

# **Business Logic**

## **Lecture 3: Introduction to Logic**

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## Lecture Learning Objectives:

At the end of the lecture, you will be able to:

1. Define logic, truth and validity.
2. Importance of Logic
2. Understand the relationship between truth and validity.
3. Differentiate premise and conclusion.
4. Analyze the different kinds of arguments which are true/false and conclusion.
5. Apply the concepts of truth and validity by writing their own argument.

## Introduction

**Logic** is about reasoning – about going from premises to a conclusion. As we begin our study of logic, we need to be clearer on what logic is and why it's important. We also need to learn some concepts (like “valid” and “argument”) that are central to the study of logic.

## Logic

**Logic** is the analysis and appraisal of arguments. When you do logic, you try to clarify reasoning and separate good from bad reasoning. As you work through this lecture, you'll examine reasoning on various topics, both philosophical (like free will and determinism, the existence of God, and the nature of morality) and non-philosophical (like backpacking, water pollution, football, Supreme Court decisions, and the Bible). You'll come to see logic not as an irrelevant game with funny symbols, but as a useful tool to clarify and evaluate our reasoning – whether on life's deeper questions or on everyday topics.

Why study logic? I can think of **three main reasons**. *First*, logic is important because reasoning is important. While you've been reasoning about things all your life, this may be the first time that you try to understand reasoning and become better at it. Reasoning and general analytical skills are important in law, politics, journalism, education, medicine, business, science, mathematics, computer science, and most other areas.

*Second*, logic can deepen your understanding of philosophy. **Philosophy** can be defined as reasoning about the ultimate questions of life. Philosophers ask questions like “Why accept or reject free will?” or “Can one prove or disprove God's existence?” or “How can one justify a moral belief?” If you don't know any logic, you'll have only a vague grasp of such issues; and you'll lack the tools needed to understand and evaluate philosophical reasoning. If you've studied philosophy, you'll likely recognize many of the pieces of philosophical reasoning in this lecture. If you haven't studied philosophy, you'll find this book a good introduction to the subject.

In either case, you should get better at recognizing, understanding, and appraising philosophical reasoning. *Finally*, logic can be fun. Doing logic is like playing a game or doing puzzles; logic will challenge your thinking processes in new ways. The rigor of logical systems will likely fascinate you. Most people find logic enjoyable.

### Valid arguments

We begin with basic logic course with a multiple-choice test. The test has ten problems; each problem gives information and asks what conclusion necessarily follows. The problems are easy, but most students get about half wrong. Here are **two of the problems** – with the right answers boxed:

If you overslept, you'll be late.

You aren't late.

Therefore:

- (a) You did oversleep.
- (b) You didn't oversleep.
- (c) You're late.
- (d) None of these follows.

If you overslept, you'll be late.

You didn't oversleep.

Therefore:

- (a) You're late.
- (b) You aren't late.
- (c) You did oversleep.
- (d) None of these follows.

While almost everyone gets the first problem right, many students wrongly pick “(b)” for the second problem. Here “You aren't late” doesn't necessary follow, since you might be late for some other reason; maybe your car didn't start. Most students, once they grasp this point, will see that (b) is wrong. Untrained logical intuitions are often unreliable. But logical intuitions can be developed; yours will likely improve as you work through this lecture. You'll also learn special techniques for testing arguments. An **argument**, in the sense used in logic, is a set of statements consisting of premises and a conclusion. The **premises** are statements that give supporting evidence; the **conclusion** is what is allegedly supported by these statements.

Arguments put into words a possible act of reasoning. Here's an example:

If you overslept, you'll be late.

You aren't late.

Á You didn't oversleep. (“Á” = therefore)

An **argument** is valid if it would be contradictory (impossible) to have the premises all true and conclusion false. In calling an argument valid, we aren't saying whether the

premises are true. We're just saying that the conclusion follows from the premises – that if the premises were all true, then the conclusion also would have to be true. In saying this, we implicitly assume that there's no shift in the meaning or reference of the terms; hence we must use "overslept," "late," and "you" the same way throughout the argument.

