, must not be understood in the sense that they can always be predicated of one another or that the first term will be predicated of the middle in the same way as the middle is predicated of the last term. The same holds. Not belonging is the same. But we must suppose the verb 'to belong' to have as many meanings as the senses in which the verb 'to be' is used, and in which the assertion that a thing 'is' may be said to be true. Take for example the statement that there is a single science of contraries. Let A stand for 'there being a single science', and B for things which are contrary to one another. Then A belongs to B, not in the sense that contraries are the fact of there being a single science of them, but in the sense that it is true to say of the contraries that there is a single science of them. It happens sometimes that the first term is stated of the middle, but the middle is not stated of the third term, e.g. if wisdom is knowledge, and wisdom is of the good, the conclusion is that there is knowledge of the good. The good then is not knowledge, though wisdom is knowledge. Sometimes the middle term is stated of the third, but the first is not stated of the middle, e.g., if there is a science of everything that has a quality, or is a contrary, and the good both is a contrary and has a quality, the conclusion is that there is a science of the good, but the good is not science, nor is that which has a quality or is a contrary, though the good is both of these. Sometimes neither the first term is stated of the middle, nor the middle of the third, while the first is sometimes stated of the third, and sometimes not: e.g. if there is a genus of that of which there is a science, and if there is a science of the good, we conclude that there is a genus of the good. But nothing is predicated of anything. And if that of which there is a science is a genus,

and if there is a science of the good, we conclude that the good is a genus. The first term then is predicated of the extreme, but in the premises one thing is not stated of another. Not belonging is the same. For 'that does not belong to this' does not always mean that 'this is not that', but sometimes that 'this is not of that' or 'for that', e.g. 'there is not a motion of a motion or a becoming of a becoming, but there is a becoming of pleasure: so, pleasure is not a becoming.' Or again it may be said that there is a sign of laughter, but there is not a sign of a sign, consequently laughter is not a sign. This holds in the other cases too, in which the thesis is refuted because the genus is asserted in a particular way, in relation to the terms of the thesis. Again, take the inference 'opportunity is not the right time: for opportunity belongs to God, but the right time does not, since nothing is useful to God (*Prior Analytics*, 48^a40 & 48^b1-38).

As we can clearly observe in this crucial passage, Aristotle explicitly states that there is no necessary connection between "*to belong to /not to belong to*" (*belonging mode*) and "*being predicated / not being predicated*" (*copula mode*):

- A can sometimes belongs to B, meaning that A exists for Bs. For instance, there is a science for opposites.
- Sometimes the major term (A) is predicated on the middle term (B), but the middle term is not predicated on the minor term (Γ). For example, if wisdom is knowledge, and there is wisdom for good, then the conclusion follows: there is knowledge for good. Therefore, good is not knowledge, even though wisdom is knowledge.
- Sometimes the middle term (B) is predicated on the minor term (Γ), but the major term (A) is not predicated on the middle term (B). For example, if there is a science for every quality or every opposite, and good is both an opposite and a quality, then there is a science for good. However, good is not knowledge, and neither are quality or opposite knowledge, even though good possesses these determinations.
- Sometimes the major term (A) is not predicated on the middle term (B), and the middle term (B) is also not predicated on the minor term (Γ). For example, if there is a genus for everything that has a science, and there is a science for good, then there is a genus for good. But here, no predication has taken place.
- Sometimes the major term (A) is predicated on the middle term (B), and sometimes it is not. For instance, if there is a genus for everything that has a science, and there is a science for good, then good is a genus. Therefore, the major term (A) is predicated on the minor term (Γ), while the terms (in the premises) are not predicated on each other.

- There is a becoming for pleasure, but there is no becoming for becoming. Therefore, pleasure is not becoming. (Or, there is a sign for laughter, but there is no sign for sign. Therefore, laughter is not a sign.).
- Time is not an opportunity, because God has time, but does not have an opportunity.

In these cases, two possibilities emerge. The first possibility is that Aristotle considered these multiple and non-predicative meanings from the outset when he employed "*to belong to*" to introduce the forms of syllogism. If this is true, several questions can be raised:

- Why did Aristotle place such emphasis on the four categorical propositions in introducing the syllogism?

