CHAPTER SEVEN

Methods of Deduction

7.1 The General Pattern of Deduction

A deduction is a series of steps that lead from the premises to the conclusion of an argument, where each step is logically justified. The deduction performs the role of "therefore." It links the premises to the conclusion deductively.

In everyday life, arguments are usually presented in an informal way, without any intervening deduction at all, or with a partially complete deduction. If the conclusion is very closely linked to the premises, the validity of the argument may be obvious enough. But frequently an argument that looks valid turns out to be invalid when an attempt is made to "fill in" the deduction. A *formal deduction* is one in which all the logical links between the premises and the conclusion have been filled in and justified by established logical rules. In the example below, lines 3-7 create a formal link between the premises and the conclusion. (We have added the English equivalents in this case for clarity.)

A formal deduction is one in which all the logical links between the premises and the conclusion have been filled in and justified by established logical rules.

1. PREMISE	(A then B)	If George is the winner, Mary will be quite impressed.
2. PREMISE	(A and nnC)	George is the winner, and he is not unhappy with the outcome
DEDUCE	(B and C)	Mary will be quite impressed and George is happy with the outcome
3. CONJUNCT 2	A	George is the winner
4. SUFEST 1,3	B	Mary is quite impressed
5. CONJUNCT 2	nnC	George is not unhappy with the outcome
6. DBLNEG 5	C	George is happy with the outcome
7. JOINUP 4,6	(B and C)	Mary is quite impressed and George is happy with the outcome
8. CC 7		

Notice that we changed "will be quite impressed" to "is quite impressed" on line 4. The reason the tense can be changed from future to present tense here is that line 3 says George *is* the winner, so the result for Mary is now in the present tense, not in the future. This sort of change was discussed in Chapter Five (5.6).

In this formal deduction, every line has a number except for the DEDUCE line. After each line number comes the justification for the line. The premise lines are justified by PREMISE (PR). Other lines are justified by *inference rules* such as CONJUNCT (CJ), SUFEST (SE), and JOINUP (JU). Lines of a deduction may also be justified by *replacement rules,* which will be described later in this chapter.

LINE REFERENCES WITH INFERENCE RULES. After the short name (or the two-letter abbreviation) for each inference rule, you will see one or more *line references.* A line reference is the number of the line or lines of the deduction to which the rule is applied in order to obtain a result. For example, "CONJUNCT 2" means that the rule of CONJUNCT (CJ) has been applied to line 2 in order to obtain the result on line 3. JOINUP 4,6 means that the rule of JOINUP (JU) has been applied to lines 4 and 6 to obtain a conjunction. In the case of JOINUP, it doesn't matter in what order you list the lines joined, because the AND connector is symmetrical.

However, ALTDEN (AD), SUFEST (SE), and NECDEN (ND) require *two* line references, which should be written in a definite order. In the pattern below, let *m* and *n* refer to any line reference. The justifications for each of the three rules would be read as shown.

ALTDEN *m,n*	"One ALTernate of line *m* has been DENied in line *n.*"
SUFEST *m,n*	"The SUFficient of line *m* is ESTablished in line *n.*"
NECDEN *m,n*	"The NECessary of line *m* is DENied in line *n.*"

For example, "SUFEST 4,7" (or "SE 4,7") is read "The sufficient of line 4 is established in line 7." This tells you that line 4 is a conditional, and that line 7 is the sufficient condition of that conditional. Thus the order of line references for these three rules can help you remember just how each one works, and gives you a way of checking to see if you have used the rule correctly in any given case.

7.2 The DEDUCE Line

After you have written in the PREMISE (PR) lines of your deduction (e.g., lines 1 and 2 of the example above) the next line will be the DEDUCE line (DD). The DEDUCE line is a line stating the desired conclusion of the argument. The DEDUCE line is the one exception to the rule that all the lines are numbered. The DEDUCE line has no number, as you can see in the example above, where the DEDUCE line falls between lines 2 and 3 but is not itself numbered.

The DEDUCE line has no line number because, strictly speaking, it is not part of the deduction. When you begin a deduction, your purpose is to find out whether the conclusion *would* be true when the premises are true. The DEDUCE line merely states in advance the conclusion you hope to prove. In a deduction, therefore, although you treat the PREMISE lines as true, you may not treat the DEDUCE line as true until the conclusion is established.

A line treated as true is called a *usable* line. A usable line is one that may be referred to by its line number in later lines of the deduction. The PREMISE lines are always usable, but the DEDUCE line is never usable. If you try to use the DEDUCE line, ignoring the fact that it has no line number, you fall prey to a well-known fallacy called *begging the question.*

NOTE: In popular usage, the expression "begging the question" is frequently misunderstood. People think this means that some information calls for a question to be asked, or "begs for a question." This is an unfortunate situation because when someone uses the long-established traditional meaning of the expression, many will not understand what is being meant. If you remember the distinction between "begs the question" and "begging for a question to be asked," this may help avoid confusion.

> FALLACY OF BEGGING THE QUESTION
>
> Attempting to use the conclusion of an argument to prove itself: "A type of logical fallacy (also called petitio principii) in which the proposition to be proved is assumed implicitly or explicitly in one of the premises."
>
> *(This does not mean* "Begs for a question.")

7.3 Looping Strategy

When you create a deduction you must be especially careful not to work in a linear fashion, going only from one line to the next and forgetting about earlier lines. Instead you should get in the habit of "looping" your attention constantly back over the usable lines, evaluating their logical connections to the latest lines you have written and to your goal as stated in the DEDUCE line. *The looping strategy is the single most important technique you can learn as an aid in creating deductions.* We will illustrate the looping technique in the example below. After writing line 3, you should "loop."

1.	PREMISE	(A then B)
2.	PREMISE	(A and nnC)
	DEDUCE	(B and C)
3.	CONJUNCT 2	A

Looping here means stopping to compare your latest result (A on line 3) with *each usable line above it,* looking for some possible interaction between the lines in accordance with the rules. (In actual practice, you would probably already have figured out these relations and that would have been your reason for writing line 3 in the first place. But when an argument is more complex the looping procedure can be a great help.)The line immediately above line 3 is the DEDUCE line, but there will never be an interaction with the DEDUCE line, since that line has no number and is unusable. The next line above line 3 is line 2, but since you originally got the A from line 2, there is no further interaction between lines 3 and 2.

Now, however, your looping brings you to line 1. When you compare line 3 with line 1, you get an immediate result. The A in line 3 is the same as the sufficient condition of the conditional in line 1; in other words, the sufficient condition of line 1 has been established in line 3. By looping, you have discovered that an application of SUFEST (SE) is now possible. We realize that result in line 4 below. Study this line carefully until you are sure you understand how it has been obtained.

4.	SUFEST 1,3	B

Now that you have a new result on line 4, repeat the looping strategy. The line immediately above line 4 is line 3, but there is no logical interaction between your B in line 4 and the A in line 3. The next line is the DEDUCE line. Normally, you would ignore the DEDUCE line, since it cannot have any logical interaction with the usable lines of the deduction. However, looping here still proves useful. Your new result, B, is the same as one of the desired conjuncts in the DEDUCE line (B and C). This means that line 4 has brought you closer to your goal. Now, since you already have B and you want (B and C), you need to get C. Looping up again to line 2, you see that nnC is one of the conjuncts of that line. An application of the rule of CONJUNCT (CJ) followed by DBLNEG (DN) gets you C. Next, you may use the JOINUP (JU) rule to match the goal as stated in the DEDUCE line.

4.	SUFEST 1,3	B
5.	CJ 2	nnC
6.	DN 5	C
7.	JU 4,6	(B and C)

Before continuing let's look at this same argument in English.

1. PR	If this is a genuine Italian sauce, then it uses fresh tomatoes
2. PR	This is a genuine Italian sauce, and it is not unimpressive.
DD	This sauce uses fresh tomatoes, and it is impressive
3. CJ 2	This is a genuine Italian sauce
4. SE 1,3	This sauce uses fresh tomatoes
5. CJ 2	This sauce is not unimpressive
6. DN 5	This sauce is impressive
7. JU 4,6	This sauce uses fresh tomatoes and it is impressive

THE POWER OF AN ABBREVIATED DEDUCTION: What is the relation between the English version of the argument above, and the abbreviated version? The English version is simply one instance of a potentially infinite number of arguments that would have *the same form* as that shown in the abbreviated version! Because of this, our method of abbreviation provides us with a great deal of logical power that we would not have if we were forced to evaluate every argument we might encounter separately. Of course this does not mean that it would be advantageous to memorize thousands of abbreviated arguments. There are similarities of form in various types of arguments, and in argument strategies, that can become familiar and give you a regular toolbox of methods for both recognizing invalid argumentation and constructing valid arguments. Unless your interest is in mathematical logic, linguistics, and philosophy of language, you are not likely to spend time abbreviating arguments as shown in this text before you can understand whether they are valid or invalid. It is, rather, the learning of the general characteristics of good logical form, and of deductive strategies, that is of value. Accordingly, the exercises at the end of this chapter will include practice doing both abbreviated arguments and arguments in plain English.

Our method of abbreviation provides us with a great deal of logical power that we would not have if we were forced to evaluate every argument we might encounter separately.

7.4 Ending the Deduction

In the example above we did not actually arrive at the final step. There are three traditional methods for ending a deduction: *Direct deduction, Indirect Deduction, and Conditional Deduction.* In this chapter, you will learn Direct Deduction and Indirect Deduction. Conditional Deduction is reserved for the chapters on advanced deduction techniques.

DIRECT DEDUCTION. A deduction may come to an end whenever you reach a line that *exactly matches the statement on the DEDUCE line.* The justification for ending a direct deduction is CONCLUDE (CC) followed by a line reference. The line reference accompanying CC must be the number of a currently usable line having a statement identical to that of the DEDUCE line. Our current example ends by direct deduction, like this:

8.	CC 7	

In this case line 7 was identical to the DEDUCE line.

INDIRECT DEDUCTION. A deduction may also come to an end whenever you reach a *contradiction.* A contradiction is any two line statements where one statement has the form *A* and the other has the form *nA*. The justification for ending an indirect deduction is CONCLUDE (CC) followed by numbers of the contradictory lines, with an exclamation mark ! between them. Below is an example of the last three lines of an indirect deduction. In this case the desired conclusion, (A and B), is written out after the justification.

15.	CJ 3	D
16.	CJ 8	nD
17.	CC 15!16	

WHY INDIRECT DEDUCTION WORKS. The method of indirect deduction is based upon a logical principle that holds firmly for any logical system based upon truth conditions alone (as is the present system). That principle is as follows: *If a contradiction ever becomes true, then anything is true.* We call this principle the *contradiction limit,* or CONLIM for short. In MEF pattern, CONLIM is *(A and nA) then B*.

CONLIM can be proven true by an examination of its truth conditions. A conditional is true when its sufficient condition is false, and (A and nA) must be false by the truth conditions for a conjunction (Chapter Three). It follows from CONLIM that if a contradiction ever becomes true within a deduction, the conclusion of the argument must also be true. Therefore the deduction may come to an end.

