

# Critical Thinking: A Student's Introduction

## Chapter 3 Basic Logical Concepts

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## Introduction

In evaluating any argument, one should always ask two key questions:

- Are the premises true?
- Do the premises provide good reasons to accept the conclusion?

We will only focus on the latter question in chapter 3

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## Example, 1

Take this argument

- Premise 1: If the moon is made of green cheese, then you will score perfectly on the next exam
- Premise 2: The moon is made of green cheese
- Conclusion: Therefore, you will score perfectly on the next exam

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## Example, 2

Even though premises 1 and 2 are false, they still provide good reasons to accept the conclusion. Why?

- Because, if they were true, the conclusion would have to be true
  - If a green cheese moon really did ensure that you ace the next exam, and it really was green cheese, then you really would ace the next exam
- So, you will never be able to show that premises don't provide "good reasons" for a conclusion by pointing out that they are false
- Save "truth evaluation" for chapter 8

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## Deduction and Induction, 1

**Deductive arguments** try to prove their conclusions with rigorous, inescapable logic

- Example
  - All humans are mortal
  - Socrates is a human
  - Therefore, Socrates is mortal

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## Deduction and Induction, 2

**Inductive arguments** try to show that their conclusions are plausible or likely given the premises

- Example
  - Every ruby so far discovered has been red
  - So, probably all rubies are red

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## Deduction and Induction: Avoid a Misconception, 1

### Misconception

- Deduction moves from general premises to particular conclusions
- Induction moves from particular premises to general conclusions

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## Deduction and Induction: Avoid a Misconception, 2

### Arguments can be presented in this manner:

- Deduction: All males are mortal. (general premise) I am a male. Therefore, I am mortal. (particular conclusion)
- Inductive: The last two winter days were cold. (particular premise) Therefore, all winter days are cold. (general conclusion)

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## Deduction and Induction: Avoid a Misconception, 3

But arguments can be presented in this manner as well:

- Deductive: Lincoln was president from 1861 to 1865. (particular premise) Therefore, all persons born during Lincoln's presidency were born in the nineteenth century. (general conclusion)
- Inductive: I have got A's in all my classes so far. (general premise) Therefore, I will get an A in this class. (particular conclusion)

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In fact, it is possible to find examples of *any possible combination* of general or particular premises or conclusions in deductive or inductive arguments.

Thus, it is a mistake to regard any particular pattern of general or particular statements as a defining characteristic of deductive or inductive reasoning.

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## Differences between Deductive and Inductive Arguments, 1

### Deductive arguments claim that:

- If the premises are true, then the conclusion **must** be true
- The conclusion follows **necessarily** from the premises
- It is **impossible** for all the premises to be true and the conclusion false
- It is **logically inconsistent** to assert the premises and deny the conclusion

### Inductive arguments claim that:

- If the premises are true, then the conclusion is **probably** true
- The conclusion follows **probably** from the premises
- It is **unlikely** for the premises to be true and the conclusion false
- Although it is logically consistent to assert the premises and deny the conclusion, the conclusion is **probably** true if the premises are true

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## Tests to Determine Whether an Argument Is Deductive or Inductive, 1

### Indicator word test

- Indicator words can be used to communicate when an argument is deductive or inductive
  - Examples of **deduction indicator words**: Certainly, definitely, this entails that, and conclusively
  - Examples of **induction indicator words**: Probably, likely, one would expect that, odds are that, and it is reasonable to assume that
- Indicator words are not always present, and they are sometimes used loosely or improperly
  - For example, a speaker may say “it certainly follows” but be exaggerating, knowing that it only “probably follows”

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## Tests to Determine Whether an Argument Is Deductive or Inductive, 2

### Strict necessity test

- An argument's conclusion either follows with strict logical necessity from its premises or it does not
  - If it does, the argument should always be treated as deductive
  - If it doesn't, the argument should be treated as inductive
- Examples
  - Alan is a father. Therefore, Alan is a male. (deductive)
  - Jill is a six-year-old girl. Therefore, Jill cannot run a mile in one minute flat. (inductive)

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## Tests to Determine Whether an Argument Is Deductive or Inductive, 3

