Why Study Logic?

I. Lesson

"The point of logic is to give an account of the notion of validity: what follows from what"

(Graham Priest, *Introduction to Non-Classical Logic*, 2008)

1. Logic in Action

Logic is all about argument and persuasion. Consider the following conversation between two students:

> Student A: Hey there! I just realized something really cool.
>
> Student B: Let's hear it.
>
> A: I realized that color isn't real.
>
> B: Ok, I'm confused. Why do you think that?
>
> A: Well, we see with our eyes, right? And seeing is just what happens when light hits our eyes and our brain processes it in a certain way. The reason something looks 'blue' is just because the light that bounces off of it is a different frequency than the light from something that looks 'red'. So, different colors don't have anything to do with the objects we are seeing, they're just different kinds of light waves!
>
> B: Well, what you say may be true, but I'm not sure you've proven that 'color isn't real'.
>
> A: What do you mean?? I just told you that color is just our brain's response to light waves, so color is just something 'in our brains', or at least something that we *think* we see after our brain processes light in a certain way — the stuff we *think* has different colors might all in fact just be the same shade of gray. The only thing that matters is how our brain processes different light waves!
>
> B: You still haven't convinced me. I accept that our brains react differently to different light waves when we see color, but you haven't given me a reason to think that this *directly* means that color isn't real. Couldn't we use our brains to get the sensation of different colors from light waves with different frequencies **AND** for it to be true that the objects *are actually colored*? Maybe the light waves just transfer the color from the object to our brains. If you want me to believe your conclusion, you are going to have to give me a better argument than that!

What's happening here? Well, Students A and B are arguing about a **conclusion**: "color is not real". To try to convince Student B, Student A presents an **argument** with **premises** (i.e. assumptions): "seeing is light hitting our eyes", "the frequency of the light determines the color we

see", (and other premises). Student B isn't convinced, because they don't think that the *conclusion follows* from the *premises.* That is, Student B thinks you can't **infer** "color isn't real" from the *premises* Student A offers.

[Activity]: Can you think of any discussions in your experience that are similar to the one between Students A and B? Share with the class/with a partner, explaining what the argument was about, explaining why you had a disagreement and what it was about. Could learning concepts like the bolded ones above help you in future discussions? If so, how?

[Activity]: What do you think is the point of logic? What do you think we study in logic and why? Share with a partner!

2. What Are We Doing When We Do Logic?

a) Premises, Conclusions, Inferences

Logic can be understood as the formal study of correct reasoning patterns. In general, we make decisions, pass judgments, and express opinions in a fairly patterned fashion. Whether explicitly or implicitly, we start from a set of assumptions which we use to arrive at some further belief. Our starting assumptions are called *premises*, while our belief resulting from our starting assumptions is called a *conclusion*. The process of moving from premises to conclusions is commonly called an *inference* or *argument*.

Logic can also be understood as the formal and precise study of reasoning in order to make it clear and unambiguous. Sometimes when we informally reason and make arguments, it is difficult to understand what exactly our conclusions are and on what basis we reached those conclusions. Logic helps to bring clarity to the answers to these questions.

It is useful here to observe that, for our purposes in logic, we care mainly about **declarative sentences**. Declarative sentences are sentences that assert something which can be true or false. For instance, the sentence "The sky is blue." asserts something (true) about the sky, and the sentence "Fire is cold." asserts something (false) about fire. For this reason, both are examples of a declarative sentence. To see the difference, consider questions like, "Are you hungry?", or commands like, "Close the door!". By themselves, these sentences do not state anything about the world. On their own, they cannot be true or false in the way that the declarative sentences "You are hungry" and "The door is closed" can.

b) Logical Form

Inferences are fundamental to virtually every kind of decision-making practice we engage in. As such, we certainly have some intuitive notion of what counts as a good inference and what does not. For example, you probably have an intuition that something goes *wrong* in the following exchange:

Premise 1 (P1): Aristotle is a person.

Premise 2 (P2): All people are mortal.

Conclusion (C): Therefore, Aristotle is not mortal.

To what went wrong, we introduce the notion of **logical form**. Every inference is reducible to a structural pattern or form. We can study these forms to establish which arguments lead to good conclusions and which don't. In future lessons, we will develop a vocabulary to describe logical forms. We will see that the example above is called a **syllogism**, and we will discuss properties of syllogism such as *validity* and *soundness*.

[Activity]: In your own words, describe what you think is wrong with the argument above!