The method of indirect deduction, described above, is often puzzling to beginners in logic. Even if the truth of a contradiction would make anything come true, how, they ask, can a contradiction ever become true? The answer is that although we do not expect a contradiction ever to be true in everyday life, there are three ways that a contradiction may emerge *within the confines of a deduction.* First, there may be a contradiction hidden within the premises of the original argument. In such a case, the argument will be valid, but it will never be *sound,* because at least one of the contradictory premises will have to be false. Second, the person advancing the argument may actually be embracing contradictory ideas in his or her own mind without realizing it. Third, a contradiction may emerge under carefully controlled conditions when a special deduction technique, called *Reductio ad Absurdum (Reduction to absurdity),* is used. This powerful technique, which is commonly used in argumentation, will be explained later on in this chapter.

7.5 The Syllogistic Chain

LOGICAL RHYTHMS. Certain logical linkages occur in groups or sequences, establishing a kind of "rhythm" in the deduction. One of these deduction rhythms is the rhythm of the *syllogistic chain.* We will illustrate the syllogistic chain by analyzing an argument from English all the way to a completed deduction. Study the deduction carefully, because it is an example of general methods of deduction as well as an example of the syllogistic chain.

> Given that the carbon test proves positive, we can assume that this bone is at least four million years old. If this bone is at least four million years old, it is well aged. But if it is well aged, Lassie will love it. The bone was found in a garbage can, but the carbon test does prove positive. Therefore Lassie will love this bone.

ABBREVIATED ARGUMENT: For convenience we show the English on the side in this example.)

1.	PR	A then B	If the carbon test proves positive, this bone is at least 4 million yrs. old.
2.	PR	B then C	If this bone is at least 4 million yrs. old, it is well aged.
3.	PR	C then D	If this bone is well aged, Lassie will love it.
4.	PR	E and A	This bone was found in a garbage can, and the carbon test proves positive.
	DD	D	Lassie will love this bone.

UNLOCKING THE CHAIN. Do you see the chain? It is in premises 1, 2, and 3, where the necessary of each is the sufficient of the next! The goal of the argument is announced on the DEDUCE line. It is D, for "Lassie will love this bone." Looking at the premises, you see that D appears in line 3, but you cannot use CONJUNCT (CJ) on line 3 because line 3 isn't a conjunction. To get D out by itself, you will have to *unlock the syllogistic chain.* To unlock the chain, establish the first sufficient condition in the chain, which is A. This is where line 4 comes in. Because line 4 is a conjunction and not a conditional, you may use CJ to obtain A. Once you have established A separately you reach D quickly by successive applications of SUFEST (SE).

5.	CJ 4	A	The carbon test proves positive
6.	SE 1,5	B	This bone is at least 4 million yrs. old
7.	SE 2,6	C	This bone is well aged
8.	SE 3,7	D	Lassie will love this bone
9.	CC 8		

The "rhythm" of this syllogistic chain is apparent in the pattern of the line references in lines 6, 7 and 8, where the references are, 1,5|2,6|3,7. (Of course, if the conditionals in the premises had not been on consecutive lines, the rhythm would not be as obvious.)

THE RULE OF SYLLOGISM (SYL). The syllogism relationship is such a common occurrence that it is convenient to express it as a special inference rule, SYL.

SYLLOGISM (SYL): Draw a result from a syllogistic chain.

PREMISE:	*A then B*
PREMISE:	*B then C*
CONCLUSION:	*A then C*

The new rule is stated above with just two premises as an example, but it holds *no matter how many premises are involved,* as long as each premise links its necessary condition with the sufficient condition of the next. The rule also holds *regardless of the order of the premises.* The order of the premises in the argument does not matter as long as the proper syllogistic linkage (necessary condition to sufficient condition) is present.

In a deduction, a result may be drawn from a series of syllogistically linked conditionals simply by referring to the SYLLOGISM (SYL) rule. Thus the example above about Lassie could be shortened as follows:

5.	CJ 4	A	
6.	SYL 1-3	A then D	(applying the SYL rule)
7.	SE 6,5	D	
8.	CC 7		

In line 6 the line reference "SYL 1-3" indicates that lines 1 through 3, in that order, are being used as the premises of the syllogism. In using the SYL rule, always make sure your line references are complete. For example, SYL 2,5 would mean you are using the rule on just lines 2 and 5. If you are using several lines and the lines are not in order, you might write a line reference like "SYL 5,2,7."

7.6 Rules of Replacement

Sometimes, in working a deduction, it is necessary to replace one form of a MEF with an equivalent form that happens to be more useful. To show the logical equivalence we will use a double arrow, which in effect means that each MEF in the equivalence is both the sufficient and the necessary condition for the other. In each case a sentence of the form shown on one side of the double arrow may be replaced by the one on the other side. Here is a complete list. Some of the rules have more than one form. There are similar rules in math, but they have to do with numbers, not with sentences. On the next page we list the most useful replacement rules. They involve situations where you can reverse the order of components, or move a negator from outside to inside of a pair of parentheses. In some of the cases the major connector will have to change.

Reversing the position of the components. This rule applies only to ANDs and ORs.

Commutation	COMMUT (CM)	*(A and B)* ↔ *(B and A)*
		(A or B) ↔ *(B or A)*

Reversing the necessary and sufficient conditions. This rule applies only to conditionals. Notice that when the components are reversed, each of them must be negated.

Transposition	TRANS (TR)	*(A then B)* ↔ *(nB then nA)*

Moving a negator into or out of the parentheses. Watch carefully just how the negators move in each case..

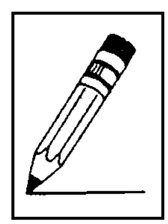
DeMorgan's	DEMORG (DM)	*n(A or B)* ↔ *(nA and nB)*
Laws		*n(A and B)* ↔ *(nA or nB)*
Negation of	NEGCOND (NC)	*n(A then B)* ↔ *(A and nB)*
a Conditional		*(A and B)* ↔ *n(A then nB)*

Changing a conditional to an alternation, or vice-versa. Again, watch what happens with the negators!

Conditional to	CONDALT (CA)	*(A then B)* ↔ *(nA or B)*
Alternation		*(A or B)* ↔ *(nA then B)*

Aside from the COMMUT rule, the useful thing about the rest of them is that they give you ways of moving negations about from outside to inside, or from inside to outside, of parentheses. In some cases both components have to be negated (as in TR and DM) and in other cases only one is negated (NC and CA). There is no need to memorize all of these replacement rules right now, although it can be helpful to study them a bit to see what is going on with the negators in each case. We will illustrate the use of these rules as they occur in our examples and exercises.

STUDY PROBLEMS. Fill in the blanks. Each example is completed up to the point where the CC line should be written. After filling in the blanks, write the CC line. The final line number is written in for you. (In many cases, to decide what result is desired, you will have to look at the moves made in following lines and extrapolate the procedure backward.) All of these problems may be solved by the method of Direct Deduction. (Answers to these study problems are in the appendix)



1.

1.	PR	A then nB
2.	PR	A
	DD	nB
3.	SE 1,2	________
4.	________	

2.

1.	PR	B and C
2.	PR	C then A
	DD	A
3.	CJ 1	________
4.	SE 2,3	________
5.	________	

3.

1.	PR	A and nB	5.	CJ 1	_________
2.	PR	A then C	6.	SE 2,4	_________
3.	PR	nB then D	7.	SE 3,5	_________
	DD	C and D	8.	JU 6,7	_________
4.	CJ 1	_________	9.	_________	

4.

1.	PR	A
2.	PR	B or C
	DD	A and (B or C)
3.	JU 1,2	_________
4.	_________	

The next two problems introduce the ALTDEN (AD) rule. Review the rule now (Chapter Three) if you are not sure how it works.

5.

1.	PR	nC or B	4.	CJ 3	_________
2.	PR	A then nB	5.	SE 2,4	_________
3.	PR	nD and A	6.	AD 1,5	_________
	DD	nC	7.	_________	

6.

1.	PR	B then nA	5.	CJ 4	_________
2.	PR	C then B	6.	AD 3,5	_________
3.	PR	D or C	7.	SE 2,6	_________
4.	PR	nD and nE	8.	SE 1,7	_________
	DD	nA	9.	_________	

Problem 7 uses the replacement rule called DEMORG (DM) on line 4. We have written in this first use of DM for you. Problem 8 below also uses the DM rule. Notice how the replacement rule helps the deduction by moving the negator to a more useful location.

7.

1.	PR	(A then B) and (A then C)	8.	CJ 1	_________
2.	PR	D then A	9.	CJ 1	_________
3.	PR	n(E or nD)	10.	SE 8,7	_________
	DD	B and C	11.	SE 9,7	_________
4.	DM 3	nE and nnD	12.	JU 10,11	_________
5.	CJ 4	_________	13.	_________	
6.	DN 5	_________			
7.	SE 2,6	_________			

8.

1.	PR	n(A and B)	3.	DM 1	_________
2.	PR	A	4.	AD 3,2	_________
	DD	nB	5.	_________	

The next problem uses the NEGCOND (NC) replacement rule on line 4. Again we put the first use of this rule in for you. Notice how the use of NEGCOND here makes the material in line 1 available for use by changing the negation of the conditional in line 1 into a conjunction. Line 5 immediately takes advantage of this by applying CONJUNCT (CJ) to line 4.

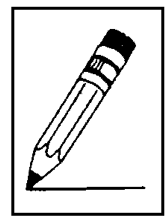
9.

1.	PR	n(C then A)	5.	CJ 4	________
2.	PR	nA then B	6.	SE 2,5	________
3.	PR	B then n(D and E)	7.	SE 3,6	________
	DD	nD or nE	8.	DM 7	________
4.	NC 1	C and nA	9.	________	

Problem 10 also uses the NEGCOND (NC) rule. The NEGCOND rule is a very important rule that you will use regularly in working problems that use the strategy of Reductio ad Absurdum (Section 7.6).

10.

1.	PR	nC or B	5.	CJ 4	________
2.	PR	n(A then B)	6.	AD 1,5	________
3.	PR	nC then D	7.	SE 3,6	________
	DD	D	8.	________	
4.	NC 2	________			



STUDY PROBLEMS. Use the replacement rule indicated to change the stated MEF. Write the changed MEF in the blank. Sometimes the rule can be applied to the entire MEF (the major connector) and sometimes it will be applied to a component of the MEF (a minor connector). If a rule can be applied to more than one connector in the same MEF, do so, converting minor connectors first. Drop any double negations in the final result. The rule to apply is indicated by its short, two-letter abbreviation. The first three are solved for you. (Answers are in the appendix.)

