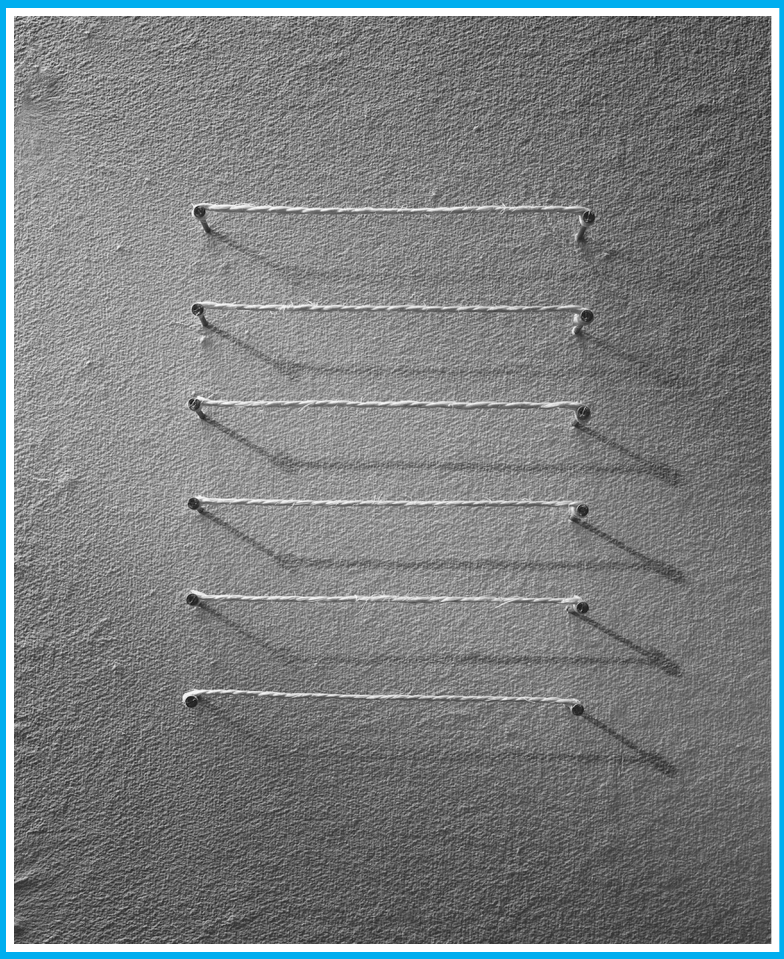
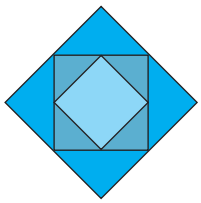




Chapter 1

Basic Concepts

Everyone thinks. Everyone reasons. Everyone argues. And everyone is subjected to the reasoning and arguing of others. We are bombarded daily with reasoning from many sources: books, speeches, radio, TV, newspapers, employers, friends, and family.

Some people think well, reason well, and argue well. Some do not. The ability to think, reason, and argue well is partly a matter of natural gifts. But whatever our natural gifts, they can be refined and sharpened. And the study of logic is one of the best ways to refine one's natural ability to reason and argue. Through the study of logic, one learns strategies for thinking well, common errors in reasoning to avoid, and effective techniques for evaluating arguments.

But what is logic? Roughly speaking, **logic** is the study of methods for evaluating arguments. More precisely, logic is the study of methods for evaluating whether the premises of an argument adequately support (or provide good evidence for) its conclusion. To get a better grasp of what logic is, then, we need to understand the key concepts involved in this definition: *argument*, *premise*, *conclusion*, and *support*. This chapter will give you an initial understanding of these basic concepts.

An **argument** is a set of statements, one of which, called the *conclusion*, is affirmed *on the basis* of the others, which are called the *premises*. The premises of an argument are offered as support (or evidence) for the conclusion, and that support (or evidence) may be adequate or inadequate in a given case. But the set of statements counts as an argument as long as one statement is affirmed on the basis of others. Here is an example of an argument:

1. All Quakers are pacifists. Jane is a Quaker. So, Jane is a pacifist.

The word "so" indicates that the conclusion of this argument is "Jane is a pacifist." And the argument has two premises—"All Quakers are pacifists" and "Jane is a Quaker."

An **argument** is a set of statements, one of which, called the *conclusion,* is affirmed *on the basis* of the others, which are called the *premises*.

What is a statement? A **statement** is a sentence that is either true or false. For example:

2. Some dogs are collies.
3. No dogs are collies.
4. Some dogs weigh exactly 124.379 pounds.

Statement (2) is true—that is, it describes things as they are. And (3) is false because it describes things as other than they are. Truth and falsehood are the two possible **truth values**. So, we can say that a statement is a sentence that has truth value. The truth value of (2) is *true* while the truth value of (3) is *false*, but (2) and (3) are both statements. Is (4) a statement? Yes. You may not know its truth value, and perhaps no one does, but (4) is either true or false, and hence it is a statement.

Are any of the following items statements?

5. Get your dog off my lawn!
6. How many dogs do you own?
7. Let's get a dog.

Item (5) is a *command*, and one may obey or disobey a command, but it makes no sense to pronounce it true or false. So, although (5) is a sentence, it is not a statement. Item (6) is a *question*, and as such it is neither true nor false; hence, it is not a statement. Finally, item (7) is a *proposal*, and proposals are neither true nor false, so (7) is not a statement.[1]

The **premises** of an argument are the statements on the basis of which the conclusion is affirmed. To put it the other way around, the **conclusion** is the statement that is affirmed on the basis of the premises. In a well-constructed argument, the premises *give good reasons for believing that the conclusion is true*. But a poorly constructed argument is still an argument. For example, compare the following arguments:

8. All uncles are male. Chris is an uncle. Hence, Chris is male.
9. Some uncles are skinny. Chris is an uncle. So, Chris is skinny.

The premises of argument (8) support (or provide a basis for) the conclusion in this sense: If they are true, then the conclusion must be true. But the premises of (9) fail to support the conclusion adequately: Even if true, they do not provide

good reason to believe that the conclusion is true. So, (9) is a bad argument, but it is still an argument.

Arguments are used frequently in our verbal and written interactions with others. And we may use arguments either to *persuade* others or to *discover truth*. For example, we often use arguments to persuade others to believe our political or ethical views. But we also use arguments as tools for *discovering truth*. Suppose a detective is investigating a crime: Who shot Alvin Smith? There are only two suspects, Griggs and Brooks. The detective establishes that Brooks was out of town at the time of the shooting and argues as follows:

10. Either Brooks or Griggs shot Smith. Brooks did not shoot Smith. Therefore, Griggs shot Smith.

In this case, the argument is used to discover truth. Of course, a given argument can be used *both* to discover truth *and* to persuade others to believe the conclusion. Persuasion and truth seeking are often compatible goals. Sometimes, however, one of these goals interferes with the other. For example, in a political campaign, one candidate might try to persuade the voters that his opponent is dishonest even though he knows his opponent is honest.

We now have a preliminary understanding of what logic is. We can gain a deeper understanding by taking a closer look at what it means for the conclusion of an argument to be adequately *based on* or *supported by* the premises. And we can best do this by exploring the basic concepts introduced in the remaining sections of this chapter—concepts such as validity, soundness, argument form, strength, and cogency.

Logic is the study of methods for evaluating whether the premises of an argument adequately support (or provide good evidence for) its conclusion.

1.1 Validity and Soundness

A valid argument is one in which the premises support the conclusion *completely*. More formally, a **valid argument** has this essential feature: It is necessary that if the premises are true, then the conclusion is true. Two key aspects of this definition should be noted immediately. First, note the important word "necessary." In a valid argument, there is a *necessary connection* between the premises and the conclusion. The conclusion doesn't just happen to be true given the premises; rather, the truth of the conclusion is *absolutely guaranteed* given the truth of the premises. We could put this negatively by saying that a valid argument has this characteristic: It is *impossible* for the conclusion to be false assuming that the premises are true. Second, note the conditional (if–then) aspect of the definition. It does *not* say that the premises and conclusion of a valid

argument are in fact true. Rather, the definition says that, necessarily, *if* the premises are true, *then* the conclusion is true. In other words, if an argument is valid, then *on the assumption that* its premises are true, its conclusion must be true also. Each of the following arguments is valid:

11. All biologists are scientists. John is not a scientist. So, John is not a biologist.
12. If Alice stole the diamonds, then she is a thief. And Alice did steal the diamonds. Hence, Alice is a thief.
13. Either Bill has a poor memory or he is lying. Bill does not have a poor memory. Therefore, Bill is lying.

In each case, it is necessary that if the premises are true, then the conclusion is true. Notice that one doesn't have to know whether the premises of an argument actually *are* true in order to determine its validity. One simply has to ascertain that the conclusion must be true *assuming* the premises are true.

In everyday English, the word "valid" is often used simply to indicate one's overall approval of an argument. But logicians focus their attention on the linkage between the premises and the conclusion rather than on the actual truth or falsity of the statements composing the argument. Thus, "valid" has a less precise meaning in ordinary English than it does for logicians.

The following observations about validity may help prevent some common misunderstandings. First, notice that an argument can have one or more *false* premises and still be valid. For instance:

14. All birds have beaks. Some cats are birds. So, some cats have beaks.

Here, the second premise is plainly false, and yet the argument is valid, for *on the assumption* that the premises are true, the conclusion must be true also. And in the following argument, both premises are false, but the argument is still valid:

15. All sharks are birds. All birds are politicians. So, all sharks are politicians.

Although the premises of argument (15) are in fact false, if they *were* true, the conclusion would *have* to be true as well. It is *impossible* for the conclusion to be false *assuming that* the premises are true. So, the argument is valid.

Second, we cannot rightly conclude that an argument is valid simply on the grounds that its premises are all true. For example:

16. Some Americans are women. Tom Hanks is an American. Therefore, Tom Hanks is a woman.

The premises here are true, but the conclusion is in fact false. So, obviously, it is *possible* that the conclusion of argument (16) is false while its premises are true; hence, (16) is not valid. Is the following argument valid?

17. Some Americans work in the movie industry. Meryl Streep is an American. Hence, Meryl Streep works in the movie industry.

Here, we have true premises and a true conclusion. But it is not *necessary* that if the premises are true, then the conclusion is true. (Streep could switch to another line of work while remaining an American.) So, even if an argument has true premises and a true conclusion, it isn't necessarily valid, for the premises may not support the conclusion in the right way. (Of course, in many cases, we simply do not know whether the premises of an argument are true or false, and yet we may know that the argument is valid.) Thus, the question "Are the premises actually true?" is distinct from the question "Is the argument valid?"

Third, suppose an argument is valid and has a false conclusion. Does it necessarily have at least one false premise? Yes. If it had true premises, then it would have to have a true conclusion, since it is valid. *Validity preserves truth;* that is, if we start with truth and reason in a valid fashion, we will always wind up with truth.

Fourth, does validity also preserve falsehood? In other words, if we start with false premises and reason validly, are we bound to wind up with a false conclusion? It is tempting to answer yes because "error in its own right breeds error—if the first step in an argument is wrong, everything that follows will be wrong."[2] But the correct answer is no. Consider the following argument:

18. All dogs are ants. All ants are mammals. So, all dogs are mammals.

Is argument (18) valid? Yes. It is impossible for the conclusion of (18) to be false *assuming that* its premises are true. However, the premises here are false while the conclusion is true. So, *validity does not preserve falsehood.* In fact, false premises plus valid reasoning may lead to either truth or falsity, depending on the case. Here is a valid argument with false premises and a false conclusion:

19. All birds are cats. Some dogs are birds. So, some dogs are cats.

The lesson here is that although valid reasoning guarantees that we will end up with truth if we start with it, we may wind up with either truth or falsehood if we reason validly from false premises.

