The Requirement of Logical Rigor for Knowledge

Has anybody ever asked you "Why?" or "How do you know?"
Have you ever had an answer?

Logic, in one form or another, runs through all of what we claim to know. It's important for us to be able to demonstrate what we know by giving reasons. We can't simply claim that a movie we saw over the weekend is great. We must have some reasoning behind it. Two forms of reasoning we'll focus on are deductive and inductive reasoning.

The strength of deduction is that, according to the rules of the logic game, if one set of statements is accepted as true, then we can see what inevitably follows as a consequence of those premises. Because one of the requirements of critical thought is the examination of implications – if this, then that –, the skill in identifying and evaluating deductive connections should occur early in the Theory of Knowledge programme.

Inductive reasoning is that name given to the multitude of ways we draw general conclusions from the various pieces of evidence and experience that come our way. Because of any person's spontaneous tendency to egocentrism and sociocentrism, it is important that the worth of such evidence and experience be evaluated. This is where the foundation for intellectual honesty is laid down, and where the student can come to an understanding of what counts as evidence in a variety of knowledge forms, as well as begin to reason within points of view they oppose as well as within those they support.

Familiarity with these two forms of demonstration should lead to a quest for clarity and precision of thought and expression, an aversion to sloppy thinking and inconsistent applications of standards, and to a respect for rational rather than emotional persuasion in those areas where rational and critical thought set the standards for agreement.

Relationship to Other Topics

The importance of logical consistency appears in many of the other units of the programme. To give a few short examples:

- in math we deal with axioms and logical operations;
- in language, both semantics and syntax have logical features; for instance, I cannot say "he is between Chicago" since this violates the logical rules of grammar and the meaning of the word "between";
- in the sciences the data is situated within a coherent theory; an hypothesis is often a logical prediction derived from a theory; we test ideas by saying "if X is the case, then Y should follow"; in the forming of inductive inferences there are standards for what sorts of instances of a particular kind will substantiate a lawful or descriptive generalisation;
- in history the fragments of evidence are woven together to make a coherent explanation of past events;
- in ethics an action may be judged according to whether it follows from a principle accepted as necessary to the moral life;
- in aesthetics music displays harmonies of logic and formal consistency is important to what is accepted as dramatic or artistic truth;
- in daily life the principle of rationality states that we expect people to have reasons for what they say and do. What counts as a good reason may vary according to circumstances and custom, but in logic we are looking for particular kinds of rational demonstration which will support conclusions within a community of knowers who demand that we have sound evidence for our knowledge claims.

Immediate References: One statement following from another

What is the status of the following propositions given that "Dale is taller than Chris"?

Are they **true**, **false** or **undetermined**, the latter being one of the points I want to bring out:

(a)	Chris is shorter than Dale.	T	F	U
(b)	Dale is shorter than Chris.	T	F	U
(c)	Dale weighs more than Chris.	T	F	U

(a) is **true** because it necessarily follows; (b) is **false** because it contradicts the accepted statement; and (c) is **undetermined** because the evidence does not assert anything about weight. However, both (b) and (c) would be invalid as inferences, since there is not logical implication for either of them. "Invalid" does not necessarily mean false; it simply means that it does not necessarily follow.

Now try this. . . .

Accept the given statement as true and tell me what would be the status of the following propositions: (T) (F) (U).

Given: Men landed on the moon in 1968.

1. The Americans were the first men on the moon.
2. Neil Armstrong was one of the astronauts.
3. The Russians have not landed on the moon.
4. No women were part of the moon-landing team.
5. No one has landed on the moon since 1968.
6. The moon landing was televised.
7. It was the first moon landing.
8. Men landed on the moon in 1964.
9. Women landed on the moon in 1968.
10. People have never landed on the moon.

Arguments

Logical arguments are a bit different from everyday arguments. An argument of logic consists of at least one premise and a conclusion. The conclusion is the statement one is trying to prove; the premise(s) are statements providing evidence for the conclusion.