Our argument is valid because of its logical form – its arrangement of logical notions (like "if- then" and "not") and content phrases (like "You overslept" and "You're late"). We can display an argument's form by using words or symbols for logical notions and letters for content phrases:

If you overslept, you'll be late.

You aren't late.

Á You didn't oversleep.

If A then B Valid

Not-B

Á Not-A

Our argument is valid because its form is correct. If we take another argument of the same form, but substitute other ideas for "A" and "B," then this second argument also will be valid. Here's an example:

If you're in France, you're in Europe.

You aren't in Europe.

Á You aren't in France.

If A then B Valid

Not-B

Á Not-A

Logic studies forms of reasoning. The content can deal with anything – backpacking, mathematics, cooking, physics, ethics, or whatever. When you learn logic, you're learning tools of reasoning that can be applied to any subject. Consider our invalid example:

If you overslept, you'll be late.

You didn't oversleep.

Á You aren't late.

If A then B Invalid

Not-A

Á Not-B

Here the second premise denies the first part of the if-then; this makes it invalid. Intuitively, you might be late for some other reason – just as, in this similar argument, you might be in Europe because you're in Italy:  
If you're in France, you're in Europe.

You aren't in France.  
Á You aren't in Europe.  
If A then B Invalid  
Not-A  
Á Not-B

## Sound arguments

Logicians distinguish valid arguments from sound arguments: An argument is valid if it would be contradictory to have the premises all true and conclusion false. An argument is sound if it's valid and has every premise true. Calling an argument "valid" says nothing about whether its premises are true. But calling it "sound" says that it's valid (the conclusion follows from the premises) and has true premises. Here's an example of a sound argument:

Valid and true premises

If you're reading this, you aren't illiterate.  
You're reading this.  
Á You aren't illiterate.

When we try to prove a conclusion, we try to give a sound argument. We must make sure that our premises are true and that our conclusion follows from our premises. If we have these two things, then our conclusion has to be true. The conclusion of a sound argument is always true. An argument could be unsound in either of two ways: **(1)** it might have a false premise or **(2)** its conclusion might not follow from the premises:

First premise false:  
All logicians are millionaires.  
Gensler is a logician.  
Á Gensler is a millionaire.  
Conclusion doesn't follow:  
All millionaires eat well.  
Gensler eats well.  
Á Gensler is a millionaire.

When we criticize an opponent's argument, we try to show that it's unsound. We try to show either that one of the premises is false or that the conclusion doesn't follow. If the argument has a false premise or is invalid, then our opponent hasn't proved the conclusion. But the conclusion still might be true – and our opponent might later discover a better argument for it. To show a view to be false, we must do more than just refute an argument for it; we must invent an argument of our own that shows the view to be false.

Besides asking whether premises are true, we could ask how certain they are, to ourselves or to others. We'd like our premises to be certain and obvious to everyone. We usually have to settle for less than this; our premises are often educated guesses or

personal convictions. Our arguments are only as strong as their premises. This suggests a third strategy for criticizing an argument: we could try to show that one or more of the premises are very uncertain. Here's another example of an argument. In fall 2008, before Barack Obama was elected US president, he was far ahead in the polls. But some thought he'd be defeated by the "Bradley effect," whereby many whites say they'll vote for a black candidate but in fact don't. Barack's wife Michelle, in a CNN interview with Larry King (October 8), argued that there wouldn't be a Bradley effect:

**Barack Obama** is the Democratic nominee. If there was going to be a Bradley effect, Barack wouldn't be the nominee [because the effect would have shown up in the primary elections]. Á There isn't going to be a Bradley effect.