The main point is that the four categorical propositions have two fundamental characteristics: they are composed of terms, and they are quantified. However, in the examples mentioned earlier, there is no reference to terms or quantifiers. In other words, terms and quantifiers are two sides of the same coin. Quantifiers define the extent of the individuals represented by the terms— "all" and "no" indicate that the predicate includes all individuals of the subject, while "some" indicates that the predicate includes at least one individual of the subject. Therefore, if an argument does not use both a term and a quantifier, it will not adhere to the rules of syllogism.

Secondly, if the syllogism does not rely on the categorical proposition, the "rule of conversion" and "Ecthesis" (assumption) become irrelevant, as Aristotle's syllogism depends on these two fundamental rules.

Thirdly, almost the entire Aristotelian tradition, including the Avicennian tradition, has deviated from Aristotelian syllogism and understood it solely from a term perspective. For example, the rules of deduction, the conditions of distribution, and the Venn diagram, which are all designed based on categorical propositions (terms and quantifiers), need to be reconsidered.

Fourthly, if quantified propositions are not the foundation of syllogism, then "inclusion" cannot be considered a fundamental principle. As a result, the concepts of genus and differentia, as well as matter and form, cannot be regarded as the roots of syllogism. Therefore, the connection made in this paper between Aristotle's metaphysics and logic is not valid.

In support of the first case, one point worth noting is that Aristotle, in defining syllogism, states:

A syllogism is discourse in which, certain things being stated, something other than what is stated follows of necessity from their being so (24^b20)

This definition is broad and includes all types of arguments, even valid arguments in classical logic. However, when Aristotle discusses syllogism in chapters 4, 5, and 6 of the first book of *Prior Analytics*, he focuses solely on predicative syllogisms. These syllogisms involve

propositions, including terms, quantifiers, and middle terms. For example, in defining the first figure, he states:

Whenever three terms are so related to one another that the last is contained in the middle as in a whole, and the middle is either contained in, or excluded from, the first as in or from a whole, the extremes must be related by a perfect syllogism (25^b32).

The initial definition of syllogism is broader than just connective syllogism; it includes any form of reasoning. The other possibility is that Aristotle, in chapters 4, 5, and 6 of *Prior Analytics*, introduced the figures of syllogism primarily from a term perspective, focusing on quantified propositions. However, as he recognized the limitations of syllogism, he felt compelled to incorporate the concept of "to belong to" mode. This adjustment occurred while he was explaining the syllogisms but maintained a focus on categorical propositions. By doing this, he could leverage the flexibility of "to belong to" mode to address the shortcomings of syllogism. Given the negative consequences associated with the first possibility, this paper argues that the second possibility is more plausible.

Avicenna's Solution to the Limitation of Syllogism

Like Aristotle, Avicenna encountered the Limitation of syllogism. However, he was unable to use Aristotle's approach of employing the "to belong to" mode. Instead, Avicenna proposed an alternative solution. In the coming section, we first, elucidate why Avicenna could not adopt Aristotle's strategy and then outline his solution to the problem of syllogism.

Step 1: Why Couldn't Avicenna Deploy Aristotle's Strategy (to Belong to Mode) to Evade the Limitation of Syllogism?

Aristotle's *Organon* consisted of six books: *Categories*, *On Interpretation*, *Prior Analytics*, *Posterior Analytics*, *Topics* and *Sophistical Refutations*. In Aristotle's framework, *Categories* acts as a bridge between metaphysics and logic. The discussions of substance in metaphysics focus on the division of substance into abstract substances (intellect and soul) and material substances, which include matter, form, and body. These debates are primarily ontological. In contrast, *Categories* addresses substance from both an ontological and an epistemological perspective. It distinguishes between primary substances and secondary substances. The combination of primary and secondary substances forms singular propositions, while the interactions among secondary substances lead to quantified propositions.

The five universals (quinque voces), as independently presented in *Isagoge*, were not discussed by Aristotle in this manner. Instead, they were presented as the four predicables (definition, property, genus, and accident) in the *Posterior Analytics* and *Topics*. Consequently, the discussion of definition for Aristotle arose within the context of demonstrative and dialectical reasoning, and it was never presented as a couple (قسیم) of syllogism.

