CHAPTER 1
BASIC CONCEPTS

TYPES OF LOGIC

Logic is primarily concerned with distinguishing correct reasoning from reasoning that is incorrect. It is most closely related to rhetoric which also deals with the reasoning process. Rhetoric, however, unlike logic, is chiefly interested in the difference between persuasive reasoning and reasoning that is not persuasive. As we will soon discover, although persuasive reasoning is often correct it is unfortunately also quite common for reasoning that is persuasive to be incorrect. Moreover, frequently reasoning that is correct may nevertheless not be very persuasive.

Admittedly a salesperson, whose primary concern probably lies with convincing his clients, might find rhetoric a more useful subject to study than logic. Perhaps most of us, however, are more interested in using reasoning to aid us in discovering truth and avoiding error. If we are, logic is undoubtedly an important subject for us to study.

There are several different ways of subdividing logic. First, there are two different types of reasoning processes and, as a result, two main branches of logic. Some reasoning processes are supposed to establish the claim being argued for with certainty (assuming the evidence is correct). Others are only supposed to establish the claim being argued for with a greater or lesser degree of likelihood. Deductive logic studies those reasoning processes in which the claim being reasoned to is supposed to follow with certainty from the evidence presented. Inductive logic, on the other hand, studies those reasoning processes in which the claim being reasoned to is only supposed to follow with likelihood from the evidence presented.

Besides this distinction between deductive logic and inductive logic we can also distinguish between two different ways of doing logic. We can either do logic in a formal or informal way. Formal logic always starts by translating the reasoning process from English into a symbolic language. It then manipulates those symbols in various ways to find out how good that reasoning process is. With informal logic, in contrast, no such translation process is involved. We simply examine and evaluate the reasoning process in ordinary English.

Thus, it is possible to distinguish four different types of logic: (1) formal deductive logic, (2) informal deductive logic, (3) formal inductive logic, and (4) informal inductive logic.

One other distinction between different types of logic is also worth introducing here. We can distinguish between a kind of logic that is, perhaps, best called "standard logic," and a vast array of other kinds of logics. We'll collectively refer to all these other kinds of logics as "nonstandard logics."

We can characterize standard logic, and any of the nonstandard logics we might want to examine, in terms of the basic assumptions presupposed by it. Shortly we will consider what these assumptions are, at least with standard logic. For now, all we need to know is that we will be doing standard logic throughout this text.

THE BEARERS OF TRUTH AND FALSITY

By now it should be clear that logic has something to do with discovering truth. What, however, are these things that we call "true" and "false?" This is an old philosophical issue and one I at least briefly need to discuss.

We say things like, "It is true that Bush is President" and "It's false that Quayle is President." What, however, is it that we are saying is true in the one case and false in the other? What, in other words, are the bearers of truth and falsity?

Philosophers have proposed many different "answers" to this difficult philosophical question. Three of these are especially worth examining.

Some philosophers have claimed that indicative sentences are the bearers of truth and falsity, while others have contended that propositions (i.e., the meanings of these sentences) are the bearers of truth and falsity. Finally, still others have suggested that statements are the bearers of truth and falsity.

Before we can evaluate these views we first need to understand the difference between an indicative sentence, a proposition, and a statement. A sentence is always a part of a language and always consists in words. Thus, the sentence, "It is raining," is English and contains three words. Though it may mean the same thing as "Es regnet," these are different sentences. For not only do they exist in different languages, one contains fewer words than the other does. A proposition, on the other hand, is not a part of any language and doesn't contain words. Moreover, the same sentence is sometimes used to express two or more propositions. For example, the sentence, "The prospector didn't get any gold from a bank," could either express the proposition that he did not withdraw any gold from a financial institution, or the proposition that he did not find any gold at the edge of a river. On the other hand, two different sentences can also sometimes express the same proposition. Thus, "John loves Mary," and "Mary is loved by John," though different sentences express the same proposition.

A statement is a claim a person makes, regardless of how he makes it. Statements are different from both sentences and propositions. They are different from sentences because the same sentence sometimes expresses more than one statement (e.g., "The prospector didn't get any gold from a bank."), and because different sentences sometimes express the same statement (e.g., "John loves Mary," and "Mary is loved by John.") In these ways, they resemble propositions. Statements, however, also differ from propositions in several respects. Sometimes we make statements without uttering any sentence, and so, without expressing any proposition. Furthermore, sometimes a sentence that expresses only one proposition nevertheless expresses more than one statement. Thus, we use the sentence, "John loves Mary," to express many different statements, depending on whom we are referring to by "John" and "Mary."

Usually when a person says something to understand his statement we must not only understand the meaning of his sentence, we also need to know when he said it and to whom he is referring. (This is the most important difference between statements and propositions.)

