CHAPTER 12 Aristotelian Logic and Venn-Euler Diagrams

Although there is no system of logic that can be used on all deductive arguments to successfully determine whether they are valid, the system of class logic and its method of Venn-Euler diagrams can be used successfully on the arguments that can be interpreted as being about classes, such as sets or collections. Class logic was created by Aristotle in ancient Greece, but it has undergone some development since then, although this chapter will not discuss that development.

Aristotle's Logic of Classes

A class is any collection, group, or set. All the black symbols on your computer screen make a class, and so do all your fingernails. You could even mentally collect these two classes into the combination class of both kinds of things, although that would be a very odd class. Surprisingly much ordinary talk that does not seem to be about classes can be interpreted so it is explicitly about classes. For example, saying Obama is a president can be interpreted as saying Obama is in the class of presidents. To be in a class is to be a member of the class, that is, to be an element of the class. So, Obama is a member of the class of presidents.

Class logic focuses on the classes that are mentioned in subjects and predicates of sentences and on the occurrence of the key words *all*, *some*, *none* and their synonyms. For example, the word *Greek* refers to the class of Greeks, and the sentence "All Greeks are Europeans" can be interpreted as saying that the class of Greeks is included within the class of Europeans—that is, any member of the class of Greeks is also a member of the class of Europeans. The sentence "Socrates was an ancient Greek" does not seem to be about classes, but it can be interpreted as saying that one object (namely, Socrates) is a member of a class (namely, the class of ancient Greeks). In class logic, the sentence "No Americans are Europeans" would be interpreted as saying that the class of Americans does not overlap with the class of Europeans—that is, the two classes do not have a member in common.

The focus in class logic is on class membership and on classes being included within other classes.

Sentences about classes have logical forms. For example, the sentence "Some Europeans are Greek" has the form "Some E are G" where the letter E stands for the class of Europeans and the letter G stands for Greeks. The sentence is interpreted in class logic as asserting that some members of E are members of G. The statement form "All N are B" is a briefer version of "All members of the class N are members of the class B." In sentential logic, the capital letters are used for sentences or clauses, but here in Aristotle's class logic, the capital letters are used for classes.

Just as sentences have logical forms, so do arguments.

The logic form of an argument is the form of its component premises and conclusion.

Here is an argument that can be paraphrased in English to reveal its class structure:

Nazis are bad.

Nazis like to beat up Catholics.

So, liking to beat up Catholics is bad.

Paraphrase in class logic:

All members of the class of Nazis are members of the class of bad persons.

All members of the class of Nazis are members of the class of persons who like to beat up Catholics.

So, all members of the class of persons who like to beat up Catholics are members of the class of bad persons.

In creating a paraphrase for use in class logic, we search for logically equivalent sentences in which the main verb is some form of *to be* and in which the subject and predicate can be read as being about classes. Using some obvious abbreviations of the classes, we can display the logical form of the above argument as follows:

All N are B

All N are L.

All L are B.

where

N = (the class of) Nazis

B = (the class of) bad persons

L = (the class of) all persons who like to beat up Catholics

The test of whether we have actually found the logical form of the argument is whether we can reproduce the argument by substituting the words back in for the letters.

Two different arguments in English might have the same form in class logic if we can change the definition of the capital letters. For example, if the letter L were to stand for the class of persons who like to breathe air, then on substituting words for letters in the above argument form, we would get an analogous argument about Nazis liking to breathe air.

Nazis are bad.

Nazis like to breathe air.

So, liking to breathe air is bad.

The two arguments rise and fall together in class logic because they are logically analogous — that is, they have the same form in class logic. This particular form is deductively invalid, isn't it?

Our choice of the letter N was arbitrary. We can re-letter formal arguments in class logic and get the same form. If we replaced N with M above, we'd get this analogous form:

> All M are B
>
> All M are L.
>
> All L are B.

Just don't substitute M for *two* different letters. In class logic, if we are talking about individual members rather than classes, the custom is to use small case letters. So, if we wanted to treat the sentence "The biggest fish in our sea is not a mammal" in class logic, we might choose the small case letter "b" for "the biggest fish in our sea" and choose "M" for the predicate "is a mammal." Then we'd translate our sentence into class logic as "b is NOT-M."

The "NOT" isn't the negation of sentential logic. Here it means the complement of M, that is, the class of all things not in M.

———CONCEPT CHECK———

Which one of the choices below has the logical form of this argument about whales? (Hint: The order in which the premises are presented in an argument is not essential to an argument's validity or to its form.)

> Whales are mammals, but the biggest fish in our sea is definitely not a mammal, so it's not a whale either.
>
> a. Potatoes are produce. Not all fattening foods are potatoes, so not all fattening foods are produce either.
>
> b. That squirming thing has no backbone. However, fish are the kind of things that do have backbones. So it's not a fish.
>
> c. Fat fish are swimmers. No house cat is a fat fish, so no house cats are swimmers.

———[281]

281 Answer (b). Both arguments have this form: All W are M. b is NOT-M, so b is NOT-W.

You aren't restricted to using single capital letters for a class. If it helps you remember its name better by giving the class a longer name, that is OK. You could have chosen "MAM" as the abbreviation of the class of mammals instead of "M."