1. n(nC then (A or nB)). Apply CM: n(nC then (nB or A))
2. (nA then B). Apply TR: (nB then A)
3. [A or (nB or C)]. Apply CA: 1. [A or (B then C)], 2. [nA then (B then C)]
4. ((A or B) then C). Apply CA: ______________
5. [C or (B and A)]. Apply CM: ______________
6. [nnC then nnE]. Apply TR: ______________
7. (A then nB). Apply CA: ______________
8. [(B or A) and C]. Apply CA: ______________
9. n(nC or nE). Apply DM: ______________
10. [nnB or (C then nD)]. Apply TR: ______________
11. n(nA then nB). Apply NC: ______________
12. (nC and n(A and B)). Apply NC: ______________
13. n(nC or D). Apply DM: ______________
14. (nA and B). Apply DM: ______________
15. n(A and nB). Apply DM: ______________
16. [(A and B) then nnC]. Apply TR: ______________
17. n(A then B). Apply TR: ______________
18. [A and n(B or C)]. Apply DM: ______________
19. (nB then C) or nA. Apply CA: ______________
20. A then n[(B and nC) and D)]. Apply DM: ______________

7.7 The Strategy of Reductio ad Absurdum

Earlier we mentioned the traditional method of argument called the method of *Reductio ad Absurdum* or "Reduction to Absurdity." This argument strategy is extremely powerful, so powerful that it is regularly used in debates, where it has the form:

> *Show that your opponent's view leads to an absurdity (a contradiction, or some situation that is absolutely not acceptable), and you have proven that your opponent is wrong.*

An English example of Reductio ad Absurdum might be: "I know that Moriarty committed the crime, because if he did *not* commit the crime, he would have to have been in Switzerland and Italy at the same time; but that's absurd (contradictory), so Moriarty had to have committed the crime." When it comes to deductions, the idea of Reductio ad Absurdum might be expressed like this:

Show that denying the conclusion leads to a contradiction, and you have shown that the conclusion must be true.

THE SUPPOSITION FOR INDIRECT DEDUCTION. In our logical system we use this powerful method of argument by allowing a special kind of supposition, called a *supposition for indirect deduction.* The supposition for indirect deduction consists in deliberately supposing, only for the sake of the argument, that the DEDUCE line of your deduction is false. If this supposition leads to a contradiction, you may conclude that the supposition is false, which means that the DEDUCE line is true. The justification for the supposition line is SUPNOT (SN) for "suppose not."

WRITING THE SUPNOT LINE. The SUPNOT line is subject to severe restrictions.

SUPNOT RESTRICTIONS

You may write a SUPNOT line only directly beneath a DEDUCE line.

The SUPNOT line statement must be the exact denial of the statement on the DEDUCE line directly above it.

Below we give several examples of correct and incorrect SUPNOT lines. The first example has a DEDUCE line that is already a negation, so the SUPNOT line simply drops the negator. (We have left out the premises to save space).

	DEDUCE	nC
3.	SUPNOT	C

When the DEDUCE line isn't a negation, a negator must be added to the SUPNOT line:

	DEDUCE	A and B
3.	SUPNOT	n(A and B)

When you add a negator like this for a SUPNOT line, be sure that you bracket the entire DEDUCE statement and then put just one negator on the left, regardless of how complex the DEDUCE line is. Here's an example.

	DEDUCE	A or n(B then nnC)
3.	SUPNOT	n[A or n(B then nnC)]

In the case of this SN line, the sentence inside the brackets is an alternation. So line 3 is the negation of an alternation. What will happen if you apply the replacement rule DEMORG to this line? DEMORG moves the outside negator inside and it attaches to both components while at the same time the connector changes from OR to AND. Of course we should then dispense with the resulting double negations using DN:

4.	DM 3	nA and nn(B then nnC)
5.	DN 4	nA and (B then C)

By doing this, you can deduce nA directly from line 5, whereas you could not get it easily out of line 3 until you have applied the DM rule. This sort of thing happens often when using the SN method and can sometimes be the only way to easily handle the deduction. Notice that there is a rhythm involved: SN, DM, DN. We will see examples of this rhythm and similar "rhythms of logic" frequently as we go along.

It is a common mistake for beginners to create incorrect SUPNOT lines by imagining that if they negate the *components* of a statement they have created the negation of the statement. But this is not correct. Here is an example of an *incorrect* SUPNOT line:

	DEDUCE	(A or B)	
4.	SUPNOT	(nA or nB)	(incorrect SUPNOT)

The correct way to create a SUPNOT for this DEDUCE line is shown below. We have followed it with another example of the SN, DM rhythm. What could you do next with line 5?

	DEDUCE	(A or B)	
4.	SUPNOT	n(A or B)	(correct SUPNOT)
5.	DM 5	nA and nB	(Rhythm: SN, DM)

> *When you introduce a SUPNOT line, your goal is to obtain a contradiction.*

THE STRATEGY GOAL. When you introduce a SUPNOT line into a deduction you have initiated the strategy of *Reductio ad Absurdum.* You are going to show that the opposite conclusion (the denial of your DEDUCE line) leads to a contradiction, and therefore must be false, so the DEDUCE line must be true. The goal of this strategy is to end the deduction by the indirect method (see the discussion of CONLIM at 7.4) rather than by direct deduction. In practical terms, this means your goal is to obtain a contradiction. If the argument is valid, a contradiction will eventually emerge as a result of the SUPNOT line. Finding the contradiction can be a lot like working a logical puzzle! (Practice in doing this can actually spill over into regular conversation, where you will be able to spot contradictory ideas that may be hidden in the comments of your acquaintances. Be careful, though. Sometimes pointing out inconsistencies can lead to a different kind of argument!!) In the deduction, when the contradiction does emerge, you can CONCLUDE by indirect deduction. The next example shows how SUPNOT (SN) and Indirect Deduction work together.

1.	PR	B then A	If Gordio is a Baratarian, then he is a liar
2.	PR	nA then C	If Gordio is not lying, then he lives in Barataria
3.	PR	C then B	If Gordio lives in Barataria, then he has to be a Baratarian
	DD	A	DEDUCE: Gordio is a liar
4.	SN	nA	Well, suppose Gordio is not a liar
5.	SE 2,4	C	Gordio lives in Barataria
6.	SE 3,5	B	Gordio is a Baratarian
7.	ND 1,4	nB	Gordio is not a Baratarian
8.	CC 6!7		(But that's impossible, so he must be a liar.)

After the SUPNOT on line 4, the applications of SUFEST (SE) and NECDEN (ND) have caused a contradiction to emerge on lines 6 and 7. This contradiction satisfies the goal of the SUPNOT strategy. The new method of indirect deduction is used in line 8 to conclude the deduction. Note the line references 6!7 to indicate that it is lines 6 and 7 that contradict one another.

NOTE: In discussing this argument we have overlooked the possible interpretation of "is a liar" as meaning "lies often" rather than "lies all the time." If "Gordio is a liar" just means "Gordio lies often," then the argument may not be valid, because on a certain occasion Gordio might be lying but still not be a person who lies often. To resolve this issue one needs more context for the argument than we have given here.

7.8 Replacement Rules and Logical Rhythms

When you use the SUPNOT method for a compound DEDUCE line other than a negation, your SUPNOT (SN) line will be the negation of a compound. This usually generates a rhythm, as we showed in some of the examples in section 7.7. What happens when the DEDUCE line is a conditional?

	DD	(A then B)
3.	SN	n(A then B)

The replacement rules give you ways to change any negation of a compound into a statement that is not a negation. The applicable rules are NEGCOND and DEMORG. In this case NEGCOND would be used. The result of the NEGCOND step applied to the SUPNOT line is very useful, since it allows you to use CONJUNCT next to obtain A and nB separately. You could not use CONJUNCT directly on the SUPNOT line, but it is perfect for the NEGCOND line.

	DD	(A then B)
3.	SN	n(A then B)
4.	NC 3	(A and nB)
4.	CJ 4	A
5.	CJ 4	nB

This strategy produces the rhythm SN, NC, CJ, CJ. By using this deduction rhythm, you gain the greatest amount of information from your SUPNOT line and move the deduction forward considerably. After the two conjuncts, you should follow the "looping strategy" described in section 7.3 above.

A SHORTCUT. You may condense the SN, NC steps or the SN, DM steps onto a single line. Here are examples of each, followed by the CJ, CJ steps.

1. Conditional DEDUCE line:

	DD	(A then B)
4.	SN,NC	A and nB
5.	CJ 4	A
6.	CJ 4	nB

2. Alternation DEDUCE line:

	DD	(A or B)
4.	SN,DM	nA and nB
5.	CJ 4	nA
6.	CJ 4	nB

When the DEDUCE line is a conjunction, however, using SUPNOT does not produce a very valuable rhythm, because SN, DM results in an alternation, which cannot be broken down further by CJ, CJ. The best method for dealing with a conjunction in the DD line is to obtain each conjunct separately, then use JOINUP to match the DD line (as in the first example in this chapter)

STRATEGY HINTS. Given these methods for using replacement rules after a SUPNOT line, we can create a table of *strategy hints* for each type of DEDUCE line statement. This table is shown below. Refer to it whenever you begin a deduction.

STRATEGY HINTS FOR DEDUCTIONS	
DEDUCE line	Strategy
Simple Sentence	Direct Deduction or SUPNOT
Conjunction	Obtain each conjunct separately, then combine them with JOINUP. Or use SUPNOT followed by DEMORG.
Alternation	SUPNOT followed by DM, CJ, CJ
Conditional	SUPNOT followed by NC, CJ, CJ
Any negation	SUPNOT

7.9 Nested Conditionals

A conditional statement that has another conditional as its necessary condition is called a *nested* conditional. For example, the DEDUCE line for the argument below is a nested conditional. the SUPNOT line produces the denial of the nested conditional. First, the standard rhythm NC CJ CJ is invoked (lines 4-6).

1.	PR	C or nB
2.	PR	D then B
	DD	nC then (D then A)
3.	SN	n[nC then (D then A)]
4.	NC 3	nC and n(D then A)
5.	CJ 4	nC
6.	CJ 4	n(D then A)

Now, however, something curious has happened. Line 6 is again the negation of a conditional! This means the rhythm applies yet again:

7.	NC 6	D and nA
8.	CJ 7	D
9.	CJ 7	nA

Thus the SN line 3 is "unpacked" by using a longer *deduction rhythm,* NC CJ CJ, NC CJ CJ. The reason for this rhythmic repetition of "NC, CJ, CJ" lies in the internal structure of the nested conditional itself. The SUPNOT strategy allows you to exploit that internal structure and to reveal its particular pattern or "rhythm." After the nested conditional SUPNOT line has been unpacked by using this rhythm, contradictions pop out all over the place! In the example below, we found B and nB. Can you rewrite this example exposing a different contradiction, for example C and nC?

1.	PR	C or nB
2.	PR	D then B
	DD	nC then (D then A)
3.	SN	n[nC then (D then A)]
4.	NC 3	nC and n(D then A)
5.	CJ 4	nC
6.	CJ 4	n(D then A)
7.	NC 6	D and nA
8.	CJ 7	D
9.	CJ 7	nA
10.	SE 2,8	B
11.	AD 1,5	nB
12.	CC 10!11	

A conditional may also have a conditional as its *sufficient* condition. In this case it is also a kind of nested conditional, but it does not produce the quite the same rhythmic structure in a deduction, as the next example illustrates.