In a moment we will return to the philosophical question we have been talking about. We will try to explain why we believe statements are the bearers of truth and falsity, and not sentences or propositions. First, however, we need to return to another topic that was briefly set aside, namely, the assumptions made by standard logic.

Of the fundamental assumptions made by standard logic two stand out as especially important, viz., the law of the excluded middle, and the law of non-contradiction. What, exactly, do these two laws say? The law of the excluded middle asserts that whatever the bearers of truth and falsity are, every one is either true or false. The law of non-contradiction, in contrast, asserts that no bearers of truth and falsity are both true and false. While one might question these "laws," we are not going to do so. For they are the building blocks of standard logic, and, as we mentioned before, that is the logic we will be learning in this text.

Now that we have a better understanding of the assumptions on which standard logic rests, let's return to our philosophical question, "What are the bearers of truth and falsity?" Perhaps we can answer it.

First, could sentences be the bearers of truth and falsity? The answer to this question is that they could not be. They could not be because this view conflicts with the law of non-contradiction. To see that it conflicts with this law consider the following case: Suppose there is a prospector who has recently returned from the bank of the Snake River where he found some gold. He walked in his local financial institution where, although he deposited the gold he had, he didn't obtain any from the bank itself. Now consider the sentence "The prospector got some gold from a bank." Is this sentence true, or is it false? Evidently, we must say here that the sentence is simultaneously true and false. It is true because the prospector did get some gold from the bank of the Snake River. However, it is also false, because he obtained no gold while he was at any financial institution. Yet this is exactly what the law of non-contradiction tells us cannot happen.

Perhaps now you can see why some philosophers have suggested that propositions instead of sentences are the bearers of truth and falsity. For it is clear here that the sentence "The prospector got some gold from a bank" could mean two different things. The proponent of the view that a proposition is the bearer of truth and falsity will simply say that one of these meanings is true and not false, while the other is false and not true.

Unfortunately, although the proponent of the propositional view can respond to our prospector example in this manner, there are other examples that show his view also conflicts with the law of non-contradiction. Imagine, for instance, two people, one in New York and the other in San Diego. Suppose both utter the sentence "It's raining," simultaneously. Finally, suppose that it is raining in New York but not San Diego.

If we ask how many propositions are involved here we evidently must say one. (Surely the sentence, "It's raining," does not mean something different when said in New York than it means in San Diego.) If so, however, then it must be both true and false. Unfortunately, however, this violates the law of non-contradiction.

How does the view that statements are the bearers of truth and falsity help us here? To understand what claim a person is making when he utters the sentence, "It's raining," we need to know when and where that sentence was uttered. In other words, we need to know about the context of utterance. Given the way our language works it is not even possible for us to utter the same sentence and make the same claim that the person in New York makes when he says, "It's raining," unless we are standing in approximately his vicinity at roughly the time he utters the sentence. Instead, to make this claim we need to say something like, "It's raining in New York," or "It was raining in New York yesterday."

If you don't understand all of this it really doesn't matter much. What does matter is that when we want to talk about the bearers of truth and falsity, we are going to call them "statements," instead of "sentences" or "propositions." Moreover, because we are doing standard logic, which presupposes the laws of the excluded middle and non-contradiction, we are committed to holding that every statement is either true (and if true, not false), or false (and if false, not true).

Strangely enough, however, in logic we do not ordinarily worry about whether a particular statement is true or false. (In fact, we often use the term "truth-value" when we want to speak of a statement's truth or falsity, but don't care whether it is true or false.) Instead, we are usually concerned with whether the statement is logically true, logically false, or logically indeterminate.

What do we mean when we say that a statement is "logically true?" What we mean is that it is true as a matter of logic alone. As we will see, it's best to view logic as a collection of methods. Sometimes, when we use one of these methods on a single statement we get the result that the statement we are examining must be true. We refer to such statements as logically true. As we will discover, the statement that either it's raining or it isn't raining, provides an example.

A statement is "logically false," on the other hand, when it is false as a matter of logic alone. The statement that it's both raining and it isn't is an example of a logically false statement. It cannot be true and logic alone can show this.

Finally, we call a statement "logically indeterminate" when logic alone cannot determine which of the two truth-values (whether true or false) that statement has. To be sure, the statement is either true or false. Logic alone is just not able to find out which it is. The statement that it is raining is an example.

As we will see, when we come to a single statement the question we will usually be asking is, "Is it logically true, logically false, or logically indeterminate?"

There is only one other concept that applies to single statements that we will be interested in, and that is the concept of the negation of a statement. Every statement has a negation, and its negation is also a statement. Where S is any statement, the negation of S will be "It is not true that S." Thus, the negation of the statement that it is raining is the statement that it is not raining, while the negation of the statement that all men are mortal is that not all men are mortal, or in other words that some men are not mortal.