A **valid argument** has this essential feature: It is necessary that if the premises are true, then the conclusion is true.

An **invalid argument** has this essential feature: It is *not necessary* that if the premises are true, then the conclusion is true. In other words, even on the

assumption that the premises are true, the conclusion could still be false. Each of the following arguments is invalid:

20. All dogs are animals. All cats are animals. Hence, all dogs are cats.
21. If Pat is a wife, then Pat is a woman. But Pat is not a wife. So, Pat is not a woman.
22. Bill likes Sue. Therefore, Sue likes Bill.

The premises of argument (20) are in fact true, but its conclusion is false; so, (20) is obviously invalid. Argument (21) is invalid because its premises leave open the possibility that Pat is an unmarried woman. And (22) is invalid because even if Bill does like Sue, that is no guarantee that she likes him. In each of these cases, then, the conclusion could be false while (i.e., assuming that) the premises are true.

An **invalid argument** has this essential feature: It is *not necessary* that if the premises are true, then the conclusion is true.

Validity matters because true premises by themselves do not make good arguments. But we obviously want our arguments to have true premises. A **sound argument** has two essential features: *It is valid, and all its premises are true*. Notice that a sound argument cannot have a false conclusion. Because a sound argument is valid and has only true premises, it must have a true conclusion. Here are two sound arguments:

23. All collies are dogs. All dogs are animals. So, all collies are animals.
24. If Akron is in Ohio, then Akron is in the United States. Akron is in Ohio. Hence, Akron is in the United States.

Valid + All Premises True = Sound

An **unsound argument** falls into one of the following three categories:

It is valid but has at least one false premise.

It is invalid, but all its premises are true.

It is invalid *and* has at least one false premise.

In other words, an unsound argument is one that either is invalid or has at least one false premise. For example, both of the following arguments are unsound:

25. All birds are animals. Some grizzly bears are not animals. Therefore, some grizzly bears are not birds.

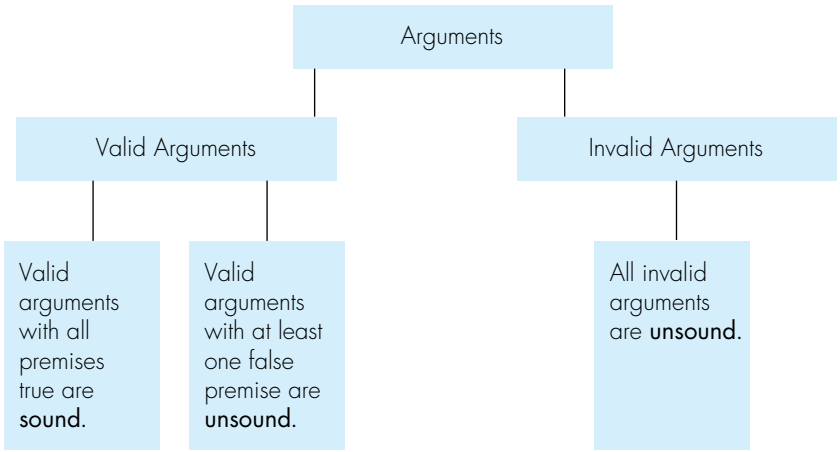
26. All birds are animals. All grizzly bears are animals. So, all grizzly bears are birds.

Argument (25) is unsound, because although it is valid, it has a false (second) premise. And (26) is unsound, because although it has true premises, it is invalid. We can easily construct an unsound argument of the third type—that is, one that both is invalid *and* has at least one false premise—by replacing "birds" in (26) with "trees":

27. All trees are animals. All bears are animals. So, all bears are trees.

An **unsound argument** is one that either is invalid or has at least one false premise.

Here is a map of the main concepts we've discussed so far:



Deductive logic is the part of logic that is concerned with tests for validity and invalidity.[3] And much of this book is devoted to an exploration of deductive logic. In fact, the next two sections will provide us with some initial tests for establishing the validity and invalidity of arguments.

A note on terminology is in order at the close of this section. Given our definitions, *arguments* are neither true nor false, but each *statement* is either true or false. On the other hand, *arguments* can be valid, invalid, sound, or unsound; but *statements* cannot be valid, invalid, sound, or unsound. Therefore, a given premise (or conclusion) is either true or false, but it cannot be valid, invalid, sound, or unsound.

Summary of Definitions

An **argument** is a set of statements, one of which, called the *conclusion*, is affirmed *on the basis* of the others, which are called the *premises*.

Logic is the study of methods for evaluating whether the premises of an argument adequately support (or provide good evidence for) its conclusion.

A **valid argument** has this essential feature: It is necessary that if the premises are true, then the conclusion is true.

An **invalid argument** has this essential feature: It is *not* necessary that if the premises are true, then the conclusion is true.

A **sound argument** has two essential features: *It is valid, and all its premises are true.*

An **unsound argument** is one that either is invalid or has at least one false premise.

Deductive logic is the part of logic that concerns tests for validity and invalidity.

The following exercises provide you with an opportunity to explore the concepts introduced in this section.

Exercise 1.1

Note: For each exercise item preceded by an asterisk, the answer appears in the Answer Key at the end of the book.

Part A: Recognizing Statements Write "statement" if the item is a statement. Write "sentence only" if the item is a sentence but not a statement. Write "neither" if the item is neither a sentence nor a statement.

* **1.** The sky is blue.

2. Let's paint the table red.

3. Please close the window!

* **4.** Murder is wrong.

5. Abraham Lincoln was born in 1983.

6. If San Francisco is in California, then San Francisco is in the U.S.A.

* **7.** It is not the case that Ben Franklin.

8. "Why?" asked Socrates.

9. Table not yes if.

* **10.** Either humans evolved from apes or apes evolved from humans.

11. Davy Crockett died at the Alamo.

12. How are you?

* **13.** If seven is greater than six, then six is greater than seven.

14. Let's have lunch.

15. Go!

* **16.** Shall we dance?

17. Patrick Henry said, "Give me liberty or give me death."

18. If punishment deters crime.

* **19.** "Stand at attention!" ordered General Bradley.

20. Despite the weather.

Part B: True or False? Which of the following statements are true? Which are false?

* **1.** All valid arguments have at least one false premise.

2. An argument is a set of statements, one of which, called the *conclusion,* is affirmed *on the basis* of the others, which are called the *premises*.

3. Every valid argument has true premises and *only* true premises.

* **4.** Logic is the study of methods for evaluating whether the premises of an argument adequately support its conclusion.

5. Some statements are invalid.

6. Every valid argument has true premises *and* a true conclusion.

* **7.** A sound argument can have a false conclusion.

8. Deductive logic is the part of logic that is concerned with tests for validity and invalidity.

9. If a valid argument has only true premises, then it must have a true conclusion.

* **10.** Some arguments are true.

11. If a valid argument has only false premises, then it must have a false conclusion.

12. Some invalid arguments have false conclusions but (all) true premises.

* **13.** Every sound argument is valid.

14. Every valid argument with a true conclusion is sound.

15. Every valid argument with a false conclusion has at least one false premise.

* **16.** Every unsound argument is invalid.

17. Some premises are valid.

18. If all of the premises of an argument are true, then it is sound.

* **19.** If an argument has (all) true premises and a false conclusion, then it is invalid.

20. If an argument has one false premise, then it is unsound.

21. Every unsound argument has at least one false premise.

* **22.** Some statements are sound.

23. Every valid argument has a true conclusion.

24. Every invalid argument is unsound.

* **25.** Some arguments are false.

26. If an argument is invalid, then it must have true premises and a false conclusion.

27. Every valid argument has this feature: Necessarily, if its premises are true, then its conclusion is true.

* **28.** Every invalid argument has this feature: It is possibly false that if its premises are true, then its conclusion is true.

29. Every sound argument has a true conclusion.

30. Every valid argument has this feature: Necessarily, if its premises are false, then its conclusion is false.

Part C: Valid or Invalid? Much of this text concerns methods of testing arguments for validity. While we have not yet discussed any particular methods of testing arguments for validity, we do have definitions of "valid argument" and "invalid argument." Based on your current understanding, which of the following arguments are valid? Which are invalid?

* **1.** If Lincoln was killed in an automobile accident, then Lincoln is dead. Lincoln was killed in an automobile accident. Hence, Lincoln is dead.

2. If Lincoln was killed in an automobile accident, then Lincoln is dead. Lincoln was not killed in an automobile accident. Therefore, Lincoln is not dead.

3. If Lincoln was killed in an automobile accident, then Lincoln is dead. Lincoln is dead. So, Lincoln was killed in an automobile accident.

* **4.** If Lincoln was killed in an automobile accident, then Lincoln is dead. Lincoln is not dead. Hence, Lincoln was not killed in an automobile accident.

5. Either 2 plus 2 equals 22 or Santa Claus is real. But 2 plus 2 does not equal 22. Therefore, Santa Claus is real.

6. Either we use nuclear power or we reduce our consumption of energy. If we use nuclear power, then we place our lives at great risk. If we reduce our consumption of energy, then we place ourselves under extensive governmental control. So, either we place our lives at great risk or we place ourselves under extensive governmental control.

* **7.** All birds are animals. No tree is a bird. Therefore, no tree is an animal.

8. Some humans are comatose. But no comatose being is rational. So, not every human is rational.

9. All animals are living things. At least one cabbage is a living thing. So, at least one cabbage is an animal.

* **10.** Alvin likes Jane. Jane likes Chris. So, Alvin likes Chris.

11. All murderers are criminals. Therefore, all nonmurderers are noncriminals.

12. David is shorter than Saul. Saul is shorter than Goliath. It follows that David is shorter than Goliath.

* **13.** It is possible that McGraw will win the next presidential election. It is possible that Lambert will win the next presidential election. Thus, it is possible that both McGraw and Lambert will win the next presidential election.

14. All physicians are singers. Madonna is a physician. Therefore, Madonna is a singer.

15. Samuel Morse invented the telegraph. Alexander Graham Bell did not invent the telegraph. Consequently, Morse is not identical with Bell.

Part D: Soundness Which of the following arguments are sound? Which are unsound? If an argument is unsound, explain why.

* **1.** All cats are mammals. All mammals are animals. So, all cats are animals.

2. All collies are dogs. Some animals are not dogs. So, some animals are not collies.

3. All citizens of Nebraska are Americans. All citizens of Montana are Americans. So, all citizens of Nebraska are citizens of Montana.

* **4.** "Let's party!" is either a sentence or a statement (or both). "Let's party!" is a sentence. So, "Let's party!" is not a statement.

5. No diamonds are emeralds. The Hope Diamond is a diamond. So, the Hope Diamond is not an emerald.

6. All planets are round. The earth is round. So, the earth is a planet.

* **7.** If the Taj Mahal is in Kentucky, then the Taj Mahal is in the U.S.A. But the Taj Mahal is not in the U.S.A. So, the Taj Mahal is not in Kentucky.