1.	PR	B then C
2.	PR	nD and A
	DD	(A then B) then C
3.	SN	n[(A then B) then C]
4.	NC	(A then B) and nC
5.	CJ 4	nC
6.	CJ 4	A then B

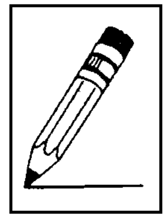
At this stage the rhythm ends instead of repeating itself as in the previous cases. Of course, the conditional result in line 6 still proves useful.

7.	CJ 2	A
8.	SE 6,7	B
9.	SE 1,8	C
10.	CC 9!5	

The reason that logical deduction produces rhythmic results such as those illustrated above is that logic, after all, is about *logos* or "order," and all rhythm is a type of order.

Below you will find a series of study problems that have been carefully selected to illustrate the most important techniques for creating deductions using SUPNOT. When working these study problems, make sure you understand fully how each line is created before going on to the next. If you are not sure just how a rule is applied on a given line, compare the result on each line with the pattern for the appropriate inference rule or replacement rule as given in Chapters Three, Four, and Seven. Be prepared to ask questions in class about any line or lines you do not fully understand.

STUDY PROBLEMS. Fill in the blanks with the appropriate line statements. You may have to look ahead to later lines and then work "backwards" to determine the statement for some of the lines. The answers to these study problems are in the appendix.



1.

1.	PR	(B then D)	6.	SE 1,5	________
2.	PR	(D then C)	7.	SE 2,6	________
	DD	(B then C)	8.	CJ 4	________
3.	SN	n(B then C)	9.	CC 7!8	
4.	NC 3	B and nC			
5.	CJ 4	________			

2.

1.	PR	(B then A)	5.	CJ 4	________
	DD	(C and B) then A	6.	SE 1,5	________
2.	SN	n[(C and B) then A]	7.	CJ 3	________
3.	NC 2	(C and B) and nA	8.	CC 6!7	
4.	CJ 3	________			

3. Line 4 below combines SN and NC. JOINUP in line 6 permits SUFEST with line 2.

1.	PR	A	6.	JU 1,5	________
2.	PR	((A and B) then C)	7.	SE 2,6	________
3.	PR	(C then D)	8.	SE 3,7	________
	DD	(B then D)	9.	CJ 4	________
4.	SN,NC	B and nD	10.	CC 8!9	
5.	CJ 4	________			

4. The next one is based upon the same idea: JOINUP to permit a SUFEST.

1.	PR	A	8.	CJ 4	________
2.	PR	B	9.	CC 7!8	
3.	PR	[(A and B) and C] then D			
	DD	(C then D)			
4.	SN,NC	________			
5.	CJ 4	________			
6.	JU 1,2,5	________			
7.	SE 3,6	________			

5. Problem 5 below is solved by the double NEGCOND rhythm. One of the CONJUNCT lines ends up being unused.

1.	PR	C then B	6.	NC 5	________
	DD	C then (D then B)	7.	CJ 6	________
2.	SN	n[C then (D then B)]	8.	CJ 6	________
3.	NC	C and n(D then B)	9.	ND 1,8	________
4.	CJ 3	________	10.	CC 9!4	
5.	CJ 3	________			

6. This is especially interesting in its use of DEMORG (DM), and the role NECDEN (ND) plays in line 8. We have written the complex DM step in line 3 for you. Study it carefully.

1.	PR	C then B	4.	CJ 3	________		6.	DM 5	________
	DD	nC or (nD or B)	5.	CJ 3	________		7.	CJ 6	________
2.	SN	n[nC or (nD or B)]	8.	ND 1,7	________				
3.	DM 2	nnC and n(nD or B)	9.	CC 4!8					

7. This one has a conjunction for its conclusion. We choose the SUPNOT, DEMORG strategy, which is the second of the two strategies for conjunctions suggested on page 73.

1.	PR	nC then A	7.	CJ 4	________
2.	PR	D then B	8.	AD 3,7	________
3.	PR	nD or nC	9.	SE 1,8	________
4.	PR	E and D	10.	SE 2,7	________
	DD	A and B	11.	JU 9,10	________
5.	SN	n(A and B)	12.	CC 11!5	
6.	DM 5	nA or nB			

8. This same problem can be solved without SUPNOT by using the other conjunction strategy suggested on page 73. Which of the two methods do you prefer?

1.	PR	nC then A	6.	AD 3,5	________
2.	PR	D then B	7.	SE 1,6	________
3.	PR	nD or nC	8.	SE 2,5	________
4.	PR	E and D	9.	JU 7,8	________
	DD	A and B	10.	CC 9	
5.	CJ 4	________			

9. We give you problem 9 below only up to the DD line. Complete the remainder on your own. What strategy will you use? Refer to the table on page 73 for suggestions.

1.	PR	nA then (C and D)
2.	PR	E then (nC or nD)
3.	PR	F and E
	DD	A or B

EXERCISE 11. Create a deduction sheet for each of the English arguments below. Be sure to include a copy of the memory pad for each argument. These arguments can be validated by the method of direct deduction.

1. If Holmes is right about the time, the butler was the culprit. If the butler was the culprit then he is having an affair with Madeleine. Holmes is the best detective in England, and he is correct about the time. Therefore the butler is having an affair with Madeleine.
2. If all of the labor force is at work, there is bound to be a shortage of workers. Assuming that there is a shortage of workers, competition for jobs increases. Wages go up on the condition that competition for jobs increases. And prices will rise if wages go up. If prices rise, we have inflation. All of the labor force is at work. Therefore we have inflation.
3. Kieth gets high scores provided that he studies, but if he does not study he has a great social life. Kieth does not study. Well, at least we can conclude that Kieth has a great social life. I wonder if this means that he doesn't get high scores?
4. If there was an eclipse of the sun, the Bartanians were all driven to madness. If the Bartanians were driven to madness, all of their temples were burned to the ground and the priesthood was deposed. Historical records were

completely destroyed assuming that the temples of the Bartanians were burned to the ground and the priesthood deposed. There was an eclipse of the sun, so we must conclude that historical records were completely destroyed.

5. Tom will desperately seek out Susan, provided that she wins the race and flies to Stockholm to receive the trophy. If Tom desperately seeks out Susan, then if Tom's mother finds out about their affair she will be angry. Tom's mother's face turns beet-red if she is angry. Susan wins the race and flies to Stockholm to receive the trophy, and Tom's mother finds out about their affair. Therefore Tom's mother's face turns beet-red.
6. If John marries Margaret, he will not marry a physician or an actress. If John does not marry a physician, then he does not wed Mary. Mary will leave for Europe at once if John does not marry her. John does marry Margaret. Therefore, Mary will leave at once for Europe.
7. If the Guerilla leader leaves the country, the movement will collapse. The collapse of the movement will bring about a power vacuum, but will also stabilize the economy. If the economy is stabilized, the minority party will win the next election. Either the guerilla leader leaves the country, or foreign support for the movement continues. However, foreign support for the movement does not continue. Therefore, the minority party will win the next election.
8. Either Tom has run out of funds or he has forgotten the payment. If Tom has forgotten the payment, he is distracted by his new responsibilities. But Tom has not run out of funds. Therefore Tom is distracted by his new responsibilities.
9. Holmes discovered arsenic in the teacup, so it is likely the victim was poisoned. Sir George had no opportunity to poison the tea, so if it is likely the victim was poisoned, Sir George is not a suspect. Lestrade suspects Martin Queems, but to have had an opportunity to poison the tea, Martin Queems would have to be a member of the household staff. Martin Queems is not on the household staff, since he was fired a year ago, and if he had no opportunity to poison the tea, he is not a suspect. Therefore Sir George is not a suspect and Martin Queems is not a suspect. (HINT: See the hints for problem 9 in Exercise #10.)
10. Donald will lose the case unless he gets Mike on the witness stand, but Mike is a member of the Roaring Raiders, and no member of the Roaring Raiders will ever testify, so Donald won't get Mike on the witness stand. We will just have to live with the fact that Donald will lose the case.

EXERCISE 12. The exercise below includes arguments with a variety of conclusion types, both simple and compound. Create deductions for each of them. Include a copy of memory pad entries along with your deduction sheet. Decide whether to use SUPNOT and indirect deduction by referring to the table on page 73.

1. If Lassie's son is part wolf, then he will bay with a singular warble. Lassie's son is part wolf provided that either Lassie or Bonzo are part wolf. Therefore, if either Lassie or Bonzo are part wolf, Lassie's son will bay with a singular warble.
2. Maria Fagliani was not at home on Wednesday night, but her husband, Bert, thought she was. If Bert Fagliani thought his wife was at home on Wednesday night, he is either near-sighted or he mistook the maid for his wife. Bert is not near-sighted. Therefore, Bert mistook the maid for his wife.
3. Assuming that this medallion is the authentic one, it is pure gold. However, if the medallion is the one DeVroot tested in the laboratory, it isn't pure gold. Therefore, the medallion is not both the authentic one and the one DeVroot tested in the laboratory.
4. If all of the labor force is at work, there is bound to be a shortage of workers. Assuming that there is a shortage of workers, competition for jobs increases. Wages go up on the condition that competition for jobs increases. And prices will rise if wages go up. If prices rise, we have inflation. Therefore if all of the labor force is at work, we have inflation.
5. If John marries Margaret, he will not marry a physician or an actress. If John does not marry a physician, then he does not wed Mary. Mary will leave for Europe at once if John does not marry her. Therefore, if John marries Margaret, Mary will leave at once for Europe.
6. If the guerilla leader leaves the country, the movement will collapse. The collapse of the movement will bring about a power vacuum, but will also stabilize the economy. If the economy is stabilized, the minority party will win the next election. Either the guerilla leader leaves the country, or foreign support for the movement continues. Therefore if foreign support for the movement does not continue, the minority party will win the next election.
7. Either Tom has run out of funds or he has forgotten the payment. If Tom has forgotten the payment, he is distracted by his new responsibilities. Therefore if Tom has not run out of funds, he is distracted by his new responsibilities.