Arguments are traditionally divided into two types (1) deductive and (2) inductive. The often-used distinction is between (1) arguing from the general to the particular and (2) arguing from the particular to the general. Although every argument involves the claim that its premises provide evidence for the truth of its conclusion, only the deductive argument can claim that its premises provide conclusive evidence. That is, if the premises of a valid deductive argument are true, this guarantees the truth of the conclusion.

The simplest example of a **deductive argument** might be:

Major premise:	Anyone who misses the exam will fail.
Minor premise:	John missed the exam.
Conclusion:	John failed.

Note what is taking place:

Major premise:	a general principle is stated
Minor premise:	a fact is related to it
Conclusion:	a particular inference follows necessarily.

Every deductive argument is either **valid or invalid**, (not true or false). These are not relative terms; an argument either is, or is not, valid. The example above is valid, which means the conclusion necessarily follows from the evidence. An invalid argument means that the evidence is not sufficient to guarantee the conclusion. The task of logical analysis is to examine the relation between premise and conclusion, and thus to discriminate the valid argument from the invalid one.

However, in everyday speech, people do not always state their arguments in such precise or completed form as our example shows. Often one of the three parts will be left out, because the speaker believes that everyone will know what he means. But, assumption is risky business; students know this from their own experience. In ordinary language, the argument above might be expressed as, "John missed the exam, so he's going to fail". The **major** is missing and assumed, although it is quite possible that someone could be unaware of the principle. Leaving out the **minor** could give, "John will fail, because anyone who misses the exam automatically fails". Or, the **conclusion** could be assumed and unexpressed as in "If you miss the exam, you will fail, and John didn't show up".

As an example, suppose I argue that "this paper must have been written by a boy, because the handwriting is so poor". What is assumed here? What premises would support this conclusion?

(a) Some boys have poor handwriting.
(b) Only boys have poor handwriting.
(c) All boys have poor handwriting.

If the argument is valid, then (b) is the right answer, but actually, unless the argument is fully stated, which is often not the case in daily life, then we are left to guess what someone is assuming as evidence for their conclusion. This underscores the need to be clear and complete in arguing for a point.

In everyday speech, it would be a bit queer to spell everything out, but in a formal demonstration of evidence for an assertion, this is a requirement.

Identify the missing parts and label them as premise or conclusion:

(Common **premise indicators** are: since, because, for, given that, in view of; common **conclusion indicators** are: thus, it follows that, hence, so, therefore.)

1. The defendant is insane, so he is not guilty.
2. That is not a good dictionary, because it does not give the origin of the word.
3. All philosophers are eccentric and Karl is a philosopher.
4. Coffee must contain a stimulant, because it keeps people awake.
5. He is either on this flight or the next one, and he was not on this one.

Identify the conclusion & premises embedded in these passages. Remember that the conclusion should be identified first, then the supporting reasons. Also, the conclusion is the point under discussion and need not be stated at the end. JUST FIND THE ARGUMENT HERE; DON'T WORRY ABOUT IT'S VALIDITY.

1. *The parking spaces at school are fast disappearing. Parking has always been a problem at this school, and the situation is getting worse, not better from year to year. Every time you think you have found a good place to park, the school sends in another excavation crew to dig the foundation for another building. And if the school keeps putting up new buildings on this already overcrowded campus, there will be fewer parking facilities year after year. Now it so happens that this is just what is taking place, so the conclusion is obvious.*

2. *Anthropologist Alexander Alland has refused the much popularised theory that man is only a 'naked ape', dominated by savage biological instincts to kill and destroy those who get in the way of his 'territorial imperative'. It turns out that aggressiveness is not instinctive, because it is not universal to human beings. Take for example, the Semal of Malaya, a culture in which youngsters are not punished, hardly ever see violence, and so have no aggressive behaviour to imitate, hence there is no such thing as murder in that culture. Nor is aggressiveness innate or biologically derived; the most primitive hunters and gatherers are the least possessive about territory, and often share the same territory with very different ethnic groups who live off the environment in quite different ways. The fact that in our culture children have to be taught to be competitive in sports and that patriotism has to be instilled by repeated rituals shows that aggressiveness is a product of culture not of biological heredity.*

Note that we may judge the individual supporting statements as true or false, but the judgement made about the argument as a whole must be "valid" or "invalid". If the argument is valid in its structure as well as true in its premise, then we may call it "sound".

