1 Arguments

1.1 We begin here.

In everyday discourse, the word *argument* typically refers to a verbal disagreement between two people. In logic and philosophy, however, it has a different and special meaning (although plenty of people do argue, in the everyday sense of the word, in logic and philosophy). We will use *argument* to refer to a set of sentences like these:

1. It is raining heavily.
2. Jeff doesn't want to get soaked.
3. If Jeff doesn't take an umbrella, he will get soaked.

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4. Therefore, Jeff will take an umbrella.

In this set, the first three sentences support—or justify—the fourth sentence. The sentences providing support are the *premises*. The sentence that is supported by (or justified by) the premises is the *conclusion*. Together, *premises* and a *conclusion* comprise an *argument*.

Argument

An ARGUMENT is a set of sentences. One or more of the sentences provide support for another sentence in the set. The sentences providing support are PREMISES. The sentence being supported is the CONCLUSION.

That's the definition of an argument, but a broader analysis must include the idea that arguments can be good or bad—or somewhere in between. A good argument is one in which the premises do, in fact, support the conclusion. For such an argument, if the premises are true, then we have good reason to believe that the conclusion is true. On the other hand,

a bad (or a weak) argument is still an argument. It is just one in which the premises provide little support for the conclusion.

In the definition of an argument, we said that each premise and the conclusion is a sentence. And, as we saw, the premises and the conclusion in the example are all individual sentences. All arguments can be expressed this way and many are, but a single sentence, like this one, can also contain a complete argument:

> Joan was wearing sunglasses when she came inside, and so it must be sunny.

This argument has one premise and a conclusion. The premise and the conclusion could both be individual sentences, but here they are just independent clauses separated by the 'and'. (The premise is before the 'and', and the conclusion is after it.)

Many arguments also start with the premises and end with a conclusion. But not all arguments are expressed in this order. For instance, here we have the same argument about Joan, but the conclusion is at the beginning:

> It must be sunny because Joan was wearing sunglasses when she came inside.

When approaching an argument, we want to know whether or not the conclusion is supported by the premises. Therefore, first, we must identify the premise or premises (the sentences providing support) and the conclusion (and the sentence being supported). As a guide, these words are often used to indicate that a sentence or clause is the conclusion of an argument:

> so, therefore, hence, thus, accordingly, consequently

And these often indicate that what follows are premises:

> since, because, given that

So that we can undertake a more detailed and precise analysis of some kinds of arguments, in chapter 4, we will begin introducing a formal language: truth functional logic. But before we get there, in this chapter and chapter 2, we will cover some basic logical notions that apply to arguments

in a natural language like English. Then, in chapter 3, we will examine logical notions that apply to just sentences (not full arguments), and still in a natural language like English.

1.2 Sentences

Only sentences that can be true or false can be the premises or the conclusion of an argument, and for the purpose of studying truth-funcitonal logic, we will define SENTENCE as a statement that can be true or false.

The following types of sentences cannot be true or false, and so they are not, in this sense, sentences and cannot be part of an argument.

Questions 'Are you sleepy yet?' is, obviously, a question. Although you might be sleepy or you might be alert, the question itself is neither true nor false. For this reason, questions will not count as sentences in logic.

Imperatives Imperative sentences are, essentially, commands (although they can be nicer than what we usually think of as a command). For instance, 'Wake up!', 'Sit up straight', and 'Please, tell me how to set the table' are all imperatives. Although it might be a good idea for you to sit up, and you may or may not do it, the command is neither true nor false. Note, however, that commands are not always phrased as imperatives. As Cartman might say,"You will respect my authority." This is a command, but it is also true or false — either you will or you will not respect Cartman's authority — and so it counts as a sentence in logic.

Exclamations Some exclamatory sentences can be true or false (and so they are also declarative sentences) and some cannot be. 'It's Friday!' is an exclamation, and it is true or false. It can be part of an argument. On the other hand, a sentence such as 'Ouch!' is neither true nor false, and so it cannot be part of an argument.

1.3 Truth values

We define SENTENCE in this restrictive way because all of the premises and the conclusion in an argument must be capable of having a TRUTH

VALUE. Although more advanced "non-classical" logic systems introduce more options, the two truth values that concern us are just 'true' and 'false'.

It may be the case that we would have great difficulty or be unable to establish whether a particular premise or conclusion is true or false, but nonethess, we can coherently think about each one being true or false (which we can't do for, say, a question).

truth values

TRUTH VALUES are the logical values that a sentence can have, *true* and *false*.

Practice exercises

Identify the conclusion of each of these arguments:

1. All men are mortal, and Socrates is a man. Therefore, Socrates is mortal.
2. Carlos must be on the train because, once the code was given to Petra and the asset was safe, he had to leave Budapest.
3. If the book isn't on the desk, then Stephen is in the archives. And if Stephen is in the dinning hall, then Patricia is stealing the document. So, if Patricia isn't stealing the document, then the book is still on the desk.
4. Miss Scarlett and Professor Plum were in the study at the time of the murder. Reverend Green had the candlestick in the ballroom, and we know that there is no blood on his hands. Hence, Colonel Mustard did it in the kitchen with the lead-piping. Recall, after all, that the gun had not been fired.