Porphyry a renowned student of Plotinus who had moved away from the Aristotelian atmosphere, which was heavily influenced by Sophistic discourse. Thereupon, he did not find it necessary to stress the ontological aspect of the categories (primary and secondary substances) in his introduction to *Categories*. As a result, he began his work, *Isagoge*, with the following thoughts:

I shall put aside the investigation of certain profound questions concerning genera and species, since such an undertaking requires more detailed examination: (1) whether genera or species exist in themselves or reside in mere concepts alone (2) whether, if they exist, they are corporeal or incorporeal; and (3) whether they exist apart or in sense objects and in dependence on them. Instead, I shall try to make clear to you how in logic the ancients, and especially the Peripatetics, dealt with genus, difference, and the rest (*Isagoge*, 9-16).

Therefore, Porphyry dedicated all his efforts to extracting the five universals (*quinque voces*) from Aristotle's other works, classifying, and introducing them. This effort resulted in two outcomes: one negative and one positive.

- Negative Result: Elimination of the categories from Aristotle's logic and making syllogism more formal.
- Positive Result: The importance of the discussion of definition to the extent of syllogism.

Both outcomes of Porphyry's efforts were fulfilled by Avicenna. That is, Avicenna not only removed the section on categories from logic in his groundbreaking book *Iṣārāt* (*Remarks*) along with Dialectics, Rhetoric, and Poetics, but even in *al-Šifā*, where he explained Aristotle's categories, he began by stating:

Teaching categories in logic is neither necessary nor even somewhat essential... Lack of knowledge about these categories does not impede the understanding of logic... The founder of this discipline mentioned categories not to teach them, but rather to serve as a reference. ...Introducing this topic at the beginning of a logic course can be more harmful than beneficial. Some readers may become confused, developing misconceptions that the text does not adequately address. This can lead to unrealistic beliefs and entanglement in styles and methods that distract their minds, resulting in the imprinting of inappropriate ideas that would not occur without the influence of the categories (*al-Šifā*, *Categories*, 4-8).

Therefore, even in *al-Šifā*, Avicenna did not consider the categories to be part of logic. So he clearly in the discussion above emphasized that “the founder of this discipline mentioned

categories not to teach them, but rather to serve as a reference... Therefore, we follow his common method” (*al-Šifā, Categories*, 8)

As it mentioned before the ontological discussions of *Organon* were presented in *Categories* to secure the connection between logic and metaphysics. Now, with the removal of the categories, logic apparently has been freed from the constraints of metaphysics and has practically moved towards becoming more formal¹.

Moreover, Porphyry's efforts to study the five universals independently led to an expanded discussion on the topic of definition. This elevated the discussion from being a marginal aspect of debates on demonstration and dialectic to becoming a significant part of syllogism. Before Avicenna, Aristotelian logic was primarily focused on syllogism, with discussions of definitions treated as secondary to demonstration and dialectic. By introducing the five universals - genus, species, differentia, general accident, and property - within his work, the *Isagoge*, Porphyry laid the groundwork for a more independent inquiry of definitions, including both term (Hadd) and description (Rasm).

Despite considering logic as an instrument to detect the error of thought (*Iḥṣā' al-'Ulūm*, 28-32) and dividing knowledge into two types, conception and assertion (*al-Mantiqīyyāt*, vol. 1, 266), al-Farabi did not establish a clear distinction between definition and argument in logic. This task was accomplished by Avicenna, who asserted that logic serves as the error detector of thought. Thought is either conception or assertion; both conceptions and assertions are subject to error; therefore, logic corrects the error of conceptions (the definition) and the error of assertions (the argument); with this description, logic has two parts: definition and argument. It was here that the definition section rose from the margin of demonstration and dialectic to the extent of a couple (قسیم) of syllogism. This tradition has remained until today.