- Exceptions to the strict necessity test: An argument in which the conclusion does not follow necessarily from the premises should nonetheless be treated as deductive in the following situations:
  - Language/ context makes clear that the arguer **intended to offer a logically conclusive argument**, but the argument, in fact, is not logically conclusive
    - Magellan's ships sailed around the world. It necessarily follows, therefore, that the earth is a sphere.
  - Argument has a pattern of reasoning that is **characteristically deductive**, and nothing else about the argument clearly indicates that the argument is meant to be inductive
    - If I am in Wilkes-Barre, then I'm in P A. I am not in Wilkes-Barre. Therefore, I am not in Pennsylvania.
    - If I'm Bill Gates, then I'm mortal. I'm not Bill Gates. Therefore, I'm not mortal.

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## Tests to Determine Whether an Argument Is Deductive or Inductive, 5

### Common pattern test

- There are many common patterns that valid arguments “use”
  - For example: If P then Q. P. Therefore, Q.
    - This argument pattern is called *modus ponens*
- If an argument follows this pattern, it is deductive

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## Tests to Determine Whether an Argument Is Deductive or Inductive, 6

### Principle of charity test

- When interpreting an unclear argument or passage, always give the speaker or writer the benefit of the doubt
  - Never attribute to an arguer a weaker argument when the evidence reasonably permits us to attribute to him or her a stronger one
  - Never interpret a passage as a bad argument when the evidence reasonably permits us to interpret it as not an argument at all

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## Tests to Determine Whether an Argument Is Deductive or Inductive, 7

- Example: *Andy told me that he ate at Maxine's yesterday, but it burned down a month ago. It is certain, therefore, that he is either lying or mistaken.*

2. Does the conclusion follow with strict necessity from the premises? No. Although it seems quite unlikely, it is certainly conceivable that the restaurant has been quickly rebuilt and has reopened for business. This suggests that the argument should be regarded as **inductive**.

1. **deduction** indicator. But deduction indicator words—loosely or improperly?

3. Does the argument have a pattern of reasoning that is either typically deductive or typically inductive? Not really. → The third test doesn't apply in this case

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## Principle of charity test

- We treat the argument as deductive, it is clearly a **bad deductive** argument because the conclusion plainly does not follow necessarily from the premises.
- On the other hand, if we treat the argument as inductive, the argument is a **good inductive** argument because the premises, if true, do make the conclusion likely.
- The most charitable way to interpret the argument is to interpret it as **inductive**.

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## Common Patterns of Deductive Reasoning

- Hypothetical syllogism
- Categorical syllogism
- Argument by elimination
- Argument based on mathematics
- Argument from definition

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## Hypothetical Syllogism, 1

Three-line argument that contains at least one hypothetical or conditional premise

Varieties of hypothetical syllogisms

- If A then B. A. Therefore, B. (**modus ponens**)
- If P then Q. If Q then R. Therefore, if P then R. (**chain argument**)
- If A then B. Not B. Therefore, not A. (**modus tollens**)

*Modus ponens*, chain argument, and *modus tollens* are all logically reliable patterns of deductive reasoning.

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## Hypothetical Syllogism, 2

- If A then B. Not A. Therefore, not B. (**denying the antecedent**)
- If A then B. B. Therefore, A. (**affirming the consequent**)
- These should be treated as deductive because they have a pattern of reasoning that is characteristically deductive

Patterns of deductive reasoning  
that are not logically reliable

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which type of hypothetical syllogism it is?	
1. If we're in London, then we're in England. We are not in England. So, we are not in London.	
2. If we're in Los Angeles, then we are in the United States. We are in the United States. So, we are in Los Angeles.	
3. If we're in the United States, then we are on Earth. We are in the United States. So, we are on Earth.	
4. If we're in Paris, then we are in France. If we're in France, then we are in Europe. So, if we are in Paris, then we are in Europe.	
5. If we're in Houston, then we are in the United States. We are not in Houston. So, we are not in the United States.	
6. If we're in Shanghai, then we are in China. So, we are in China, because we are in Shanghai.	
7. We are not in Mexico, because if we are in Mexico City, we are in Mexico, and we are not in Mexico City.	
8. Since we're in India, we are in Calcutta, since we are in India if we are in Calcutta.	
9. If we're in Toronto, then we are in Canada. So, because if we are in Canada, we are in North America, if we are in Toronto, then we are in North America.	
10. We're in Berlin, given that if we are in Berlin, then we are in Germany, and we are in Germany	