The previous "John & the exam" example is called a "categorical syllogism" (put forth by Aristotle). As it's name suggests, it allows one to work through the argument by placing things into categories. Rewritten in this manner, it would be:

All people who don't show up for the exam are people who will fail.
John is a member of those people who didn't show up for the exam.
Therefore, John is a member of the people who fail.

Symbolically, it is:

All A is B.
All C is A.
All C is B.

The logical progression relies on this form, and any argument of the same form, no matter what it says, will be valid also. Consequently, an alteration may invalidate the conclusion.

Note the change from (a) to (b):

a) All men are mortal.
Socrates is a man.
Therefore, Socrates is mortal

b). All men are mortal.
Socrates is mortal.
Therefore, Socrates is a man.

The language is the same, the truth value of the statements is the same, but the conclusion of (b) no longer follows. A counter example can easily be given. A mistake known as a "fallacy" (in this case, "the fallacy of the undistributed middle") has been made. In everyday conversation, such a fallacy might sound like, "Sure, he's a Communist; he supports socialized medicine, doesn't he?"

c). All Communists support socialized medicine.
He supports socialized medicine.
Therefore, he is a Communist.

Try this one: "He must be drunk; look at the way he staggers." Logically such a statement lacks legitimacy, but they are prevalent in practice. It's like saying the following:

d). All dogs are mammals
All cats are mammals
Therefore, all dogs are cats.

e). **All A are B**
All C are D
All A are C.

Examples (b), (c) and (d) all share the same form, and if the form is invalid in one case, it is invalid always, even though the fallacy might be obscured by the language or the sentiment it arouses.

Also, in deductive reasoning it is impossible for a valid syllogism to have two true premises and a false conclusion as in (b) and (d), since somehow the conclusion is meant to be contained within the premises.

Strictly speaking, logicians are not interested in whether premises are actually true as a matter of fact. Often it is not possible to know the truth of the premises, but any system that judges arguments has to be able to work even when the material truth of the matter is not known. As students of knowledge in general, however, we will be concerned with both material (factual) and formal truth.

Note example (c). Many assertions base their appeal for acceptance on authority, prestige, prejudice, stereotyping and the like. They are often persuasive, but their foundation is usually emotional, not rational. Our goal is to become proficient at utilizing and scrutinizing assertions in light of the value of correct logical support in service of a conclusion.

The Hypothetical Syllogism of Conditional Reasoning

The hypothetical syllogism always begins with an "If-then" statement.

Premise 1: If he fails the exam, then he won't graduate.
Premise 2: And, he failed the exam.
Conclusion: Therefore, he won't graduate.

Note what is taking place:

Premise 1: a conditional situation is stated
Premise 2: a fact is related to it
Conclusion: a particular inference follows necessarily

The parts of the syllogism have specific names and functions:

Premise 1 consists of the **antecedent** and the **consequent**. Call them (p) and (q).

(p) = the antecedent = if he fails the exam
(q) = the consequent = then he won't graduate

Premise 2 and the conclusion either affirm (p) or (q) or they **deny** (p) or (q).

affirms (p) = he failed
denies (p) = he didn't fail

affirms (q) = he won't graduate
denies (q) = he will graduate

There are four usual arrangements of the parts: only two are valid. There is no guesswork involved. To show the arrangements we will assert a relationship between studying and getting a 7 by the claim that getting a 7 follows as a consequence of studying. Only (a) and (d) are valid.

(a)	If you study, then you will get a 7. You studied. You got a 7.	 affirm the antecedent conclusion follows
(b)	If you study, then you will get a 7. You got a 7. You studied.	 affirm the consequent
(c)	If you study, then you will get a 7. You didn't study. You didn't get a 7.	 deny the antecedent conclusion does not follow
(d)	If you study, then you will get a 7. You didn't get a 7. You didn't study.	 deny the consequent conclusion follows

The validity of (a) is easily seen, but the judgements about the others are not so intuitively clear to all students. Why is (b) not valid? It has a certain plausibility. First of all, there is a rule in deductive logic which says that **affirming the consequent is a fallacy** and logic is rule–governed. Simply put: if (p) then (q), and if (–q) then (–p). Nothing else is valid. But just to make it clear, try changing the hypothetical to the categorical form and you will see that it is the fallacy of the undistributed middle again.