The Reason for Avicenna's Adoption of a More Formal Approach to Syllogism

Following his departure from the Aristotelian metaphysical constraints in logic, facilitated by Porphyry's mediation, Avicenna endeavored to establish logic as an instrumental tool for the sciences. This objective necessitated an autonomous and formalized approach to logic, requiring its neutrality with respect to other scientific disciplines to effectively serve them. Consequently, as an initial measure, he removed the *to belong to* mode from Aristotelian syllogisms, ensuring that only variables (A, B, etc.) and logical constants (all, some, is, is not) were present, devoid of any substantive terms (such as 'belongs to,' 'is included,' 'is predicated on,' etc.). By doing so, he transitioned from Syllogism I to Syllogism II:

¹ Avicenna's crucial strategy of distinguishing Aristotle's logic from his metaphysics had a significant impact on the field of logic. One of the remarkable historical influences was that the renowned jurist Al-Ghazali (1058-1111), 60 years after Avicenna, although he vehemently opposed Aristotelian metaphysics in his book *Tahāfut al-Falāsifa* (*Incoherence of the Philosophers*), authored four books in support and promotion of Aristotelian logic: *Mahak al-nazar* (*Touchstone of Reasoning*), *Miyar al-ilm* (*Criterion of Knowledge*), *al-Qistas al-mustaqim* (*The Correct Balance*), and one section of *Maqasid al-falasifa* (*The Aims of Philosophers*).

- Syllogism I: If B belongs to All A and A belongs to All C, then B belongs to All C.
- Syllogism II: All C is A, all A is B; therefore, all C is B.

This analysis by Avicenna advanced Aristotelian syllogism several steps towards greater formality:

- I. The verb "*to belong to*" was eliminated and replaced with direct use of the *copula* mode (is/are and is not/are not).
- II. With the presence of the verb "*to belong to*," the middle term was not formally prominent, but in the *copula* mode, the middle term became formally prominent.
- III. With the formalization of the middle term, its positioning within the two premises was systematically redefined, establishing it as a defining characteristic of the syllogism. (Being the predicate in the one premise and the subject in the other, being the predicate in both premises, and being the subject in both premises, etc.)
- IV. The placement of the middle term within the premises determined the importance of the order of the premises in Avicennian syllogism (first the minor premise, then the major premise).
- V. When the order of the premises is crucial due to the placement of the middle term, the assumption of the fourth figure becomes quite natural. Specifically, the middle term can be positioned as the predicate in the minor premise and the subject in the major premise, contrary to its placement in the first figure.
- VI. In formal syllogism as presented by Avicenna, the principle of equality is considered a major problem, and logicians must strive to refer this self-evident principle to Aristotelian syllogism at all costs. However, in the "*to belong to*" mode, there is no difference between the principle of equality and Barbara¹.

So far, it has become evident that, due to the predominance of formalism in Avicenna's logic, he could not employ the "*to belong to*" mode; consequently, he resorted to an alternative strategy.

Step 2: Avicenna's Solution to Overcome the Limitation of Syllogism

In order to expand the scope of syllogism, Avicenna broadened its definition to encompass conditional arguments (under the title of exceptive syllogism). This general response can be explained with the following points:

In an effort to expand the scope of syllogism, Avicenna extended its definition to include conditional arguments, which he categorized under exceptive syllogism (*istitnāi*). This comprehensive approach can be elucidated through the following points:

¹ This topic has been discussed elsewhere: [See: Logical Essays, The Secret of the Evidentiality of the First Form]

The Stoics appear to have been the first to systematize conditional arguments. Chrysippus's famous formulation of five indemonstrable principles of argumentation is as follows (Kneale & Kneale, 1971, 163):

1. If the first, then the second; but the first; therefore, the second.
2. If the first, then the second; but not the second; therefore, not the first.
3. Not both the first and the second; but the first; therefore, not the second.
4. Either the first or the second; but the first; therefore, not the second.
5. Either the first or the second; but not the second; therefore, the first.

Principle 1 corresponds to Modus Ponens, and Principle 2 aligns with Modus Tollens. Principle 4 represents disjunction elimination with exclusive disjunction, while Principle 5 denotes disjunction elimination with inclusive disjunction. Principle 3, in fact, signifies disjunction elimination with inclusive disjunction, with the added clarification that the disjunction has been converted into a conjunction, and the rule has been applied to the conjunction. Given that any disjunction can be transformed into a conditional, all the Stoic rules can be categorized under conditional argumentation.

Indeed, it appears that Galen was the first logician to incorporate Stoic conditional syllogisms as a couple of connective syllogisms. According to Bochenski (1953, 105), Galen delineated syllogisms into three distinct categories: hypothetical, categorical, and relative. The profound influence and dominance of Aristotle are evident in Galen's inclusion of Stoic conditional arguments under the broader classification of syllogisms, specifically as a subdivision of Aristotelian connective syllogisms. Galen's conceptualization of relative syllogisms encompasses principles such as the principle of equality, recognizing that it need not be confined to connective syllogism.