———CONCEPT CHECK———

Choose the correct class logic pattern for the following biological argument:

> All insects have exactly six legs. So no spider is an insect because all spiders have exactly eight legs.

Here are four choices for the pattern. SIX stands for the class of things that have six legs.

a. All INS are SIX.
No SPID are INS.
No SIX are EIGHT.
———————
All SPID are EIGHT.

b. All INS are SIX.
No SPID are INS.
No SIX are EIGHT.
———————
No SPID are INS.

c. All INS are SIX.
No SPID are INS.
No INS are SPID.
———————
All SPID are EIGHT.

d. All INS are SIX.
All SPID are EIGHT.
No SIX are EIGHT.
———————
No SPID are INS.

[282]

The two arguments below have different forms. Any argument with the form on the right is valid:

$$\begin{array}{l} \text{All } N \text{ are } B. \\ \underline{\text{All } N \text{ are } L.} \\ \text{All } L \text{ are } B. \end{array} \quad \text{(invalid)} \qquad \begin{array}{l} \text{All } N \text{ are } B. \\ \underline{\text{All } B \text{ are } L.} \\ \text{All } N \text{ are } L. \end{array} \quad \text{(valid)}$$

You should be able to think of a counterexample to the argument form on the left. Think about what definitions you could give to N, B and L that would create an argument with true premises and a false conclusion.

Substituting *Nazis* for N and *bad people* for B and *like to breathe air* for L will produce a counterexample to the form on the left.

CONCEPT CHECK

If some A are C and all C are R, then must some R be A?

[283]

From the answer to the previous concept check you can see that deductive logic is placing limits on what you can think of.

> You cannot think of counterexamples to valid arguments.

CONCEPT CHECK

Is this a deductively valid argument form?

No A are B.

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282 Answer (d). Only (b) and (d) have the correct conclusion below the line.

283 Yes, this is deductively valid reasoning in class logic. You cannot think of any definitions for the letters that will produce an invalid argument.

Some B are C.

No A are C.

———[284]

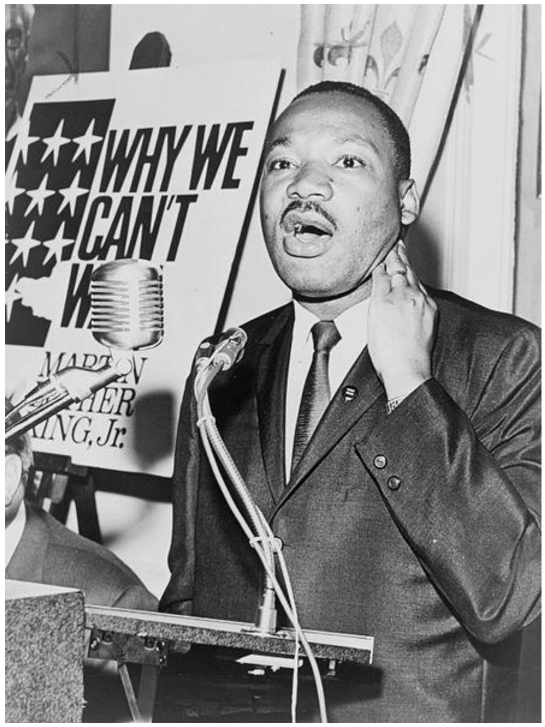
Using Venn-Euler Diagrams to Test for Invalidity

In class logic, we can create diagrams to help us test arguments for validity. Before we do this, though, let's improve our skill at reasoning with the complement of classes, that is, the set of all things not in a class. If you're an American, then what's our name for the non-Americans? It's "foreigner." The more Americans travel, the more they meet non-Americans.

Assuming that nobody can be both a Jew and a Christian, it would be true to say that all Jews are non-Christians and true to say that some non-Jews are non-Christians, but it would be false to say that all non-Christians are Jews and false to say all non-Christians are non-Jews. Whew! Congratulations and compliments if you could carefully comprehend the complexities of those complementations about classes. If you could, you can complete this concept check correctly.

———CONCEPT CHECK———

284 No, it is deductively invalid. You can probably think of some definitions for the letters that will produce an invalid argument. How about A being apples and B being bananas and C being fruit?



Martin (pictured above) is not a white male if Martin is

a. a white non-male. b. a non-white male,

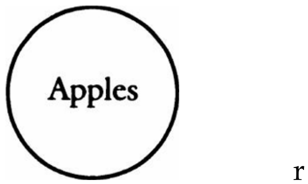
c. a non-white non-male. d. all of the above.

[285]

Skill at negating terms is needed for constructing Venn-Euler diagrams. This diagramming method is a helpful way to quickly assess the deductive validity of arguments in class logic. It can guide you to the correct assessment when the argument is too intricate to analyze in your head. In presenting this method, we shall first introduce the diagrams for classes, then generalize the method so that it can be used to display whether sentences about classes are true or false, and then generalize the method again so that it can be used to show whether arguments using these sentences are deductively valid.