8. All women are married. Some executives are not married. So, some executives are not women.

9. All mammals are animals. No reptiles are mammals. So, no reptiles are animals.

* **10.** All mammals are cats. All cats are animals. So, all mammals are animals.

11. Wilber Wright invented the airplane. Therefore, Orville Wright did not invent the airplane.

12. All collies are dogs. Hence, all dogs are collies.

* **13.** William Shakespeare wrote *Hamlet*. Leo Tolstoy is identical with William Shakespeare. It follows that Leo Tolstoy wrote *Hamlet*.

14. If San Francisco is in Saskatchewan, then San Francisco is in Canada. But it is not true that San Francisco is in Saskatchewan. Hence, it is not true that San Francisco is in Canada.

15. Either Thomas Jefferson was the first president of the U.S.A. or George Washington was the first president of the U.S.A., but not both. George Washington was the first president of the U.S.A. So, Thomas Jefferson was not the first president of the U.S.A.

1.2 Forms and Counterexamples

We have seen that deductive logic is the part of logic that concerns tests for validity and invalidity. This section introduces the concept of an argument form and explains how an understanding of argument forms can be used to establish that an argument is valid or invalid.

Consider the following two arguments:

28. 1. All oaks are trees.
    2. All trees are plants.
    So, 3. All oaks are plants.

29. 1. All emotivists are prescriptivists.
    2. All prescriptivists are metaethicists.
    So, 3. All emotivists are metaethicists.

These two arguments have the same *form*—that is, they exemplify the same pattern of reasoning. We can represent the form as follows:

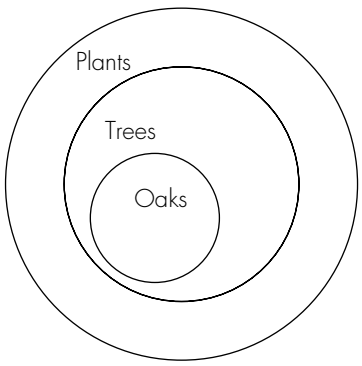
Form 1

1. All *A* are *B*.
2. All *B* are *C*.

So, 3. All *A* are *C*.

Here, the letters *A*, *B*, and *C* stand for *terms*. For the purposes of this chapter, let us say that a **term** is a word or phrase that stands for a class (i.e., collection or set) of things, such as the class of oaks or the class of trees. Thus, the words "oaks," "trees," and "plants" are terms in argument (28) above. (Certain descriptive phrases such as "oak trees less than 2 years old" also count as terms in the sense defined.) Form 1 provides a representation of the pattern of reasoning common to arguments (28) and (29). With regard to (28), *A* stands for the term "oaks," *B* for the term "trees," and *C* for the term "plants." With regard to (29), *A* stands for the term "emotivists," *B* stands for the term "prescriptivists," and *C* stands for the term "metaethicists."

Argument (28) is clearly valid: If all members of class *A* (oaks) are members of class *B* (trees), and all members of class *B* (trees) are members of class *C* (plants), then all members of *A* (oaks) are members of *C* (plants). We can diagram the logic as follows:



And as regards argument (29), even if its technical terms are unfamiliar, one can still see that if its premises are true, its conclusion must be true as well; hence, it is valid. In fact, any argument having Form 1 will have the following feature: On the assumption that its premises are true, its conclusion must be true. Thus, *the validity of the argument is guaranteed by its form and does not depend on its content* (i.e., its specific subject matter).

Using Form 1, we can generate valid arguments at will by substituting terms for the letters *A*, *B*, and *C*. An argument that results from uniformly replacing letters with terms (or statements) in an argument form is called a **substitution instance** of that form. Note that the replacement must be uniform. For example, if "oaks" replaces *A* in one instance, "oaks" must replace *A* in all instances. (In this section, we will focus primarily on argument forms in which the letters stand for terms; in the next section, we will focus on argument forms in which the letters stand for statements.)

Here is another valid form of argument, along with two substitution instances:

Form 2

1. All *A* are *B*.
2. Some *C* are not *B*.

So, 3. Some *C* are not *A*.

Substitution Instances

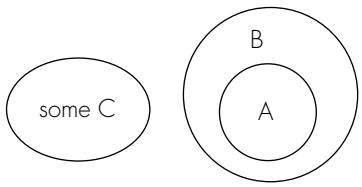
30. 1. All emeralds are gems.
    2. Some rocks are not gems.

    So, 3. Some rocks are not emeralds.

31. 1. All collies are dogs.
    2. Some animals are not dogs.

    So, 3. Some animals are not collies.

In argument (30), "emeralds" replaces *A*, "gems" replaces *B*, and "rocks" replaces *C*. In (31), "collies" replaces *A*, "dogs" replaces *B*, and "animals" replaces *C*. Every argument having this form is valid. We can diagram the logic as follows:



Clearly, if all members of class *A* are members of class *B*, and some members of class *C* are not members of *B*, then some members of *C* are not members of *A*. Thus, necessarily, if an argument of this form has true premises, then it has a true conclusion.

An **argument form** is a pattern of reasoning.
An argument that results from uniformly replacing letters in an argument form with terms (or statements) is called a **substitution instance** of that form.

Let us now consider the relationship between form and invalidity. The following argument has true premises and a false conclusion, so it is plainly invalid.

32. 1. All birds are animals.
    2. All dogs are animals.
So, 3. All birds are dogs.

If we let *A* stand for "birds," *B* for "animals," and *C* for "dogs," we can represent the form of the argument as follows:

Form 3

1. All *A* are *B*.
2. All *C* are *B*.

So, 3. All *A* are *C*.

This argument form is invalid because it allows us to move from true premises to a false conclusion. Argument (32) proves this, for it is a substitution instance of Form 3.

The relationship between argument (32) and Form 3 suggests a procedure for showing that an argument is invalid. First, identify the form of the argument. Second, if the validity of the argument is suspect, produce a substitution instance of the argument form in which the premises are true and the conclusion is false. This will show that the argument form is invalid. Third, given that the validity of the argument depends on the form identified, we may conclude that the argument itself is invalid. Let us now make this procedure a bit more explicit and note some complications that may arise.

Consider the following argument:

33. 1. All determinists are fatalists.
    2. Some fatalists are not Calvinists.
So, 3. Some Calvinists are not determinists.

Argument (33) has this form:

Form 4

1. All *A* are *B*.
2. Some *B* are not *C*.

So, 3. Some *C* are not *A*.

We can prove that this form is invalid by producing a substitution instance that has premises known to be true and a conclusion known to be false. For example:

34. 1. All dogs are animals. [true]
    2. Some animals are not collies. [true]
So, 3. Some collies are not dogs. [false]

A substitution instance with premises known to be true and a conclusion known to be false is a **counterexample** to the form in question. A counterexample demonstrates the invalidity of an argument form by showing that the form does not preserve truth—that is, that the form can lead from true premises to a false conclusion. A good counterexample must have the following features:

It must have the correct form.

Its premises must be *well-known* truths.

Its conclusion must be a *well-known* falsehood.

A **counterexample** to an argument form is a substitution instance whose premises are *well-known* truths and whose conclusion is a *well-known* falsehood.

Counterexample (34) shows that Form 4 is invalid: "All *A* are *B*; some *B* are not *C*; so, some *C* are not *A*." And argument (33)—"All determinists are fatalists; some fatalists are not Calvinists; so, some Calvinists are not determinists"—has Form 4. Therefore, we may provisionally conclude that (33) is invalid. (The *provisional* nature of the conclusion will be explained shortly.)

Now, let's break the process of finding a counterexample down into steps. We begin with an argument:

35. 1. No capitalists are philanthropists.
    2. All philanthropists are altruists.
So, 3. No capitalists are altruists.

If we let *A* stand for "capitalists," *B* for "philanthropists," and *C* for "altruists," we can represent the form as follows:

Form 5

1. No *A* are *B*.
2. All *B* are *C*.

So, 3. No *A* are *C*.

Next, we construct a substitution instance whose premises are well-known truths and whose conclusion is a well-known falsehood. It is best to employ

terms whose interrelations are well understood—for example, simple biological terms such as "dog," "collie," "mammal," "cat," and "animal," or simple geometrical terms such as "square," "figure," "rectangle," and "circle." It often helps to begin by writing a blatantly false conclusion and then work backward. For instance:

36. 1. No dogs are *B*.
    2. All *B* are animals.
So, 3. No dogs are animals.

Notice that since "dogs" replaces *A* in the conclusion, it must also replace *A* in the first premise; and because "animals" replaces C in the conclusion, it must replace C in the second premise. Now we merely need to find a term to replace *B* with—a term that will make the premises well-known truths. "Cats" is an obvious choice. So, our completed counterexample looks like this:

37. 1. No dogs are cats.
    2. All cats are animals.
So, 3. No dogs are animals.

Because the premises are well-known truths but the conclusion is a well-known falsehood, Form 5 is invalid ("No *A* are *B*; all *B* are C; so, no *A* are C"). And we may provisionally conclude that argument (35) is invalid.

The counterexample method has some limitations and complications that should be noted at this time. First, although the counterexample method can be used to prove that an invalid argument form is invalid, it cannot show that a valid form is valid. For example, suppose we show that a given argument form has a substitution instance that has true premises and a true conclusion. Does that show that the argument form is valid? No. Invalid forms often have such substitution instances. Here is one for Form 5 ("No *A* are *B*; all *B* are C; so, no *A* are C):

38. 1. No cats are collies. [true]
    2. All collies are dogs. [true]
So, 3. No cats are dogs. [true]

Nevertheless, the argument form remains invalid because it *can* lead from true premises to a false conclusion, as counterexample (37) illustrates. Again, the point is that the counterexample method cannot establish validity, but only invalidity.

Of course, it is impossible to construct a counterexample to a valid form. If an argument form is valid, then any substitution instance with true premises is bound to have a true conclusion. This indicates a second limitation of the counterexample method. What if we suspect that an argument form is invalid but have difficulty constructing a counterexample? Perhaps the form is valid after all,

or perhaps we simply need to be more creative in thinking of substitution instances. How do we tell which? The counterexample method does not answer this question.

A minor complication that arises when constructing counterexamples concerns the word "some." In logic, the word "some" means "at least one." Hence, the statement "Some dogs are animals" is true: *At least one dog* is an animal. And "Some dogs are animals" does *not* imply that some dogs are not animals. Both of the following are true statements: "Some dogs are animals" and "All dogs are animals."

A more interesting complication regarding counterexamples stems from the fact that an argument can have more than one form. This complication explains why the counterexample method allows us to draw only *provisional* conclusions regarding the invalidity of *arguments* (as opposed to argument *forms*). Let's consider an argument having Form 1:

39. 1. All cats are mammals.
    2. All mammals are animals.
So, 3. All cats are animals.

Like all arguments having Form 1, argument (39) is valid. But suppose we let the letters *A*, *B*, and *C* stand for *statements* (instead of terms, as we have been doing). Such a use of letters is entirely legitimate; indeed, we will focus on forms in which letters stand for statements in the next section. And if we let *A* stand for the first premise, *B* for the second premise, and *C* for the conclusion, we can rightly say that argument (39) has the following form:

40. 1. A.
    2. B.
So, 3. C.

This form, however, is invalid—here is a counterexample:

41. 1. Trees exist.
    2. Frogs exist.
So, 3. Unicorns exist.

