**Ian’s Introduction to Logic**

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You reason all the time. Sometimes you reason unconsciously and without using words – for example (probably), when you try to figure out which brand of laundry detergent to buy at the supermarket. Sometimes you reason deliberately, consciously, and out loud – for example, when you write a paper defending a particular thesis. In general, we reason because it helps us make satisfactory decisions and form beliefs that are more likely to be true.

Doing philosophy is doing your best to find out the answers to difficult and often very abstract questions. The reasoning required to do this well is often itself difficult and abstract – hard to understand, and easy to mess up. If we want to philosophize well, we need to reason as carefully as possible – we need to understand our own and others’ reasoning and we need to recognize mistakes when we see them.

**Arguments are made up of premises and conclusions**

When you want to give a reason to believe something, you give an *argument* for it. Loosely speaking, **an argument is a chain of reasoning leading to a conclusion.** (In everyday language, we often use the word “argument” to mean “heated verbal fight”. That isn’t how we use the word in philosophy. The use of the word “argument” in philosophy is more faithful to its etymology – “argument” comes from the Latin word for “clarification”.) **Logic is the study of arguments.**

Arguments can take all sorts of different forms. Here are three arguments that might occur in an ordinary text or conversation:

* You can cut cesium with a butter knife, so it’s softer than wood.
* I think Flatbush Avenue is the closest 2 station to Brooklyn College because everyone who takes the 2 train here gets off at that stop.
* If God exists, then why do bad things happen?

These arguments are all very different, but they have a couple of things in common. In particular, **each argument has a *conclusion*, which is what is being argued for**. (Here the conclusions are, respectively: cesium is softer than wood, Flatbush Avenue is the closest 2 train to Brooklyn College, God does not exist.) Also, **each argument has at least one *premise*, which is a statement that is made to support the conclusion**. (Here, some of the premises are, respectively: you can cut cesium with a butter knife, everyone who takes the 2 train to Brooklyn College gets off at Flatbush Avenue, bad things happen.) **Every argument has a conclusion and at least one premise**.

Usually, it is OK to leave arguments in this kind of “informal”, casual form. But these arguments leave some of the premises *implicit*, meaning that the argument makes some assumptions that aren’t written down. (Sometimes arguments even leave the conclusion implicit.) In philosophy, it is often important to state an argument as formally and clearly as possible, with every premise explicit. For example, in its best form, the last argument might look like this:

1. If God exists, then bad things do not happen.
2. Bad things do happen.
3. God does not exist.

(1) and (2) are the two premises, and (3) is the conclusion. Here, all of the premises are explicit – nothing is being implicitly assumed – and stated separately, and the conclusion is stated after all of the premises. Stating an argument this way makes it easier to criticize – if you disagree with the argument, you have to disagree with either (1) or (2).

*Quick test #1: suppose someone says: “Everyone loves sour fruit candy, so everyone loves Sweet Tarts”. What is the conclusion? What is the explicit premise? What is the implicit premise?*

**Two important features of good arguments: soundness and validity**

When we’re dealing with an argument like (1)-(3) (we’ll look at the other kind of argument in a moment), we want our argument to have at least two features. These special features of arguments don’t have names in everyday English, so logicians have come up with two technical terms for these features. First, we want our arguments to be valid. **An argument is *valid* when, if the premises are true, the conclusion has to be true**.Another way of saying this is that the premises *entail* the conclusion, or that it’s impossible for the premises to be true and the conclusion false. Second, we want our arguments to be sound. **An argument is *sound* when it is valid, and all of its premises are true.** (Again, the use of “valid” and “sound” in logic and philosophy is different from its use in everyday language. In everyday language, an argument or a belief is valid, roughly, if it’s acceptable or tolerable to believe it. In logic and philosophy, whether something is valid has nothing to do with whether you can tolerate it.)