SETS OF STATEMENTS

It is sometimes useful to consider several claims as a unified whole. When we do, we are considering a set of statements. What, however, are these things we call "sets?" What are "sets of statements?" Finally, what are the terms we apply to sets of statements?

Sets in logic and mathematics and sets in everyday life differ in many important respects. First, sets in daily life at least frequently have a color. (Thus, we can intelligibly say things like, "My set of dishes is beige.") Logical and mathematical sets, in contrast, have no color. Second, sets in daily life have a spatial location. (We can, for example, ask, "Where is your set of dishes?") In contrast, sets in logic and mathematics have no spatial location. Third, sets in daily life can undergo changes in their membership. If we break a plate we can go to the store, buy another one, and still have the same set of dishes we had before. Logical and mathematical sets, however, cannot. A set in logic and math is completely determined by its members. Finally, sets in daily life must have at least several members. (Imagine asking to see our set of dishes and our telling you that it's in the cupboard. Yet when you look in the cupboard, all you see is one lonely plate. Would you be happy calling that a set of dishes?) In logic and math, however, a set can have as few as one member. Actually, there is a very special set called "the empty set" which has no members.

In this chapter we are going to be concerned with sets of statements. A set of statements is just some statements that we have decided to view together as one unit. There might be as few as one statement, or as many as you like, in a particular set.

To show that we are considering a set of statements, we simply surround those sentences that express the statements we wish to include in the set with curly braces. For example, we represent the set consisting in the statements that John loves Mary, Mary loves Bill, and Bill loves John, as: {John loves Mary; Mary loves Bill; Bill loves John}.

Once we have specified exactly what set of statements we are talking about, the problem of evaluating that set can then begin. Unlike single statements, we never evaluate sets of statements as true or false, or as logically true, logically false, or logically indeterminate. Instead, the only terms we ever apply are "consistent" and "inconsistent." Every set of statements will be either consistent or inconsistent, and no set will ever be both.

What do we mean when we say that a set of statements is consistent? What we mean, and all we mean, is that there is a possibility that all of the statements in that set are true together. A set is inconsistent, on the other hand, if it is impossible for all of the statements in the set to be true together.

The set, {John loves Mary; Mary loves Bill; Bill loves John}, is an example of a consistent set of statements, since it is possible for all three of the statements in the set to be true together. (Note that in saying that this set is consistent we are not saying that the statements in the set are true.) On the other hand, the set {John is taller than Mary; Mary is taller than Bill; Bill is taller than John} is inconsistent, since we cannot imagine all of the statements in this set true simultaneously.

How is this notion of a set of statements and the question whether a given set is consistent or inconsistent, useful? We sometimes want to know if all of the claims someone has made even could be true. If we discover that they could not all be true together, then we know that at least one claim he has made is false. In other words, if we discover that the set of statements someone has made is inconsistent we know he has made a mistake somewhere. This might be worth discovering.

ARGUMENTS

Although single statements and sets of statements are important objects of study, by far the most important entities that logicians study are arguments. As a working example of an argument, consider the following:

Since all men are mortal,
and Socrates is a man,
It follows that Socrates is mortal.

This argument resembles every other argument in one very important respect. Some statements are presented as evidence in an attempt to establish another statement. (Thus, the claims that all men are mortal and that Socrates is a man are presented to establish the claim that Socrates is mortal.)

ARGUMENTS AND EXPLANATIONS

Arguments are close relatives of, but are nonetheless distinct from explanations. We argue to convince people of a claim. However much or little someone says, an argument is being presented if and only if the individual making the claims is trying to convince his audience of something. On the other hand, a person is providing an explanation when he is attempting to account for something he thinks his audience takes to be a fact. The author is not trying to convince them of this "fact." He takes it as obvious they agree with him to this extent. Yet he also assumes that they find this "fact" surprising and he wants to provide them with an understanding of why it has occurred.

To see the difference between arguments and explanations compare the following:

ARGUMENT	EXPLANATION
Since all men are mortal and Socrates is a man, Socrates is mortal.	Because he drank hemlock, and hemlock is a poison, Socrates died.

Although these passages resemble each other quite closely you should view the one on the right as an explanation, not an argument. In it the author is not trying to convince us that Socrates died. Instead, he is assuming that we know this but we feel puzzled about why Socrates died.

Admittedly, the distinction between an argument and an explanation is not an easy one. Indeed, there may be occasions when it is virtually impossible for us to tell which we are dealing with. Yet it is important nevertheless, if only because we treat them quite differently in logic.

PREMISES AND CONCLUSIONS

Once we have decided we are dealing with an argument and not an explanation our job as logicians can begin. Our first task in analyzing any argument is to figure out exactly how it goes. To do this, we need to distinguish its premises from its conclusion.