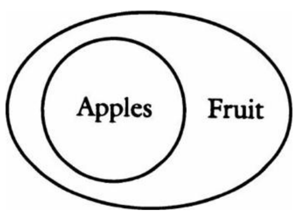
The circle below is Euler's diagram of the class of apples.

285 Answer (d). Answering questions like this would be so much easier if we had some sort of picture or diagram method that would show us what is going on. Maybe you can invent one. Euler tried to do this back in the 18th century in Switzerland.



In this two-dimensional diagram, any point within the circle represents an apple and any point outside the circle represents a non-apple such as a Muslim or a pencil. The custom for labeling is to use a capital to start the name of a region (class) and a small case letter to name a specific member of a region (class). The small letter "r" labels the point to the right of the circle that represents a specific non-apple, let's say Thomas Edison, the American inventor and founder of the General Electric Corporation. There is nothing important about the shape of the region. An ellipse or a rectangle would be fine, just as long as it is clear what is in the region and what is out, that is, what is in the class and what is not. The size of the circle isn't important either. Nor do we pay attention to moving the diagram to the left or right or up or down. All those changes would produce the same diagram, as far as class logic is concerned.

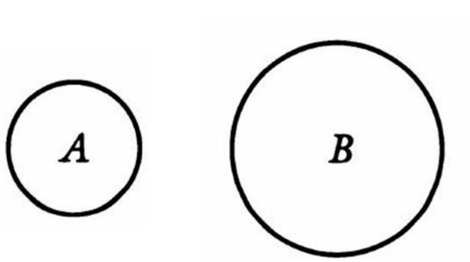
The following is a more complicated diagram that represents both the class of apples and the class of fruit. In the real world, the class of apples is included wholly within the larger class of fruit. The diagram provides a picture of this real-world relationship:



The above diagram represents the truth of the sentence "All apples are fruit," but you are welcome to draw diagrams that don't picture the way the world is.

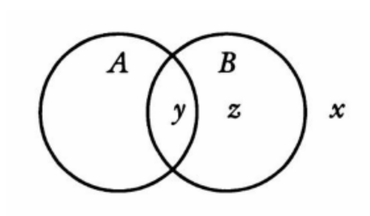
Any label for a region can be inside or outside it, provided there is no ambiguity about which label goes with which region. Sometimes we will call oval regions "circles" since we don't pay any attention to the difference between a circle and an ellipse.

Here is a diagram in which statements of the form "No are B" are true:



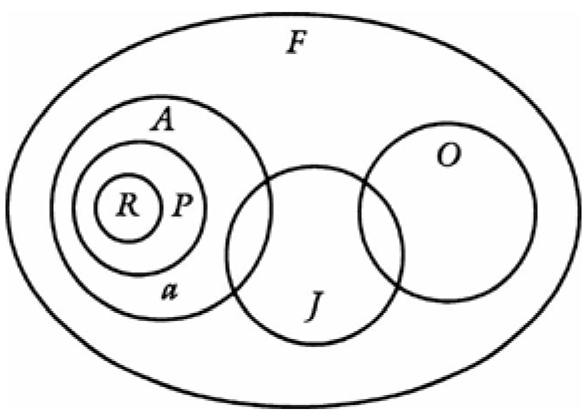
What is important about this diagram is that the two circles do not intersect (overlap). The circles shouldn't be tangent either, because that would make it hard to tell whether the two classes have a common member.

Consider the points x, y, and z in the following diagram. The classes A and B intersect — that is, they have members in common. One of those members is y.



Point x is neither in class A nor in class B. It's in the complement of each. Point y is in both A and B. Point z is in B but not in A. By viewing the diagram you can see that some members of B are in A and some aren't. However you cannot tell whether A has more members than B. If region A is larger than B in a diagram, you can't tell whether A has more members than B. For that matter, you can't even tell whether the class has any members at all. However, in all diagrams from now on, we will assume that we are starting with classes that are not empty.

Here is a diagram representing the real-world relationship among apples, fruits, oranges, apples in Paris, apples in restaurants in Paris, and fruit owned by our friend Juan:

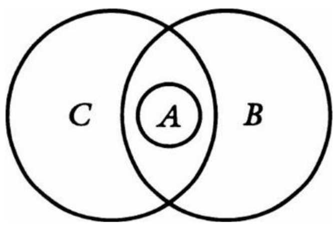


A = things that are apples
F = things that are fruit
O = things that are oranges
P = things that are apples in Paris
R = things that are apples in restaurants in Paris
J = things that are fruit owned by our friend Juan

To be clear, we shall always use capital letters or capitalized words for classes of things. If we want to add the information that some specific object is a member of one of the classes, we will use a lowercase letter to represent the member. In the previous diagram the lowercase *a* represents the one apple in my refrigerator. You can see that the letter *a* is outside the P circle; this shows that the apple in my refrigerator is not in Paris. Notice that Juan himself is not a member of any of the classes in the above diagram; the information about Juan is embedded in the definition of *J*. By inspecting the diagram you can tell that Juan doesn't own any Parisian apples (because J and P do not overlap), but he does own apples (because J intersects A), does own oranges (because J intersects O), and does own some other unspecified fruit (because J is in F but not all of J is in A or O).

