

Aristotelian Logic

Supplement
to

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to Critical Thinking*

and

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A. The Tradition

Over 2,300 years ago, Aristotle in his *Prior Analytics* focused his study on arguments built from claims of the forms:

All S are P.

Some S is (are) P.

No S is (are) P.

Some S is (are) not P.

The following argument, for example, uses claims of only these forms:

No police officers are thieves.

Some thieves are sent to prison.

So no police officers are sent to prison.

Aristotle developed a method for determining whether such an argument is valid by inspection of its *form*. From then until the early 1900s his work was the basis for most argument analysis. That tradition, called *Aristotelian logic*, was very broad, and in the Middle Ages—especially from about 1100 to 1400—it was made into a very subtle tool of analysis of reasoning.

In the late 1500s scholars became more interested in studying informal reasoning, inspired also by the work of Aristotle. They ignored the complexities of the formal logic of the medievals and were content with just the rules and forms of Aristotelian logic, rote exercises and puzzles for students. That simplified tradition of Aristotelian logic, current since about 1600, is what is presented here. It is worth studying because many writers from that time to today have used its terminology. It also makes a contrast with modern formal logic. But it is only in the work of the medievals, which in the last hundred years has begun to be rediscovered, translated, and discussed, that the Aristotelian tradition can offer us anything in the way of a serious study of arguments.

B. Categorical Claims

Categorical claims A categorical claim is a claim that can be rewritten as an equivalent claim that has one of the following *standard forms*:

All S are P.

Some S is P.

No S is P.

Some S is not P.

For any claim in one of these forms, the *term* (word or phrase) that replaces the letter S is called the *subject* of the claim. The term that replaces the letter P is called the *predicate* of the claim.

For example,

All dogs are mammals.

No nurse is a doctor.

Some newspaper is written in Arabic.

Some snow is not white.

In the first, the subject is “dogs” and the predicate is “mammals”. Note that this is not how “subject” and “predicate” are not used in modern grammar. Your English teacher would say that the predicate is “are mammals.”

Most of the claims we reason with in daily speech aren’t in one of these forms. But, Aristotelians suggest, we can rewrite many of them to show that they are categorical. For example, using “ \equiv ” to stand for “is equivalent to” we can rewrite:

All dogs bark. \equiv All dogs are things that bark.

No horse eats meat. \equiv No horse is a thing that eats meat.

Some cats eat birds. \equiv Some cat is a thing that eats birds.

Some dogs don’t chase cats. \equiv Some dog is not a thing that does chase cats.

Somewhat more colloquially, or at least avoiding the constant use of the phrase “thing that,” we could rewrite these as:

All dogs are barkers.

No horse is a meat eater.

Some cat is a bird eater.

Some dog is not a cat chaser.

It might seem that categorical claims are concerned only with things and collections of things. But the following argument uses only categorical claims:

All snow is white.

All that is white is visible.

So, all snow is visible.

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Snow, whatever it is, isn't a thing or collection of things, like dogs or pencils. Snow is a mass, like gold or mud, and Aristotelian logic is useful for reasoning about masses, too.

It's often difficult to rewrite claims to "show" their categorical form, and there are no general rules for how to do so. That's because so many different kinds of words for so many different kinds of things and substances and classes can be used for the S or P in the forms. *In this appendix we'll concentrate on words that stand for classes or collections of things in order to make the discussion simpler.*

Recall from the text that "All S is not P" is equivalent to "No S is P." So claims of the form "All S are P" and "No S is P" are called **universal** claims. Aristotelians call claims of the form "Some S is P" and "Some S is not P" **particular** claims, since they are about some particular things, even if those are not picked out. In order to make their logic more applicable, they also say that claims of the form "a is P" or "a is not P" are **universal** categorical claims, where "a" stands for a name, as in:

Maria is Hispanic.

Spot is not a cat.