In any argument we call the single statement, the one being argued for, "the conclusion of the argument." On the other hand, we call each statement that provides evidence to establish the conclusion "a premise of the argument." Every argument must have least one premise and exactly one conclusion. The conclusion is always the claim being argued for, and each premise is a statement that is supposed to contribute something toward establishing that conclusion. Together, the total group of premises (i.e., the set of statements containing all the argument's premises) is the arguer's evidence for that conclusion.

Although the person arguing usually formulates the conclusion of his argument after he has stated its premises, this is not mandatory. Often enough the arguer begins by stating his conclusion first. So instead of saying, "Since all men are mortal and Socrates is a man, it follows that Socrates is mortal" he might say, "Socrates is mortal, because all men are mortal and he is a man." However he might even sandwich the conclusion between premises. For the person presenting the argument might express it by saying, "Since all men are mortal, Socrates is mortal, because he is a man."

Ordinarily the author of an argument uses words and phrases that help us distinguish the premises of his argument from its conclusion. Words like "if," "for," "as," "since," and "because," commonly function as premise-indicators, and serve to inform us that the claim immediately following them is a premise of the argument. While words like, "hence," "thus," "so," and "therefore," are often used as conclusion-indicators, and serve to inform us that the conclusion of the argument will be presented next.

In the example we have been considering -- "Since all men are mortal, and Socrates is a man, it follows that Socrates is mortal." -- the word "since" is functioning as a premise-indicator. While the expression, "it follows that" is serving as a conclusion-indicator. In representing this argument, instead of including premise-indicators and conclusion-indicators, the normal procedure is simply to list the premises above the conclusion, and separate them with a line. Thus, however the argument is expressed in English, we formulate it as follows:

All men are mortal.
Socrates is a man.

Socrates is mortal.

Alternately, in this text, we will represent the argument on one line by separating its premises with semicolons, surrounding them with curly braces, and then writing '/' followed by the conclusion. So we will write the argument as follows: {All men are mortal; Socrates is a man}/Socrates is mortal.

The comments we have made so far may make it seem that locating the argument and distinguishing its premises from its conclusion is not an especially difficult task. It can, however, be extremely challenging. Not only do people sometimes not use any premise or conclusion indicators, they occasionally fail to state premises, or even the conclusion of the argument they are presenting. (We call these "suppressed premises" and "suppressed conclusions.") Thus, instead of saying, "Since all men are mortal, and Socrates is a man, it follows that Socrates is mortal" someone might simply say, "Since all men are mortal, Socrates is mortal."

When representing the argument we want to include any suppressed premises or conclusions in our formulation of it. The principle to use in deciding whether to include a particular premise as a suppressed premise is: We should include it if its inclusion would make the argument better than it would otherwise be and it seems likely that the author of the argument intended it to be a part of his argument. (This principle of charity -- try to make the other fellow's argument as good as you can -- is only common courtesy.)

Another factor that frequently makes the task of locating an argument and identifying its premises and conclusion more difficult is that people often present several interrelated arguments in a single passage. When this happens, we not only need to understand what those arguments are, we also need to see exactly how the various arguments relate to each other. The section of this chapter on Diagramming explains a technique you can use to represent these sorts of passages.

EVALUATING ARGUMENTS

Once we have clearly formulated the argument, we can begin evaluating it. To decide how to evaluate it, however, we first need to know whether the argument in question is inductive or deductive. This is so because we use different terms in evaluating deductive arguments than we use in evaluating inductive arguments. If the argument is deductive (i.e., if the arguer thinks that the conclusion of his argument follows with certainty from its premises), the evaluative terms used are "valid" and "invalid," or "sound" and "unsound." While if the argument is inductive (i.e., if the arguer thinks that the conclusion of his argument follows only with likelihood from its premises) the terms used are "stronger" and "weaker."

Of all the terms we have discussed in this chapter, perhaps "valid" and "invalid" are the most important. What do we mean when we say that an argument is valid? There are two ways of defining this concept:

1) An argument is valid =DF. It cannot have all true premises and a false conclusion.

2) An argument is valid =DF. The set of statements consisting in the argument's premises and the negation of its conclusion is inconsistent.

To use the first definition, it is easiest to simply draw a little box in front of the argument. Place a T in the box directly left of each premise and an F left of the conclusion. Then decide whether the combination of all true (=T) premises and a false (=F) conclusion is possible. If it is not possible the argument is valid, while if it is possible the argument is invalid.

Let's use this definition on our Socrates example to find out whether it is valid or invalid.

T	All men are mortal.
T	Socrates is a man.
	___________
F	Socrates is mortal.

We see here that we cannot imagine it true that all men are mortal, and true that Socrates is a man, but false that Socrates is mortal. The combination of T's and F's in the box is not possible. Therefore, our definition tells us that this argument is valid.

Now let's consider our second definition of valid.

An argument is valid =DF. The set of statements consisting in the argument's premises and the negation of its conclusion is inconsistent.