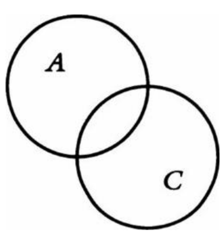
———CONCEPT CHECK———

Find some classes in the real world that have the relationships indicated in the following diagram:



———[286]

How would you draw a diagram in which the statement that some apples are from Canada and some aren't is true? This will do the trick:



C = the class of things from Canada

A = the class of apples

The sentence pattern "All A are non-B" is true in the following diagram:

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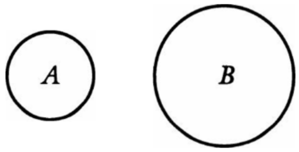
286 Be sure to think about these concept check before looking at the answer, or you might not have acquired the skills you need to do well on the homework and tests. A = U.S. citizens who live in New York City, B = city dwellers, C = Americans.



Notice that it is the same as the diagram you'd draw for "No A are B." Logically equivalent sentences have the same kinds of diagrams. That's a key idea in class logic.

The above diagram would represent the false sentence "No Texans are Americans" if the following dictionary were used:

A = Texans

B = Americans

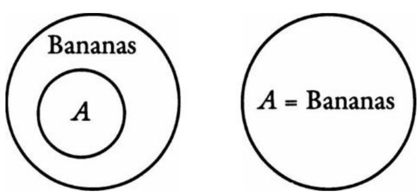
Although that sentence is false in the real world, the diagram shows how the world would be if the sentence were true. The same point is made by saying that the diagram is a picture of what is true in a certain "possible world" that isn't the actual world.

CONCEPT CHECK

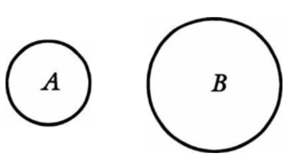
Make the statement "All Texans are non-Americans" be true in a diagram, using the above dictionary for A and B.

______[287]

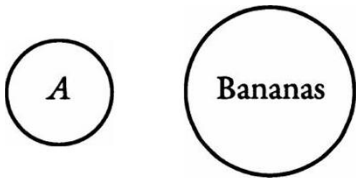
Letting A be the class of apples. In the two diagrams below the sentence "All apples are bananas" is true (even though the sentence is false in the real world):



287 Notice that in this diagram every Texan A is outside America B and thus is a non-American. So this possible world isn't the actual world.



But notice the difference in the two diagrams. In the one on the left some bananas fail to be apples. This is not so in the diagram on the right. In the second diagram, the class of apples and the class of bananas are the same class. A diagram of the real-world relationships between apples and bananas would instead look like this:



CONCEPT CHECK

Draw a diagram for apples and fruit in which the following sentence *isn't* true in the diagram: "All apples are fruit." The sentence is true in the real world, but it won't be in the possible world represented by your diagram.

[288]

With a sentence such as "All apples are fruit," the analyst has the option of treating it in class logic or in sentential logic. In class logic, it is logically equivalent to "All things in the class of apples are also things in the class of fruit." This states a relationship between two classes. In sentential logic, the sentence is logically equivalent to "If it's an apple, then it's a fruit." This states a conditional relationship between two sub-sentences.

We can now generalize the diagram method to a technique for assessing the deductive validity of arguments, provided that the sentences constituting the argument describe how classes of objects are related to each other. **The Venn-Euler diagram method of assessing arguments works only for deductive arguments in class logic**. It shows an argument to be valid if there is no diagram of a counterexample to the argument. By definition, the counterexample to an argument is a possible situation or an interpretation of the argument showing how it could have true premises and a false conclusion.

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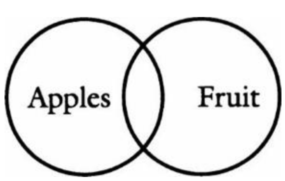
288 There is more than one kind of diagram that will work.



In class logic, an argument is valid if there is no diagram of a counterexample.

More specifically, here is **how to apply the method of checking for validity** in class logic:

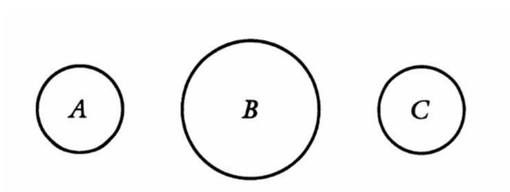
> Translate the premises and conclusion of the argument into appropriate sentences of class logic. Search for a counterexample. That is, try to diagram these sentences in class logic so that the premises come out true in the diagram and the conclusion comes out false in the diagram. If there is a diagram like this, then this counterexample diagram shows that the argument is deductively invalid. However, if all possible diagrams fail to produce a counterexample, then the argument is declared to be deductively valid.

This method never gives an incorrect answer if you have actually correctly examined all possible diagrams. An argument is valid if there *exists* no counterexample, not merely if you can't find one. Maybe you can't find one because you didn't look carefully. So, the application of the method of Venn-Euler diagrams is risky since its answer depends on you being correct when you say you've looked and are confident that no counterexample exists.