(To obtain the counterexample, simply substitute "Trees exist" for *A*, "Frogs exist" for *B*, and "Unicorns exist" for *C*.) Have we shown that argument (39) is invalid? No. We have merely shown that it has *one* form that is invalid. As a matter of fact, we might add that every argument has at least one invalid form because we can represent *any* argument as a series of statements, followed by a conclusion, along these lines: "*A; B; C; D;* so, *E*" (where the letters stand for *statements*). And it is easy to construct a counterexample similar to (41) to prove that any such form is invalid.

Very well, then. A single argument can have both valid and invalid forms. But here is a key point to remember: *An argument is valid if any of its forms is valid.* In other words, if an argument has a valid form, then it is impossible for its conclusion to be false while its premises are true. To illustrate, argument (39) is valid because it has a valid form, namely, Form 1.

We can now see why the counterexample method yields only provisional results. Suppose we have correctly identified one of the argument's forms and shown *that* form to be invalid by means of a counterexample. It remains possible—at least in theory—that the argument has an additional form that is valid. And, as we have just seen, it is not the possession of an invalid form that makes an argument invalid; rather, it is the lack of a valid form that makes an argument invalid.[4]

What good is it, then, to show that an argument has a form that is invalid? Generally speaking, if we identify the form of an argument *with due sensitivity to its key logical words and phrases*, and if the form thus identified is invalid, then the argument has no further valid form, and so it is invalid. And this is why the counterexample method is a powerful tool for evaluating arguments even though it cannot rigorously prove that a given *argument* is invalid. In addition, bear in mind that the counterexample method *can* be used to prove *rigorously* that invalid *forms* are invalid, and it is of great value for this reason also.

The following exercise gives you some practice in identifying argument forms and constructing counterexamples. In this exercise, the capital letters in the argument forms stand for terms. In the next section, we will focus on argument forms in which the capital letters stand for statements.

Process for Constructing a Counterexample

1. Identify the form of the argument, using capital letters to stand for terms (or for statements).
2. Find English terms (or statements) that, if substituted for the capital letters in the conclusion of the argument form, produce a *well-known* falsehood. Substitute these English terms (or statements) for the relevant capital letters uniformly throughout the argument form.
3. Find additional English terms (or statements) that, if substituted uniformly for the remaining capital letters in the argument form, produce premises that are *well-known* truths.
4. Check to make sure that your counterexample is a substitution instance of the argument form and that its conclusion is a *well-known* falsehood while each premise is a *well-known* truth. In checking your counterexample, here's a good question to ask yourself: "Will my classmates readily agree that the premises of my counterexample are well-known truths and that its conclusion is a well-known falsehood?"

Exercise 1.2

Counterexamples Use counterexamples to show that the following arguments are invalid. Remember, it is usually best to employ terms whose interrelations are well known, such as "dog," "cat," "collie," "animal," and "mammal."

* **1.** No genuine Americans are communist spies. Some Oregonians are not communist spies. Therefore, some Oregonians are genuine Americans.

2. All dogmatists are hypocrites. All dogmatists are bigots. So, all bigots are hypocrites.

3. All who seek public office are noble. Some who seek public office are not wise persons. So, some wise persons are not noble.

* **4.** No rock is sentient. Some mammals are sentient. Hence, no mammal is a rock.

5. All fatalists are determinists. Some predestinarians are not fatalists. So, some predestinarians are not determinists.

6. All vegetarians who refuse to eat animal products are vegans. No vegetarians who refuse to eat animal products are cattle ranchers. Hence, no vegans are cattle ranchers.

* **7.** Some intelligent people are highly immoral. All highly immoral people are unhappy. Therefore, some unhappy people are not intelligent.

8. No perfect geometrical figures are physical entities. No physical entities are circles. Therefore, no circles are perfect geometrical figures.

9. All Fabians are socialists. Some socialists are not communists. So, some Fabians are not communists.

* **10.** All trespassers are persons who will be prosecuted. Some trespassers are not criminals. So, some criminals are not persons who will be prosecuted.

11. All observable entities are physical entities. Some quarks are not observable entities. Therefore, some quarks are not physical entities.

12. No wines are distilled liquors. Some beers are not distilled liquors. So, some beers are not wines.

* **13.** All statements that can be falsified are scientific. All empirical data are scientific. Hence, all statements that can be falsified are empirical data.

14. All diligent persons are individuals who deserve praise. Some students are individuals who deserve praise. So, some students are diligent persons.

15. All black holes are stars that have collapsed in on themselves. All black holes are entities that produce a tremendous amount of gravity. So, every entity that produces a tremendous amount of gravity is a star that has collapsed in on itself.

* **16.** Every rock musician is cool. No nerd is a rock musician. Hence, no nerd is cool.

17. All miracles are highly improbable events. Some highly improbable events are cases of winning a lottery. So, some cases of winning a lottery are miracles.

18. No positrons are particles with a negative charge. No neutrons are particles with a negative charge. Therefore, some positrons are neutrons.

* **19.** All people who despise animals are neurotic. No veterinarian is a person who despises animals. Hence, no veterinarian is a neurotic.

20. All destructive acts are evil. Some wars are evil. So, some wars are destructive acts.

1.3 Some "Famous" Forms

We have seen how the concept of an argument form can be used to establish that an argument is invalid. And we have seen that if an argument has a valid form, then it is valid. In this section, we will identify some forms that occur so often that they have been given names by logicians. Five of these forms are valid, and two are invalid. Because these forms appear very frequently, let us call them "famous" forms. Prior to identifying these forms, however, we need to understand conditional ("if-then") statements because some of the most important argument forms centrally involve conditional statements.

Understanding Conditional Statements

Each of the following are conditional statements (often called simply "conditionals" by logicians):

42. If it is snowing, then the mail will be late.

43. If Abraham Lincoln was born in 1709, then he was born before the American Civil War.

44. If Abraham Lincoln was born in 1809, then he was born after the American Civil War.

Conditionals have several important characteristics. First, note the components of conditionals. The if-clause of a conditional is called its **antecedent**; the then-clause is called the **consequent**. But the antecedent does not include the word "if." Hence, the antecedent of statement (42) is "it is snowing," not "*If* it is snowing." Similarly, the consequent is the statement following the word "then," but it does not include that word. So, the consequent of (42) is "the mail will be late," not "*then* the mail will be late."

Second, conditionals are hypothetical in nature. Thus, in asserting a conditional, one does not assert that its antecedent is true. Nor does one assert that its consequent is true. Rather, one asserts that *if* the antecedent is true, *then* the consequent is true. Thus, statement (43) is a true conditional even though its antecedent is false (Lincoln was born in 1809, not 1709). If Lincoln was born in 1709, then, of course, his birth preceded the American Civil War, which began in 1861. And (44) is a false conditional even though its antecedent is true. If Lincoln was born in 1809, then he certainly was not born *after* the American Civil War.

Third, there are many ways to express a conditional in ordinary English. Consider the following conditional statement:

45. If it is raining, then the ground is wet.

Statements (a) through (f) following are all **stylistic variants** of (45), that is, alternate ways of saying the same thing:[5]

a. *Given that* it is raining, the ground is wet.
b. *Assuming that* it is raining, the ground is wet.
c. The ground is wet *if* it is raining.
d. The ground is wet *given that* it is raining.
e. The ground is wet *assuming that* it is raining.
f. It is raining *only if* the ground is wet.

Each of the above statements is logically equivalent to (45). Two statements are **logically equivalent** if each validly implies the other. Since each of (a) through (f) is logically equivalent to (45), (45) can be substituted for each of them in an argument. And as we will see, making such substitutions is an aid to identifying argument forms. Accordingly, a close look at these stylistic variants is warranted. Consider (c). Note that "if" comes not at the beginning but in the middle of the statement. Yet, (c) has the same underlying logical meaning as (45). And the phrase "given that" in (d) plays a role exactly analogous to the "if" in (c). We might generalize from these examples by saying that "if" and its stylistic variants (e.g., "given that" and "assuming that") *introduce an antecedent*. But we must hasten to add that this generalization applies only when "if" or its stylistic variants appear by themselves. When combined with "only," as in (f), the situation alters dramatically. Statement (f) has the same logical force as (45), but the phrase "only if" is confusing to many people and bears close examination.

To clarify the logical force of "only if," it is helpful to consider very simple conditionals, such as the following:

46. Rex is a dog *only if* Rex is an animal.
47. Rex is an animal *only if* Rex is a dog.

Obviously, (46) and (47) say different things. Statement (47) is false. Rex may well be an animal even if Rex isn't a dog. Thus, (47) says, in effect, that "If Rex is an animal, Rex is a dog." But (46) says something entirely different, and something true—namely, that if Rex is a dog, then Rex is an animal. In general, statements of the form "*A* only if *B*" are logically equivalent to statements of the form "If *A*, then *B*." They are *not* logically equivalent to statements of the form "If *B*, then *A*." Another way to generalize the point is to say that "only if" (unlike "if") *introduces a consequent*, that is, a then-clause.

The Argument Forms

We are now ready to examine some "famous" argument forms.

Modus Ponens

Let us begin with **modus ponens**. Consider the following argument:

48. 1. If it is raining, then the ground is wet.
    2. It is raining.
    So, 3. The ground is wet.

This argument is obviously valid: On the assumption that its premises are true, its conclusion must be true also. Using letters to stand for statements, the form of the argument is as follows:

Modus Ponens

1. If *A*, then *B*.
2. *A*.

So, 3. *B*.

(*A* stands for "it is raining"; *B* stands for "the ground is wet.") This form of argument is always valid. It is called *modus ponens* (which means "the mode of positing") because the second premise posits (i.e., sets down as fact) the antecedent of the conditional (first) premise.

Two points about *modus ponens* are worth noting. First, the order of the premises does not matter. For example, both of the following count as *modus ponens:*

49. If Einstein was a physicist, then he was a scientist. Einstein was a physicist. So, Einstein was a scientist.

50. Einstein was a physicist. If Einstein was a physicist, then he was a scientist. So, Einstein was a scientist.

In other words, arguments of the form "*A*; if *A*, then *B*; so, *B*" count as examples of *modus ponens*.

Second, the conditionals involved in *modus ponens* can be rather long and complex. For example:

51. If every right can be waived and each person has a right to life, then euthanasia is permitted in those cases in which the person to be "euthanized" waives his or her right to life. Moreover, every right can be waived and each person has a right to life. Hence, euthanasia is permitted in those cases in which the person to be "euthanized" waives his or her right to life.

The conditional premise in argument (51) is relatively long and complex, but the form is still *modus ponens*. ("Every right can be waived and each person has a right to life" replaces *A*; "euthanasia is permitted in those cases in which the person to be euthanized waives his or her right to life" replaces *B*.)

Modus Tollens

A second basic argument form is called **modus tollens**. Like *modus ponens*, one of its key premises is a conditional:

52. 1. If it is raining, then the ground is wet.
    2. The ground is not wet.
So, 3. It is not raining.

Modus tollens means "the mode or way of removing." The argument form gets its name from the second premise, which denies (removes the truth of) the consequent of the first premise. The form is as follows:

Modus Tollens

1. If *A*, then *B*.
2. Not *B*.

So, 3. Not *A*.

"Not *A*" and "not *B*" stand for negations. A **negation** of a statement is its denial. For example, in argument (52), "the ground is not wet" plays the role of "not *B*." The negation of a statement can be formed in various ways. Take the statement "the ground is wet." Each of the following is a negation of it:

a. *It is not the case that* the ground is wet.
b. *It's false that* the ground is wet.
c. *It is not true that* the ground is wet.
d. The ground is *not* wet.