Al-Farabi was the pioneering Muslim logician who classified syllogisms into two distinct categories: predicative and conditional (*al-Mantiqiyyāt*, vol. 1, 125). Evidently, al-Farabi did not accord an independent status to principles such as the principle of equality. Unlike Galen, he did not refer to such principles as a subdivision within predicative and conditional syllogisms. Consequently, the principle of equality must be subsumed under one of these two primary categories.

Al-Farabi posited that a conditional syllogism comprises two premises: a conditional major premise and a predicative minor premise, accompanied by an exceptive particle such as "except that," "unless," or "but," among others. Notably, al-Farabi consistently employed the verb "except" to elucidate conditional syllogisms (*al-Mantiqiyyāt*, vol. 1, 166-169, 452, 480- 484), and he also referenced the term "exceptions" on one occasion (*al-Mantiqiyyāt*, 286). Al-Farabi identified two types of conditionals: conjunctive and disjunctive (*al-Mantiqiyyāt*, 137-139). He did not regard disjunctive propositions as independent entities, instead, he considered them reducible to conjunctive propositions. As a result, he classified both conjunctive and disjunctive propositions under the broader category of conditional syllogisms.

Avicenna and Conditional-Connective Syllogisms

Avicenna was profoundly influenced by Aristotle and did not conceal his intellectual debt. After referencing Aristotle's apology for potential errors in syllogistic reasoning, he proceeds to write: O students and scholars of science! Ponder the words of this great man: Has anyone emerged after more than 13 centuries to reveal his shortcomings or expose his errors? Has anyone been able to add anything to his logic? Never! What the First Teacher has done is complete and perfect. This achievement belongs entirely to him and has been denied to others.” (*al-Šifā, al-Manteq, Alsafsate*, 114)

We can also see this influence in Avicenna's establishment of Conditional-Connective syllogisms:

We say: What you learned of the affirmative, the negative, the universal, and the particular, will help you to know the contradictory, the contrary, the subcontrary and the subaltern. There is no need to start again teaching you all this. For, in these cases, what applies to predicative propositions applies also to conditional propositions. (*al-Šifā, Logic, syllogism*; 362).

Accordingly, Avicenna endeavored to use sentences in place of syllogistic terms to construct the same four figures of connective syllogisms (Table 2). In determining the quantifier, he recognized that within connective syllogisms, the quantifiers pertained to the general term, thereby specifying the number of individuals referenced by the proposition. It becomes evident that when a sentence replaces a term, the quantifier can no longer refer to the individuals within that sentence. So, Avicenna adopted temporal quantifiers and validated the following propositions.

Table 2. *Avicenna's figures of connective syllogisms*

Quarter quantifieds	Predicative	Conditional
Universal affirmative	Every A is B.	Always, when A is B, then C is D.
Universal negative	No A is B.	Never, when A is B, then C is D.
Particular affirmative	Some A is B.	Sometimes, when A is B, then C is D.
Particular negative	Not every A is B.	Not always, when A is B, then C is D.

And as Avicenna said, he applied all the rules of propositions to this category of conditionals; for example, he reconstructed the second mode of the second figure as follows: (*al-Šifā; Syllogism*: 300)

Always, when A is B, then C is D.

Never, when M is N, then C is D.

Therefore, Never, when A is B, then M is N.

He further asserted that he independently derived these types of syllogisms over an eighteen-year researching, without recourse to any written texts (*al-Šifā, Logic, syllogism*; 256).

Avicenna and Exceptive Syllogisms

Avicenna, who pioneered the aforementioned syllogisms, designated them as "Conditional-Connective Syllogisms" within his nomenclature. This implies that he attributed the term "conditional" to this particular type of syllogism. Therefore, when he encountered the Stoic conditional arguments, he undertook two specific actions.

Firstly, he refrained from labeling them as conditional, as he believed the previously mentioned connective syllogisms, which he had developed, merited this designation. Thus, he adopted the term "exceptive," frequently used by al-Farabi, and stated: "The majority have widely termed conditional, but I do not call them conditional; rather, I call them exceptive because some conditionals are connective" (*al-Šifā, Logic, syllogism; 106*).

