sciendo

studia humana
QUARTERLY JOURNAL

Studia Humana
Volume 9:1 (2020), pp. 19—27
DOI: 10.2478/sh-2020-0004

Theory of Syllogisms with Categorical, Conditional and Disjunctive Connectives Developed by Arabian Logicians

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Abstract: In this paper, we are trying to summarize the peak of achievement of the Arabian logicians of the fifteenth century by making a classification and sketching in familiar terms the conditional and subjunctive syllogisms in Muḥammad Ibn Yusūf al-SSinūsī's (1426-1490) work, i.e. in his explanation of *Kitāb al-Muḫtaṣar fī al-Manṭiq* of al-Imām Muḥammad Ibn ʿArafa (1316-1401).
Keywords: Syllogism, Ibn Yusūf al-SSinūsī's, categorical syllogism, conditional syllogism, Muḥammad Ibn ʿArafa, conditional connectives, Arabian logicians, Šarḥ al-Muḫtaṣar.

1. Introduction

The ancient Arabian logicians knew and developed a form of deduction of which neither Aristotle nor the Stoics had an idea about [2, p. 06], i.e. the theory of syllogisms with conditional and disjunctive connectives that they subsumed under five categories and had its completion in Muḥammad Ibn Yusūf al-SSinūsī's (1426-1490) work, i.e. in his explanation of *Kitāb al-Muḫtaṣar fī al-Manṭiq* of al-Imām Muḥammad Ibn ʿArafa (1316-1401).

In fact, Muḥammad Ibn ʿArafa summarized in his book *al-Muḫtaṣar* the discoveries of Ibn Sīnā (980-1037) in his *al-Šifā*, and Naǧm al-Dīn al-Ḫaṭīb (1203-1277) in his *al-Risālā al-Šamsīyya*, and Sirağ al-Dīn al-ʾArmāūī (1198-1283) in his *Maṭālieʿ al-ʾAnwār fī al-Manṭiq* [2, p. 6]. This book, i.e. *al-Muḫtaṣar*, was explained by Muhammad Ibn Yūsuf al-SSinūsī in the last book of his work *Šarḥ al-Muḫtaṣar* [3, pp. 380-381]. We will not, in this paper, trace that development exactly,

instead we will organize, classify and reformulate these syllogisms as they are found in al-SSinūsī's work (*Šarḥ*) as the last form we have had from the ancient Arabian logicians concerning syllogism, keeping in mind that we will put these syllogisms in more readable and familiar form.

The syllogisms that we point out below – in this work – could be subsumed under five categories: conditionals, with two disjunctives, categorical-conditional syllogisms, categorical-disjunctive syllogisms and disjunctive-conditional syllogisms. They are displayed one after another in Section 1, 2, 3, 4, 5, respectively.

2. The First Category: Conditionals

The first category of our syllogisms contains syllogisms that have two premises with conditional connectives having as a common component through its figures: (1) the antecedent of the major premise which is the consequent of the minor premise (the first figure), (2) the consequent of the two premises (the second figure), (3) the antecedent of the two premises (the third figure), or (4) the consequent of the major premise which is the antecedent of the minor premise (the fourth figure).

The components of these complex premises (and of course the components of premises of the other categories to come) are treated as if they be terms of the simple premises of categorical syllogisms, while the common propositions, i.e. those antecedent or consequent, play the role of the middle term of categorical syllogisms. Thus; the syllogisms with conditional connectives are governed by the same rules that govern categorical syllogisms. I shall now sketch these syllogisms with conditional connectives, i.e. syllogisms which have two premises with conditional connectives and a conditional conclusion [2, p. 11].

All the syllogisms are defined by their examples, using a metavariable *x* to denote some objects for inferring some properties about them.

First Figure

BARBARA
Whenever *x* is an animal it is mortal, and whenever *x* is human it is an animal, therefore, whenever *x* is human it is mortal.

CELARENT
Not everything if *x* is a mammal it is a fish, and whenever *x* is a dolphin it is a mammal, therefore, not everything if *x* is a dolphin, it is a fish.

DARRII
Whenever *x* is flying it is winged, and it can happen that if *x* is a mammal it is flying, therefore, it can happen that if *x* is a mammal it is winged.

FERIO
Not everything if *x* is a ruminant it is a carnivore, and it can happen that if *x* is a mammal it is a ruminant, therefore, it cannot happen that if *x* is a mammal it is a carnivore.