As with *modus ponens*, the order of the premises does not matter. In other words, arguments of the form "Not *B*; if *A*, then *B*; so, not *A*" count as *modus tollens*.

Consider a more complicated example of *modus tollens*. According to some physicists who endorse the Big Bang theory, the universe cannot be infinitely old. The second law of thermodynamics tells us that in a closed physical system entropy always tends to increase; that is, energy gets diffused over time. (For instance, the radiant energy of a star will gradually become spread out evenly into the space surrounding it.) According to these physicists, if the physical universe has existed for an infinite period, there are now no concentrations of energy (e.g., no stars or planets). But obviously, there are stars and planets, so the physical universe has not existed for an infinite period. We can put this reasoning explicitly into the *modus tollens* form as follows:

53. 1. If the physical universe has existed for an infinite period, then all the energy in the universe is spread out evenly (as opposed to being concentrated in such bodies as planets and stars).
2. It is not true that all the energy in the universe is spread out evenly (as opposed to being concentrated in such bodies as planets and stars).

So, 3. It is not true that the physical universe has existed for an infinite period.

Notice how putting the argument into explicit form helps to focus attention on the key issues. There is no debate whatsoever about the second premise of this argument. Stars and planets exist, so energy is not in fact spread out evenly throughout the physical universe. Nor is there any debate about the validity of the argument. Every argument having the form *modus tollens* is valid. The focus of the debate, therefore, must be on the first premise, and that is just where physicists have placed it. For example, some physicists think that the universe oscillates, that is, goes through a cycle of "Big Bangs" and "Big Crunches." And if the universe can oscillate, then its diffuse energy can be reconcentrated into usable forms, in which case the first premise is doubtful.[6]

Denying the Antecedent

Having examined two valid forms of argument, let us now take note of two invalid forms with which they are often confused. These invalid forms are called *fallacies*. (A fallacy is an error in reasoning.) Let us begin with the **fallacy of denying the antecedent**, which is often confused with *modus tollens*. Consider:

54. 1. If it is raining, then the ground is wet.
2. It is not raining.

So, 3. The ground is not wet.

The first premise here is a conditional, as in the case of *modus tollens*. However, whereas the second premise of *modus tollens* denies the consequent of the conditional, the second premise of this argument denies the antecedent. This difference in form is crucial because even if the premises of this argument were true,

the conclusion could still be false. For example, let us suppose that the ground is soaking wet due to a sprinkler having been left on all night. Then, even if it is not raining, the ground is wet. (And remember, the first premise, being hypothetical, does not assert or imply that it is raining.) Denying the antecedent is an invalid form of argument. We can represent its form as follows:

Fallacy of Denying the Antecedent

1. If *A*, then *B*.
2. Not *A*.

So, 3. Not *B*.

(The order of the premises does not matter; hence, arguments of the form "Not *A*; if *A*, then *B*; so, not *B*" count as examples of denying the antecedent.) Here is a counterexample that shows that denying the antecedent is invalid:

55. 1. If lemons are red, then lemons have a color. [true]
2. Lemons are not red. [true]

So, 3. Lemons do not have a color. [false]

In thinking about this counterexample, it is important to recall that conditionals are hypothetical statements. Thus, premise (1) does not say that lemons *are* red; it merely says that *if* lemons are red, *then* they have a color.

Affirming the Consequent

A second fallacy, often confused with *modus ponens*, is the **fallacy of affirming the consequent**. Here is an example:

56. 1. If it is raining, then the ground is wet.
2. The ground is wet.

So, 3. It is raining.

The form is as follows:

Fallacy of Affirming the Consequent

1. If *A*, then *B*.
2. *B*.

So, 3. *A*.

(The order of the premises does not matter; hence, arguments of the form "*B*; if *A*, then *B*; so, *A*" are examples of affirming the consequent.) Again, the example of a sprinkler left on overnight reveals the invalidity of the argument. One cannot assume that rain is the only thing that will make the ground wet. The

fallacy of affirming the consequent gets its name from its second premise, which affirms the consequent of the conditional premise. Here is a counterexample that shows that the form is invalid:

57. 1. If lemons are red, then lemons have a color. [true]
    2. Lemons have a color. [true]
So, 3. Lemons are red. [false]

Again, in thinking about this counterexample, bear in mind that the conditional premise is hypothetical in nature.

Two issues should be considered here before going on. First, it is sometimes alleged that we can imagine circumstances in which *modus ponens* or *modus tollens* fails—that is, in which the premises are true and the conclusion is false. For example, let's go back to *modus ponens:* "If it's raining, then the ground is wet. It's raining. So, the ground is wet." What if the ground is covered, you might ask? What if the whole earth were enclosed in a plastic bag? Then, even if it was raining, the ground wouldn't be wet. Wouldn't *modus ponens* fail in such (admittedly farfetched) circumstances? No. These are not circumstances in which the premises are true and the conclusion is false. Rather, they are circumstances in which the conditional premise ("If it's raining, the ground is wet") is false. And remember: When we are testing for validity, we must assume that the premises are true and consider whether this assumption forces us to assume that the conclusion is true as well.

Second, although the invalidity of denying the antecedent and affirming the consequent is readily apparent in the examples used thus far, the error isn't always quite so obvious. Consider the following example of affirming the consequent:

58. If lying causes ill feelings, then it is wrong. And lying is wrong. Therefore, it causes ill feelings.

Argument (58) is invalid because it overlooks the possibility that an act might be wrong for some reason other than its causing ill feelings. For instance, some say lying is wrong simply because society disapproves of it or because the liar violates a moral rule. The following example of the fallacy of denying the antecedent involves a similar error:

59. If using placebos causes harm, then doing so is wrong. But using placebos does not cause harm. Hence, using placebos is not wrong.

Argument (59) overlooks the possibility that an act might be wrong even if it doesn't harm anyone. For example, some say that acts are wrong simply because God disapproves of them (and regardless of the effects the actions have on other people).

Hypothetical Syllogism

Let us now return to valid forms. Consider the following argument:

60. 1. If tuition continues to increase, then only the wealthy will be able to afford a college education.
    2. If only the wealthy will be able to afford a college education, then class divisions will be strengthened.
    So, 3. If tuition continues to increase, then class divisions will be strengthened.

We can represent the form as follows; it is called **hypothetical syllogism**:

Hypothetical Syllogism

1. If *A*, then *B*.
2. If *B*, then *C*.

So, 3. If *A*, then *C*.

(The order of the premises does not matter; hence, arguments of the form "If *B*, then *C*; if *A*, then *B*; so, if *A*, then *C*" are examples of hypothetical syllogism.) The argument is called *hypothetical syllogism* because it involves only hypothetical (i.e., conditional) statements. *Syllogism* comes from Greek roots meaning "to reason together" or to put statements together into a pattern of reasoning. Every argument that exemplifies the form hypothetical syllogism is valid. Here is another example of this form:

61. If I am morally responsible, then I can choose between good and evil. If I can choose between good and evil, then some of my actions are free. Therefore, if I am morally responsible, then some of my actions are free.

Note that the conclusion of a hypothetical syllogism is a conditional statement.

Disjunctive Syllogism

Thus far in this section, we have focused on argument forms that involve conditional statements. Not all argument forms are like this. Some make central use of **disjunctions**, that is, statements of the form "Either *A* or *B*." For example:

62. 1. Either Michelangelo painted *Guernica* or Picasso painted it.
    2. Michelangelo did not paint *Guernica*.
    So, 3. Picasso painted *Guernica*.

The argument has the following form, which is called **disjunctive syllogism** because of its "either-or" premise:

Disjunctive Syllogism

1. Either *A* or *B*.
2. Not *A*.

So, 3. *B*.

Arguments having this form are *always* valid. (The order of the premises does not matter; hence, arguments of the form "Not *A*; either *A* or *B*; so, *B*" are examples of disjunctive syllogism.)

Some brief remarks about disjunctions are in order here. First, some terminology: The statements comprising a disjunction are called its **disjuncts**. For instance, the disjuncts of premise (1) in argument (62) are "Michelangelo painted *Guernica*" and "Picasso painted *Guernica*."

Second, we will take "Either *A* or *B*" to mean "Either *A* or *B* (or both)." This is called the **inclusive** sense of "or." For instance, suppose a job announcement reads: "Applicants must have either work experience or a bachelor's degree in the field." Obviously, an applicant with *both* work experience *and* a bachelor's degree is not excluded from applying.

Third, some authors speak of an **exclusive** sense of "or," claiming that "Either *A* or *B*" sometimes means "Either *A* or *B* (but not both)." For example, in commenting on a presidential election, one might say, "Either Smith or Jones will win the election," the assumption being that both will not (indeed cannot) win. However, it is a matter of controversy whether there really are two different meanings of the word "or" *as opposed to* there simply being cases in which the context indicates that *A* and *B* are not (or cannot) both be true. Rather than let this controversy sidetrack us, let us simply assume that the locution "Either *A* or *B*" means "Either *A* or *B* (or both)."

Having made this assumption, however, we must immediately add that arguers are free to use the locution "Either *A* or *B* (but not both)." This locution is equivalent to two statements: "Either *A* or *B*. Not both *A* and *B*." Consider the following argument:

63. Either Millard Fillmore was the 13th president of the United States, or Zachary Taylor was the 13th president of the United States (but not both). Millard Fillmore was the 13th president. So, Zachary Taylor was not the 13th president.

We can represent the form of argument (63) as "Either *A* or *B*; not both *A* and *B*; *A*; so, not *B*." This form is valid, but notice that it differs from disjunctive syllogism.

Also note that disjunctive syllogism differs from the following form of argument:

64. Either Hitler was a Nazi, or Himmler was a Nazi (or both were). Hitler was a Nazi. Therefore, it is not the case that Himmler was a Nazi.

The form of argument (64) can best be represented as "Either *A* or *B* (or both); *A*; therefore, not *B*." As a matter of historical fact, the premises of (64) are true, but its conclusion is false, so this argument form is definitely invalid.

Now, what is the form of the following argument?

65. Either Bloggs is guilty or Brennan is guilty. It is false that Bloggs is guilty. Hence, Brennan is guilty.

Yes, the form is disjunctive syllogism, and the argument is valid.

Constructive Dilemma

Let's look at one more "famous" argument form. This form is called the **constructive dilemma**, and it combines both conditional and disjunctive statements. Here is an example:

66. 1. Either Donna knew the information on her tax returns was inaccurate, or she did not know it.
    2. If Donna knew the information was inaccurate, she was lying.
    3. If Donna did not know the information was inaccurate, then she was negligent.

    So, 4. Either Donna was lying, or she was negligent.

The form of this argument is as follows:

Constructive Dilemma

1. Either *A* or *B*.
2. If *A*, then *C*.
3. If *B*, then *D*.

So, 4. Either *C* or *D*.

Arguments of this form are always valid. (The order of the premises in a constructive dilemma does not matter. For example, sometimes the conditional premises are given first, followed by the disjunctive premise.) The age-old problem of evil can be put in the form of a constructive dilemma:

67. If God cannot prevent suffering, then God is not omnipotent. If God does not want to prevent suffering, then God is not perfectly good. But either God cannot prevent suffering or God does not want to prevent suffering. So, either God is not omnipotent or God is not perfectly good.