Secondly, he incorporated this same exceptive type within the broader category of syllogism. In doing so, he redefined syllogism to encompass these exceptive types. In *al-Šifā*, 389, he stated: We say: The difference between the exceptive and the conjunctive [connective] syllogism is that the premises in the exceptive syllogism actually contain either the conclusion or its contradictory; while the premises of the conjunctive syllogism contain them potentially - as when we say:

Every man is an animal,
and every animal is a body,
therefore, every man is a body.

In this conjunctive syllogism neither the conclusion nor its contradictory are actually stated in the premises. But when we say:

If man is an animal, then he is a body,
but man is an animal,
therefore, man is a body."

He also wrote in *Remarks*:

The syllogism, as has been determined by us, is of two kinds, conjunctive [connective] and repetitive [exceptive]. The conjunctive syllogism is one in which there is no explicit mention of either one of the extreme contradictories, incorporating the conclusion. Rather, it has this in potentiality only as the abovementioned example shows. As for the repetitive syllogism, it is one in which there is an explicit mention of that. As for the majority of logicians, they have paid attention to predicative syllogisms only, thinking that conditional syllogisms can only be repetitive. We will mention predicative syllogisms with their various types. This will be followed by [a discussion of] some conditional conjunctive syllogisms (*Ibn Sīnā, 1984, Chapter Two*).

Thus, it is evident that Avicenna undertook two significant actions simultaneously to navigate beyond the constraints of syllogism. First, he reclassified the Stoic arguments—which Galen

had previously categorized under predicative [connective] syllogism and which al-Farabi had termed 'exceptive,' although both had labeled them as conditional syllogisms—as '*exceptive syllogisms*,' arguing that the term 'conditional' should be reserved for conditional-connective syllogisms. Second, through his unique definition, Avicenna integrated this 'exceptive syllogism' as a couple of connective syllogisms.

Analysis of Avicenna's Trick

1. Avicenna's analysis of the types of syllogism—where the conclusion or its contradictory is explicitly stated in the premises (exceptive) or not stated (connective)—is his innovation. This approach is preferred over the methods of Galen and al-Farabi because their surviving works do not explain why they classified Stoic arguments as a couple of Aristotelian syllogisms. However, Avicenna, using this criterion, clarifies the reason for this division.
2. Avicenna's classification of syllogisms serves an additional purpose: it clarifies a distinction in the conclusions of connective and exceptive syllogisms. In exceptive syllogisms, the conclusion or its contradictory is explicitly stated within the premises, whereas, in connective syllogisms, the conclusion or its contradictory is not expressly indicated. Nonetheless, this classification does not offer any insight into the constructive aspects of connective or exceptive syllogisms. Thus, this classification of syllogism into connective and exceptive has no other practicality than to classify Stoic arguments as exceptive syllogisms, making them a subset of syllogism and a couple of connective syllogisms.
3. The term 'exceptive syllogism' was implicitly introduced by al-Farabi as 'exceptions' in *al-Mantiqiyyāt* (vol. 1, 286). This term, however, obscures the significant and unparalleled role of these types of arguments¹. Furthermore, rules such as Modus Ponens and Modus Tollens, which resemble innate principles of reasoning, have been consistently employed in argumentation². To verify a proposition, individuals identify and affirm its necessary conditions. Conversely (Modus Ponens), to refute a proposition, they identify and eliminate its refutable conditions (Modus Tollens). In this context, the Stoics' contribution to the formulation of rules like Modus Ponens and Modus Tollens was one of discovery rather than invention. These rules are not subject to stipulation or convention³. Hence, it is unsurprising that both Aristotle and Frege used these rules extensively in establishing their logical systems.

Statistical analysis indicates that over 90% of arguments are classified as exceptive syllogisms, with less than 10% classified as connective syllogisms. Consequently, the

¹ We have explained this important issue elsewhere. (Logical Essays, pp. 175 onwards)

² Zakiani. Gh, The art of reasoning, Introduction and Chapter Three.

³ Zakiani. Gh, Logical Essays, Articles 8 and 9

instrumental dimension of logic is predominantly supported by these innate arguments. However, in the Avicennian tradition, despite the inclusion of exceptive syllogisms rules as a couple of connective syllogisms, they constitute less than 10% of the content in educational texts in terms of pedagogical focus. As a result, it is improbable that students of Avicennian logic will develop skills such as discovery, analysis, criticism, and argumentation.