Once she gives this argument, we can't just say "Well, my opinion is that there will be a Bradley effect." Instead, we have to respond to her reasoning. It's clearly valid – the conclusion follows from the premises. Are the premises true? The **first premise** was undeniable. To dispute the **second premise**, we'd have to argue that the Bradley effect would appear in the final election but not in the primaries; but it's unclear how one might defend this. So, an argument like this changes the nature of the discussion. (By the way, there was no Bradley effect when the general election took place a month later.) Logic, while not itself resolving substantive issues, gives us intellectual tools to reason better about such issues. It can help us to be more aware of reasoning, to express reasoning clearly, to determine whether a conclusion follows from the premises, and to focus on key premises to defend or criticize. I have two points on terminology. We'll call statements true or false (not valid or invalid). And we'll call arguments valid or invalid (not true or false). While this is conventional usage, it pains a logician's ears to hear "invalid statement" or "false argument." So far we've seen deductive arguments, where the conclusion is claimed to follow with necessity. There also are inductive arguments, where the conclusion is claimed to follow only with probability; this claim is either implicit or else expressed by terms like "probably." Consider these **examples**:

Deductively valid Inductively strong  
All who live in France live in Europe.  
Pierre lives in France.  
Á Pierre lives in Europe.

Most who live in France speak French.  
Pierre lives in France.  
This is all we know about the matter.  
Á Pierre speaks French (probably).

The **first argument** has a tight connection between premises and conclusion; it would be impossible for the premises to all be true, but the conclusion is false. The **second** has a looser premise–conclusion connection. Relative to the premises, the conclusion is only a good guess; it's likely true but could be false (perhaps Pierre is the son of the Polish ambassador and speaks no French).

## Truth and Validity

Source: Introduction to Logic  
Irving Copi  
Carl Cohen  
Kenneth McMahon  
14th edition

There are many possible combinations of true and false premises and conclusions in both valid and invalid arguments. Here follow **seven illustrative arguments**, each prefaced by the statement of the combination (of truth and validity) that it represents. With these illustrations (whose content is deliberately trivial) before us, we will be in a position to formulate some important principles concerning the relations between truth and validity.

**I.** Some valid arguments contain only true propositions—true premises and a true conclusion:

All mammals have lungs.  
All whales are mammals.  
Therefore, all whales have lungs.

**II.** Some valid arguments contain only false propositions—false premises and a false conclusion:

All four-legged creatures have wings.  
All spiders have exactly four legs.  
Therefore, all spiders have wings.

This argument is valid because, if its premises were true, its conclusion would have to be true also—even though we know that in fact both the premises and the conclusion of this argument are false.

**III.** Some invalid arguments contain only true propositions—all their premises are true, and their conclusions are true as well:

If I owned all the gold in Fort Knox, then I would be wealthy.  
I do not own all the gold in Fort Knox.  
Therefore, I am not wealthy.

The true conclusion of this argument does not follow from its true premises. This will be seen more clearly when the immediately following illustration is considered.

**IV.** Some invalid arguments contain only true premises and have a false conclusion.

This is illustrated by an argument exactly like the previous one (III) in form, changed only enough to make the conclusion false.

If Bill Gates owned all the gold in Fort Knox, then Bill Gates would be wealthy.

Bill Gates does not own all the gold in Fort Knox.  
Therefore, Bill Gates is not wealthy.

The premises of this argument are true, but its conclusion is false. Such an argument cannot be valid because it is impossible for the premises of a valid argument to be true and its conclusion to be false.

**V.** Some valid arguments have false premises and a true conclusion:

All fishes are mammals.  
All whales are fishes.  
Therefore, all whales are mammals.

The conclusion of this argument is true, as we know; moreover, it may be validly inferred from these two premises, both of which are wildly false.

**VI.** Some invalid arguments also have false premises and a true conclusion:

All mammals have wings.  
All whales have wings.  
Therefore, all whales are mammals.

From Examples V and VI taken together, it is clear that we cannot tell from the fact that an argument has false premises and a true conclusion whether it is valid or invalid.