[Activity]: With a partner, come up with your own examples of arguments like the one above. Try replacing 'All' with 'Some', putting 'not' in front of 'mortal', replacing the words with others you like better – get creative! Discuss how each argument you come up with works (or doesn't). Try to find patterns!

II. Examples

Let's return to some more examples of imperfect arguments. First, we will look at two instances that show how helpful it can be to take commonly expressed arguments and recast them in the premise-conclusion form. Consider the following sequence of statements:

1. It's pretty obvious that all snakes are animals. Think about it. What's a snake? It's a reptile, right? I mean, not just a single snake, all of the snakes. You take any snake and it's a reptile. But then what's a reptile? Again, all the reptiles, not just a single one, you get it. Take any reptile – is it *not* an animal? Of course it's an animal! So, all snakes are animals.

This is an unclear way to make an argument, at least compared to a formally structured one, with premises and conclusions clearly stated. But, in everyday life, we don't always formalize our arguments before making them. This is not to say that formalized arguments are more correct or that our common way of speaking is defective. But, formalizing arguments *do*es make it easier for us to characterize what is going wrong (or not) in an inference. The previous paragraph is just a roundabout way to express the following argument:

Premise 1 (P1): All snakes are reptiles.

Premise 2 (P2): All reptiles are animals.

Conclusion (C): All snakes are animals.

Reducing to this premise-conclusion form is a useful tool to parse out what is really going on in an argument. Now let's consider another argument:

2. It's pretty obvious that all tables are chairs. Think about it. What's a table? It's a piece of furniture, right? I mean, not just a single table, all of the tables. You take any table and it's a piece of furniture. But then what's a piece of furniture? Again, all the pieces of furniture, not just a single one, you get it. Take any piece of furniture – is it *not* a chair? Of course it's a chair! So all tables are chairs.

If someone expressed this to us, we might be tempted to say, "That's not an argument!" While that is a common response to particularly faulty reasoning, from a logical perspective, it's not correct. The above paragraph *is* an argument, albeit a *bad* one – we can see just how bad it is when we reduce it to premise-conclusion form:

Premise 1 (P1): All tables are pieces of furniture.

Premise 2 (P2): All pieces of furniture are chairs.

Conclusion (C): All tables are chairs.

From this reduction, we can see what is wrong with the argument – the second premise is *false*.

The point is that all arguments have a well-defined set of features, and any sequence of statements that fits them counts as an argument. Of course, not all sequences of statements are arguments. Consider the following:

3. A self-taught musician, [Julian] Bream learned playing to radio dance bands with the lute his father bought from a sailor on London's Charing Cross Road in 1947. As a child prodigy, his early recitals led to him being "acknowledged as one of the most remarkable artists of the post-war era", according to the Royal Academy of Music. After studying piano and composition at the Royal College of Music, and completing national service, he became one of the most prolific and best-selling recording artists in classical music."

(BBC News, *Julian Bream: Classical Guitarist Dies Aged 87*, 2020)

This sequence of statements does use some language that is frequently employed in argumentation, and each declarative statement taken on its own *is* capable of being true or false. However, there is no discernible *logical connection* between them – there is no conclusion reached by drawing inferences from premises. So, this cannot be called an argument. It is merely a sequence of claims about the life of a beloved classical guitarist.

[Activity]: We have mentioned that declarative sentences are a basic element of logical arguments. Recall that declarative sentences can be either true, or false. Considering this, do you think that statements such as questions or exclamations can be evaluated from a logical perspective? Why or why not? Explain your answer in your own words.

III. Exercises

1. Identify whether the following sequences of statements are arguments or not. If you find an argument, reduce it to premise-conclusion form. If you find a sequence of statements that is not, explain why it isn't an argument.

    a. I was watching a David Attenborough documentary the other day, and it was about penguins. Some of the penguins in the program were black and white, but some of them were albino! It's actually pretty strange to see albino penguins after only seeing black and white penguins your whole life. Anyway, it got me thinking. You know, old TV shows used to be black and white too; like, *all* of them. I realized some penguins are old TV shows.

    b. Symmetrical buildings look so imposing, don't they? I think so. That's why the Taj Mahal is so imposing. It's a perfectly symmetric building.

    c. I really like the Taj Mahal. It's a really beautiful building. I learned recently that it was architecturally designed to be perfectly symmetric on a bilateral plane. This means that it's identically designed along a vertical line of symmetry along the very middle of the building.