The predominance of exceptive syllogisms can be attributed to factors extending beyond Avicenna's classification. Basic arguments such as Modus Ponens, Modus Tollens, and Disjunctive arguments, along with their various combinations, constitute nearly 90% of all arguments. Such arguments have been explained elsewhere - especially in the third chapter of *The Art of Reasoning*- by the same author.

An Explanation on Instrumental or Scientific Nature of Logic

The scientific or instrumental nature of logic, akin to many epistemological dualities, can be referenced along a spectrum where only the extremes negate each other. However, within the spectrum, there are varying degrees where the acceptance of one aspect does not necessarily entail the denial of the other. For instance, some consider logic to be 80% science and 20% tool, while others regard it as 50% science and 50% tool, and so on.

The critical point is that individuals' inclinations toward various positions on this spectrum are not based on rational or argumentative grounds but rather pre-logical factors. These positions are shaped by a myriad of genetic, educational, environmental, political, and scientific influences, which subsequently inform their personal and professional lives. Naturally, people endeavor to appear logical to avoid seeming irrational. For this reason, we engage in numerous debates, the outcomes of which are often predetermined, as neither side is willing to relinquish its stance. This inflexibility arises because their positions were not formulated through reasoning and, thus, cannot be easily altered through reasoning.

Results

1. The Aristotelian syllogism, due to centrality of concepts and terms, could not deal with conditional statements and mathematical relationships; therefore, it remained in the limits of concepts.
2. Aristotle was the first to recognize the limitation and narrowness of syllogism.
3. The First Teacher (Aristotle) attempted to escape this significant limitation by using a belonging structure (B belongs to every A) instead of a categorical structure (every A is B), in order to move beyond the narrow circle of concepts.
4. This effort by Aristotle was not accepted or followed by his students and commentators.
5. Galen, in the second century AD, considered syllogism to include categorical, conditional, and conjunctive propositions in order to overcome this limitation.

6. Porphyry, in his book written as an introduction to the Categories (Isagoge), extracted the five universals (genus, species, differentia, property, and accident) from the books of the *Topics* and the *Posterior Analytics*, and gave identity to the discussion of definition alongside syllogism, thereby moving Aristotelian syllogism a step towards formalization.
7. Although Avicenna, in the book of "Healing" (*shefa*) elaborated on the six books of the Organon, namely *Categories*, *Interpretation*, *Syllogism*, *Demonstration*, *Dialectic*, and *Sophistical Refutations*, And three books that were later added to the Organon, namely *Isagoge*, *Rhetoric* and *Poetry*, in the book of "Remarks" (*esharat*) under the influence of Porphyry he set aside the non-formal dimensions of Aristotle's syllogism - such as *Categories*, *Dialectic*, *Rhetoric*, *Poetry*, and the use of belonging structure for analyzing propositions. As a result, he could not utilize Aristotle's trick to escape the limitations of syllogism.
8. To free himself from the limitations of syllogism, Avicenna resorted to Galen's trick - through the division of syllogism for deductive, conditional, and relative arguments - and categorized Stoic arguments under the title of exceptional syllogism within his definition of syllogism.
9. Therefore, both these great teachers of syllogistic logic became aware of the constraints of syllogism, and both endeavored to free themselves from this limitation: Aristotle resorted to the analysis of logical propositions through belonging structure, while Avicenna, who could not turn to belonging structure due to his formalism, expanded the meaning of syllogism under the influence of Galen in order to categorize Stoic conditional arguments as exceptional syllogisms within the framework of Aristotelian syllogism.
10. In sum, to escape the constraints of syllogism, Aristotle turned to the analysis of propositions, while Avicenna resorted to the expansion of meaning in syllogism.

Discussion and Conclusion

Both Aristotle and Avicenna were aware of the limitations inherent in syllogism; however, each adopted distinct strategies to get rid of such constraints. Aristotle used the "belonging mode" to expand the scope of syllogism. In contrast, Avicenna, influenced by Porphyry's emphasis on formalism, was unable to employ Aristotle's approach. Instead, he drew upon Galen's methodology, which allowed him to expand the domain of syllogism to incorporate stoic arguments, later calling them "exceptional syllogism". Regarding the constraints of syllogism, logicians such as Aristotle and Avicenna were aware that syllogism pertains only to categorical propositions and concepts with specific instances - namely, concepts that could either be included in or excluded from other concepts. In other words, the "inclusion of concepts" was a fundamental element of syllogism.