Second Figure [1, p. 379]

CESARE
Not everything that if *x* is a carnivore it is herbivore and whenever that *x* is a sheep it is herbivore, therefore, not everything that if *x* is a sheep it is a carnivore.

CAMESTRES
Whenever *x* is carnivorous it is a predator, and not everything that if *x* is a sheep it is a predator, therefore, not everything that if *x* is a sheep it is a carnivore.

FESTINO
Not everything that if *x* is a carnivore it is herbivore, it can happen that if *x* is a mammal it is a herbivore, therefore, it cannot happen that if *x* is a mammal it is a carnivore.

BAROCO
Whenever *x* is a carnivore it is a predator, and it cannot happen that if *x* is a mammal it is a predator, therefore, it cannot happen that if *x* is a mammal it is a carnivore.

Third Figure [1, p. 384]

DARAPTI
Whenever *x* is a lion it is a carnivore and whenever *x* is a lion it is a mammal, therefore, it can happen that if *x* is a mammal it is a carnivore.

FELAPTON
Not everything that is *x* is a camel it is a carnivore, and whenever *x* is a camel it is herbivore, therefore, it cannot happen that if *x* is herbivore it is a carnivore.

DATISI
Whenever *x* is a carnivore it is a predator, and it can happen that *x* is a carnivore it is a mammal, therefore, it can happen that *x* is a mammal it is a predator.

DISAMIS
It can happen that if *x* is a mammal it is a carnivore, and whenever that *x* is a mammal it is a vertebrate, therefore, it can happen that if *x* is a vertebrate, it is a carnivore.

FERISON
Not everything that if *x* is a fish it is a mammal, and it can happen that if *x* is a fish it is a predator, therefore, it can happen that if *x* is a predator it is a mammal.

BOCARDO
It cannot happen that if *x* is a mammal it is a carnivore, and whenever *x* is a mammal it is a vertebrate, therefore, it cannot happen that if *x* is vertebrate it is carnivorous.

Fourth Figure [4, pp. 384-388]

BAMALIP
Whenever *x* is a vegetable it is alive, and whenever *x* is alive it feeds, therefore, it can happen that if *x* feeds it is a vegetable.

CAMENES
Whenever *x* is a dolphin it is a mammal, and not everything that if *x* is a mammal it is a fish, therefore, not everything that if *x* is a fish it is a dolphin.

DIMARIS
It can happen that if *x* is a mammal it is flying, and whenever *x* is flying it is winged, therefore, it can happen that if *x* is winged it is a mammal.

FESAPO
Not everything that if *x* is a ruminant it is a fish, and whenever *x* is a fish it is aquatic, therefore, it cannot happen that if *x* is aquatic it is a ruminant.

FRESISON
Not everything that if *x* is a ruminant it is a fish, and it can happen that if *x* is a fish it is a predator, therefore, it cannot happen that if *x* is a predator it is a ruminant.

3. The Second Category: Syllogisms with Two Disjunctives

The acceptable form of the second category (syllogisms with two disjunctives) has a form in which the common component is presented by a non-whole part in the two premises, it is subject to three conditions: (1) its two premises should be affirmative, (2) one of the premises should be universal, (3) the two premises should be exclusive.

Again all the syllogisms are defined by their examples.

First Figure

BARBARA
One always has that either every human being is mortal or no human being is mortal, and one always has that either a philosopher is not a human being or every philosopher is a human being; therefore, one always has that either no philosopher is a human being or every philosopher is mortal or no human being is mortal.

CELARENT
One always has that either no human being is immortal or every human being is immortal, and one always has that either no philosopher is a human being or every philosopher is a human being; therefore, one always has either no philosopher is a human being or no philosopher is immortal or every human being is immortal.

DARII
One always has that either every human being is an animal or no human being is an animal, and one always has that either no rational being is human or some rational beings are human; therefore, one always has that either no rational being is human or some rational beings are animal or no human being is an animal.

FERIO
One always has that either no man is immortal or every man is immortal, and one always has that either no animal is human or some animals are human; therefore, one always has that either no animal is human or it cannot happen that some animals are immortal or every human being is immortal.

Second Figure [1, pp. 388-392]

CESARE
One always has that either no human being is immortal or every human being is immortal, and one always has that either no philosopher is immortal or every philosopher is immortal; therefore, one always has that either no philosopher is immortal or no philosopher is human or every human being is immortal.

CAMESTRES
One always has that either every physician is a human being or no physician is human, and one always has that either every stone is human or no stone is human; therefore, one always has that either every stone is human or no stone is a physician or no physician is human.