The answers are on p. 14

2 Validity and other standards

2.1 Validity

Consider this argument:

1. You are reading this book.
2. This is a logic book.
3. Therefore, you are a logic student.

> When we list the premises and the conclusion of an argument this way, the final line is always the conclusion. All of the lines before the final one are the premises.

If the premises of this argument are true—which, as it turns out, they are—it is very likely that the conclusion is true. But it is possible that someone besides a logic student is reading this book. If, say, the roommate of the book's owner picked it up and began looking through it, he or she would not immediately become a logic student. So, for this argument, we can say that, if the premises are true, then it is *likely*, but not certain, that the conclusion is also true.

Now, take this one:

1. Paris is in France, or it is in Germany.
2. Paris is not in Germany.
3. Therefore, Paris is in France.

In this case, if the premises are true—which, again, they are—then the conclusion has to be true. There is no way for the premises to be true and the conclusion to be false.

Here is another example,

1. Paris is in Sweden, or it is in Spain.
2. Paris is not in Sweden.
3. Therefore, Paris is in Spain.

Although this argument might strike you as a bit odd, we can say almost the exact same thing about this one as we did for the previous one:

> In this argument, if the premises are true, then the conclusion has to be true. There is no way for the premises to be true and the conclusion to be false.

We have to drop the bit about the premises being true because the first one is false. But nonetheless, *if the premises are true*, then the conclusion has to be true.

This brings us to an important definition as well as an important point about doing logic. First the definition.

Valid

These are two equivalent definitions of VALID (or DEDUCTIVELY VALID):

1. An argument is VALID when, and only when, it is the case that, if the premises are true, then the conclusion has to be true.
2. An argument VALID when, and only when, it is impossible for all of the premises to be true and the conclusion to be false.

Every argument that does not satisfy the definition of *valid* is INVALID (or DEDUCTIVELY INVALID).

Typically, the study of logic focuses on determining when the conclusion of an argument follows from the premises with certainty. From the perspective of logic, whether the premises actually are true is less important. Of course, determining whether or not they are true can be important for many reasons, but this task is normally left to historians, scientists, or the Hardy boys.

Here is another argument to consider:

1. Paris is a large city in France, or Paris is a large city on Jupiter.
2. Paris is not a large city in France.
3. Therefore, Paris is a large city on Jupiter.

This argument is valid. *If* both premises are true (they're not, but if they were), then the conclusion has to be true. Now, let's think about this argument:

1. London is in England.
2. Beijing is in China.
3. Therefore, Paris is in France.

The premises and conclusion of this argument are all true, but the argument is invalid. If Paris were, somehow, to become independence from the rest of France, then the conclusion would be false, even though both of the premises would remain true. Thus, it is *possible* for the premises of this argument to be true and the conclusion false. Hence, the argument is *invalid*. Here is another example of an invalid argument:

1. If you are in Paris, then you are in France.
2. You are in France.
3. Therefore, you are in Paris.

The important point to remember is that validity is not about the actual truth or falsity of the sentences in the argument. It is about whether it is *possible* or *impossible* for all of the premises to be true and the conclusion to be false. (Or, to say the same thing in a different way, whether the conclusion has to be true *if* all of the premises are true.)

We can, however, classify the arguments that are valid and have all true premises. We call these SOUND. The second argument on p. 7 is sound.

Sound

An argument is SOUND when, and only when, it is valid and has all true premises.

2.2 Inductively strong arguments

Many good arguments are invalid. Consider this one:

1. In January 2019, it rained in London.
2. In January 2020, it rained in London.
3. In January 2021, it rained in London.
4. In January 2022, it rained in London.
5. In January 2023, it rained in London.
6. In January 2024, it rained in London.
7. In January 2025, it rained in London.
8. Therefore, next January, it will rain in London.

This argument generalizes from observations about several recent past cases to a conclusion about the next one. It could be made even stronger by adding additional premises, for instance: 'In January 2018, it rained in London,' 'In January 2017, it rained in London,' and so on. But, however many premises like this we add, the argument will remain invalid. Even if it has rained in London every January for the past 10,000 years, it remains *possible* that it won't rain in London next January. Hence, this argument is invalid. But, at the same time, you might think, "but it's still a good argument!" It is, and we have a way of classifying such arguments.

Inductively strong

An argument is INDUCTIVELY STRONG when (and only when) [1] it is not valid and [2] it is the case that if the premises are true, then their being true makes it likely that the conclusion is true.

When an argument is invalid, the probability that the conclusion will be true (if the premises are true) can range from very high to zero. To simplify matters, we can say that the options are *inductively strong*, *medium*, or *weak*, although since this is a continuum, we could be much more fine grained than this. (But we won't. See table 2.1.)

Whereas a valid argument that has all true premises is *sound*, an inductively strong argument that has all true premises is *reliable*.

Reliable

An argument is RELIABLE when (and only when) it is inductively strong and has all true premises.