## Categorical Syllogism

Three-line argument in which each statement begins with the word all, some, or no

### Forms

- All a's are b's. All b's are c's. Therefore, all a's are c's.
- Some a's are b's. All b's are c's. Therefore, some a's are c's.

### Example

- All oaks are trees
- All trees are plants
- So, all oaks are plants

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## Argument by Elimination, 1

Seeks to logically rule out various possibilities until only a single possibility remains

- Example 1
  - Either Joe walked to the library or he drove
  - But Joe didn't drive to the library
  - Therefore, Joe walked to the library

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## Argument by Elimination, 2

- Example 2
  - If Dutch or Jack committed the murder, then the weapon was a rope
  - The weapon was not a rope
  - So, neither Dutch nor Jack committed the murder
  - Therefore, Celia committed the murder

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## Arguments Based on Mathematics

Argument in which the conclusion depends largely or entirely on some mathematical calculation or measurement

### Example

- Eight is greater than four
- Four is greater than two
- Therefore, eight is greater than two

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## Arguments from Definition

An argument in which the conclusion is presented as being “true by definition,” that is, as following simply from the meaning of some key word or phrase used

### Examples

- Bob is a bachelor. Therefore, Bob is unmarried.
- *“bachelor”: a man who is not and has never been married.*
- Janelle is a cardiologist. Therefore, Janelle is a doctor.
- *“cardiologist”: a doctor who specializes in the study or treatment of heart diseases and heart abnormalities.*

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## Common Patterns of Inductive Reasoning

- Inductive generalization
- Predictive argument
- Argument from authority
- Causal argument
- Statistical argument
- Argument from analogy

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## Inductive Generalization, 1

Drawing a generalization as a likely conclusion based on information about some members of a particular class

- **Generalization:** Statement that attributes characteristics to all or most members of some group or class

Common form

- So far, the b's I have seen have had property p.  
Therefore, all b's must have property p.

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## Inductive Generalization, 2

Example

- All dinosaur bones so far discovered have been over 65 million years old
- Therefore, probably all dinosaur bones are more than 65 million years old

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## Predictive Argument, 1

An argument in which a prediction is defended with reasons

- **Prediction:** A statement about what someone thinks will happen in the future

Common form

- So far, all the b's I have seen have had property P
- Therefore, the next b I see will have property P

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## Predictive Argument, 2

Example

- Most U.S. presidents have been tall
- Therefore, probably the next president will be tall

In some cases, predictions can be argued for deductively

- Example
  - If Amy goes, then Ted goes
  - Amy will go
  - Therefore, Ted will go

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## Argument from Authority, 1

Asserts a claim and then supports that claim by citing some presumed authority or witness who has said that the claim is true

Common form

- P said that A was true. Therefore, A is true.

Example

- The Encyclopedia said that bats eat bugs; therefore, it is likely that bats eat bugs

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## Argument from Authority, 2

Normally treated as inductive because one can never be absolutely certain that a supposed authority or witness is accurate or reliable

- Arguments from authority can sometimes be deductive
  - Example
    - Whatever the Bible teaches is true
    - The Bible teaches that we should love our neighbors
    - Therefore, we should love our neighbors

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## Causal Argument

Asserts or denies that something is the cause of something else

- Example: I can't log in. The network must be down.