All people who study get 7's.	All A is B
She got a 7.	All C is B
Therefore, she studied.	All A is C

Moreover, strict attention to the evidence, the major premise, shows that this statement asserts only what will happen when you study. When that condition is fulfilled, then the consequent follows. It does not say what happens when the antecedent is fulfilled. It is not a 2–way implication.

Example (c) shows a similar error. The premise does not say what will happen as a consequent of **not** studying. It says no more and no less than what will happen when you do study. The tendency in (b) and (c) is to jump to a conclusion form personal experience, since the language describes a familiar situation.

If it is not clear why (d) is valid, try putting it into other words using the same form. And if the form is valid once, it is valid always. For instance:

If you are alive, then you are breathing.	
But you are not breathing.	deny the consequent
Therefore, you are not alive.	conclusion follows

Moreover, the principle of the first premise asserts that you cannot have (p) without (q) following. And if (q) does not occur, then obviously (p) could not, because if (p) did, then (q) would too, but (q) does not in this case since you denied it. This is the logic of the meaning of conditional reasoning, and bears mentioning, even if it is not understood for the moment by everyone.

Without language, there would be no argument; however, language often complicates the job of someone trying to see if a conclusion is valid. That is why it is sometimes effective to transpose the arguments into (p's) an (q's) and be rid of the connotations of the wording. Thus, as pure form we have the following with only (a) and (d) valid.

(a)	$p \rightarrow q$	(b)	$p \rightarrow q$	(c)	$p \rightarrow q$	(d)	$p \rightarrow q$
	$\underline{p}$		$\underline{q}$		$\underline{-p}$		$\underline{-q}$
	q		p		$-q$		$-p$

Using these as a guide, try to abstract the (p's) and (q's) from the following in order to avoid the distraction of the language. To make this point I use examples with high emotional content such as losing weight, getting sick or falling in love. (I give answers in Appendix A.)

1. If I go on a diet, then I will lose weight. V inV
   And I lost weight.
   So, I went on a diet.

2. If I go on a diet, then I will lose weight. V inV
   And I went on a diet.
   So, I lost weight.

3. If I take the poison, then I will die. V inV
   But I didn't die.
   So, I didn't take the poison.

4. If he likes me, then he will call me. V inV
   And he called me.
   So, he likes me.

5. If she loves me, then she will marry me. V inV
   She doesn't love me.
   She won't marry me.

6. If it snows, then my car won't start. V inV
   My car started.
   Thus, it didn't snow.

7. If it snows, then school will be closed. V inV
   It didn't snow.
   So, the school will not be closed.

Having set out almost all the elementary principles and vocabulary of deductive reasoning, it only remains to introduce one other form, **the disjunctive.** [redacted]

Note how the argument below sets up alternatives, then denies one which automatically affirms the other.

It doesn't make sense to have Christmas vacation and then come back for three more weeks to complete the term. So the only feasible alternatives are **either** *to cut out the Christmas vacation and continue school until the term is finished* **or** *to start a little earlier in September and finish the term by Christmas-time. Well, as matters stand, it would be unreasonable to omit the Christmas holiday at a time when everyone else celebrates, so we'll have to start the term a bit earlier.*

The disjunctive form has strong rhetorical value and is often used by politicians and debaters. A speaker may pit his view against one the audience is sure to disapprove of. Then he persuades them to reject the unpopular view which gives strength to the one he is proposing.

Either we forsake the principle of national sovereignty, or we surrender all hope for a peaceful world. But the latter we cannot do, since the prospect of war is abhorrent to every right-thinking man and woman, and inconceivable in view of the destructive power of modern weapons. Thus, there is but one alternative: we must surrender a measure of our national sovereignty.

The **disjunctive syllogism** always begins with an "either–or" statement.