Claims of the form "All S are P" and "Some S is P" are called **affirmative**, and claims of the form "No S is P" and "Some S is not P" are called **negative**. So, for example, "All dogs are mammals" is a universal affirmative claim, while "No dog is a feline" is a negative universal claim. Whether a claim is universal or particular denotes its **quantity**; whether a claim is affirmative or negative denotes its **quality**.

Exercises for Section B

1. What is a categorical claim?
2. What is a universal categorical claim?
3. What is a particular categorical claim?
4. What is an affirmative categorical claim?
5. What is a negative categorical claim?
6. What does the quantity of a categorical claim designate?
7. What does the quality of a categorical claim designate?

Here are some of Tom's exercises, as graded by Dr. E.

All students are employed.

Categorical? Yes. Already in standard form.

Subject: Students.

Predicate: Employed.

Quantity: Universal.

Quality: Affirmative.

Good, except that since we've decided to view all subjects and predicates as either things or collections of things, let's take the predicate here to be "employed people."

Not even one art student is enrolled in calculus.

Categorical? Yes. "No art student is enrolled in calculus."

Subject: Art students.

Predicate: Enrolled in calculus.

Quantity: Universal.

Quality: Negative.

Good, except take the predicate here to be "people enrolled in calculus" or "calculus enrollees."

Someone who likes Picasso also likes Monet.

Categorical? Yes. "Some people who like Picasso are people who like Monet."

Subject: People who like Picasso.

Predicate: People who like Monet.

Quantity: Particular.

Quality: Affirmative.

Good work.

Dr. E's students all pass.

Categorical? Yes. "All students of Dr. E pass."

Subject: Students of Dr. E.

Predicate: Pass.

Quantity: Universal.

Quality: Affirmative.

Almost. But you haven't given a categorical form for the claim. Where is "is a" or "is not a" or "are"? We need "All students of Dr. E are people who pass." Then the predicate is "people who pass."

Very few dogs chase mice.

Categorical? Yes. "No dog chases mice."

Subject: Dogs.

Predicate: Mice chasers.

Quantity: Universal.

Quality: Negative.

No. "Very few" does not mean the same as "No," which means the same as "None." Don't try to force every claim into one of these forms.

Some football players don't take steroids.

Categorical? Yes. "Some student who is a football player is not someone who takes steroids."

Subject: Students who are football players.

Predicate: People who take steroids.

Quantity: Particular.

Quality: Negative.

Almost—just delete the words "student who is a": "Some football player is not someone who takes steroids." Your claim isn't equivalent, because it could be true and the original false if a professional football player takes steroids.

Some student at this school is majoring in football or there is a student who will not get a degree.

Categorical? No. This is a compound claim, and I can't figure out how to get it into a standard form.

Subject: Students.

Predicate: Football players and people who get degrees.

Quantity: Particular.

Quality: Affirmative and negative.

I don't think this exercise is very funny, Dr. E. We football players work hard at school and sport.

You're right that if it's a compound it isn't a categorical claim. But then why did you fill in after the other parts? Were you on automatic pilot? Only categorical claims have subjects and predicates, quantity and quality.

You're also right that I should be more sensitive about the examples. In the future I'll talk about basketball players.

For each of the following fill in the blanks

Categorical? (If yes, and it is not already in one of the standard forms, rewrite it.)

Subject:

Predicate:

Quantity:

Quality:

8. All dogs are carnivores.
9. Some cat is not a carnivore.
10. Tom is a basketball player.
11. No fire truck is painted green.
12. Donkeys eat meat.
13. There is at least one chimpanzee who can communicate by sign language.
14. Every border collie likes to chase sheep.
15. No one who knows critical thinking will ever starve.
16. Nearly every college graduate is employed at a full-time job.
17. All dogs bark or Spot is not a dog.
18. There is a teacher of critical thinking at this school who gives all A's to her students.
19. Heroin addicts cannot function in a 9–5 job.
20. Some people who like pizza are vegetarians.
21. Not every canary can sing.
22. Dr. E does not have a cat.
23. If Zoe does the dishes, then Dick will take Spot for a walk.
24. Of all the teachers at his school, none is as good as Dr. E.
25. Maria has a part-time job.