The premises being true,	↶ These are all invalid.
make it very probable that the conclusion will be true.	inductively strong
...	
make it somewhat probable that the conclusion will be true.	inductively medium
...	
do not make it very likely that the conclusion will be true.	inductively weak

Table 2.1: Every argument is valid or invalid. Invalid arguments can have any degree of inductive strength, depending on how likely the conclusion is to be true given the premises.

In this textbook, we are going to set aside the analysis of inductively strong arguments and focus just on valid versus invalid arguments.

Practice exercises

A. Determine if each of the following arguments is valid or invalid.

(1)
1. Socrates is a man.
2. All men are carrots.
3. Therefore, Socrates is a carrot.

(2)
1. Either today is Labor Day, or the building is full.
2. The building isn't full.
3. Therefore, today is Labor Day.

(3)
1. If the green van is missing, then Claire is at the beach.
2. The green van is missing.
3. Therefore, Claire is at the beach.

(4) If Jones decided that she is going to get divorced, then she called a lawyer. Jones just called a lawyer. Hence, she has decided that she's going to get divorced.

(5)
1. Jeff is playing basketball, or Mary is watching television.
2. Mary is watching television.

3. Therefore, Jeff is playing basketball.

(6)
1. 160 12th graders at Central High School were asked if they planned to go to college next year.
2. 75 percent said that they were planning to go to college the following year.
3. Therefore, about 75 percent of all the 12th graders at Central High School are probably going to college next year.

(7)
1. If Mary stole the painting, then Jeff is in New Jersey.
2. Therefore, if Jeff is in New Jersey, then Mary stole the painting.

(8)
1. As vacation destinations, Florence and Lisbon have many similarities: nice weather, historical attractions, and great restaurants.
2. Sarah enjoyed visiting Florence.
3. Therefore, Sarah will probably enjoy visiting Lisbon.

(9)
1. If Mary stole the painting, then Jeff is in New Jersey.
2. Therefore, if Jeff is not in New Jersey, then Mary did not steal the painting.

(10)
1. Amy is on campus.
2. Therefore, Amy is on campus, or she is on the moon.

(11)
1. Jack is taking a nap.
2. Therefore, Jack is taking a nap, and Kate is reading.

(12)
1. If Roger is in the bank, then Steven is waiting in the apartment.
2. Roger is not in the bank.
3. Therefore, Steven is not waiting in the apartment.

(13)
1. If Joan is at work, then Kate is sleeping.
2. Therefore, if Kate is not sleeping, then Joan is not at work.

(14)
1. If Mary is in the library, then Jeff is watching tv.
2. If Jeff is watching tv, then Claire is taking a nap.
3. Therefore, if Claire is taking a nap, then Mary is in the library.

(15)
1. If Mary is in the library, then Jeff is watching tv.
2. If Jeff is watching tv, then Claire is taking a nap.

3. Therefore, if Mary is in the library, then Claire is taking a nap.

(16)
1. If Mary is in the library, then Jeff is watching tv.
2. If Jeff is watching tv, then Claire is taking a nap.
3. Therefore, if Claire is not taking a nap, then Mary is not in the library.

(17)
1. George is an architect, or Susan is a lawyer.
2. George is not an architect.
3. Therefore, Susan is a lawyer.

(18)
1. Amy is walking in the park, or Sarah is playing basketball.
2. Amy is walking in the park.
3. Therefore, Sarah is not playing basketball.

(19)
1. George is mowing the lawn.
2. Therefore, George is mowing the lawn, and Fred is looking for his coat.

(20)
1. Almost all sea lions live in the Atlantic Ocean around New York and New Jersey.
2. Sammy is a sea lion.
3. Therefore, Sammy lives in the Atlantic Ocean around New York and New Jersey.

(21)
1. All sea lions live in the Atlantic Ocean around New York and New Jersey.
2. Sammy is a sea lion.
3. Therefore, Sammy lives in the Atlantic Ocean around New York and New Jersey.

B. For each statement, determine if it is possible or not. If it is possible, given an example as illustration. If it is not possible, then explain why it isn't.

1. A valid argument that has one false premise and one true premise
2. A valid argument that has a false conclusion
3. A valid argument that has only false premises
4. A valid argument with only false premises and a false conclusion

5. An invalid argument that can be made valid by the addition of a new premise
6. A valid argument that can be made invalid by the addition of a new premise

2.3 Answers

These are the answers for the chapter 1 practice problems :

1. Therefore, Socrates is mortal.
2. Carlos must be on the train.
3. So, if Patricia isn't stealing the document, then the book is still on the desk.
4. Hence, Colonel Mustard did it in the kitchen with the lead-piping.

A.

(1)
1. Socrates is a man.
2. All men are carrots.
3. Therefore, Socrates is a carrot.

This argument is valid.

(2)
1. Either today is Labor Day, or the building is full.
2. The building isn't full.
3. Therefore, today is Labor Day.

This argument is valid.

(3)
1. If the green van is missing, then Claire is at the beach.
2. The green van is missing.
3. Therefore, Claire is at the beach.

This argument is valid.

(4) If Jones decided that she is going to get divorced, then she called a lawyer. Jones just called a lawyer. Hence, she has decided that she's going to get divorced.

This argument is invalid.