FESTINO
One has always that either no human being is immortal or every human being is immortal, and one always has that either no being is immortal or some beings are immortal; therefore, one always has that either no being is immortal or some beings are human or every human being is immortal.

BAROCO
One always has that every philosopher is human or no philosopher is human, and one always has that either every physician is human or some physicians are human; therefore, one always has that either every physician is human or some physicians are not philosophers or no philosopher is human.

Third Figure

DARAPTI
One always has that either every human being is mortal or no human being is mortal, and one always has that either every human being is an animal or every human being is an animal; therefore, one always has that either no human being is an animal or some animals are mortal or no human being is mortal.

FELAPTON
One always has that either no human being is an animal or every human being is an animal, and one always has that either no human being is rational or every human being is rational; therefore, one always has that no human being is rational or some rational beings are not animals or every human being is an animal.

DATISI
One always has that either every philosopher is human or no philosopher is human, and one always has that either no philosopher is immortal or some philosophers are immortal; therefore, one always has that no philosopher is immortal or some immortals are human or no philosopher is human.

DISAMIS
One always has that either some humans are immortal or no human being is immortal, and one always has that either no human being is an animal or every human being is an animal; therefore, one always has that either no human being is an animal or some animals are immortal or no human being is immortal.

FERISON
One always has that either no human being is an animal or every human being is an animal, and one always has that either no human being is rational or some human beings are rational; therefore, one always has that either no human being is rational or some rational beings are not animals or every human being is an animal.

BOCARDO
One always has that either some human beings are philosophers or every human being is a philosopher, and one always has that either no human being is immortal or every human being is immortal; therefore, one always has that either no human being is immortal or some immortals are not philosophers or every human being is a philosopher.

Fourth Figure [1, pp. 415-423]

BAMALIP
One always has that either every human being is an animal or no human being is an animal, and one always has that either no animal is mortal or every animal is mortal; therefore, one always has that either no animal is mortal or some mortals are human or no human being is an animal.

CAMENES
One always has that either every human being is an animal or no human being is an animal, and one has always that either every animal is mortal or no animal is mortal; therefore, one always has that either every animal is mortal or no mortal is human or no human being is an animal.

FESAPO
One always has that either no human being is immortal or every human being is immortal, and one always has that either no immortal is an animal or every immortal is an animal; therefore, one always has that either no immortal is an animal or some immortals are not humans or every human being is immortal.

DIMARIS
One always has that either some animals are mortal or no animal is mortal, and one always has that either no mortal is divine or every mortal is divine; therefore, one always has that either no mortal is divine or some divines are animals or no animal is mortal.

FRESISON
One always has that either no carnivore is an herbivore or some carnivore beings are herbivorous, and one always has that either no herbivorous being is a fish or some herbivorous beings are fishes; therefore, one always has that either no herbivorous being is a fish or some fishes are carnivorous or some carnivorous beings are herbivorous.

4. The Third Category: Categorical-Conditional Syllogisms

The third category consists of a categorical proposition and a conditional proposition. Its acceptable form is whenever the categorical proposition is the major premise and a connection is made with the consequent of the conditional premise. For this to be conclusive (1) the conditional should be affirmative, (2) and the conclusion should be conditional its consequent to be the synthesis of (a) the consequent of the conditional of the premise (b) and the major. With this form one can construct its figures which some logicians describe as ‘embarrassed.’

First Figure [1, pp. 393-425]

BARBARA
All organisms are breathing, and whenever that which is nourished is a human being it is an organism; therefore, whenever that which is nourished is a human being it is breathing.

CELARENT
No herbivore is carnivorous, whenever a camel is a ruminant it is herbivore; therefore, whenever a camel is a ruminant it is not a carnivore.

DARII
All birds are winged, whenever an animal is a mammal then some animals are birds; therefore, whenever an animal is a mammal then some animals are winged.

FERIO
No ruminant is carnivorous, whenever an animal is a mammal then some animals are ruminant, and whenever an animal is a mammal then some animals are ruminant; therefore, whenever an animal is a mammal then some animals are not carnivorous.

Second Figure

CESARE
No carnivore is herbivore, whenever a ruminant is a mammal, then it is a herbivore; therefore, whenever a ruminant is a mammal, then no ruminant is a carnivore.

CAMESTRES
Every predator is carnivore, whenever a carnivore is an herbivore, then no herbivore is carnivore; therefore, whenever no carnivore is an herbivore, then no herbivore is a predator.

FESTINO
No carnivore is an herbivore, whenever an animal is a mammal, then some animals are herbivores; therefore, whenever no animal is a mammal, then some animals are not carnivores.