26. Waiters in Las Vegas make more money than lecturers at the university there.
27. In at least one instance a professor at this school is known to have failed all the students in his class.
28. Make up five claims, three of which are categorical and two of which are not. Give them to a classmate to classify.

C. **Contradictories, Contraries, and Subcontraries**

In evaluating whether a categorical claim is true, we are faced with the issue we saw in Chapter 8. Consider:

All polar bears in the Antarctic eat fish.

There aren't any polar bears in the Antarctic. So is this true or false?

Aristotelians assumed that universal claims have *existential import*. That is, for the claim to be true, the subject term has to stand for something that exists. So the example is false. Similarly, "All dodos are birds" is false because there are no dodos. And "No dodo is a bird" is false because it's understood to be equivalent to "All dodos are not birds".

With this convention established, we have the following definitions.

Contradictory claims Two claims are contradictory if it is not possible for them to have the same truth-value.

Contrary claims Two claims are contrary if it is not possible for them both to be true at the same time.

Subcontrary claims Two claims are subcontrary if it is not possible for them both to be false at the same time.

If two claims are contradictory, they're also contrary, but not vice-versa. For example, "All dogs bark" and "No dogs bark" are contrary (they can't both be true), but they're not contradictory: since "dogs" must refer to some object when it's used in this way, they can both be false.

Contradictories are also subcontraries, but not vice-versa. For example, "Some dogs bark" and "Some dogs don't bark" can't both be false, since to use the term "dogs" in a categorical claim is to assume there are such things. But both of these claims could be true.

In order to discuss these relationships when they apply to pairs of categorical claims, it is traditional to name the forms with letters:

All S are P. **A**

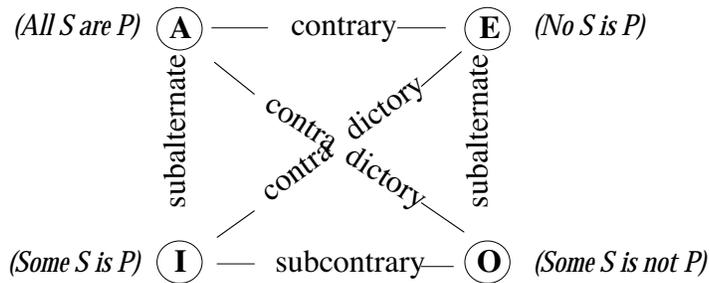
No S is P. **E**

Some S is P. **I**

Some S is not P. **O**

Further, A and I claims using the same subject and predicate are *subalternates*, and E and O claims using the same subject and predicate are also subalternates.

Aristotelians used the following diagram to summarize how these terms apply to pairs of categorical claims.

The Square of Opposition

But despite being memorized by generations of students over hundreds of years, the diagram doesn't work. According to the diagram, these claims are contradictory:

All dogs are domesticated.
Some dogs are not domesticated.

That's certainly the case if there are dogs. But if there were no dogs (horror of horrors), then both are false because they both have existential import, so they wouldn't be contradictory.

According to the diagram, these claims are contradictory:

Some teacher is kind.
No teacher is kind.

That's certainly the case if there are teachers. But if there are no teachers, both are false because they both have existential import, so they wouldn't be contradictory.

According to the diagram, these claims are contrary:

All cats are vicious.
No cats are vicious.

Here the diagram is correct. Both can't be true, and if there were no cats, neither is true because both have existential import.

According to the diagram, these claims are subcontrary:

Some diamonds are precious stones.
Some diamonds aren't precious stones.

Again, that's correct if there are diamonds. But if there are no diamonds, both are false and hence not subcontraries.

Attempts have been made to rescue the square of opposition from these problems, but no solution is generally accepted.