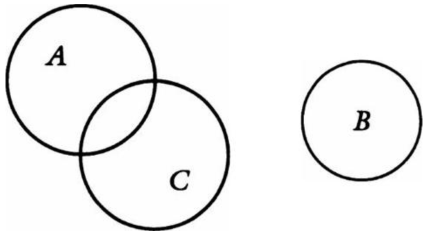
To see the technique in action, let's try it out on this argument pattern:

> No A are B.
>
> No C are B.
>
> So, No A are C.

Here is a diagram that makes all the premises be true:



None of the circles intersect or are contained within another. In this diagram the conclusion is true. Can we conclude that the argument pattern is valid? No, not from this information. We should instead have been searching to make sure that there is no diagram that makes the premises true but the conclusion *false*. In fact, there is such a diagram:



Here the conclusion is false when the premises are true, a telltale sign of invalidity. Therefore, the diagram method declares the argument pattern to be invalid.

———CONCEPT CHECK———

Use the diagram method to show the validity of this argument pattern:

All A are B.

All B are C.

So, All A are C.

———[289]

———CONCEPT CHECK———

Use the diagram technique to assess the validity or invalidity of this argument. Remember to interpret *some* to mean "at least one but not all."

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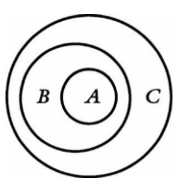
289 Here is a way to draw a diagram of both the premises being true



There can be other diagrams of the premises: permit circle A to equal circle B, or for B to equal C. However, in all the possible diagrams of the premises, the conclusion comes out true in the diagram. So, no counterexample can be produced. Therefore, the Venn-Euler technique declares this argument pattern to be valid.

Some cats are felines.

Some animals are felines.

So, some animals are cats.

[290]

When trying to find the logical form of an argument, it is not always possible to tell whether you should look for its form in class logic or in sentential logic. Experiment to see what will work. Some arguments have logical forms that cannot be expressed adequately either way, and then more powerful logics such as predicate logic must be brought to bear on the argument.

In addition, some arguments are deductively valid although their validity is not a matter of logical form using any formal logic. Here is an example:

John is a bachelor.

So, he is not married.

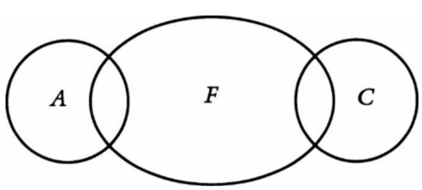
The validity is due not just to form, but to content — in particular, to the fact that the definition of *bachelor* implies that all bachelors are not married. We could force this argument to be valid due to its logical form in class logic if we could encode the idea that all bachelors are not married into class logic, and we can. Just add the premise: All bachelors are not married. Valid arguments that don't need the insertion of definitions are called *formally valid*. All formally valid arguments are deductively valid, but the reverse doesn't hold. However, in our course we won't pay attention to this fine distinction. If you see that a definition is needed to make the argument be valid, go ahead and insert it and don't worry about the fact that this shows your argument is deductively valid but not formally valid.

290 The argument is invalid; the following diagram serves as a counterexample:

Some C are F.

Some A are F.

Some A are C.



Venn-Euler diagrams have other uses besides checking for validity. If two sentences can have the same diagram, then they are *logically equivalent* in class logic. The diagrams also can be used to check for consistency. If there is a diagram in which each sentence in a set of sentences comes out true, then the set is *logically consistent*.

The Logic of *Only* in Class Logic

Consider whether these two sentences are logically equivalent:

> Only Americans are Texans.
>
> Only Texans are Americans.

They aren't equivalent. One way to tell is that in the real world one is true and one is false. Logically equivalent sentences are true together or false together. The first sentence is saying, "If you are in the class of Texans, then you are in the class of Americans." The second sentence is saying, "If you are in the class of Americans, then you are in the class of Texans."

Diagrams can be useful for demonstrating the logical relations of sentences containing the tricky word *only*. Let TX be the set or class of Texans, and let USA be the set of Americans. Then "Only Americans are Texans" has this diagram:

and "Only Texans are Americans" has this diagram:

Now it is clear that the two sentences are not saying the same thing and so are not logically equivalent. If they said the same thing, they'd have the same diagram.

Would it be OK to say only Europeans are Greek? Hmm. We will come back to this question in a moment.

———CONCEPT CHECK———

Use the Venn-Euler diagram technique to show the validity or invalidity of the following argument:

Only living things have children.

A computer does not have children.

So, a computer is not a living thing.

———[291]

To abstract from these examples, the main points about the logic of the word *only* are that the class logic statement

Only A's are B's

is logically equivalent to the class logic statement

All B's are A's.

Both of those statements are equivalent to the conditional statement

If anything is a B, then it's an A.

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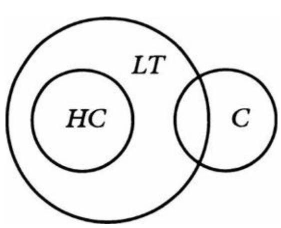
291 The argument is invalid because in the following diagram the premises come out true but the conclusion doesn't:



HC = the class of things that have children

LT = the living things

C = computers

———CONCEPT CHECK———

Create a counterexample to the following argument by producing a logically analogous argument that is more obviously invalid:

Only Simbidians are Greek. So, only Greeks are Simbidians.