BAROCO
Every predator is a carnivore, whenever an animal is a mammal, then some animals are carnivores; therefore, whenever an animal is a mammal, then some animals are not predators.

Third Figure [1, pp. 415-426]

DARAPTI
Every bat is an animal, whenever a bat is a bird, then it is winged; therefore, whenever a bat is a bird, then some winged animals are mammals.

FELAPTON
No camel is a predator, whenever a camel is a ruminant, then it is an herbivore; therefore, whenever a camel is a ruminant, then some herbivores are not predators.

DATISI
Every predator is a carnivore, whenever a predator is marine, then some predators are sharks; therefore, whenever a predator is marine, then some sharks are carnivores.

DISAMIS
Some camels are two-humped, whenever a camel is a ruminant, then it is a herbivore; therefore, whenever a camel is a ruminant, then some herbivores are two-humped.

FERISON
No fish is a mammal, whenever a fish is a shark, then some fishes are carnivores; therefore, whenever a fish is a shark, then some carnivores are not mammals.

BOCARDO
Some animals are not carnivores, whenever an animal is a mammal, then it is a vertebrate; therefore, whenever an animal is a mammal, then some vertebrates are not carnivores.

Fourth Figure [1, p. 423]

BAMALIP

All plants are organisms, whenever an organism is breathing, then it is nourished; therefore, whenever every organism is breathing, then something that is nourished is a vegetable.

CAMENES
Every dolphin is a mammal, whenever no fish is a mammal, then no mammal is a fish; therefore, whenever no fish is a mammal, then no fish is a dolphin.

DIMARIS
Some mammals are birds, whenever a bird is an animal, then it is winged; therefore, whenever a bird is an animal, then some winged beings are mammals.

FESAPO
No ruminant is a fish, whenever a fish is a shark, then it has gills; therefore, whenever a fish is a shark, then something with gills is not a ruminant.

FRESISON
No ruminant is a fish, whenever a fish is a shark, then some fishes are predators; therefore, whenever a fish is a shark, then some predators are not ruminants.

5. The Fourth Category: Categorical-Disjunctive Syllogisms

The syllogisms of the fourth category consist of a categorical proposition (the major) and a disjunctive proposition (the minor). It is of two kinds:

1) The first kind is one whose number of its categorical propositions is equal to the number of its disjunctive propositions so that each categorical proposition has in common a component from each disjunction. The condition of this syllogism is that it should have a disjunctive or analytical affirmative.

The first form:
All Libyans are Africans; all Tunisians are Africans; all Algerians are Africans; all Moroccans are Africans; all Mauritanians are Africans; each Moroccan is either Libyan or Tunisian or Algerian or Moroccan or Mauritanian; therefore, all these North Africans are Africans.

The second form:
Every animal is sensitive; every vegetable is growing; every mineral is inert; all corpus are an animal or vegetable or mineral; therefore, all corpus are sensitive or growing or inert.

2) The second kind is one whose number of its categoricals are lesser than the number of its disjunctions. The categorical proposition consists of a single component and the disjunctive one consists of two components:
All the unjust are guilty; one always has that either some governors are not unjust, or every governor is unjust; therefore, one always has that either some governors are unfair, or every governor is guilty.

6. The Fifth Category: Disjunctive-Conditional Syllogisms

The acceptable form of the fifth category is one which consists of a disjunctive (the major) and a conditional (the minor), and whose common component is a complete or an incomplete part of the antecedents. The disjunctive major should be either inclusive or exclusive.

The First case with an inclusive premise:

It can happen that the figure is a triangle or square, and whenever the figure has three sides it is a triangle; therefore, it can happen that the figure has three sides or is square.

The second case with an exclusive premise:

One has always either a figure and a polygon, or it is a circle, and whenever a figure is a triangle it is a polygon; therefore, it can happen that either a figure is a triangle or a circle.

7. Conclusion

What we have already exposed did not, to our knowledge, exist, even in part, in any other treatise on logic than the ones left to us by the ancient Arabian logicians since Ibn Sīnā up to al-SSinūsī's. By reflection on the syllogisms above we could say that Arabic logic developed to its peak by amalgamating propositional logic into a predicate one.

We hope that the arguments which I have provided will be convincing enough to show that *the old Arabian logicians were the first to discover* the structure of conditional syllogisms and to realize concisely their importance.

Acknowledgement

This paper was translated and edited from French into English by Hany Moubarez and edited by Moussa Fatahine.

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