Exercises for Section C

1. What is the contradictory of a claim?
2.
 - a. What does it mean to say that two claims are contrary?
 - b. Give an example of two claims that are contrary but not contradictory.
3.
 - a. What does it mean to say that two claims are subcontrary?
 - b. Give an example of two claims that are subcontrary but not contradictory.

4. a. What does it mean to say that “All dogs bark” and “Some dogs bark” are subalternate?
b. What does it mean to say that “No cats bark” and “Some cats do not bark” are subalternate?
5. a. What is an A claim? Give an example.
b. What is an E claim? Give an example.
c. What is an I claim? Give an example.
d. What is an O claim? Give an example.
6. Show that for claims that use the same subject and predicate:
 - a. If the I claim is false, then the A claim is false.
 - b. If the O claim is false, then the E claim is false.

For each pair of claims below state which of the terms following it apply.

contradictory
contrary
subcontrary
subalternate
none

7. All dogs bark.
Some dogs do not bark.
8. No Russians are communists.
All Russians are communists.
9. Maria is a widow.
Maria was never married.
10. No animals with horns are carnivores.
Some animals with horns are carnivores.
11. All uranium isotopes are highly unstable substances.
Some uranium isotopes are highly unstable substances.
12. Some assassinations are morally justifiable.
Some assassinations are not morally justifiable.
13. Dick and Tom are friends.
Dick and Tom can't stand to be in the same room together.
14. Not even one zebra can be trained to jump through fire.
Every zebra can be trained to jump through fire.
15. Homeless people don't like to sleep on the street.
Some homeless people don't like to sleep on the street.
16. Dick almost always washes the dishes after dinner.
Dick almost never washes the dishes after dinner.
17. Very few cats will willingly take a bath.
Very few cats won't willingly take a bath.

D. Syllogisms

Arguments for which Aristotelian logic was devised contain only categorical claims. Many of those can be reduced to arguments of a special kind.

Categorical syllogism A categorical syllogism is an inference composed of three categorical claims: two premises and a conclusion. Exactly three terms are used as subject or predicate in those claims, each of which appears in exactly two of the claims.

The first argument we considered in this supplement is a categorical syllogism:

No police officers are thieves.
 Some thieves are sent to prison.
 So no police officers are sent to prison.

The terms in this are “police officers,” “thieves,” and “people sent to prison.” Each appears in exactly two of the claims.

Aristotelians identify the predicates and subjects in syllogisms by the roles they play in determining whether the argument is valid.

Major, minor, middle terms of a categorical syllogism

<i>major term</i>	=	predicate of the conclusion
<i>minor term</i>	=	subject of the conclusion
<i>middle term</i>	=	the term that appears in both premises
<i>major premise</i>	=	the premise that contains the major term
<i>minor premise</i>	=	the premise that contains the minor term

For example, in the last argument:

The major term is “people sent to prison.”
 The minor term is “police officers.”
 The middle term is “thieves.”
 The major premise is “Some thieves are sent to prison.”
 The minor premise is “No police officers are thieves.”

The main focus of Aristotelian logic, as traditionally presented, is to show that we can mechanically determine of any given categorical syllogism whether it is valid or invalid. One way to do that is by inspecting its form. A syllogism is in **standard form** if all the claims in it are in standard form, the major premise comes first, then the minor premise, then the conclusion. We can list all possible forms of syllogisms in standard form. For example,

No S is M
 All M are P
 So No S is P.

has form EAE.

Given any categorical syllogism, we can first rewrite it in standard form and then check whether it is one of the valid forms.

But instead of listing all the forms, Aristotelians have shown how we can start with knowing whether a few are valid or invalid and then convert any other form into one of those by a detailed reduction procedure.

Alternatively, we can take any categorical syllogism, put it in standard form, and then use the method of diagrams presented in Chapter 8 of the text to determine whether it is valid.