To use this definition, we first must convert the argument into a set of statements. The set of statements we need to consider consists in the premises of the argument and the negation of its conclusion. The set will be:

{All men are mortal; Socrates is a man; Socrates is not mortal}.

Even a brief glance at this set of statements should suffice to show that it is inconsistent. Therefore, the definition tells us the argument above is valid.

Usually when we say that an argument is valid this amounts to saying that it has a good structure. (One thing it does not say is that the premises of the argument are true. A valid argument can have false premises.) There are, however, examples of arguments we would in daily life evaluate as structurally defective, but which our definitions commits us to saying are valid. One such example is the following:

It's raining.
It's not raining.
____

The moon is made of green cheese.

Although most of us would count this a terrible argument, since its conclusion has nothing to do with its premises, it is, nevertheless, valid on both of our definitions of "valid" because it cannot have all true premises and a false conclusion (since both of its premises cannot be true), and so, on our first definition it is valid. Moreover, since the set consisting in the argument's premises and the negation of its conclusion, viz., {It's raining; It's not raining; The moon is not made of green cheese}, is inconsistent, the argument is also valid on our second definition. So although the word "valid" comes close to meaning good structure, there are cases where a valid argument does not have what we would normally think of as good structure.

The concept of soundness comes much closer than validity to what we would ordinarily think of as a good (deductive) argument. We call an argument "sound" if it is valid and it has all true premises. On the other hand, an argument is unsound just in case it is not sound. So every invalid argument is unsound, and every argument that has any false premises is also unsound.

Although the concept of soundness comes much closer to what we usually mean when we say an argument is good, it isn't a very important notion in logic. This is so for a very simple reason. Often, to tell whether an argument is sound, we must decide if its premises are really true. This, however, involves looking at the world, and that is not the business of the logician.

As we mentioned before, we evaluate inductive arguments differently than deductive ones. Instead of using the terms "valid" and "invalid," or "sound" and "unsound," we evaluate inductive arguments as "stronger" or "weaker." As these terms are clearly relational in nature, and imply a comparison between two arguments, we must here be comparing arguments with each other. When we say one argument is stronger than another, what this means is that its conclusion is more likely to be true, given its premises, than the other argument.

PAIRS OF STATEMENTS

There is only one other concept that we will be occasionally using. This concept applies to two statements. Two statements are said to be "logically equivalent" if and only if they must have the same truth-values. Thus, the statement that it is raining is logically equivalent to the statement that it isn't not raining because one of these cannot be true and the other false.

Although these are not the only concepts used in logic, they are at least the most important ones. We will introduce other notions when we need them.

DIAGRAMMING

Frequently passages contain multiple arguments. When this happens we need to know how the various arguments in the passage interrelate. In this section we will learn one method that will help us understand how these arguments intertwine.

Let's begin with a very simple passage so that we can illustrate several salient features of diagramming. Consider the following example:

> I saw Bill looking at Sandy's paper during the exam. He must have cheated, because they got the same questions wrong. We cannot tolerate cheating. So someone should discipline him.

This passage contains five statements that function as either premises or conclusions. The diagramming process begins by simply identifying and numbering each of these claims. Doing this we get:

^{1}I saw Bill looking at Sandy's paper during the exam. ^{2}Bill must have cheated. ^{3}Bill and Sandy got the same questions wrong. ^{4}We cannot tolerate cheating. ^{5}Someone should discipline Bill.

What is the main point of this passage? Clearly, it is trying to establish that someone should discipline Bill. Although it contains more than one argument, this is the main conclusion of its main argument. We'll represent this by writing a "5" down and drawing an arrow to it. Thus, we get:

$$\begin{array}{c}\downarrow\\ 5\end{array}$$

Now why does the arguer think that someone should discipline Bill? He believes this because he believes that Bill cheated (which we have identified as claim 2), and because he thinks that we cannot tolerate cheating (which we have labeled claim 4). Both these claims combined are evidently required to get to the conclusion in question. So let's put them both above the arrow and draw a line under them. In this way we can represent the fact that the author of the argument we are diagramming believes both these premises are needed to obtain this conclusion.

$$\begin{array}{c}\underline{2\quad 4}\\ \downarrow\\ 5\end{array}$$

So far so good, but we still need to worry about claims 1 and 3, however. What role do they play in the passage? One thing at least is clear. Claim 3 must be a premise, since it is preceded by the word "because," which we know is a premise-indicator. However, which claim is claim 3 supposed to be providing support for? Surely it is supposed to be supporting claim 2. The arguer thinks Bill must have cheated because Bill and Sandy got the same questions wrong. Claim 3 alone, however, is obviously not sufficient to establish claim 2, since Sandy might have been the one who was cheating, instead of Bill. Why does the author of the argument think it was Bill? Obviously he believes this because he saw Bill looking at Sandy's paper during the exam. So, claims 1 and 3 together are intended to support claim 2. We will represent this by putting 1 and 3 above 2, drawing a line under both of them, and then drawing an arrow from them to 2. The completed diagram will read:

$$\begin{array}{l}\underline{1\ \ 3}\\ \ \downarrow\\ \ \ \underline{2\quad 4}\\ \quad\ \ \downarrow\\ \quad\ \ 5\end{array}$$

Let's try a different example. Consider the following passage:

> Sandy would not have cheated on the test, because she already knew the material, as she amply proved by tutoring other students in it last week. Moreover, she didn't need a good grade on it, since she already had a guarantee of an A in the course.