8. Inspector Lestrade is suspicious of everyone in the household, including Sir George. But Holmes discovered arsenic in the teacup, so it is likely that the victim was poisoned, and Sir George had no opportunity to poison the tea, so if it is likely that the victim was poisoned, Sir George is no longer a suspect. Therefore if Sir George is a suspect, Inspector Lestrade has lost his marbles. (HINT: Treat “so” in the premises as “and.”)
9. If Holmes is right about the time, the butler was the culprit. If the butler was the culprit and the blue tie with the purple stripes belonged to him, then he is having an affair with Madeleine. Inspector Lestrade disputes Holmes' theory about the time, and Lady MacInnes does not suspect Madeleine. However, the blue tie with the purple stripes does belong to the butler, so we must conclude that if Holmes is right about the time, the butler is having an affair with Madeleine. (NOTE: “so” is not treated as “and” in this case. Why not?)
10. Fenwether's new book will be published only if the lurid passages are expunged. Without the lurid passages, Fenwether's new book is drab and uninteresting. If Fenwether's new book is drab and uninteresting, it will ultimately fail in the market. You can see then that if Fenwether's new book is published, it will ultimately fail in the market. (NOTE: be sure to convert the second premise correctly to IF...then form. Your abbreviation must take note of the relation between “expunged” and “without the lurid passages.”)
11. God, provided that he (or she?) exists, can do anything. Not only that, but if God exists, he or she is also loving and knows everything. If God can prevent evil, then if God knows that evil exists but does not prevent it, God is not loving. If God can do anything, then God can prevent evil, and if God prevents evil then there is no evil. If God knows everything, then if there is evil God knows that it exists. There is evil. Therefore, God does not exist.
12. Michael will win on the condition that Burt does, and if Cordelia wins, so does Burt. Either Burt or Cordelia will win, but Michael and Cordelia can't both win. Therefore Cordelia doesn't win.
13. I am thinking if I doubt that I am thinking. And I am thinking if I do not doubt that I am thinking. But if I do not exist, I am not thinking. Therefore I do exist. (HINT: let “I” represent yourself.)
14. The rights amendment will be passed if Doreen is backed by the Union, but if Arbuthnot continues his tirade, the assembly will adjourn. If the rights amendment passes, the assembly will not adjourn and the new budget will be considered. Therefore if Doreen is backed by the Union and Arbuthnot continues his tirade, a general uprising can be expected.
15. The President should be impeached. After all, she supports Nuclear Disarmament, but she insists upon a firm defense posture. The new ZAPPO weapons system will be installed if the President insists upon a firm defense posture; and if the ZAPPO system is installed, the President does not support Nuclear Disarmament. That proves my point conclusively.
16. If King Leopold's new fortress is to be impregnable, it will have to be located on the hill overlooking the river. Furthermore, it will have to have its own well if it is to withstand an extended siege. Now if the new fortress is to be located on the hill overlooking the river and is to have its own well, the workmen must have two years to build. But King Leopold has decreed that the fortress must be built within six months, so the workmen will not have two years to build. We must conclude, then, that the new fortress is to be impregnable only if it will not stand an extended siege.
17. Lassie will either eat the bone, or leave it buried until things blow over. If she eats it, she could contract Dinasauritis. Therefore if Lassie does not leave the bone buried until things blow over, she could contract Dinasauritis.
18. Either the butler robbed the banker and the maid helped him or the garbage man deceived the dressmaker. If the maid helped the butler, then either she is in love with him or she intended to doublecross him. The dressmaker was not deceived by the garbage man, and the maid has no love for the butler. Therefore the maid intended to double-cross the butler.
19. If the Lithium isotope vaporizes, Von Kranz has set the dials too high. Either the Lithium isotope will vaporize, or it will shatter. Von Kranz has not set the dials too high. Therefore the Lithium isotope will shatter.
20. If Artificial Intelligence is possible, then the things of the Spirit do not exist. Either the things of the Spirit exist, or the universe is founded upon mechanical principles. Therefore if Artificial Intelligence is possible, the universe is founded upon mechanical principles.
21. Richard Montague and Donald Kalish are famous logicians. Therefore, either Donald Kalish is not not a famous logician, or Montague's lost his glasses. (NOTE: Why is it possible to complete this deduction, even though Montague's glasses are not mentioned in the premises? Discuss the peculiarities of this example in class.)
22. The warheads will be contracted on the condition that the President overcomes congressional objections and the Republican voting bloc holds steady. We know that the president has not lost her persuasive power, so it is safe to assume that she will overcome congressional objections. Therefore if the Republican voting bloc holds steady, the warheads will be contracted.

FALLACIES IN THIS CHAPTER

BEGGING THE QUESTION: Attempting to use the conclusion of an argument to prove itself. In a formal deduction, you commit this fallacy if you try to use the DEDUCE line, or if the DEDUCE line has somehow gotten into the premises. ("Begs the question," when said of an argument, does not mean "begs for a certain question to be asked.")

INFERENCE RULE IN THIS CHAPTER

SYLLOGISM (SYL): Draw a result from a syllogistic chain.

PREMISE: *A then B*
PREMISE: *B then C*
CONCLUSION: *A then C*

This rule is stated above with two premises as an example, but the rule holds no matter how many premises are involved, as long as they are linked in the correct manner.

STRATEGY HINTS FOR DEDUCTIONS

DEDUCE line	Strategy
Simple Sentence	Direct Deduction or SUPNOT
Conjunction	Obtain each conjunct separately, then combine them with JOINUP. Or use SUPNOT followed by DEMORG.
Alternation	SUPNOT followed by DM, CJ, CJ
Conditional	SUPNOT followed by NC, CJ, CJ
Any negation	SUPNOT

CHAPTER EIGHT

ALL and SOME: Applying Sentence Logic to Generalizations

8.1 Generalizations

Sentences that use the basic logic words ALL and SOME are *generalizations* because they refer in general to all or part of a certain group, class, or kind. ALL and SOME are not connectors. They are called *quantifiers,* because they indicate the quantity of individuals referred to in a generalization. Generalizations may be *universal* or *partial*. Universal generalizations refer to all members of a group. Partial generalizations apply only to some limited part of a group. A universal generalization depends upon some form of the quantifier word ALL, while a partial generalization depends upon the quantifier word SOME or any of its variations. Because "Some" can be uncertain with regard to quantity, logicians have adopted the convention of interpreting "Some" to mean *at least one*. In this text we will follow that convention. (Some apples are green = There is *at least one apple* and that apple is green.)

A generalization is *simple* when it contains no connectors and mentions exactly two groups. For example, "All textbooks are boring" mentions the group of textbooks and the group of things that are boring. "Some books are exciting" mentions the group of books and the group of things that are exciting. Both of these are simple generalizations. On the other hand, "All lions and tigers are predators" is *compound* because it contains a connector, and there are more than two groups mentioned, lions, tigers, and predators. Compound generalizations may be analyzed as conjunctions or alternations of two or more simple generalizations:

All lions and tigers are predators = All lions are predators /AND/ all tigers are predators.
Some men or women were pleased = Some men were pleased /OR/ some women were pleased.

8.1.1 Generalizations, Conditionals and Conjunctions

UNIVERSALS. When we say something like "All cows are mammals," this is meant to apply *universally*, for everything that is a cow. In fact, "All cows are mammals" is shorthand for an indefinite number of *conditionals*. If "All cows are mammals" is true, then it is true that *if* Bossy is a cow, *then* Bossy is a mammal, and *if* that large animal over there in the meadow is a cow, *then* that large animal over there in the meadow is a mammal, and so on indefinitely, for any name you choose.

PARTIALS. A partial generalization expresses a particular kind of *conjunction*. The quantifying word SOME, according to our convention, refers to at least one thing. So if we say that "Some cows are brown" we are asserting that there is *at least one thing* that is a cow /AND/ that same thing is brown.

HISTORICAL NOTE: In traditional texts, a partial generalization is called "existential" because a partial asserts the *existence* of at least one thing. In contrast, a universal generalization does *not* assert existence because it is made up only of conditionals.

8.1.2 Names in Generalizations

USING A NEUTRAL NAME. To deal with the conditionals "hidden" in universal generalizations, we can enlist the help of a special kind of name, which we will call a *neutral name*. The neutral name we will use is the lower case letter *n* (for *name*). We call it a neutral name because it acts like a kind of variable. Using "Fs" and "Gs" to stand for two groups of things, we can say in general that

All Fs are Gs = If *n* is an F then *n* is a G

There is no restriction on what name you may substitute for *n* if you have a universal generalization for a premise. For example, "All cows are mammals" may be expressed as the conditional "If *n* is a cow then *n* is a mammal, from which you could conclude "If Bossy is a cow then Bossy is a mammal," but you could also conclude "If the Moon is a cow then the Moon is a mammal." Although that sounds peculiar, it does no logical harm because it is a conditional and its sufficient condition is simply false.

USING AN ARBITRARY NAME. In order to express a simple partial generalization as a conjunction, we will need to enlist the help of another special kind of name, which is called an *arbitrary name*. For example, upon hearing some sounds I might say that there is at least one person in the next room, although I don't know for sure who it is. Now If I want to say something about this (unknown) person, I could say, for example, "I hope he or she doesn't try to open the closet," But instead of using "he" or "she" I could just refer to this unknown person by using an arbitrary name. The lower-case letter *a* (for *arbitrary*) is our arbitrary name. We may then say a number of things about *a*, like "I hope *a* doesn't open the closet." But until *a* comes out of the room, or we go into the room, we are not sure just who (or what!) *a* is. We are using *a* as a "place-holder" that might eventually be replaced by the actual name, should we ever find out who or what *a* is. So just as *n* is a variable name, *a* is a place-holder for just *one* specific thing only and is never variable. We can now use *a* to help us express a partial generalization as a conjunction, where *a* represents the "at least one thing."

Some cows are brown = At least one thing is a cow and that thing is brown = *a* is a cow /AND/ *a* is brown

There are two inference rules for partial generalizations.

INSTANCE OF A PARTIAL (PI). Any partial may be expressed as a conjunction, using an *arbitrary* name that has *not been used previously* in an argument. Letting Fs and Gs stand for two groups,

PREMISE	Some Fs are Gs
CONCLUSION	*a* is an F and *a* is a G (restricted to arbitrary name)

GENERALIZATION OF A PARTIAL (PG). This rule is the reverse of PI. It changes a conjunction of two simple sentences about the same individual person, place or thing, into the SOME form. Below <name> refers to any name of a particular individual person, place or thing including arbitrary names such as *a*.

PREMISE	<name> is an F and <name> is a G
CONCLUSION	Some Fs are Gs

MORE THAN ONE ARBITRARY NAME. If we used *a* to refer to a particular (unknown) brown cow, and then we had another partial generalization like "Some people like pizza," we could not then say "*a* is a person and *a* likes pizza," because then we would be identifying the person who likes pizza with a brown cow! In such a case we would have to use a different arbitrary name, for example we might use *b*. In this chapter, however, we will be dealing mostly with situations where only one arbitrary name is required.

DESCRIPTIVE NAMES. An expression like "that large animal over there in the meadow" is a *descriptive name*. Instead of a more familiar kind of name like Bossy or Sarah, descriptive names might take a number of forms. "My automobile" is a descriptive name because it singles out one particular thing, your automobile. (Of course "John's automobile" or "Betty's automobile" would be more specific.)

There is just one inference rule for universal generalizations.. It is based on our understanding of universals as representing an indefinite number of conditionals, and our use of *n* as a neutral name that may be replaced by any name.

INSTANCE OF A UNIVERSAL (UI). Whenever you have a universal expressed as a conditional using the neutral name *n*, you can replace the neutral name *n* with any name of any individual person, place or thing. In the rule below <name> refers to any name including arbitrary and descriptive names.