Where soundness is also about whether the premises are true, validity is just about the *relationship* between the premises and the conclusion. An argument can be valid, sound, both, or neither. (An argument can’t be invalid and sound, though.) We are interested in valid and sound arguments because a valid, sound argument has to have a true conclusion. If an argument is missing either one of these features – if it is *invalid* or *unsound* – it might not have a true conclusion. Here are some examples of each kind of argument:

|  |  |  |
| --- | --- | --- |
|  | Sound | Unsound |
| Valid | All sharks are fish; no dog is a fish; therefore, no shark is a dog.  If North West can legally drink, she is over 21; North West is not over 21; therefore, she cannot legally drink. | Some horses are unicorns; all unicorns are magical; therefore, some horses are magical.  Either everyone is tall or everyone is short; not everyone is tall; so everyone is short. |
| Invalid |  | Whenever the sun is up, it’s hot outside; therefore, Ian is ten feet tall.  Every cat is either skinny or tall; so, Garfield is a cat. |

There are three important things to remember about soundness and validity. First is a terminological point: only arguments can be sound or valid. An individual sentence can’t be sound or valid. An individual sentence can be true or false, and it can entail or be entailed by some other sentence or sentences.

Second, whether an argument is sound is different from whether you know or believe that it’s sound. This is because there is a difference between whether something is true or false, and whether it is reasonable or unreasonable to believe, or whether it is a matter of fact or a matter of opinion. Soundness has nothing to do with what anyone thinks or what evidence anyone has.

Third, logic can tell you only whether an argument is valid, not whether it is sound. Logic can’t tell you whether an argument is sound because it can’t tell you whether a certain premise is true or false; studying logic won’t tell you whether you can cut cesium with a butter knife, or whether sharks are fish. Logic tells us only whether an argument is valid. Unfortunately, telling whether an argument is valid requires some fancy technical tools, which we can’t really develop here. (If you want to find out more about the fancy tools, take a logic course! It’s fun! Seriously!) Without any technical tools, here’s a simple test – the *imagination test* – to figure out whether an argument is valid: **try** **to imagine a situation in which the premises are true, and the conclusion is false. If you can imagine such a situation, then the argument is probably invalid; if you can’t imagine such a situation, then the argument is probably valid.**

*Quick test #2: come up with your own example of a sound, valid argument. Remember to make all the premises explicit!*

*Quick test #3: “Every cat has claws; Dora has claws; therefore, Dora is a cat”. Why is this an invalid argument?*

*Quick test #4: if an argument is sound, what can you say about its conclusion? If it is valid and has true premises, what can you say about it? If an argument is valid and has a false conclusion, what can you say about it? If an argument has a true conclusion, why* **can’t***you say it’s valid?*

**Argument forms**

Logicians are primarily interested in arguments that are valid just because of their form or structure. The idea of the form of an argument is hard to grasp, but let’s try.

Sometimes arguments are valid because there is some sort of special connection between the meanings of the non-logical words they contain. For example, consider the following argument:

1. Some apples are red.
2. Some apples are not transparent.

The non-logical words here are “apples”, “red”, and “transparent”. The argument (4)-(5) is valid because there is a connection between the meaning of “red” and the meaning of “transparent”. In some sense, by definition, if something is transparent, it is not red. You need to know this about what “transparent” means in order to know that (4)-(5) is valid. If you didn’t know what “transparent” means, you couldn’t know that this is a valid argument.

Sometimes arguments are valid, but not because of any special connection between the meanings of the non-logical words they contain. For example, consider the following argument:

1. Either my keys are in my coat or my keys are on the desk.
2. My keys are not in my coat.
3. My keys are on the desk.

Now consider another, very similar argument:

1. Either everyone worships Trump or no one is happy.
2. Not everyone worships Trump.
3. No one is happy.

You can see how these two arguments have a lot in common. What they have in common is their form. One way of describing the form of these arguments is this:

(6`) Either p or q.

(7`) Not-p.