This passage also contains five claims. They are:

[1] Sandy would not have cheated on the test.
[2] She already knew the material.
[3] She was tutoring other students in it last week.
[4] She didn't need a good grade on it.
[5] She already had a guarantee of an A in the course.

Now what is the main claim the arguer is attempting to establish in this passage? Evidently it is that Sandy would not have cheated on the test. (Unlike the last example, where the main conclusion was presented at the end of the passage, here it comes at the very beginning.)

This time we should put "1" at the bottom of our diagram. But it would be a mistake to draw a single arrow to it because the arguer has two independent reasons for thinking that claim 1 is true. First, she wouldn't have cheated because she already knew the material. Second, she would not have cheated since she didn't need a good grade on it. What we will do here, then, is to draw two separate arrows, one leading from 2 to 1, and the other going from 4 to 1. In this way we can illustrate how the passage in question has two distinct main arguments that just happen to have the same conclusion.

$$\begin{tikzcd} 2 \arrow[dr] & & 4 \arrow[dl] \\ & 1 & \end{tikzcd}$$

All we need to do now is to figure out the role played, in the passage, by claims 3 and 5. This, however, is easy. Claim 3 is preceded by the premise-indicator, "as she amply proved by," and is clearly intended to support claim 2; while claim 5 is supposed to support claim 4. Thus, the completed diagram should read:

$$\begin{tikzcd} 3 \arrow[d] & & 5 \arrow[d] \\ 2 \arrow[dr] & & 4 \arrow[dl] \\ & 1 & \end{tikzcd}$$

Let's consider one more example:

> Either Jill went to the beach or she went to the movie. However, she never goes to the beach on Sundays. Moreover, the only movie she hasn't seen is at the Strand Cinema. So she must be there.

If we number these claims in the order in which they occur, we get:

^{1}Either Jill went to the beach or she went to the movie.
^{2}Jill never goes to the beach on Sundays.
^{3}The only movie she hasn't seen is at the Strand Cinema.
^{4}Jill must be at the Strand Cinema.

Now clearly, the claim the person presenting the argument is attempting to establish is that Jill must be at the Strand Cinema (i.e., claim 4). Why does this person think that she must be at the Strand? Because that is the only movie she hasn't seen (viz., claim 3). But so what? If the arguer didn't think Jill went to a movie at all, or thought she might go to movies she had already seen, the claim that Jill must be at the Strand wouldn't be very plausible. In fact, these two added points are suppressed premises, and we really should include them in our representation of the argument. Let's label them "5" and "6." To make it clear, however, that they are suppressed premises we will place brackets around these numbers. Doing this we get:

[5] Jill went to the movie.
[6] Jill doesn't go to movies she has seen before.

From the combination of claims 3, [5], and [6], the arguer thinks claim 4 follows. Let's now represent what we have learned so far.

$$\begin{tikzcd} \underline{3\ [5]\ [6]} \arrow[d] \\ 4 \end{tikzcd}$$

This is all clear enough, but how then do claims 1 and 2 fit in? Surely they are designed to establish claim [5]. In other words, claim [5] is not only a suppressed premise of the main argument; it is also the suppressed conclusion of a secondary argument. At first glance, this argument proceeds: "Either Jill went to the beach, or she went to the movie. However, she never goes to the beach on Sundays. So, she went to the movie." There is a problem with this interpretation, however. The argument as thus formulated is invalid. Unless today is Sunday, claims 1 and 2 don't provide good support for claim [5]. It seems from the context, however, that the arguer is assuming this. So let's add a seventh claim to our list as a suppressed premise. The claim will simply read:

[7] Today is Sunday.

We can then finish diagramming the argument as follows:

$$\begin{array}{c}\underline{1\ \ 2\ \ [7]}\\ \downarrow \\ \underline{3\ \ [5]\ \ [6]} \\ \downarrow \\ 4\end{array}$$

Although the diagramming method we have been learning may be time consuming, and may even seem like a waste of time, it is not. Not only is it frequently useful in allowing us to find flaws in other people's arguments, it sometimes even helps us understand exactly what they are saying.