Once we've checked for validity, we still have to decide whether the syllogism is a good argument. We know that a valid argument need not be good, for a premise could be false, or a premise might not be more plausible than the conclusion. Indeed, many valid Aristotelian syllogisms beg the question. Consider, for example:

All dogs eat meat.
Spot is a dog.
So Spot eats meat.

It's more plausible that Spot eats meat than that all dogs do. Categorical syllogisms, as originally used by Aristotle, are really a logic of explanations, not arguments. In an explanation the conclusion is supposed to be more plausible than the premises, as discussed in Chapter 16 of the text.

In any case, in ordinary speech we first have to decide how the person giving the argument intends "all" and "some" to be understood, and many times those readings won't be compatible with the assumptions of Aristotelian logic. Even if those readings are compatible, we often have to do a lot of work to rewrite the claims into standard categorical form. Then we have to check against a (memorized?) list of valid Aristotelian forms. Then we have to ask about the plausibility of the premises to determine whether the syllogism is a good argument. Even then, many simple arguments using "some" or "all" can't be analyzed as categorical syllogisms, such as "Some dogs like cats; some cats like dogs; so some dogs and cats like each other."

For hundreds of years students and scholars preoccupied themselves with the methods of Aristotelian logic as the primary focus of their analysis of reasoning. They could rely on standard methods and checkable rules. But that tradition missed most of the important work in critical thinking of the last 150 years, though much of that can also be traced to Aristotle.

Exercises for Section D

1. What is a categorical syllogism?
2. What is the major term of a categorical syllogism?
3. What is the minor term of a categorical syllogism?
4. What is the middle term of a categorical syllogism?
5. What is the major premise of a categorical syllogism?
6. What is the minor premise of a categorical syllogism?
7. What is the standard form for a categorical syllogism?

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Which of the forms of categorical syllogisms in Exercises 8–15 are forms of arguments that must be valid? The forms are presented by giving the letter name of the standard form of the major premise, then the minor premise, then the conclusion.

8. EAE (No S is M; all M are P; so no S is P.)
9. AAA
10. AEO
11. IAO
12. III
13. AEE
14. AOO
15. AAI

For each of the following arguments, either rewrite it in the standard form of a categorical syllogism and identify the form, or explain why it cannot be rewritten in a standard form. In either case, determine if the argument is valid.

16. All students at this school pay tuition. Some people who pay tuition at this school will fail. So some students at this school will fail.
17. There aren't any wasps that will not sting. Some bumblebees will not sting. So some bumblebees aren't wasps.
18. Badly managed businesses are unprofitable. No oyster cultivating business in North Carolina is badly managed. So some oyster cultivating business in North Carolina is profitable.
19. Most critical thinking books do not teach Aristotelian logic. Chemistry textbooks never teach Aristotelian logic. So most chemistry books are not critical thinking textbooks.
20. Nothing that's smarter than a dog will cough up hair balls. Cats cough up hair balls. So cats are not smarter than dogs.
21. Dick will not visit Tom tonight if Zoe cooks dinner. Zoe didn't cook dinner. So Dick visited Tom tonight.
22. No pacifists will fight in a war. Dick is a pacifist. So Dick will not fight in a war.
23. Police chiefs who interfere with the arrest of city officials are always fired. People who are fired collect unemployment. So some police chiefs who interfere with the arrest of city officials collect unemployment.
24. Some temporary employment agencies do not give employee benefits. All employees of Zee Zee Frap's restaurant get employee benefits. So no employee of Zee Zee Frap's is hired through a temporary employment agency.