This dilemma nicely illustrates how logic can be used to formulate a problem in a revealing way. Because argument (67) is valid, the conclusion must be true if the premises are true. And the first premise seems undeniable. Moreover, theists, against whom the argument is directed, can hardly deny the third (disjunctive)

premise. (If God *can* prevent suffering, then God must not want to prevent it for some reason.) Historically, the second premise has been the focus of debate, with theologians suggesting that God does not want to eliminate all suffering because suffering is the necessary means to certain good ends (e.g., the spiritual maturation of free creatures).

The Process

The "famous" forms we now have in hand are quite useful for determining the validity of arguments. Many arguments either possess one of these forms or, when briefly summarized, are naturally put into one of these forms. In order to make use of these new tools, we employ the following process. First, we identify the component statements in the argument, labeling them with capital letters as we have throughout this section. To avoid errors, write the capital letter by each instance of the statement it stands for, taking negations into account, like this:

A *B* *not B*

68. Ken is old *only if* he is over seventy. But Ken is not over seventy, and hence he is not old.

not A

Second, rewrite the argument using capital letters instead of English statements and eliminating the stylistic variants. Rewriting argument (68) in this fashion, we get:

69. 1. If *A*, then *B*.
    2. Not *B*.
    So, 3. Not *A*.

Third, identify any "famous" forms that appear and evaluate for validity. Here the form is *modus tollens*, so the argument is valid. If none of our "famous" forms is employed and the argument seems invalid, try to construct a counterexample. Of course, if the argument is valid, it won't be possible to construct a counterexample. And in order to assess a wider range of valid arguments, we will need additional tools such as those introduced in subsequent chapters of this book.

It may be useful to highlight some complications that can arise when employing our three-step process. Consider the following argument:

A *B*

70. Alice is a fast runner *if* she can run the mile in under four minutes. But Alice cannot run the mile in under four minutes. Therefore, Alice in not a fast runner.

not B *not A*

When we rewrite the argument using capital letters and eliminating stylistic variants, we get:

71. 1. If *B*, then *A*.
    2. Not *B*.
    So, 3. Not *A*.

Our labeling results in the conditional "If *B*, then *A*" rather than "If *A*, then *B*." But this is not a problem—there is no need to try to make the letters appear in alphabetical order. The important thing to note is that the second premise *denies the antecedent* of the conditional premise, while the conclusion denies the consequent of the conditional premise. Thus, we have an instance of the fallacy of denying the antecedent, and the argument is invalid.

Here's another argument that illustrates a slight complication that can arise when applying our three-step process:

A *B* *A*
72. The sun is shining; but the room is hot *given that* the sun is shining; hence, the room is hot.
B

We may rewrite the argument as follows:

73. 1. *A*.
    2. If *A*, then *B*.
    So, 3. *B*.

The conditional premise appears second, but that's not a problem—the order of the premises does not matter. What matters is this: We have a conditional and its antecedent as premises, with the consequent of the conditional as the conclusion. Thus, the argument form is *modus ponens*, and the argument is valid.

Another complication arises when you need to construct a counterexample for an argument that involves conditional statements. For example:

A *B*
74. If computer hacking causes harm, it should be penalized. So, if computer hacking should be penalized, then it causes harm.
B *A*

The form of the argument is as follows:

75. 1. If *A*, then *B*.
    So, 2. If *B*, then *A*.

Now, we follow our usual procedure in constructing a counterexample, beginning with a conclusion that is a *well-known* falsehood. For instance, "If Tom Hanks is over 2 years old, then he is over 100 years old." Notice that this conditional has a true antecedent and a false consequent. *Conditionals with a true*

Using Forms to Test for Validity

Step 1. Identify the component statements in the argument, labeling each with a capital letter.

Step 2. Rewrite the argument using capital letters instead of English statements. Eliminate any stylistic variants.

Step 3. Identify any "famous" forms that appear, and evaluate for validity. If none of the "famous" forms is employed and the argument seems invalid, try to construct a counterexample.

antecedent and a false consequent are always false. The counterexample looks like this:

76. 1. If Tom Hanks is over 100 years old, then he is over 2 years old. [true]
So, 2. If Tom Hanks is over 2 years old, then he is over 100 years old. [false]

Remember, the premise does not say that Hanks is over 100 years old; it just says that *if* he is over 100, then he's over 2, which is obviously true. The following additional counterexamples to form (75) will give you some ideas for constructing your own counterexamples to arguments involving conditional statements:

77. 1. If Abe Lincoln was over 10 feet tall, then he was over 4 feet tall. [true]
So, 2. If Abe Lincoln was over 4 feet tall, then he was over 10 feet tall. [false]

Summary of Forms

Valid Forms

Modus ponens: If *A*, then *B*. *A*. So, *B*.
Modus tollens: If *A*, then *B*. Not *B*. So, not *A*.
Hypothetical syllogism: If *A*, then *B*. If *B*, then *C*. So, if *A*, then *C*.
Disjunctive syllogism: Either *A* or *B*. Not *A*. So, *B*.
Constructive dilemma: Either *A* or *B*. If *A*, then *C*. If *B*, then *D*. So, either *C* or *D*.

Invalid Forms

Denying the antecedent: If *A*, then *B*. Not *A*. So, not *B*.
Affirming the consequent: If *A*, then *B*. *B*. So, *A*.

78. 1. If lemons are red, then lemons have a color. [true]
So, 2. If lemons have a color, then lemons are red. [false]

(Note that the false conditionals here have a true antecedent and a false consequent.) As always, when constructing counterexamples, it is important that the premises be well-known truths and the conclusion a well-known falsehood.

The following exercise gives you an opportunity to use your knowledge of the "famous" forms in order to assess the validity of arguments.

Exercise 1.3

Part A: Arguments to Evaluate Identify the forms of the following arguments, using capital letters to stand for statements and eliminating any stylistic variants. If the argument form is one of the "famous" forms, give the name of the form and indicate whether it is valid. If the argument form is not one of the "famous" forms, construct a counterexample to show that the form is invalid.

* **1.** If the solution turns blue litmus paper red, then the solution contains acid. The solution turns blue litmus paper red. So, the solution contains acid.

2. If the solution turns blue litmus paper red, then the solution contains acid. The solution does not contain acid. So, the solution does not turn blue litmus paper red.

3. Lewis is a famous author only if he knows how to write. But Lewis is not a famous author. Hence, Lewis does not know how to write.

* **4.** If Susan is a famous author, then she knows how to write. Moreover, Susan knows how to write. So, she is a famous author.

5. Souls transmigrate. But it is wrong to eat animals if souls transmigrate. Hence, it is wrong to eat animals.

6. Either Jones is an innocent bystander, or Jones fired a shot at the mayor. Jones is not an innocent bystander. Therefore, Jones fired a shot at the mayor.

* **7.** Rilke is a dreamer if he is a poet. Therefore, Rilke is a poet.

8. Either you marry young, or you wait. If you marry young, you incur a high risk of divorce. If you wait, the field of available partners grows ever smaller. So, either you incur a high risk of divorce, or the field of available partners grows ever smaller.

9. It is not wrong to kill spiders. But if spiders have eternal souls, then it is wrong to kill them. Thus, it is false that spiders have eternal souls.

* **10.** If you study hard, you refine your communication skills. If you refine your communication skills, then your job opportunities increase. Hence, if you study hard, your job opportunities increase.

11. If Mubarak is from Egypt, then he is from Africa. Therefore, if Mubarak is not from Egypt, then he is not from Africa.

12. Ben is a rat. Ben is a rat only if Ben is a mammal. So, Ben is a mammal.

* **13.** Sam is wealthy if he has more than a billion dollars. But Sam does not have more than a billion dollars. Therefore, Sam is not wealthy.

14. There is life on Mars given that there is life on Earth. Hence, there is life on Mars.

15. It is true that corrupt institutions are hard to reform. It is false that individuals are totally depraved. Therefore, if corrupt institutions are hard to reform, then individuals are totally depraved.

Part B: More Arguments to Evaluate Identify the forms of the following arguments, using capital letters to stand for statements and eliminating any stylistic variants. If the argument form is one of the "famous" forms, give the name of the form and indicate whether it is valid. If the argument form is not one of the "famous" forms, construct a counterexample to show that the form is invalid.

* **1.** The sky is blue. The sky is cobalt blue only if it is blue. Hence, the sky is cobalt blue.

2. Abortion in the case of ectopic pregnancy is not wrong. But if it is always wrong to kill an innocent human being, then abortion in the case of ectopic pregnancy is wrong. So, it is not always wrong to kill an innocent human.

3. Kidnapping is wrong if society disapproves of it. Kidnapping is wrong. So, society disapproves of kidnapping.

* **4.** Eating meat is unhealthy if meat contains a lot of cholesterol. Meat does contain a lot of cholesterol. Therefore, eating meat is unhealthy.

5. Either the "eye for an eye" principle is interpreted literally, or it is interpreted figuratively. If it is interpreted literally, then the state should torture torturers, maim maimers, and rape rapists. If the "eye for an eye" principle is interpreted figuratively, then it does not necessarily demand death for murderers. So, either the state should torture torturers, maim maimers, and rape rapists, or the "eye for an eye" principle does not necessarily demand death for murderers.

6. Affirmative action is preferential treatment of disadvantaged groups, and preferential treatment of disadvantaged groups is reverse discrimination. If affirmative action is preferential treatment of disadvantaged groups and preferential treatment of disadvantaged groups is reverse discrimination, then affirmative action is wrong. Hence, affirmative action is wrong.

* **7.** If the zygote lacks a brain, then the zygote lacks a soul. If the zygote lacks a soul, then killing the zygote is permissible. So, if the zygote lacks a brain, then killing the zygote is permissible.

8. If Mary is a psychiatrist, then she is a physician. Mary is not a physician. Therefore, Mary is a psychiatrist.

9. If you want to ruin your life, you should take hard drugs. But you don't want to ruin your life. So, you should not take hard drugs.

* **10.** Lying causes social discord. Hence, lying is wrong.

11. It is not true that acts are right because God approves them. But either acts are right because God approves them, or God approves of acts because they are right. Therefore, God approves of acts because they are right.

12. If Dracula is a vampire, then he is dangerous. But Dracula is not a vampire. Hence, he is dangerous.

* **13.** Either the animals used in research are a lot like humans, or they are not a lot like humans. If the animals are a lot like humans, then experimenting on them is morally questionable. If the animals are not a lot like humans, then experimenting on them is pointless. So, either experimenting on animals is morally questionable, or it is pointless.

14. The state cannot uphold the value of life by taking it. And if the state cannot uphold the value of life by taking it, then the death penalty should be abolished. Therefore, the death penalty should be abolished.

15. If my society approves of genetic engineering, then genetic engineering is right. But my society does not approve of genetic engineering. Hence, genetic engineering is not right.

Part C: Still More Arguments to Evaluate Identify the forms of the following arguments, using capital letters to stand for statements and eliminating any stylistic variants. If the argument form is one of the "famous" forms, give the name of the form and indicate whether it is valid. If the argument form is not one of the "famous" forms, construct a counterexample to show that the form is invalid.

* **1.** Overeating is foolish only if it causes disease. Overeating does not cause disease. So, overeating is not foolish.

2. Either films depicting graphic violence have caused the increase in violent crime or bad parenting has caused it (or both). Movies depicting graphic violence have caused the increase in violent crime. Therefore, bad parenting has not caused the rise in violent crime.