PREMISE	All sailors know a lot about knots
CONCLUSION	If <name> is a sailor then <name> knows a lot about knots

There is, however, one exception. You cannot use UI to go to an arbitrary name such as *a*, unless the arbitrary name has been used *earlier* in a deduction. The condition that the arbitrary name has to have been used *earlier* in the deduction is imposed because until you have introduced an arbitrary name by PI from a partial generalization, you have no idea who or what the arbitrary name refers to.

8.2 Categorical Syllogisms

In our previous work (Chapters 1-7) we did not deal specifically with arguments containing generalizations. This is because a somewhat more powerful logical system is necessary to handle generalizations in more complex arguments. However, the logic we have learned is much stronger than is ordinarily acknowledged in traditional texts. We will be able to use what we have already learned to considerable advantage, particularly in the case of an important kind of argument using generalizations, called a *categorical syllogism*. A categorical syllogism is like a regular syllogism in certain respects, but because it involves categories (groups) of things it came to be called "categorical." Here is an example. The premises and the conclusion are all generalizations. We could not have dealt with this using only Chapters 1 - 7.

All butterflies flutter. Some nervous people flutter. Therefore, some nervous people are butterflies.

For the moment we are not interested in the question of validity, but in the arrangement of the groups in the argument. There are three groups: *butterflies, things that flutter*, and *nervous people*. One group (things that flutter) is common to the two premises, and the other two groups appear one in each premise and together in the conclusion. This is the pattern which any categorical syllogism must have.

1. Just two premises and one conclusion.
2. The premises and the conclusion are all simple generalizations.
3, Taken together, the premises and the conclusion mention just three groups of things.
4. The premises share one of the groups in common, forming a possible link between them.
5, The conclusion relates the other two groups.

Of course, the example about butterflies is invalid! But we should not dismiss it as invalid just because the conclusion is false. We learned earlier that to do this would be to commit a fallacy. Instead we need to be able to say *why* it is invalid. Suppose we express this example in the corresponding conditional and conjunction forms. Can you spot the exact fallacy?

1. PR	If *n* is a butterfly, then *n* flutters	(All butterflies flutter)
2. PR	*a* is a nervous person, and *a* flutters	(Some nervous people flutter)
DD	*a* is a nervous person, and *a* is a butterfly	(Some nervous people are butterflies)
3. UI 1	If *a* is a butterfly, then *a* flutters	(Instance of a universal)
?????		

The hoped-for link between the premises is the group common to each premise, things that flutter. But the conjunct "*a* flutters" from premise 2, only matches the *necessary* condition of line 3. Just knowing the necessary condition is true tells you nothing about the sufficient condition, as we know quite well from our previous study. The fallacious reasoning here is THE FALLACY OF CONCLUDING THE SUFFICIENT IS TRUE (Chapter 4).

The above analysis shows us that the logic of chapters 1 - 7 is powerful enough to allow us to detect any invalid categorical syllogism. Of course, you could also use the method of the Venn diagram and draw circles, but aside from not always being as simple as it looks, doing that teaches you very little about the actual course of an argument and how standard kinds of fallacious reasoning lead to invalid uses of generalizations. With what you have learned already, you now have a simple way to deal with the 256 possible combinations of simple universal and partial generalizations that qualify as categorical syllogisms. Among these many are not valid but are frequently mistaken to be valid. Actually only 16 of these 256 are valid! And since the premises and conclusion of a categorical syllogism can be expressed in their conditional or conjunction form, we can construct a table showing the only valid forms of any categorical syllogism. If you understand this table, you should be able to recognize valid or invalid categorical syllogisms simply looking closely at them. The important thing to understand is the column labeled LINK.

Validity of Categorical Syllogisms			
PREMISES	LINK	CONCLUSION	RESULT
All Universal	Proper SYL	Universal, from proper SYL	**Valid**
Mixed (Universal & Partial)	Proper CJ, SE or CJ, ND	Partial, from proper CJ, JU	**Valid**
Both Partial	No link	None beyond the premises	**Invalid**

Why is the last case, both premises partial, invalid? Both premises would be expressed as conjunctions., and when we use arbitrary name *a* for one partial, we must use a *different* arbitrary name for the other, because we have no way of knowing whether the SOME thing referred to in the first partial are the same as the SOME thing referred to in the second partial.

Some persons are lawyers = *a* is a person and *a* is a lawyer
Some lawyers are tall = *b* is a lawyer and *b* is tall

We can't tell whether *a* and *b* refer to the same person, so we can draw no conclusion that goes beyond the premises.

In section 8.3 we will show how the table above works in actual cases. But first, it is important to know just how negations work with generalizations.

8.2.1 Negative Generalizations and Negations of Generalizations

A negation of a generalization is its denial, stating that the generalization is not true. If we want to negate "All tigers are predators," what we need to do is find an example of at least one tiger that is not a predator. Then we could say "Some (at least one) tigers are *not* predators." So the negation of a universal generalization is a partial generalization.

If we want to negate "Some tigers are grazers," we would have to deny that there are any grazing tigers at all by saying "No tigers are grazers." This is a universal generalization (about all tigers). So the negation of a partial generalization is a universal generalization.

What about a generalization that is not strictly a denial, but which just says something negative about a group of things? For example, "Some tigers are not tame." This is not the negation of "Some tigers are tame." (Some might be tame and some not tame.) Instead we just call "Some tigers are not tame" a negative partial.

Similarly, saying "No tigers have stripes" isn't the negation of "All tigers have stripes" although it would seem to be. One problem is that the negative universal "If *n* is a tiger then *n* does **not** have stripes" is a *conditional*, which does not actually assert the existence of anything. To deny that all tigers have stripes we need to say instead "Some tigers do not have stripes" which does assert the existence of at least one tiger that does not have stripes. So we just call "No tigers have stripes" a negative universal (remember, partials are also called "existential" because they assert existence).

TABLE OF NEGATIONS FOR GENERALIZATIONS SENTENCE	 NEGATION
Some F's are G's *a* is an F and *a* is a G (Positive Partial)	No F's are G's If *n* is an F then *n* is **not** a G (Negative Universal)
All F's are G's If *n* is an F then *n* is a G (Positive Universal)	Some F's are not G's *a* is an F and *a* is **not** a G (Negative Partial)

This terminology can certainly be confusing! But if we focus on the corresponding conditionals or conjunctions it is easier to see the difference between the *negation* of a generalization and a *negative* generalization. Notice that the negative universal and the negative partial characteristically have the negator *not* attached to the second group. Study the table above carefully. Be sure you can answer the questions, "Why does a negative partial contradict a positive *universal*?" and "Why does a negative universal contradict a positive *partial*?" (If necessary, discuss this in class.)

8.2.2 Variations of ALL and SOME

There are many variations of the ALL quantifier. For example, using ANY, EVERY, EACH, or just the generic name of the group as a whole. The diagram on the next page shows most of these variations. They are all, of course, quite familiar expressions.

ANY lizard is a reptile
EVERY lizard is a reptile
EACH lizard is a reptile
Lizards are reptiles
A lizard is a reptile
The lizard is a reptile

= ALL lizards are reptiles

Another expression, WHOEVER, is ambiguous. If we say "Whoever would reap must first sow," we mean WHOEVER universally: "All who reap must first sow." On the other hand, when we use WHOEVER to refer to a specific individual, it may be meant partially. "Whoever took the cake was addicted to chocolate" = "Someone took the cake and was addicted to chocolate." The decision as to which is meant depends upon knowledge of context and of English idiom.

ONLY and NONE BUT. We have already learned that ONLY and NONE BUT point to the *necessary* condition (see Chapter Four). When these appear in a universal generalization they still point to the necessary condition..

ONLY fools enter here = All who enter here are fools = If *n* enters here, *n* is a fool
NONE BUT fools enter here = All who enter here are fools = If *n* enters here, *n* is a fool

NONE and NOT ALL. Just "none" by itself, however, does not indicate a necessary condition. "None of these birds is rare," is actually a kind of negative universal, meaning "All of these birds are common (not rare)." In English it is not so easy to state this without using an awkward expression like "non-rare" or a synonym like "common." This is because of an ambiguity when we try to use NOT ALL. If we say "Not all of these birds are rare" it would most likely mean that not all of them are rare, but some might be rare. Similarly if we say "All of these birds are not rare" we could be understood to mean the same thing, that just some of them are rare. However, to help avoid ambiguity, we can try first putting the NONE generalization into an equivalent conditional form, and the NOT ALL generalization into the equivalent partial form, like this:

NONE of these birds are rare = If *n* is one of these birds then *n* is not rare
NOT ALL of these birds are rare = Some of these birds are not rare

SOMEONE and ANYONE. These expressions refer to persons. If I say "Someone was in this room" I am expressing a partial having to do with a person. Also I am not necessarily implying that there was only one person in the room, I am just saying that there was at least one person in the room.

Someone was in this room = Some person was in this room = *a* is a person /AND/ *a* was in this room

Anyone in that room should stay out of the closet = All persons in that room should stay out of the closet

In this case the first group is "persons in that room" and the other group is "those who should stay out of the closet."

8.3 Recognizing Validity and Invalidity

Our aim now is to recognize an invalid or a valid categorical syllogism simply by inspecting the premises and the conclusion, and knowing what to look for. Assuming you are working with an actual categorical syllogism (two premises, one conclusion, three groups, one group common to the premises, and the other two groups together in the conclusion), you are looking for a proper SYL link (when both premises are universals), or a proper CJ, SE or proper CJ, ND relation (when there are mixed premises). Here is the first example. Can you analyze it for validity just by inspecting it?

"All politicians should be punished, because all politicians are liars , and all liars should be punished."

Both premises are ALL statements, which means they would both be expressed as conditionals (using neutral *n*), so right away you know you are looking for a proper SYL relation. It is easy to see that the necessary condition of the first premise (liars) will match the sufficient of the second premise, so there is a proper SYL relation between politicians and those who should be punished; and that's what the conclusion says. We could even express this whole argument using MEFs if we first put it into conditional form.

1. PR	If *n* is a politician, then *n* is a liar	(A then B)
2. PR	If *n* is a liar, then *n* should be punished	(B then C)
DD	If *n* is a politician, then *n* should be punished	
3. SYL 1,2	If *n* is a politician, then *n* should be punished	(A then C.)
4. CC 3		

The categorical syllogism is valid because of a proper SYL. Now how about this next one?

All aviators are brave. Some aviators are in the Air Force. So some in the Air Force are brave.

Now we have mixed premises. Instead of a SYL link we look for either a CJ, SE possibility or a CJ, ND possibility. Well, you are going to get an aviator out of the second premise, and the first premise is about ALL aviators, so you have a CJ, SE right away. You'll get someone who's brave out of that, and you will already know that this person is in the Air Force (premise 2), so you get the conclusion.