———[292]

Now let's examine some complicated arguments that depend crucially on the word *only*. Is the following argument deductively valid?

Only living things can have feelings.

A computer is not a living thing.

So, a computer cannot have feelings.

Also, is the following argument valid?

Only living things can have feelings.

A computer does not have feelings.

So, a computer is not a living thing.

Both of these arguments appear to be valid to many people who hold certain views about artificial intelligence. Yet these people are being illogical.

———CONCEPT CHECK———

Are *either* of the previous two arguments about computers deductively valid?

———[293]

292 Consider the situation in which a "Simbidian" is a European. In this situation, the argument has a true premise and a false conclusion. I made up the word Simbidian; you won't find it in the dictionary.

293 The first argument is valid.

Review of Major Points

This chapter focused on the logical forms of arguments in Aristotle's class logic. For deductive arguments involving class relationships, Venn-Euler diagraming is a useful picture method for assessing validity or invalidity. The method is applied to an argument by attempting to discover a counterexample to the argument. If one is found, the argument is deductively invalid. But if none can be found, then the argument is valid.

Glossary

class logic The logic developed by Aristotle that turns on the relationships among classes of things, especially the classes referred to by the subjects and predicates of sentences whose verb is a form of "to be."

complement The complement of a class is all the things not in the class.

counterexample to an argument A state of affairs, real or imagined, in which the premises of the argument turn out to be true and the conclusion turns out to be false.

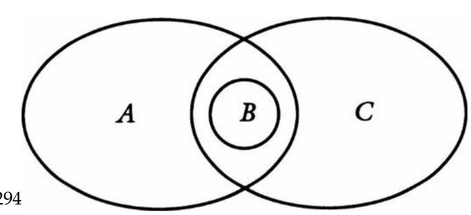
formally valid Deductively valid because of its logical form.

Venn-Euler diagram Diagram representing the class inclusion and class membership relationships.

Venn-Euler diagram method A method of determining the validity of arguments in class logic by using diagrams in order to produce a counterexample to the argument, if one exists.

Exercises

■ 1. Find three classes in the real world that have the relationships indicated in the following diagram:



[294]

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294 A = fruit, B = oranges, C = things that grow on trees.

2. Draw a diagram in which the following statement is true, and draw one in which it is false: "Only non-handheld things are returnable." Be sure to define your labels.

■ 3. Draw a diagram in which it is true that although no Americans are voters, some of them are free and some aren't, yet all of them are rich. In your diagram, are all the voters rich?[295]

4. If all A are C but no C are B, then are some A also C?

■ 5. Finding something that has both properties W and T tends to confirm the statement "All W are T"; for example, finding a black raven tends to confirm the statement "All ravens are black."

a. true b. false[296]

6. If all non-black things are non-ravens, then you can be sure there are no albino ravens.

a. true b. false

7. Assuming that all non-black things are non-ravitious, it follows with certainty that all nonravitious things are non-black.

a. true b. false

8. Even if all ravens are black, it would not necessarily be the case that everything that is not black fails to be a raven.

a. true b. false

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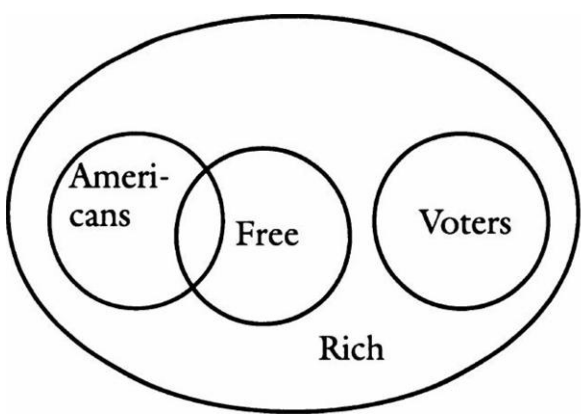
295 There are many acceptable diagrams. The relationship between voters and rich people is not fixed by the sentence. Consequently, you have leeway about where the voters' region can go. It can go outside the rich area, it can intersect it, or it can be wholly within it — provided that the voter area is wholly separate from the American area. In the following diagram all the voters are rich, but this need not be true in other acceptable diagrams.



296 Answer (a).

9. The sentence can be used to express an invalid argument. Turn it into a deductively valid argument by adding the word *only*.

> Children pay no taxes at all, because children are not adults and because adults pay taxes.

■ 10. Give the logical form of the following argument in class logic. Define your new symbols, but let M = the class of modern works of art. Draw the relevant diagrams for assessing the deductive validity of the argument. Assess its validity by referring to your diagram(s): that is, say, "These diagrams show that the argument is valid (or invalid) because . . ."

> Since all modern works of art are profound works of art, but not all profound works of art are modern works of art, and because some religious works of art are modern works of art, even though some aren't, it follows that some religious works of art fail to be profound.[297]

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297 Although you weren't asked for the standard form, here it is:

> All modern works of art are profound works of art.
>
> Not all profound works of art are modern works of art.
>
> Some religious works of art are modern works of art.
>
> Some religious works of art are not modern works of art.
>
> Some religious works of art fail to be profound.