QUESTIONS (true/false)

1. Deductive logic studies those processes of reasoning in which the claims we are reasoning about follow with certainty from the evidence presented.
2. Rhetoric studies the principles of correct and incorrect reasoning.
3. Standard logic presupposes both the laws of non-contradiction and of the excluded middle.
4. The law of non-contradiction asserts that every bearer of truth and falsity (i.e., every statement) is either true or false.
5. The view that sentences are the bearers of truth and falsity conflicts with the law of non-contradiction.
6. The negation of the statement that some cows are brown is that some cows are not brown.
7. If a statement is logically true, then its negation will be logically false.
8. The following set of statements is consistent: {Bill was at the party if and only if Sarah wasn't; Sarah was at the party; Bill and Tom were both at the party.}
9. Every set of statements containing a statement that is logically false will be inconsistent.
10. Suppose that a set contains exactly two statements, one of which is logically true, and the other logically indeterminate: The set must be consistent.
11. Every set of statements containing exactly two logically indeterminate statements must be a consistent set.
12. Every argument has at least one premise and exactly one conclusion.
13. "McDuff isn't doing this tutorial because he's flying to Egypt for a LONG vacation." This is an example of an inductive argument.
14. "Since the sun always rises in the east, we'll be able to figure out where we are in the morning." This is an inductive argument.
15. All valid arguments are sound.
16. All sound arguments are valid.
17. Every sound argument has a true conclusion.
18. The following statements are logically equivalent:
    1) Bush is President and Cheney is Vice President.
    2) Cheney is Vice President and Bush is President.
19. The following statements are logically equivalent:
    1) Bush is President. 2) Cheney is Vice President.

PROBLEMS

1. Instructions: Determine whether each of the following passages contains an argument or an explanation. If it contains an argument, add any suppressed premises or conclusions that are needed, and identify its conclusion and then state whether the argument is inductive or deductive.

A. The price of gold should rise. Worldwide production is down and the Chinese are purchasing more of it than they have in the past.
B. Bill didn't go to the dance because he had a broken leg at the time.
C. Either the butler or the maid committed the crime. But the butler couldn't have done it.
D. The teacher gave everyone in the class an A. So Mildred must have gotten one too.

E. Of course it was a well-acted movie with a weak plot. It was a Golan-Globus production.

2. Instructions: Diagram the following passages, each of which contains more than one argument.

A. [1]Dick saw Spot if and only if Jane didn't. However, [2]Dick saw Spot only if Spot used a fire hydrant. [3]Spot didn't use a fire hydrant. [4]He used the carpet. So [5]Jane saw Spot. But [6]if Jane saw Spot, she punished him. Moreover, [7]if Spot used the carpet then Jane punished him. So [8]Jane punished Spot.

B. [1]Dracula must be a bat because [2]he is a vampire and [3]all vampires are bats. Moreover, [4]he must be hungry because [5]he has not eaten in three days, and [6]anyone who has not eaten in three days is hungry. [7]If Dracula is a hungry bat, tourists will wake up drained in the morning if they stay the night. [8]The tourists are idiots because [9]they are staying the night. So [10]they are going to wake up drained in the morning. Unfortunately, [11]anyone who wakes up drained in the morning will stay forever.

C. [1]Bloodless Charity is afraid of vampires because [2]she's a hemophiliac and [3]all hemophiliacs are afraid of vampires. But, [4]all vampires are bats. [5]So she must be afraid of bats. [6]Don't expect her to go in the cave. [7]There are bats in it.

D. [1]MADD gets mad at any organization that advocates the consumption of alcoholic beverages. But [2]beer is an alcoholic beverage, and [3]SETA advocates the consumption of beer over milk. So [4]MADD gets mad at SETA. [5]According to SETA, beer is less harmful to the health of the drinker than milk, and [6]people ought to care about their health when selecting what to eat and drink. Moreover, [7]milk harms other animals--namely cows--whereas beer does not, and [8]SETA maintains that we ought to care about the health of other animals when selecting what to eat and drink. [9]MADD won't get any money of mine because [10]no organization that gets mad at SETA will get my money.

E. [1]Everything old Mack Schnell did, he did in a hurry. [2]One night he drove his car on Hairpin Alley. [3]He must have driven it in a hurry. [4]But those who drive their cars in a hurry on Hairpin Alley are not only dead meat, that isn't moot, they're fools to boot. [5]So Mack Schnell died a fool. [6]Unfortunately, dead fools, I'm told, are headed for hell. [7]From this I surmise that old Mack Schnell is bound for hell. [8]But my guess is that if he ever gets there, he's sure to get there in one quick hurry.

F. [1]Rex is a miserable, pathetic, unloved dog. [2]All of those at the party who were children and wanted donuts got them. [3]Rex wanted donuts, and [4]he was at the party, but [5]he didn't get any. So [6]Rex wasn't a child. [7]Besides Momma Lina and the kids, the only one at the party was a dog. [8]Rex must have been a dog because [9]he sure wasn't Momma Lina. [10]Dogs that don't get donuts are miserable, pathetic, and unloved.