(8`) q.

(6`)-(8`) describes the form of the arguments above by replacing the basic independent clauses they contain (e.g. “my keys are in my coat”, “everyone worships Trump”) with the variables “p” and “q”, and leaving the logical words “either”, “or”, and “not”. (6)-(8) and (9)-(11) are *formally valid* arguments, because any argument with their form is valid. No matter what independent clauses I substitute for “p” and “q” in (6`)-(8`), what comes out will be a valid argument.

The branch of logic that studies argument forms like (6`)-(8`) is called propositional logic, because you get an actual argument by replacing those variables “p” and “q” with propositions, or independent clauses like “my keys are in my coat”. (Interestingly, the development of propositional logic in the 19th century was crucial to the invention of the computer. Who said philosophy isn’t useful?) The other branch of logic is called predicate logic, because it studies argument forms that you describe by replacing predicates (not propositions) with variables. Here’s an example of an argument that is formally valid, but only because of predicate logic:

1. All elementary school students are friendly.
2. Some pirates are not friendly.
3. Some pirates are not elementary school students.

Here, if I replace all the predicates (roughly, the noun phrases or stand-alone adjective phrases) with variables, I get this:

(12`) All E are F.

(13`) Some P are not F.

(14`) Some P are not E.

Any argument with this form is valid, no matter what predicates I put in place of E and F. In the table below, you can find some valid argument forms, with some examples of arguments of each form.

*Quick test #5: Come up with another argument with the form (12`)-(14`).*

*Quick test #6: Come up with a propositional argument form that is invalid.*

**Two kinds of arguments: deductive and inductive**

All of the arguments that we have looked at so far are deductive. When I said that you want an argument to be valid, I was talking about *deductive* arguments. Deductive arguments are supposed to be valid. There is another kind of argument, though. An *inductive* argument can give a good reason to believe the conclusion, even if it’s not deductively valid. Here is a good inductive argument:

1. Most New Yorkers who voted, voted for Clinton.
2. I’m a New Yorker who voted.
3. I voted for Clinton.

|  |  |  |  |
| --- | --- | --- | --- |
| Propositional | | Predicate | |
| Form | Example | Form | Example |
| If p, then q.  p.  Therefore, q. | If Janeway is decisive, then the Voyager will be safe; Janeway is decisive; therefore, the Voyager will be safe. | All F are G.  Some F are H.  Therefore, some G are H. | All French fries are greasy; some French fries are hot; therefore, some greasy things are hot. |
| If p, then q.  If q, then r.  Therefore, if p, then r. | If global warming is a Chinese hoax, then Trump is right; if Trump is right, then we’re doomed; therefore, if global warming is a Chinese hoax, then we’re doomed. | All F are G.  All G are H.  Therefore, all F are H. | All frogs are gross; all gross things are healthy; therefore, all frogs are healthy. |
| p and q.  Therefore, p. | Ian is wise and Ian is handsome; therefore, Ian is wise. | No F are G.  Some F are H.  Therefore, some H are not G. | No war is just; some wars are popular; therefore, some popular things are not just. |

Here, (15) and (16) are the premises and (17) is the conclusion. It is an *inductively strong* argument, since (15) and (16) give a good reason to believe (17) – if (15) and (16) are true, then (17) is probably true. However, (15)-(17) is not a valid argument, since (15) and (16) don’t entail (17). (15) and (16) could be true even if (17) is false – I could be in the minority of voting New Yorkers who didn’t vote for Clinton.

Here’s another inductive argument:

1. The best explanation of why my hands are warm is that my keyboard is hot.
2. My keyboard is hot.

Again, this is an invalid argument, but it gives a good reason to believe the conclusion. Inductive arguments like (15)-(17) and (18)-(19) are a little more mysterious than deductive arguments. While logicians have worked out precise theories of when an argument is valid, no one knows exactly what it takes to make a strong inductive argument.