3. Corporations contribute huge sums of money to political campaigns. If that is so, then corporations exert undue influence on elections. So, corporations exert undue influence on elections.

* **4.** You will win the chess tournament if you are very good at chess. Unfortunately, you are not very good at chess. Hence, you will not win the chess tournament.

5. Either virtue is good for its own sake, or it is good as a means to an end. It is not the case that virtue is good for its own sake. So, virtue is good as a means to an end.

6. You should be an optimist if pessimists are less likely to succeed than optimists. And it is a fact that pessimists are less likely to succeed than optimists. Therefore, you should be an optimist.

* **7.** If God can arbitrarily decide what is morally right, then God can make cruelty right. And if God cannot arbitrarily decide what is morally right, then morality is not entirely in God's control. But either God can arbitrarily decide what is morally right, or God cannot arbitrarily decide what is morally right. Therefore, either God can make cruelty right, or morality is not entirely in God's control.

8. The dinosaurs vanished due to a sudden, extreme drop in temperature. The earth must have suffered some sort of cataclysm millions of years ago, assuming that the dinosaurs vanished due to a sudden, extreme drop in temperature. So, the earth must have suffered some sort of cataclysm millions of years ago.

9. Assuming that you treat like cases alike, you are fair. Hence, you are fair only if you treat like cases alike.

* **10.** The death penalty is inequitably applied to the poor and to minorities. And given that the death penalty is inequitably applied to the poor and to minorities, it is unjust. Therefore, the death penalty is unjust.

11. Philosophy is important if ideas are important. And assuming that ideas change lives, ideas are important. Hence, if philosophy is important, then ideas change lives.

12. If you join the military, you give up a lot of freedom. If you go to college, you incur enormous debts. However, you either join the military, or you go to college. Therefore, you either give up a lot of freedom, or you incur enormous debts.

* **13.** Mercy killing is morally permissible only if it promotes a greater amount of happiness for everyone affected than the alternatives do. And mercy killing does promote a greater amount of happiness for everyone affected than the alternatives do. Therefore, mercy killing is morally permissible.

14. You must either love or hate. If you love, then you suffer when your loved ones suffer. If you hate, then you suffer when your enemies flourish. Hence, either you suffer when your loved ones suffer, or you suffer when your enemies flourish.

15. A severe depression will occur given that the economy collapses. The economy collapses if inflation soars. So, inflation soars only if a severe depression will occur.

Part D: Constructing Arguments Construct your own substitution instances for each of the following argument forms: *modus ponens*, *modus tollens*, hypothetical syllogism, disjunctive syllogism, constructive dilemma, denying the antecedent, and affirming the consequent. Make your substitution instances for the two fallacies counterexamples.

1.4 Strength and Cogency

Our discussion to this point may leave the impression that, from a logical point of view, each argument is either valid or not, and if an argument is not valid, then it is entirely without logical merit. But matters are not quite this simple. Even if an argument is not valid, its premises may still provide significant support for its conclusion. A strong argument is one in which the premises provide *partial* support for the conclusion. More precisely, a **strong argument** has this essential feature: It is probable (but not necessary) that if its premises are true, then its conclusion is true. In other words, it is improbable (but possible) that the conclusion is false *on the assumption that* the premises are true. For example:

> 79. Ninety percent of American males over 50 years of age cannot run a mile in less than 6 minutes. Thomas is an American male over 50 years of age. So, Thomas cannot run a mile in less than 6 minutes.

The premises of argument (79) do not absolutely guarantee the truth of the conclusion. Possibly Thomas belongs to that small percentage of American men over 50 who can run a mile in less than 6 minutes. Nevertheless, it is probable that if the premises of (79) are true, then its conclusion is true also.

Now, let's alter argument (79) systematically to clarify the concept of strength. Suppose we replace "ninety" with "ninety-nine." Does the argument remain strong? Yes, of course. In fact, it is even stronger. This indicates that *strength*, unlike validity, is very much a matter of degree. Suppose we replace "ninety" with "fifty-one." Is the argument then strong? Strictly speaking, yes, because the conclusion remains *slightly* more probable than not. Of course, once we replace "ninety" with "fifty-one," the argument is of little value: The amount of support given to the conclusion is scarcely worth mentioning. But the important point to keep in mind is that because strength comes in degrees, we can legitimately speak of arguments that are *slightly* strong, *moderately* strong, or *very* strong. By contrast, it would make no sense to speak of "slightly valid" or "moderately valid" arguments. Validity is an all-or-nothing affair.

What if we replace "ninety" with "fifty" in argument (79)? Then the argument is not strong, but weak. A **weak argument** has this essential feature: *It is not probable that if its premises are true, then its conclusion is true*. If we replace "ninety" with "fifty," then it is as probable, given the premises, that Thomas *can* run the mile in less than 6 minutes as that he *cannot*. So, the argument is weak. And, of course, the argument becomes progressively weaker as we replace "ninety" with "forty," "thirty," and so on.

At the other end of the scale, what if we replace "Ninety percent of" with "All" in argument (79)? Does the argument remain strong? No. At that point, the argument becomes *valid*—necessarily, if its premises are true, its conclusion is true also. But, by definition, in a strong argument, it is *possible* that the

conclusion is false while the premises are true. Thus, no valid argument is strong, and no strong argument is valid.

A **strong argument** has this essential feature: It is probable (but not necessary) that if the premises are true, then the conclusion is true.

A **weak argument** has this essential feature: It is not probable that if its premises are true, then its conclusion is true.

We will explore the concept of strength more fully in subsequent chapters, but it will be helpful at this point to consider some additional examples of strong arguments in order to underscore the fact that they come in very different types. For instance, **arguments from authority** can be strong. They have the following structure:

80. 1. *R* is a reliable authority regarding *S*.
    2. *R* sincerely asserts that *S*.
    So, 3. *S*.

(Here, *R* stands for a person or reference work, while *S* stands for any statement.) For example:

81. According to historian Howard Zinn, by 1933, the worst year of America's Great Depression, one-fourth to one-third of America's labor force was out of work. Therefore, one-fourth to one-third of American workers were unemployed in 1933.[7]

This appeal to authority is legitimate, but authorities can make mistakes, so it is possible that the conclusion of (81) is false while its premises are true—possible, but unlikely. Hence, the argument is strong. Yet it would be impossible to state the degree of strength with numerical precision.

Like arguments from authority, **arguments from analogy** are very common, and they, too, can be strong. The structure of an argument from analogy is as follows:

82. 1. Object (event or situation) *A* is similar to object (event or situation) *B* in certain relevant respects.
    2. *B* has property *P*.
    So, 3. *A* has property *P* also.

Here is an example. Suppose Jack and Jill are riding horseback. Jill's horse jumps a fence, but Jack is unsure whether his horse can jump the fence. Jill

points out that his horse is very similar to hers in size, speed, strength, and training. She adds that because Jack is an experienced rider and weighs no more than she does, Jack's horse is not operating with a handicap. She concludes that Jack's horse can jump the fence, too. We could outline Jill's reasoning as follows:

> 83. Jack's horse is similar in relevant respects to Jill's horse (and is similarly situated). Jill's horse is able to jump the fence. Hence, Jack's horse is able to jump the fence also.

This argument is not valid because its conclusion can be false while its premises are true. For example, unknown to Jill, Jack's horse may have been given a drug that renders it unable to jump well today. Still, it is more probable than not that if the premises of (83) are true, then the conclusion is true, and hence the argument is at least slightly strong.

To say that an argument is strong is *not* to say that its premises are in fact true (just as to say that an argument is valid is *not* to say that its premises are in fact true). Let us use the phrase **cogent argument** to refer to any argument that is both strong and has only true premises (just as we use the phrase *sound argument* to refer to any argument that is both valid and has only true premises). Here is an example of a cogent argument:

> 84. All or nearly all lemons that have been tasted were sour. So, all or nearly all lemons are sour.

This argument is not valid because the conclusion concerns not merely the lemons that have been tasted but lemons in general, *including those that have not been tasted*. And the premise does not rule out the *possibility* that a large percentage of untasted lemons are not sour. Nevertheless, it is unlikely that the conclusion is false given that the premise is true. And the premise is true. So, the argument is cogent.

A cogent argument can have a false conclusion, for its premises do not absolutely guarantee the truth of its conclusion. In this respect, cogent arguments differ markedly from sound arguments. A sound argument cannot have a false conclusion because it is valid and all its premises are true. (And if a valid argument has only true premises, its conclusion must be true also.)

Strong + All Premises True = Cogent

An **uncogent argument** is one that is either (a) weak or (b) strong with at least one false premise. (Note that by this definition a weak argument with a false

premise counts as uncogent.) Here is an example of an argument that is uncogent because it is weak:

85. Slightly less than 50 percent of Americans are men. Julia Roberts is an American. Therefore, Julia Roberts is a man.

Although argument (85) has true premises, the premises do not provide even partial support (in our technical sense) for the conclusion: It is *not* probable that if the premises are true, then the conclusion is true. (*Note:* This is not because Julia Roberts is a woman. If we replace "Julia Roberts" with "Woody Allen," the argument is still weak even though its conclusion is true.)

Here is an example of an argument that is uncogent because it is strong but has a false premise:

86. There is intelligent life on all of the following planets: Mercury, Venus, Earth, Jupiter, Uranus, Neptune, and Pluto. So, there is intelligent life on Mars.[8]

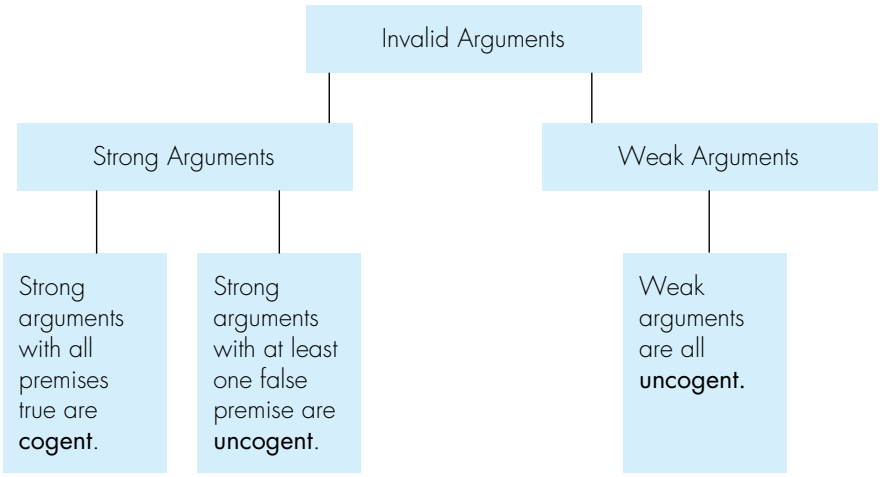
As far as we know, the premise of argument (86) is false, and so is the conclusion. But it is improbable that the conclusion is false *on the assumption that* the premise is true. So, the argument is strong but uncogent.

An **cogent argument** has two essential features:
It is strong, and all its premises are true.

An **uncogent argument** is one that is either
(a) weak or (b) strong with at least one false premise.

Note that according to our definitions, no sound argument is cogent, for no valid argument is strong. Similarly, no cogent argument is sound, since no strong argument is valid. Note also that a valid argument with a false premise is unsound, but it is not uncogent because a valid argument is neither strong nor weak.