Premise 1: Either this or that.
Premise 2: Not this.
Conclusion: Therefore that.

Note what is taking place:

Premise 1: Two alternatives are stated asserting **one or the other or both.**
Premise 2: One of the two is denied.
Conclusion: The other is affirmed.

Only two forms are valid:

(a)
$$\begin{array}{l} p \vee q \\ \underline{-p} \\ q \end{array}$$

(b)
$$\begin{array}{l} p \vee q \\ \underline{-q} \\ p \end{array}$$

Because the disjunctive premise asserts that one or the other must be the case, by denying one, the other is automatically affirmed. But beware: the first premise **does not say that it cannot be both.** Because they could both occur, affirming one does not rule out the other. Students must be careful not to read into the evidence more than it states. For instance, look at the arrangements of the following.

(a) Either he studied or he failed.
He didn't study.
He failed.

(b) Either he studied or he failed.
He didn't fail.
Therefore, he studied.

(c) Either he studied or he failed.
He studied.
He didn't fail.

(d) Either he studied or he failed.
He failed.
He didn't study.

Arguments (a) and (b) are valid which means they demonstrate their conclusion without exception. Arguments (c) and (d) are invalid which means that the evidence is not enough to guarantee the conclusion, no matter how plausible it may seem.

A speaker may intend to imply one or the other **but not both**; however, in the example above the two situations are not contradictory. Both studying and failing can occur together. Only if the wording of the first premise contains mutually exclusive terms can we affirm one and rule out the other. Mutually exclusive terms such as boy or girl, dead or alive, valid or invalid are different in nature from studying and failing. Although students will argue that "either–or" conventionally means one or the other, but not both, I insist on my interpretation both as being logically correct and as following the (p v q) of their mathematical truth tables. (To make the point even more forcefully and arouse even more ire, try asking if "some students passed" **logically** implies "some did not".)

The disjunctive is valuable, since often a premise is set up so that it appears as if it covers all conditions, when in fact, there may be many more than two alternatives, and you might not wish to choose between the two given. Also, the disjunctive operation is common to other pursuits as a ruling out procedure.

Remembering the only rule for validity, **deny one and get the other.** [redacted] quickly do the following exercises. [redacted]

1.	Either she will cook or I will starve. She cooked. So, I didn't starve.	V	inV
2.	Either she will cook or I will starve. I starved. She didn't cook.	V	inV
3.	Either she will cook or I will starve. She didn't cook. I starved.	V	inV
4.	Either she will cook or I will starve. I didn't starve. She cooked.	V	inV
5.	Either she will cook or I will starve. She cooked. I didn't starve.	V	inV

1. If Fidel Castro is a Scorpio, so is Ronald Reagan. But Ronald Reagan is not. If Fidel Castro is not a Scorpio, or Margaret Thatcher is not a Virgo, then it is the case both that Castro is a Capricorn and Ronald Reagan is a Leo. Hence, it follows that Fidel Castro is a Capricorn.

   Valid or invalid?

2. Either the picture is valuable or it is a forgery. If it is valuable, it is by Picasso; if it is a forgery, then there will be a police investigation. Therefore, either there will be a police investigation or the picture is by Picasso.

   Would you accept the picture if you were an art dealer?

Test these

Argument Recognition

[redacted] use these problems for (1) recognition of forms of arguments and (2) testing the validity of arguments.

1. If inflation is allowed to continue, the unions will demand a steep rise in wages. And that is what is going to happen, because inflation is going to be allowed to continue.

2. The alternatives seem to be that the United States government weakens its NATO commitment by withdrawing troops from Europe or that it meets increasing criticism at home for the enormous funds spent in maintaining these troops abroad. The government will never weaken its NATO commitment; so we may expect that criticism to increase.

3. The food in the cafeteria will improve or there will be a student strike. And since there is a student strike scheduled for tomorrow, it follows that the food will improve.

4. The streets are no safer today than they were five years ago; yet if the Crime Control Act was effective, we would expect streets to be safer. Hence, the Act was not effective.

5. Granted that if there were no problems on earth, man should explore the moon. But you admit that there are problems on earth, so man should not be spending money to explore the moon.