The logical form of the argument is:

> All M are P.
>
> Not all P are M.
>
> Some R are M.
>
> Some R are not M.
>
> Some R are not P.

where we used these definitions:

> M = (the class of) modern works of art
>
> P = the profound works of art

■ 11. The Venn-Euler diagram technique is a way of testing whether something is wrong (invalid) with the pattern of arguments that are about classes of things.

a. true b. false[298]

12. Given a class logic argument that is deductively valid but unsound, the diagram technique can show why it is unsound.

a. true b. false

13. Use the method of diagrams to determine the validity or invalidity of the following argument:

There are doctors who aren't rich, because all doctors are professionals yet some professionals are not rich.

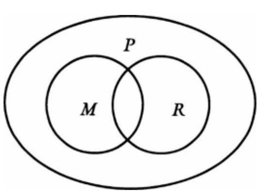
14. If no items from column C are nondeductible, and if column C is not empty of items, then can we infer with certainty that at least one item from column C is deductible?

■ 15. Is this argument deductively valid?

Some anthropoids are surreptitious and some aren't; hence there are brazen things that aren't anthropoids because all surreptitious beings are brazen.[299]

JR. = religious works of art

"Not all P are M" means that not all members of P are members of M.



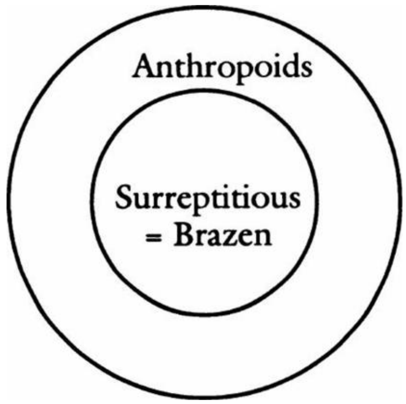
This diagram shows that the argument is deductively invalid because the diagram makes the premises (of the logical form) true while the conclusion is false.

298 Answer (a).

299 It is invalid because of the possibility of the situation shown in the following diagram:

■16. Is this argument deductively valid? Use the method of diagrams, and show your work.

> There are prize winners who aren't avaricious, because every early entrant is a prize winner and because one or more avaricious beings did enter early, though some didn't.[300]



300 To find the answer, translate it into the kind of English that more obviously talks about classes and that uses the terms all, some, and none in place of their equivalents.

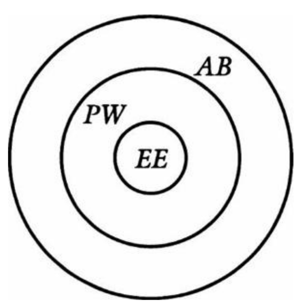
All early entrants are prize winners.
Some avaricious beings are early entrants.
<u>Some avaricious beings are not early entrants.</u>
Some prize winners aren't avaricious.

The logical form of the above is:

All EE are PW.
Some AB are EE.
<u>Some AB are not EE.</u>
Some PW are not AB.
Where

EE = (the class of) early entrants
PW = (the class of) prize winners
AB = (the class of) avaricious beings

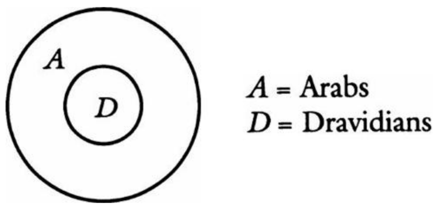
Goal: To draw a diagram showing that the argument can have true premises while having a false conclusion — the sure sign of deductive invalidity. The diagram below achieves this goal:



17. Is this argument deductively valid? Use the method of diagrams, and show your work.

> There are prize winners who aren't avaricious, because all early entrants are prize winners and some avaricious persons entered early and some early entrants aren't avaricious.

18. Is the statement "Some Arabs are Dravidians" true in the following diagram?



a. yes   b. no   c. depends on the meaning of *same*

19. Is this argument deductively valid? First, consider whether the argument is best handled with sentential logic or class logic.

> The moon maidens don't like Miller Lite. If the Beast controls planet Gorp, then Xenon is in power on that moon. If Xenon is in power on that moon, then the moon maidens like Miller Lite. So the Beast doesn't control planet Gorp.

Give the logical form of the argument. Define your terms.

20. One of the following two arguments is deductively valid, and the other is not. Identify the invalid one, and use the method of Venn-Euler diagraming to defend your answer.

A = Arabs   D = Dravidians

a. There are biopical persons who aren't devious because some devious persons are not surreptitious, and some are, and because a person is surreptitious only if he or she is biopical.

b. There are biopical persons who aren't devious because some surreptitious persons are not devious, and some are, and because any person is biopical if he or she is surreptitious.