However, with respect to solutions, it seems that no logician has previously examined the strategies proposed by the First Teacher and Avicenna with due diligence. This article presents,

for the first time, a deep analysis of Aristotle's strategy, specifically the use of the relational framework. By drawing on scientific evidence from Aristotle's '*Organon*', the author revealed how Aristotle had used 'relational' to deal with the limitations imposed by terms and concepts. Avicenna's strategy - extending the meaning of syllogism to include Stoic reasoning - has been employed by logicians but has not been critically analyzed in terms of overcoming the limitation of syllogism. The most significant ambiguity resolved in this research pertains to why Aristotle insists on employing "belonging mode" instead of "Copula mode" in Chapters Four to Six of the first book on syllogism. The most significant remaining question is why, despite being familiar with conditional arguments and employing them frequently, Aristotle did not formally introduce them himself. All the proposals made regarding this issue are mainly speculative.

Therefore, if one believes in the spectrum of formalism, Aristotle's perspective on syllogism appears to possess fewer formal dimensions compared to that of Avicenna.

References

- al-Fārābī. (1986). *Kitāb al-alfāz al-musta'malah fī al-mantiq* [Utterances employed in logic] (M. Mahdī, Ed.). Dār al-Mashriq.
- al-Fārābī. (1987). *Al-Manṭiqiyyāt* (M. T. Dāneshpazhūh, Ed.). Kitābkhāneh-ye Āyatollāh al-'Uzmā Mar'ashī Najafī.
- al-Fārābī. (1996). *Iḥṣā' al-'ulūm* ('A. Bū Mulḥim, Ed.). Dār wa-Maktabat al-Hilāl.
- Al-e-Yassin, J. (1984). *al-Fārābī fī ḥudūdihi wa rusūmihi*. 'Ālam al-Kutub.
- Aristotle. (1924). *Metaphysics* (W. D. Ross, Trans.). Oxford University Press.
- Aristotle. (1952). *Prior and posterior analytics*. In W. D. Ross (Ed.), *The works of Aristotle translated into English*. The Clarendon Press.
- Bochenski, I. M. (1951). *Ancient formal logic*. North-Holland Publication Company.
- Copi, I. M., & Cohen, C. (2014). *Introduction to logic*. Pearson Education Limited.
- Cycleback, D. (2024, December 30). *The limits of human logic*. <https://davidcycleback.com/2024/12/30>
- Ibn Khaldūn. (2014). *Introduction* (M. Parvin Gonabadi, Trans.). Scientific and Cultural Publishing Company. (In Persian)
- Ibn Sīnā [Avicenna]. (1973). *The propositional logic of Avicenna: A translation from al-Shifā': al-Qiyās* (N. Shehaby, Trans.). D. Reidel Publishing Company.
- Ibn Sīnā [Avicenna]. (1984). *Remarks and admonitions: Part one: Logic* (S. C. Inati, Trans.). Pontifical Institute of Mediaeval Studies.
- Ibn Sīnā [Avicenna]. (2016). *Al-Shifā': al-Qiyās* (W. Hodges, Trans.). Online publishing.
- Kant, I. (1980). *Critique of pure reason*.
- Khalef Nouria, & Alla Mokhtar. (2024). Deficiencies of Aristotelian logic from the perspective of symbolic logic. *Psychology and Education Journal*. <http://psychologyandeducation.net/pae/index.php/pae/article/view/8264>
- Kneale, W., & Kneale, M. (1971). *The development of logic*. The Clarendon Press.
- Porphyry the Phoenician. (1975). *Isagoge* (E. W. Warren, Trans.). Pontifical Institute of Mediaeval Studies.
- Thabit al-Fandi, M. (1972). *Principles of mathematical logic* (Uṣūl al-mantiq al-riyāḍī). Dār al-Nahḍat al-'Arabīya.
- Zakiani, G. R. (2007). *The art of reasoning*. Ruyesheno Publication.
- Zakiani, G. R. (2021). *Logical essays*. Taha Publication.