If you did not follow that reasoning right away, looking a few times at how this would work out when thinking of the equivalent conditional and conjunction will help. This kind of case is slightly tricky compared to the SYL case because you are looking for both a CJ and a SUFEST step, but only at first. To be exact, let's express the argument in conditional and conjunction form. We can even use MEFs if we do this! But look carefully. Are we ignoring the first premise?

1. PR	All aviators are brave	
2. PR	*a* is an **aviator** and *a* is in the Air Force	(A and B)
DD	*a* is in the Air Force and *a* is brave	
3. UI 1	If *a* is an aviator, then *a* is brave	(A then C)

In step 3, we used UI to substitute the arbitrary name *a* for the neutral *n*. Notice that we did not bother to change the first premise to its conditional form! This is because the UI in step 3 is an obvious result. We did not do the same thing for the previous example because the SYL relation in that example is clearer that way, but when there are mixed premises going directly to the UI step is a reasonable move. Also, speaking of *a* in step 3 is OK because we have already used *a* to express the partial generalization in step 2. Now we can go on to CJ, SE.

4. CJ 2	a is an aviator	A
5. SE 3,2	a is brave	C
6. CJ 2	a is in the Air Force	B
7. JU 6,5	a is in the Air Force and a is brave	(B and C)
8. CC 7		

The categorical syllogism is valid. Well, what about invalid cases?

All you need to do is to determine whether either of the two valid cases in our table (8.3) are violated. What to look for is whether there can't be a proper SYL step (if both premises are universals), or whether there can't be a proper SUFEST or NECDEN step (if the premises are mixed). Try this one.

Bumble bees buzz loudly. Some things that buzz loudly are dangerous. Therefore, bumble bees are dangerous

Valid, or not? Explain your decision..Could this be a valid *inductive* argument? If not, why not? (Chapter 1.)

NEGATIONS AND NEGATIVES. If there are negatives or negations in a categorical syllogism, does this make things more complicated? Not really! A negative partial is still a partial, and a negative universal is still a universal. Similarly, the negation of a universal is a partial, and the negation of a partial is a universal. The table in section 8.2.1 shows us this. So regardless of the presence of negators in the sentences, the requirement for a proper SYL link when both premises are universals, or for a proper SE or ND link when the premises are mixed, still holds. Let's try an example.

Some insane person was seriously injured, because no sane person would try to climb this cliff, and someone who tried to climb this cliff was seriously injured

Valid, or not? The first premise is a negative universal, which makes it a very little bit trickier to deal with. The trick here is that when you change a NO universal to a conditional, the NO gets turned into a *not* attached to the necessary condition: "If *n* is sane, *n* would *not* try to climb this cliff." Then we see that the first part of the second premise will contradict the necessary condition of the conditional. So a NECDEN step is possible. All you have to do then is make sure the conclusion is the correct one for a categorical syllogism. Again, just to make this relation clear, here's the deduction using CJ, ND. Again we have to do a UI in step 3 to get from *n* to *a* .

1. PR.	No sane person would try to climb this cliff
2. PR.	*a* tried to climb this cliff and *a* was seriously injured
DD	*a* is not sane and *a* was seriously injured
3. UI 1	If a is sane, then a would *not* try to climb this cliff
4. CJ 2	a tried to climb this cliff
5. ND	a is not sane
6. CJ 2	a was seriously injured
7. JU 5,6	a is not sane and a was seriously injured
8. PG 7	Some insane person was seriously injured
9. CC 8	

The categorical syllogism is valid. Notice again, that we did not bother to re-state the first premise as a conditional because as long as we know how the negative universal becomes a conditional we can make the conversion and replace *n* with *a* in the UI step 3 without a problem. Note carefully how the word "no" in premise 1 slips over to *not* in step 3 (see the table in section 8.2.1) . Next, what if *both* premises are negative universals?

No sane person would try to climb this cliff. No one who tries to climb this cliff is under 16 years old. Therefore, no sane person is under 16 years old.

Should you be worried if you are under 16? Well, instead we could try a little bit of informal analysis. The first premise would say that anyone who is sane would *not* try to climb the cliff, and the second premise would say that anyone who tries to climb the cliff is *not* under 16 years old. Since both premises are universals, there has to be a proper SYL relation. But there isn't, because the necessary condition of the first premise is the *negation* of the sufficient condition of the second premise. End of analysis. The categorical syllogism is invalid.

Just to make sure you understand this fully, here are the two premises as conditionals and with their MEF analogues.

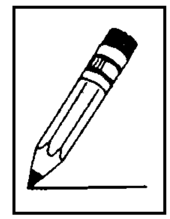
1. PR	If *n* is a sane person then *n* would *not* try to climb this cliff	(A then nB)
2. PR	If *n* tries to climb this cliff then *n* is *not* under 16 years old	(B then nC)

Looking at the MEF form you can easily see that there is no proper SYL link. But suppose, in desperation, you tried to use TRANS on premise 1 so it doesn't talk about *not* climbing the cliff:

1. PR	If *n* tries to climb this cliff then *n* is not sane	(B then nA)
2. PR	If *n* tries to climb this cliff then *n* is *not* under 16 years old	(B then nC)

It does you no good, because there is still not a proper SYL link.

STUDY PROBLEMS. Look over the arguments below and determine whether they are valid or invalid, If necessary, write the premises and conclusion out in the form of the corresponding conditionals or conjunctions. Explain the basis for your decision in each case. Be prepared for class discussion.



1. All politicians are liars. Some politicians are lawyers. Therefore some lawyers are liars.

2. All legal residents are subject to code requirements. No wigwams are subject to code requirements. Therefore, no wigwams are legal residences.

3. Every contractor must have a license. Some at the meeting are contractors, so some at the meeting must have a license.

4. All Democrats are committed to the principles of liberalism. All foggy-minded intellectuals are committed to the principles of liberalism. Therefore Democrats are all foggy-minded intellectuals.

5. All successful Jockeys are under five feet tall. No Watusis are successful jockeys. Therefore, no one under five feet tall is a Watusi.

6. All peaches are fruit. All fruit are sweet. Therefore, anything sweet is a peach.

7. Criminals break the law. All who deserve punishment are criminals. Therefore, everyone who breaks the law deserves punishment.

8. All engineers must know calculus. Some college graduates know calculus. Therefore, some college graduates are engineers.

9. All engineers must know calculus. Some college students are not engineers. Therefore, some college students do not know calculus.

10. No conservatives have flexible viewpoints. Some conservatives simply rubber-stamp the president. Therefore, some who have a flexible viewpoint do not rubber-stamp the president.

8.3.1 Singular Statements and Longer Arguments

Many longer arguments use sequences of reasoning based on one or more categorical syllogisms embedded in the longer structure. Longer arguments also frequently include statements about individual persons, places or things and then make general claims about such individuals. Statements about individuals are called *singular* statements. "John is tall" and "The man in the red hat is an actor" are singular statements.

Our logic of generalizations can quite easily handle many arguments that mix generalizations with singular statements. After all, a universal generalization expressed as a conditional using the neutral name *n* can apply to any name, not just to our arbitrary name *a*. For example, if we know that Jennifer is a politician, and we believe that all politicians are lawyers, we would not hesitate to conclude that Jennifer is a lawyer. Speaking formally, our premise is If *n* is a politician then *n* is a lawyer, from which we can easily obtain "If Jennifer is a politician then Jennifer is a lawyer" by using UI to substitute "Jennifer" for *n*.

1. PR	All politicians are lawyers
2. PR	Jennifer is a politician
DD	Jennifer is a lawyer
3. UI 1	If Jennifer is a politician, then Jennifer is a lawyer
4. SE 3,2	Jennifer is a lawyer
5. CC 4	

Notice that in step 3 we simply went directly to the substituted name "Jennifer" without bothering to convert the first premise to the conditional form using *n*. That's OK because the step is obvious.

What about connections between partial generalizations and singular statements? A partial generalization doesn't have anything to say about any particular *known* individual. That's why we have to use arbitrary names in writing any instance of a SOME statement. So there are not going to be any logical connections between partials and singulars with the one exception of using PG to move from a singular statement to a partial, which would not happen in a categorical syllogism because a categorical syllogism does not contain singular statements.

HISTORICAL NOTE: Traditionally a rather artificial device was used in order to include a singular statement such as "Joan is a veterinarian" as part of a categorical syllogism. This was to imagine that "Joan" refers to a "singular group," that is, a group having just one member, who is Joan. On that interpretation the sentence "Joan is a veterinarian" would be interpreted as "All Joan (i.e. every member of the group whose only member is Joan) is a veterinarian," a kind of pseudo-generalization about two groups, the "group of Joan" and the group of veterinarians. But aside from there being significant philosophical objections to this idea, there is no need under the interpretation in this text to treat such a statement as other than a singular statement about one individual person named Joan.

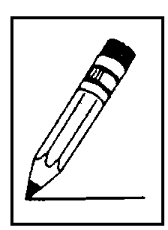
Just to illustrate how easy our less formal approach in this chapter can become, consider this next example.

> Everyone in the legislature agrees on the policy. Some legislators live outside the city. Therefore, some who agree on the policy live outside the city.

From premise 2 we would find that *a* is a legislator who lives outside the city. Since *a* is a legislator, he or she must agree on the policy by premise 1. So then we know that someone both agrees on the policy and lives outside the city. But that is the conclusion. The argument is valid.

The reasoning above is a step more sophisticated and more accurate than relying entirely on intuition, because it is informed by all the knowledge you have gained by studying this and the previous seven chapters. While untutored intuition is often accurate, generalizations can be tricky and with our more informed approach you are better equipped to handle generalizations in arguments. In the study problems below, try using this kind of informal reasoning as often as possible. If you are uncertain you can always try a simple deduction like those shown above.

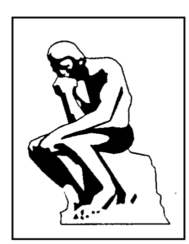
STUDY PROBLEMS. Determine validity or invalidity. Be prepared for class discussion.



1. All politicians are liars. Some politicians are lawyers. Therefore some lawyers are liars.
2. Any legal residence is subject to code requirements. No wigwams are subject to code requirements. Therefore, no wigwams are legal residences.
3. Every contractor must have a license. Some at the meeting are contractors, so some at the meeting must have a license.
4. Anyone who is a Democrat is committed to the principles of liberalism. All foggy-minded intellectuals are committed to the principles of liberalism. Therefore Democrats are all foggy-minded intellectuals.