2. Think of some more of your own examples of arguments in premise-conclusion form. Get creative!

    Ex: P1: Some dogs are cats. P2: All cats are flowers. C: Some dogs are flowers.

3. Are rhetorical questions ("Is the sky blue?") analyzable by logic? Why or why not?

4. Match the pairs of premises in the left-hand column to the appropriate conclusions in the right-hand column.

i. P1: All tables are chairs. P2: All chairs are green.	a. C: Some fruits are not red .
ii. P1: Some days are sunny days. P2: All sunny days are happy.	b. C: All snakes are chairs .
iii. P1: Some apples are not red. P2: All apples are fruits.	c. C: Some days are happy.
iv. P1: All snakes are trees. P2: All trees are chairs.	d. C: All tables are green.

5. Are the following statements declarative sentences or not?

    a. Get out of here!

    b. You are fun.

    c. Where is Beth?

    d. I am not bored.

    e. Is exercise beneficial?

6. (Challenge) Here is a classic type of logic problem, more commonly in line with what people think about when they hear the term 'logic'. As you work through it, make a note of all the assumptions that you make and of the conclusions to which you arrive on your way to the final answer. Try to express them as declarative sentences and think about how close or how far this reasoning is from premise-conclusion form.

   You are on an island where the people belong to one of two classes: knights or knaves. The knights always tell the truth, while the knaves always lie. Apart from this specific quirk, there is nothing to tell them apart. You run into two people, Alf and Beth. Alf says, "Beth is knave.". Beth says, "Neither Alf nor I are knaves.". What class does each person belong to?

IV. Conclusion

Logic is the formal study of *correct* patterns of reasoning. When we engage in logical argumentation, we care about the *logical form* of the inferences made from the set of sentences taken to be premises. In order to characterize these inferences, we will need to develop a particular vocabulary that captures its features.

In this course, we will mainly be learning *Aristotelian Logic*. This means that we will be using Aristotle's interpretive system to understand the meanings of *terms*, *propositions*, and *syllogisms*. In order to understand which conclusions follow from certain premises and which do not, we will need to conduct an in-depth study of these three things - the three building blocks of logic.

V. Lesson Goals

At the end of this lesson, students will be able to:

- grasp the scope and purpose of logic;
- define an argument and its main features and components;
- define logical form;
- define a declarative sentence and its role in inferential practice;
- characterize the intellectual and practical importance of logic;
- recast natural language arguments in premise-conclusion form;
- understand what classes of statements can be described by logic.

Answer Key:

Exercise 1

a. This is an argument: P1: Some penguins are black and white. P2: All old TV shows are black and white. C: Some penguins are old TV shows. b. This is an argument: P1: Symmetrical buildings are imposing. P2: The Taj Mahal is a symmetrical building. C: The Taj Mahal is imposing. c. This is not an argument since it cannot be reduced to a set of declarative sentences.

Exercise 2

Answers may vary.

Exercise 3

They are not. Even though such questions are used as a purely *rhetorical* device to imply that some statement or conclusion is very obvious or trivial, they are still not either true or false, so they are not part of our logic.

Exercise 4

i.-d.; ii.-c.; iii.-a.; iv.-d.

Exercise 5

a.,c.,e. are not declarative sentences; b. and d. are declarative sentences.

Exercise 6

Assume that Alf is telling the truth. People who tell the truth are knights. Thus, Alf is a knight. Therefore, "Beth is a knave." is a true sentence. Knaves are people who lie. Therefore, Beth is lying, so she is a knave. Therefore, "Neither Alf, nor I are knaves." is a lie. Therefore, either Alf is a knight, or Beth is a knight, or both. But Beth is knave, so she cannot be a knight, so they cannot also both be knights. So we are right that Alf is a knight and Beth is a knave. Now assume Alf is lying. People who lie are knaves. Thus, Alf is a knave. Thus, "Beth is a knave." is a lie. Thus, Beth is a knight. Knights are people who tell the truth. Therefore, "Neither Alf, nor I knaves." is true. Therefore, both Alf, and Beth are knights. But Alf is a knave. Therefore, Beth is lying. Therefore, Beth is a knave. Therefore, "Neither Alf, nor I are knaves." is a lie. Therefore, either Alf is a knight, or Beth is a knight, or both. But we have established that they are both knaves. We have arrived at a contradiction. Therefore, our assumption that Alf is lying cannot be the case. Therefore, Alf cannot be a knave. Therefore, Alf is a knight and Beth is knave.