Key Words	categorical claim	affirmative categorical claim
	standard form of a	negative categorical claim
	categorical claim	quantity of a categorical claim
	universal categorical claim	quality of a categorical claim
	particular categorical claim	subject of a categorical claim

predicate of a categorical claim
contradictory
contrary
subcontrary
A claim
E claim
I claim
O claim
subalternate

Square of Opposition
categorical syllogism
major term
minor term
middle term
major premise
minor premise
standard form of a
categorical syllogism

Answers to Selected Exercises

Section B

6. Whether the claim is universal or particular.
7. Whether the claim is affirmative or negative.
9. *Categorical?* Yes.
Subject: Cats.
Predicate: Carnivores.
Quantity: Particular.
Quality: Negative.
10. *Categorical?* Yes.
Subject: Tom.
Predicate: Football players.
Quantity: Universal.
Quality: Affirmative.
12. *Categorical?* Yes. All donkeys are meat eaters.
Subject: Donkeys.
Predicate: Meat eaters.
Quantity: Universal.
Quality: Affirmative.
15. *Categorical?* Yes (though it's a stretch). No knowers of critical thinking are things that will ever starve.
Subject: Knowers of critical thinking.
Predicate: Things that will ever starve.
Quantity: Universal.
Quality: Negative.
16. *Categorical?* No. Nearly every \neq all. Nearly every \neq some.
17. *Categorical?* No. It's a compound.
22. *Categorical?* Yes. Dr. E is not a cat owner.
Subject: Dr. E.
Predicate: Cat owners.
Quantity: Universal.
Quality: Negative.
24. *Categorical?* No. You can't make comparisons in categorical claims, or at least not in a way that's useful for reasoning.
27. *Categorical?* Yes. Some professor at this school is a person known to have failed all students in his class.
Subject: Professors at this school.
Predicate: People known to have failed all students in his class.
Quantity: Particular.
Quality: Affirmative.

Section C

2. a. In no possible circumstance can they both be true, though they can both be false.
3. a. In no possible circumstance can they both be false, though they can both be true.
4. a. If "All dogs bark" is true, then "Some dogs bark" is true. If "Some dogs bark" is false, then "All dogs bark" is false.
b. If "No cats bark" is true, then "Some cats do not bark" is true. If "Some cats do not bark" is

- false, then “No cats bark” is false.
5. a. A claim equivalent to one in the form “All S are P.”
 - b. A claim equivalent to one in the form “No S is P.”
 - c. A claim equivalent to one in the form “Some S is P.”
 - d. A claim equivalent to one in the form “Some S is not P.”
8. Contrary.
 9. Contrary, but not via categorical form.
 10. Contradictory.
 11. Subalternate.
 12. Subcontrary.
 16. Contrary, but neither are categorical.

Section C

4. The term that appears in both premises.
5. The premise that uses the major term.
6. The premise that uses the minor term.
8. Invalid. Reasoning backwards with “no.”
9. All S are M. All M are P. So all S are P. Valid. Reasoning in a chain with “all.”
10. All S are M. No M is P. So some S is not P. Valid.
11. Some S is M. All M are P. So some S is not P. Invalid.
12. Some S is M. Some M is P. So some S is P. Invalid. Reasoning in a chain with “some.”
13. All S are M. No M are P. So no S are P. Valid.
14. All S are M. Some M is not P. So some S is not P. Invalid.
15. All S are M. All M are P. So some S are P. Valid.
17. All wasps are stingers (A).
Some bumblebees are not stingers (O).
So some bumblebee is not a wasp (O).
Valid.
18. No badly managed business is profitable (E).
No oyster cultivating business in North Carolina is badly managed (E).
So some oyster cultivating business in North Carolina is profitable (I).
Invalid.
19. Not categorical because “most” ≠ “all” and “most” ≠ “some.” Invalid, but strong.
20. No straightforward way to view this as categorical. But valid.
21. Not categorical, because compounds aren’t categorical. Invalid, weak, affirming the consequent.
22. EAE. Valid.
23. Police chiefs who interfere with the arrest of city officials are always fired. (A)
People who are fired are people who collect unemployment. (A)
So some police chiefs who interfere with the arrest of city officials are people
who collect unemployment (I).
Valid.
24. No obvious rewrite as categorical. But valid.