21. Use the technique of diagrams to assess the validity of the following arguments:

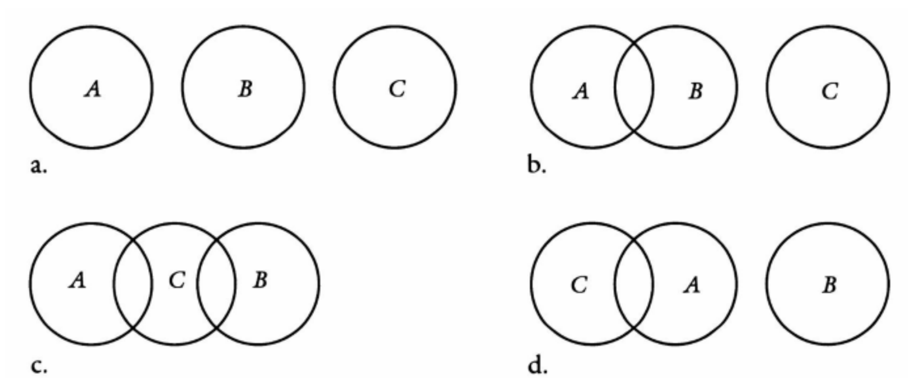
a. If some A are C, and all C are R, then some R must be A

b. No A are B.	c. No A are B.
Some B are C.	All B are C.

So, no A are C. So, no A are C.

22. Which diagram demonstrates the deductive invalidity of the following argument?

No apes are bears.
No bears are cats.
So, no apes are cats.



23. Draw a diagram that will demonstrate the deductive invalidity of the following argument that might be given by a political liberal who isn't reasoning logically:

> No conservatives in Congress are for helping humanity, because all supporters of legislation to increase welfare programs want to help humanity, yet none of the conservatives support legislation to increase welfare programs.

24. Are the following statements logically consistent with each other? Use diagrams to defend your answer.

> Not only are no bluejays arachnids, but no dialyds are either. Still, some bluejays are catalytic, but not all are. Anything catalytic is a dialyd.

■ 25. To say that all the people who go to this restaurant are kids is to say something logically equivalent to

a. Only the people who go to this restaurant are kids.

b. Only kids (are the people who) go to this restaurant.

c. Neither a nor b.

d. Both a and b.[301]

■ 26. Which pairs of statement forms from the following list are logically equivalent to

each other? In answering, use only the lowercase letters, not the statement forms themselves.

a. No Aare B. b. No B are A

c. All are not-B. d. All not-B are A.

e. Only not -A are B.[302]

27. Which pairs of statements from the following list are logically equivalent to each other? In answering, use only the letters, not the statements. Hint: Use Aristotelian logic.

a. Every hand-held thing is nonreturnable.

b. No returnable thing is hand-held.

c. All nonreturnable things are hand-held.

d. Only non-hand-held things are returnable.

e. No hand-held thing is returnable.

■ 28. Are these logically equivalent? If not, why not?

a. Not all profound works of art are modern.

b. Not all profound works of art are modern works of art.[303]

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301 Answer (b).

302 All pairs from the group {a, b, c, d} are logically equivalent.

303 Yes, they say the same thing, using the principle of charity. They are different grammatically but not logically. It is possible to interpret the first as meaning mean modern in time and the second as meaning modern in style. However, if you make the latter point, you

29. During Ronald Reagan's presidency, the United States Attorney General Edwin Meese III criticized the Supreme Court's Miranda decision that spelled out the legal rights of accused persons that the police must respect. Meese said, "The thing is, you don't have many suspects who are innocent of a crime. ... If a person is innocent of a crime, then he is not a suspect." One of the following statements is logically equivalent to what Meese said in his last sentence. That is, Meese said

a. If a person is not innocent of a crime, he is not a suspect.

b. No suspects in a crime are innocent.

c. No persons who are not innocent of a crime are suspects.

d. All suspects in crimes are innocent.

e. If a person is innocent of a crime, then he is not guilty of the crime.

■ 30. Let's try out some more terminology from everybody's friend, the United States Internal Revenue Service.

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should also notice that the two could be (better yet, are likely to be) logically equivalent; it is wrong to say they definitely are not equivalent. In fact, if the two sentences were used in a piece of reasoning and they did have different meanings, and if the context didn't make this clear, the reasoner would be accused of committing the fallacy of equivocation.

If no items from column C are deductible, then can we infer with certainty that no deductible items are from column C? How about vice versa? What can you conclude about whether the two statements are logically equivalent?[304]

31. *Sofa* and *couch* are equivalent terms — that is, they are synonymous. Now consider the term *weird*. Is the term closer to being equivalent to *unusual* or instead to *very unusual*? If someone disagreed with you about this, what could you do to prove the person wrong?

32. To say that only the people who go to this restaurant are kids is to say something logically equivalent to

- a. All the people who go to this restaurant are kids.
- b. All kids go to this restaurant.
- c. Neither a nor b.
- d. Both a and b.

■ 33. Suppose someone says, "Only kids go to Chuck E. Cheese restaurants."

- i. Would the following sentence, if true, be a counterexample?

  Some kids in Russia don't go to Chuck E. Cheese restaurants.

- ii. How about this as a counterexample instead?

  I'm an adult, not a kid, and I go to Chuck E. Cheese restaurants.[305]

34. Consider this argument:

> All cylinders contain petroleum, since each one has a blue top and only petroleum containers have blue tops.
>
> Does it follow from the second premise that some things can have blue tops but not be petroleum containers?

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304 Yes. Yes. They are equivalent; they are two ways of saying the same thing.

305 i. no ii. yes

photo by Ferenghi