G. [1]The United States should forcibly remove Hussein from office because [2]he is a cruel dictator and [3]he is a menace not only to his neighbors and to other nations, but also, [4]he is a clear and present danger to the United States.

[5]He used chemical weapons on the Kurds in Northern Iraq when they rose up against his dictatorship, and [6]he had many members of his own parliament, some of whom were completely innocent, summarily shot when there was an attempted coup against him.

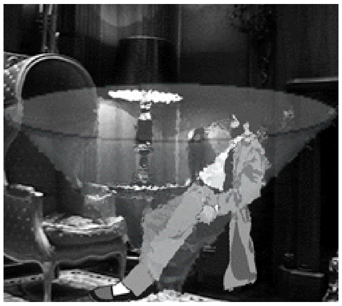
[7]He attacked other nations, notably Iran and Kuwait, and this shows that [3]he is a menace not only to his neighbors but to other nations as well. Moreover, [8]he used chemical and/or biological weapons during the Iran/Iraq War, and this indicates that [9]he would not hesitate to use WMD on the United States if he has the opportunity. Also, [10]he was attempting to develop nuclear weapons before the First Gulf War, and [11]there is no reason to believe that he has stopped attempting to develop such weapons since then. In fact, there is reason to believe that [12]he is still perusing this policy because [13]he attempted to purchase aluminum tubes from Niger, and [14]these tubes could only be used to make nuclear weapons.

[15]If we allow Hussein to continue his WMD programs there is no doubt that he will eventually have the opportunity to use them on the United States. For [16]even if he cannot deliver the weapons himself, he has contacts with members of Al-Qaida, and he would not hesitate to provide members of

that organization with these weapons, which they surely would use.[17] Eliminating Hussein will also be beneficial to the people of Iraq and it will allow us to transfer military bases from Saudi Arabia, where they engender local antagonism, to Iraq. [18] A United States attack will also be cost effective because we can use Iraqi oil to pay for our war expenses.

3. Instructions: Determine who committed the crime, how it was done, and what the motive was.

THE SITUATION



Lord Mumbleton has been found dead at his desk in his study; the attending physician diagnoses arsenic poisoning. Two empty glasses of wine are on a tray on his desk, along with a half-eaten crumb cake. The only people on the estate were Lord and Lady Mumbleton, Doxy the maid, Flo Main the cook, Stodgson the butler, and Shiftless the chauffeur. The inspector has just told you that there are two entrances to Lord Mumbleton's study; one door leads to his and Lady M.'s bedroom that was locked from the study side, while the other door leads into the hallway. A large window looks out onto the garden. Because Scotland Yard is baffled as to motive, means, and opportunity, your assistance is requested. Under cross-examination the following facts become apparent:

THE EVIDENCE

1. Either Lady M. was locked in her bedroom by Lord M. to keep her from spying on him, or else, she stole the butler's keys.
2. Only Lord M. eats crumb cake.
3. Either Lady M. is lying, or Lord M. hasn't seen his lawyer in years.
4. Flo Main killed Lord M. only if Doxy is her natural daughter or Lord M. made improper suggestions about her tarts.
5. Shiftless was walking in the garden at the time and he saw Stodgson enter the study.
6. If Lady M. went to a convent, she would never lie.
7. If the diamond necklace he gave her was a fake, Doxy killed Lord M. in a fit of pique.
8. Last night, Shiftless heard Doxy and Lord M. giggle about what Flo Main could do with her tarts.
9. Stodgson poisoned Lord M. if and only if Lord M. gave Stodgson two weeks notice.
10. Doxy poisoned the cakes only if she helped bake them.
11. Lord M. didn't damage the 1947 Daimler because he canceled all of his insurance to save money.
12. Stodgson swears that his keys are always in his possession and that Doxy had a private meeting with Lord M. every night.
13. The cook is very proud of her work and never lets anyone help her bake.
14. Stodgson entered the study through the hallway and saw Lord M. open the bottle of wine and pour out two glasses of it.
15. Lord M. paid three thousand pounds for Doxy's necklace.
16. Lady M. went to school in a convent in Switzerland.
17. Doxy's natural mother is a pawnbroker in the village.
18. Either Stodgson poisoned the wine or the arsenic was in the crumb cake.
19. Shiftless killed him only if Lord M. damaged the 1947 Daimler.
20. Lord M. gave Stodgson two weeks notice only if Lord M. had a new will drawn up at his lawyer's office.
21. Unless there is a lot of insurance money, Lady M. didn't kill her husband; but she wanted to.
22. The entire household heard Lord M. and Doxy giggling last night.