We have defined deductive logic as the part of logic that is concerned with methods of evaluating arguments for validity and invalidity. Let us now add that **inductive logic** is the part of logic that is concerned with methods of evaluating arguments for strength and weakness. Thus, we have defined deductive and inductive logic not in terms of the kinds of arguments they treat but in terms of the standards and methods employed. And indeed, we might use methods from both branches of logic on the same argument. For example, we might use a method from deductive logic to determine that an argument is invalid and then use a method from inductive logic to determine that the same argument is strong (or that it is weak). Since, by definition, any argument that is either strong or weak is invalid, we can draw a map of the main concepts discussed in this section as follows:



Note that strong arguments with at least one false premise are unsound (as well as uncogent). They are unsound for two reasons: (a) They are invalid, and (b) they have a false premise. Of course, weak arguments are also unsound, for every weak argument is invalid. And if a weak argument has at least one false premise, then it is unsound both because it is invalid and because it has a false premise.

A **strong argument** has this essential feature: It is probable (but not necessary) that if the premises are true, then the conclusion is true.

A **weak argument** has this essential feature: It is not probable that if its premises are true, then its conclusion is true.

A **cogent argument** has two essential features: It is strong, and all its premises are true.

An **uncogent argument** is one that is either (a) weak or (b) strong with at least one false premise.

Inductive logic is the part of logic that concerns tests for strength and weakness.

Some general remarks on terminology are in order. Notice that given our definitions, *arguments* can be strong, weak, cogent, or uncogent. But *arguments* are never true, and they are never false. Both *premises* and *conclusions* are either true or false. But neither *premises* nor *conclusions* are ever strong, weak, cogent, or uncogent.

The following exercises give you an opportunity to apply the concepts introduced in this section.

Exercise 1.4

Part A: Matching In the space provided, write the letter of the item on the right that best characterizes the item on the left.

___ **1.** Valid
___ **2.** Invalid
___ **3.** Strong
___ **4.** Weak
___ **5.** Sound
___ **6.** Cogent
___ **7.** Statement
___ **8.** Unsound
___ **9.** Uncogent
___ **10.** Deductive logic
___ **11.** Inductive logic
___ **12.** Logic
___ **13.** Argument
___ **14.** Arguments from analogy
___ **15.** Arguments from authority

A. A sentence that is either true or false.
B. An argument that is either invalid or has a false premise.
C. A strong argument with (all) true premises.
D. The part of logic concerned with tests for validity and invalidity.
E. It is not probable that if the premises are true, then the conclusion is true.
F. A valid argument with (all) true premises.
G. The part of logic concerned with tests for strength and weakness.
H. The study of methods for testing whether the premises of an argument adequately support its conclusion.
I. It is necessary that if the premises are true, then the conclusion is true.
J. A set of statements, one of which, called the *conclusion*, is affirmed *on the basis* of the others, which are called the *premises*.
K. *R* is a reliable authority regarding *S*. *R* sincerely asserts that *S*. So, *S*.
L. An argument with the following essential feature: It is possible that the conclusion is false while the premises are true.
M. Object *A* is similar to object *B* in certain relevant respects. *B* has property *P*. So, *A* has property *P* also.
N. It is probable (but not necessary) that if the premises are true, then the conclusion is true.
O. An argument that is either (a) weak or (b) strong but has a false premise.

Part B: True or False?

* **1.** All arguments having only true premises are cogent.
2. All strong arguments are cogent.
3. All weak arguments are uncogent.
* **4.** All arguments with a false premise are uncogent.
5. Some cogent arguments have a false conclusion.
6. Some sound arguments have a false conclusion.
* **7.** The following argument is true: "Over 90 percent of Americans speak English. Hank Williams is an American. So, Hank Williams speaks English."

8. The following argument is an argument from analogy: "According to Flew's *Dictionary of Philosophy,* the British philosopher Bertrand Russell died in 1970. So, Bertrand Russell died in 1970."
9. A strong argument has this essential feature: It is impossible for its conclusion to be false while its premises are true.
* 10. Every uncogent argument has at least one false premise.
11. Every uncogent argument is weak.
12. Some arguments have valid premises, and some do not.
* 13. The following argument is an argument from authority: "Scholars are like the Roman emperor Nero. Nero, you'll recall, played his violin while Rome burned. Similarly, scholars play with ideas while civilization is threatened by the 'flames' of greed, poverty, racism, and violence. Now, plainly, Nero was morally irresponsible. Hence, scholars are morally irresponsible also."
14. A strong argument has these two features: (a) It is possible that if its premises are true, then its conclusion is false, and (b) it is probable that if its premises are true, then its conclusion is true.
15. A weak argument has this essential feature: It is not likely that if its premises are true, then its conclusion is true.

Part C: Valid or Invalid? Strong or Weak? As best as you can determine, which of the following arguments are valid? Invalid? Which are strong? Weak?

* 1. Fifty percent of serial killers were abused as children. Ted Bundy was a serial killer. Therefore, Bundy was abused as a child.
2. This lovely china plate is similar in size, weight, and composition to the one I just dropped. The one I just dropped broke. So, if I drop this lovely china plate, it will break.
3. According to Lillian Roxon's *Rock Encyclopedia,* Buddy Holly, who wrote "Peggy Sue," "That'll Be the Day," and other early rock hits, died in an airplane crash on February 3, 1959. So, Buddy Holly died in an airplane crash in 1959.
* 4. One hundred percent of all the frogs that have ever been dissected had hearts. Therefore, 100 percent of the entire frog population have hearts.
5. It is always wrong to kill an innocent human intentionally. A fetus is an innocent human. So, it is always wrong to kill a fetus intentionally.
6. Research based on Gallup polls indicates that a random sample of 4000 is sufficient to support highly accurate conclusions about large populations—conclusions having a margin of error of only 2 percentage points. And according to a recent poll, 83 percent of a random sample of 4000 American voters favor Jones for president. Thus, approximately 83 percent of American voters favor Jones for president.
* 7. A porpoise is similar to a human being. It has lungs rather than gills. It is warm-blooded rather than cold-blooded. And porpoises nurse their young with milk. Therefore, porpoises, like humans, are capable of speaking languages.
8. Every serial killer is a psychopath. Some criminals are not psychopaths. So, some criminals are not serial killers.

9. Ninety percent of the cars in the parking lot were vandalized, and your car was in the parking lot. Therefore, your car was vandalized.

* **10.** No spiders are humans. Dawn is a human. Thus, Dawn is not a spider.

11. All observed emeralds have been green. Therefore, the next emerald to be observed will be green.

12. Linda is younger than Maria. Hence, Maria is older than Linda.

* **13.** According to H. W. Janson, professor of fine arts at New York University, the Norwegian artist Edvard Munch painted *The Scream* in 1893. So, Munch painted *The Scream* prior to 1900. (See Janson's *History of Art* [New York: Abrams, 1971], p. 513.)

14. Sixty-five percent of the students at St. Ambrose College are Democrats. Joan is a student at St. Ambrose College. Therefore, Joan is a Democrat.

15. Mark Twain is identical with Samuel Clemens. Mark Twain wrote *Huckleberry Finn*. It follows that Samuel Clemens wrote *Huckleberry Finn*.

* **16.** No circles are squares. All circles are figures. So, no figures are squares.

17. According to Lewis Hopfe, a noted authority on world religions, the religion called Jainism originated in India in the sixth century B.C.E. It is the goal of Jainism to liberate the soul from matter. All life, but especially animal life, is sacred to the Jains. And the Jains hold that the gods cannot help humans attain salvation. Therefore, at least one religion holds that the gods cannot help humans attain salvation. (See Hopfe's *Religions of the World,* 4th ed. [New York: Macmillan, 1987], pp. 134–138.)

18. In a certain factory, there is a machine that produces tin cans. Quality-control inspectors examine (in a random fashion) one-tenth of all the tin cans produced by the machine. Of the tin cans examined by the inspectors, 5 percent are malformed. So, approximately 5 percent of all the tin cans produced by the machine are malformed.

* **19.** Computers are similar to humans in that both are capable of complex calculations. Humans generally feel ashamed if they make a mistake. Hence, computers generally feel ashamed if they make a mistake.

20. According to the *Encyclopedia Britannica,* the first use of poison gas as a weapon in modern warfare occurred on April 22, 1915, when the Germans launched a highly successful chlorine gas attack against the Allied positions at Ypres, Belgium. So, the first use of poison gas as a weapon in modern warfare occurred on April 22, 1915.

Part D: Cogency Which of the following are cogent? Which are uncogent? (If the argument is uncogent, explain why.) Which of the arguments are neither cogent nor uncogent?

* **1.** Most humans fear death. Woody Allen (the famous comedian and filmmaker) is a human. Therefore, Woody Allen fears death.

2. Fifty percent of the students at Seattle Pacific University are Republicans. Kathy is a student at Seattle Pacific University. So, Kathy is a Republican.

3. All humans are mortal. Socrates is a human. Hence, Socrates is mortal.

* **4.** All of the birds that have been observed (in the entire history of the world) can fly. Therefore, all birds can fly.

5. War is similar to playing a game of chess. For instance, in both war and chess, strategy is important. And in both war and chess, there is a struggle for victory. Now, when one is losing a game of chess, one should not attack one's opponent with lethal weapons. So, when a nation is losing a war, it should not attack its opponent with lethal weapons.

6. Ninety percent of Americans speak Chinese. Harrison Ford (the famous actor) is an American. Thus, Harrison Ford speaks Chinese.

* **7.** Sue is taller than Tom. Tom is taller than Fred. It follows that Sue is taller than Fred.

8. The vast majority of Americans are fluent speakers of English. The Queen of England is an American. So, the Queen of England is a fluent speaker of English.

9. Most Americans live in Nevada. Aretha Franklin (the famous singer) is an American. Hence, Aretha Franklin lives in Nevada.

* **10.** Forty percent of students at Reed College are from the Northwest. Sally is a student at Reed College. So, Sally is from the Northwest.

Notes

1. I have said that arguments are composed of statements. Some logicians would prefer to say that arguments are composed of *propositions*. For more about this issue, see section 3.1.
2. C. S. Lewis, *The Problem of Pain* (New York: Macmillan, 1962), p. 116.
3. My characterizations of deductive and inductive logic are borrowed from Brian Skyrms, *Choice and Chance*, 3rd ed. (Belmont, CA: Wadsworth, 1986), p. 12.
4. Some logicians would qualify this statement. These logicians are not convinced that validity is always due to form. Their views are based on such examples as the following: "Some things are green. So, some things have a color." This argument is clearly valid, but it is difficult to specify any valid form for which it is a substitution instance. Of course, one might reply that the argument has an unstated premise: "All green things have a color." But some logicians would counter that the argument already seems to be valid without *adding* a premise, so why insist that validity is always determined by form? From this perspective, validity is sometimes due to specific content, even if it is typically determined by form.
5. A more complete list of stylistic variants for "if-then" is provided in Chapter 7. The intent here is to provide a short list of the more common stylistic variants.
6. For a useful discussion of these issues, see P. C. W. Davies, *The Physics of Time Asymmetry* (Berkeley and Los Angeles: University of California Press, 1977), chap. 7, pp. 185–200.
7. Howard Zinn, *A People's History of the United States* (New York: HarperCollins, 1995), p. 378.
8. This example is borrowed from Skyrms, *Choice and Chance*, p. 9.