5. All successful Jockeys are under five feet tall. No Watusis are successful jockeys. Therefore, no one under five feet tall is a Watusi.
6. All peaches are fruit. Whatever is a fruit is sweet. Therefore, anything sweet is a peach.
7. Criminals break the law. All who deserve punishment are criminals. Therefore, everyone who breaks the law deserves punishment. HINT: "Everyone" is understood as ALL.
8. Each engineer must know calculus. Some college graduates know calculus. Therefore, some college graduates are engineers.
9. All engineers must know calculus. Some college students are not engineers. Therefore, some college students do not know calculus.
10. No conservatives have flexible viewpoints. Some conservatives simply rubber-stamp the president. Therefore, some who have a flexible viewpoint do not rubber-stamp the president.
11. All humans are mortal. Socrates is a human. Therefore Socrates is mortal.
12. Veterinarians care about animals. Joan is a veterinarian. Therefore, Joan cares about animals.
13. All who are fearful are timid. Some daredevils are not fearful. Therefore some daredevils are not timid.
14. No politicians are liars. No liars are honest. Therefore no politicians are honest.
15. No one in his right mind would enter that cave. No one who enters that cave is not brave. Therefore no one who is brave is in his right mind.
16. All fascists are totalitarians. Some totalitarians are dogmatic. Therefore, some fascists are dogmatic.
17. No totalitarians are egalitarians. Some totalitarians are fools. Therefore, some fools are not egalitarians.
18. All politicians are liars. All used car salesmen are liars. Therefore, all used car salesmen are politicians.
19. The dictator is undermining democracy, because he has declared that all freedoms are suspended, and anyone who declares all freedoms suspended is undermining democracy. HINT: "The Dictator" is a descriptive name.
20. All champion bodybuilders drink MAXIM. No one who drinks MAXIM lacks energy. Therefore, no champion bodybuilders lack energy.
21. All champion bodybuilders drink MAXIM. No champion bodybuilders lack energy. Therefore, No one who drinks MAXIM lacks energy.
22. No coffee plants blossom in August, but some members of the nut family blossom in August, so some coffee plants are not members of the nut family.
23. Deepwater fish must need sunlight, because no deepwater fish are cave-dwellers, and no cave-dwelling fish need sunlight.
24. George Washington could tell no lies. No liar is trustworthy. It's obvious, then, that George Washington was trustworthy. HINT: "George Washington" is a singular name.
25. All who are overpaid are lazy, but no factory workers are overpaid. Therefore some factory workers are not lazy.
26. All politicians are liars. All politicians are frauds. Therefore, all liars are frauds.
27. All politicians are liars. All cowboys are liars. Therefore, All politicians are cowboys.
28. All politicians are liars. No cowboys are politicians. Therefore, no cowboys are liars.
29. All tubers grow underground. Some things that grow underground are edible. Therefore some tubers are edible.
30. All communists are totalitarians. Some totalitarians, however, are not such bad fellows. Therefore some bad fellows are not communists.
31. No aircraft are invisible. Some aircraft are supersonic vehicles. Therefore, some supersonic vehicles are visible.
32. All aviators learn to fly on instruments only. No aviators are unwilling to accept a challenge. Therefore, no one who can fly on instruments only is unwilling to accept a challenge.

EXERCISE 13. For each example below, decide whether it is valid or invalid. If you decide it is invalid, explain your reasoning. For any cases you are unsure of, attempt a deduction. Answers to selected problems are in the appendix. Be prepared for class discussion.



1. No penny stocks are reliable. Some private investments are reliable. Therefore some private investments are not penny stocks.
2. Some aircraft are vehicles that exceed the speed of sound. Some supersonic vehicles become superheated. Therefore some aircraft become superheated.
3. All cows are mammals. All mammals bear live young. Therefore some cows bear live young.
4. All cows are mammals. All mammals bear live young. Therefore all cows bear live young.

5. Julie does not care about the environment, because all those who recycle care about the environment, and Julie does not recycle.
6. Every reptile is cold-blooded. Anything cold-blooded must take warmth from the sun. Therefore all reptiles must take warmth from the sun. HINT: "Every" and "Anything" are variations of ALL.
7. Murderers approve of abortion. Liberals approve of abortion. Therefore some liberals are murderers. HINT: The two premises are universals (ALL is assumed).
8. Some murderers approve of abortion, and no conservatives approve of abortion. Therefore conservatives are not murderers.
9. Some murderers approve of abortion, and no conservatives approve of abortion. Therefore some conservatives are not murderers.
10. Some murderers approve of abortion, and those who approve of abortion are murderous, so some murderous individuals are murderers.
11. William likes potatoes, and Pete likes potatoes. Therefore William is Pete.
12. No lawyers are interested in justice. Some politicians are interested in justice. Therefore some politicians are not lawyers.
13. No criminals are intoxicated with life. Some dancers are intoxicated with life. Therefore some dancers are not criminals.
14. All Fakirs are fakers. No fakers get away with it. Therefore no Fakirs get away with it.
15. Every artist is intoxicated with life. Some artisans are not intoxicated with life. Therefore some artisans are not artists.
16. Some liberals are not communists. All liberals are kindly human beings. Therefore no kindly human beings are communists.
17. Some liberals can be trusted, since no liberals are communists, and no communists can be trusted.
18. Everything that breathes needs air. Some rocks do not breathe. Therefore some rocks do not need air. HINT: "Everything" indicates a universal generalization.
19. Everything that breathes needs air. Some rocks do not need air. Therefore some rocks do not breathe.
20. Everything that breathes needs air. No rocks breathe. Therefore no rocks need air.
21. Only fools enter here, and no fools are atheists. Therefore no atheists enter here. HINT:"Only" marks the necessary condition.
22. All farmers are friendly. There are some pioneers who are farmers. Therefore some pioneers are friendly.
23. No successful person is not happy. There are no happy window washers. Therefore successful persons are never window washers. HINT: Think carefully about "never" here.
24. Only idiots are fools, and none but fools enter here. Therefore any who enter here are idiots. HINT: "None but" is like ONLY.
25. To be a manager is to be a business person. None but the meticulous are business persons. Therefore managers are always meticulous. HINT: "To be a manager" refers to ALL managers.
26. Everything that goes up must come down. George's airplane does not come down. Therefore George's airplane does not go up. HINT: "George's airplane" is a descriptive name.
27. All fast food restaurants serve hamburgers. Some places that serve hamburgers use low quality meat. Therefore, some fast food restaurants use low quality meat.
28. All Britons are enemies of Rome. Some Britons are slaves. Therefore, some enemies of Rome are slaves.
29. All Rock musicians are concerned with social protest, because all Rock musicians are anti-establishment and no anti-establishmentarian is unconcerned with social protest.
30. All of Slick's investments are in gold or government bonds. No investments in gold or government bonds are in danger of losing their value. Therefore some of Slick's investments are not in danger of losing their value.
31. All pork dishes should be thoroughly cooked. Some Italian dishes should be thoroughly cooked. Therefore, some Italian dishes are pork dishes.
32. No college students are morons. Some teachers are morons. Therefore some teachers are not college students.
33. All automobiles are wheeled vehicles. All wheeled vehicles are subject to tire wear. Therefore some things subject to tire wear are automobiles.
34. All automobiles are wheeled vehicles. All wheeled vehicles are governed by licensing restrictions. Therefore licensing restrictions apply to all automobiles.
35. Only an electrician could have put the burglar alarm out of commission. Whoever put the burglar alarm out of commission robbed the bank. Therefore whoever robbed the bank was an electrician.
36. Some senators are not greenhorns. All neophytes are greenhorns. Therefore some senators are not neophytes.

37. Some rocks are not minerals. All gems are rocks. Therefore some gems are not minerals.
38. Anyone who experiments with opium becomes addicted to opium. Whoever smokes Marijuana will experiment with opium. Therefore anyone who smokes Marijuana becomes addicted to opium.

In the next two problems we introduce longer and more complex arguments which depend on generalizations, partials and singular statements. (We will be discussing these two problems again in the next chapter on informal logic.)

39. In this problem, the question is: Who robbed the safe? Which premises are universals, which are partials, and which are singular? In your analysis show how there is an underlying argument that dispenses with irrelevant statements and reveals the guilty person. Identify which statements are irrelevant and which are relevant. Can you write the underlying argument out as a deduction?

    Miriam Greenview, the hotel clerk, and Aloysius Templeton, the bellhop, were the only persons who had an opportunity to put the burglar alarm out of commission, and whoever put the burglar alarm out of commission robbed the safe. Only someone with a knowledge of electrical circuits could have put the burglar alarm out of commission. Aloysius quit school in sixth grade and knows nothing about electrical circuits. On the other hand, Miriam once attended technical school and worked for a year as an electrician's apprentice before moving on to her job in the hotel. Nevertheless, Aloysius is shifty-eyed and was hesitant about answering questions. He also seemed quite nervous, while Miriam is very attractive and has been perfectly calm throughout the investigation. Some people who are shifty-eyed and nervous are criminals. Furthermore we know that Aloysius is deeply in debt and is in desperate need of funds. But Miriam seemed quite concerned about the loss of the money in the safe.

40. Valid, or invalid? Here is another longer argument using singular, partial and universal statements. Analyze it along the same lines as you analyzed the previous problem.

    Every Rock musician I've ever known or listened to has been anti-establishment. Because of this, I believe that all Rock musicians are anti-establishmentarian. Shahm Di-diddi is a musician whose music is exclusively Rock, even though it is avant-garde. Besides this, Shahm smokes dope, has a weird hair-do and has tattoos all over his arms and legs. Most anti-establishment people I've known smoke dope or have weird hair-dos, or have tattoos, or even all three at once! Because of this, I believe that anyone who does any of these things is anti-establishment. Furthermore all anti-establishmentarians are concerned with social protest. So Shahm Di-diddi, despite his quite traditional family life, is clearly an anti-establishmentarian.

INFERENCE RULES IN THIS CHAPTER

INSTANCE OF A PARTIAL (PI). Any partial may be expressed as a conjunction, using an *arbitrary* name that has *not been used previously* in an argument. Letting Fs and Gs stand for two groups,

PREMISE	Some Fs are Gs	
CONCLUSION	*a* is an F and *a* is a G	(restricted to arbitrary name)

GENERALIZATION OF A PARTIAL (PG). This rule is the reverse of PI. It changes a conjunction of two simple sentences about the same individual person, place or thing, into the SOME form. Below <name> refers to any name of a particular individual person, place or thing including arbitrary names such as *a*.

PREMISE	<name> is an F and <name> is a G
CONCLUSION	Some Fs are Gs

INSTANCE OF A UNIVERSAL (UI). Whenever you have a universal expressed as a conditional using the neutral name *n*, you can replace the neutral name *n* with any name of any individual person, place or thing. In the rule below <name> refers to any name including arbitrary and descriptive names.

PREMISE	All sailors know a lot about knots
CONCLUSION	If <name> is a sailor then <name> knows a lot about knots

EXCEPTION. You cannot use UI to go to an arbitrary name such as *a*, unless the arbitrary name has been used *earlier* in a deduction.

Table of Validity for Categorical Syllogisms

Validity of Categorical Syllogisms			
PREMISES	LINK	CONCLUSION	RESULT
All Universal	Proper SYL	Universal, from proper SYL	**Valid**
Mixed (Universal & Partial)	Proper CJ, SE or CJ, ND	Partial, from proper CJ, JU	**Valid**
Both Partial	No link	None beyond the premises	**Invalid**