**VII.** Some invalid arguments, of course, contain all false propositions—false premises and a false conclusion:

All mammals have wings.  
All whales have wings.  
Therefore, all mammals are whales.

These seven examples make it clear that there are valid arguments with false conclusions (Example II), as well as invalid arguments with true conclusions (Examples III and VI). Hence it is clear that the truth or falsity of an argument's conclusion does not by itself determine the validity or invalidity of that argument. Moreover, the fact that an argument is valid does not guarantee the truth of its conclusion (Example II). Invalid arguments can have every possible combination of true and false premises and conclusions.

### **True Conclusion False Conclusion**

If an argument is valid and its premises are true, we may be certain that its conclusion is true also. To put it another way: If an argument is valid and its conclusion is false, not all of its premises can be true. Some perfectly valid arguments do have false conclusions, but any such argument must have at least one false premise. When an argument is valid and all of its premises are true, we call it sound. The conclusion of a sound argument obviously must be true—and only a sound argument can establish the

truth of its conclusion. If a deductive argument is not sound—that is, if the argument is not valid or if not all of its premises are true—it fails to establish the truth of its conclusion even if in fact the conclusion is true. To test the truth or falsehood of premises is the task of science in general, because premises may deal with any subject matter at all. The logician is not (professionally) interested in the truth or falsehood of propositions so much as in the logical relations between them. By logical relations between propositions, we mean those relations that determine the correctness or incorrectness of the arguments in which they occur.

The task of determining the correctness or incorrectness of arguments falls squarely within the province of logic. The logician is interested in the correctness even of arguments whose premises may be false. Why do we not confine ourselves to arguments with true premises, ignoring all others? Because the correctness of arguments whose premises are not known to be true may be of great importance. In science, for example, we verify theories by deducing testable consequences from uncertain theoretical premises—but we cannot know beforehand which theories are true. In everyday life also, we must often choose between alternative courses of action, first seeking to deduce the consequences of each. To avoid deceiving ourselves, we must reason correctly about the consequences of the alternatives, taking each as a premise. If we were interested only in arguments with true premises, we would not know which set of consequences to trace out until we knew which of the alternative premises was true. But if we knew which of the alternative premises was true, we would not need to reason about it at all, because our purpose was to help us decide which alternative premise to make true. To confine our attention to arguments with premises known to be true would therefore be self-defeating.

**Exercise:**

For each of the argument descriptions provided below, construct a deductive argument (on any subject of your choosing) having only two premises.

1. A valid argument with one true premise, one false premise, and a false conclusion
2. A valid argument with one true premise, one false premise, and a true conclusion
3. An invalid argument with two true premises and a false conclusion
4. An invalid argument with two true premises and a true conclusion
5. A valid argument with two false premises and a true conclusion
6. An invalid argument with two false premises and a true conclusion
7. An invalid argument with one true premise, one false premise, and a true conclusion
8. A valid argument with two true premises and a true conclusion

**READINGS AND VIDEOS** (Please see the digital copies of the materials.)

Reading 2.1 Gensler, H. (2010). Introduction to Logic Second Edition. New York: Routledge

Reading 2.2 Copi, I., Cohen, C & McMahon, K. (2014). Introduction to Logic Fourteenth Edition. London: Pearson Education Limited

Video 2.1 Critical Thinking –Fundamentals: Truth and Validity in <https://www.youtube.com/watch?v=pCGnyaa5E5g>

Video 2.2 Critical Thinking –Fundamentals: Truth and Validity in <https://www.youtube.com/watch?v=kdJ6aGToDlo>

LECTURES (Please refer to the PowerPoint presentations)

**ACTIVITY AND ASSESMENT**

Answer Exercise (Write your answer in a separate sheet of paper)

**REFERENCES:**

Introduction To Logic  
Harry Gensler  
2nd Edition New York: Routledge, 2010

Introduction to Logic  
Irving Copi  
Carl Cohen  
Kenneth McMahon  
14th edition, Pearson Education Limited, 2014