Not all causal arguments are inductive

- Example
  - Whenever iron is exposed to oxygen, it rusts
  - This iron pipe has been exposed to oxygen and water
  - Therefore, it will rust

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## Statistical Argument, 1

Rests on statistical evidence (evidence that some percentage of some group or class has some particular characteristic)

Example

- 83% of Notre Dame students are Catholic
- Bob is a Notre Dame student
- Therefore, Bob is probably Catholic

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## Statistical Argument, 2

Because statistical evidence is used to support claims that are presented as probable, statistical arguments are usually inductive

- Statistical evidence can also be used in deductive reasoning
  - Example
    - If 65% of likely voters polled support Senator Beltway, then Senator Beltway will win in a landslide
    - Sixty-five percent of likely voters polled do support Senator Beltway
    - Therefore, Senator Beltway will win in a landslide

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## Argument from Analogy, 1

Argument in which the conclusion is claimed to depend on an analogy (that is, a comparison or similarity) between two or more things

Common form

- These things are similar in such-and-such ways
- Therefore, they are similar in some further way

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## Argument from Analogy, 2

### Example

- Hershey Park has a thrilling roller-coaster ride
- Dorney Park, like Hershey Park, is a great amusement park
- Therefore, probably Dorney Park also has a thrilling roller-coaster ride

Since being similar in one way does not guarantee being similar in another, most analogies are inductive

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## Argument from Analogy, 3

### Some analogical arguments are deductive

- Example
  - Automobiles cause thousands of deaths each year and produce noxious and offensive fumes
  - Smoking causes thousands of deaths each year and produces noxious and offensive fumes
  - Thus, if smoking is heavily regulated, automobiles should also be heavily regulated
  - But automobiles shouldn't be heavily regulated
  - Therefore, smoking shouldn't be heavily regulated, either

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## Deductive Validity, 1

A **valid deductive argument** is an argument in which it is impossible for all the premises to be true and the conclusion false

- The following conditions apply in a valid deductive argument:
  - If the premises are true, the conclusion must be true
  - The conclusion follows necessarily from the premises
  - The premises provide logically conclusive grounds for the truth of the conclusion
  - It is logically inconsistent to assert all the premises as true and deny the conclusion

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## Deductive Validity, 2

It is not necessary to know whether an argument's premises or conclusion are true to know whether the argument is valid

- Some valid arguments have obviously false premises and a false conclusion
  - Example: All squares are circles. All circles are triangles. Therefore, all squares are triangles.

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## Deductive Validity, 3

- Some valid arguments have false premises and a true conclusion
  - Example: All fruits are vegetables. Spinach is a fruit. Therefore, spinach is a vegetable.
- Some valid arguments have true premises and a true conclusion
  - Example: If you're reading this, you are alive. You are reading this. Therefore, you are alive.
- No valid argument can have all true premises and a false conclusion

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## Deductive Validity, 4

Get it out of your head that a “valid argument” means a “good argument”

- An argument can be a good argument and be invalid and could be a bad argument but be valid

**Invalid deductive argument:** Deductive argument in which the conclusion does not follow necessarily from the premises

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## Deductive Validity, 5

- Notice, in the following argument, even though the premises and conclusion are true, it is invalid:
  - All dogs are animals
  - Lassie is an animal
  - Therefore, Lassie is a dog
    - What if “Lassie” here referred to an iguana? The premises would still be true, and yet the conclusion would be false

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## Deductive Validity, 6

- If you get rid of your assumption (which is not in the argument) that we are talking about the TV dog, the invalidity becomes clear. Let's use a different name:
  - All dogs are animals.
  - Jub-Jub is an animal.
  - Therefore, Jub-Jub is a dog.

Validity is important because it preserves truth

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## Deductive Validity: Sound and Unsound Deductive Arguments

- **Sound deductive argument:** Deductive argument that is both valid and has all true premises
- **Unsound deductive argument:** Deductive argument that either is invalid or has at least one false premise, or both

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## Inductive Strength, 1

**Strong inductive argument:** Inductive argument in which the conclusion follows probably from the premises

- The following conditions apply in a strong inductive argument:
  - If the premises are true, the conclusion is probably true
  - The premises provide probable, but not logically conclusive, grounds for the truth of the conclusion
  - The premises, if true, make the conclusion likely

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## Inductive Strength, 2

- Example
  - All recent U.S. presidents have been college graduates
  - Thus, it is likely that the next U.S. president will be a college graduate

**Weak inductive argument:** An inductive argument in which the conclusion does not follow probably from the premises

- Example
  - All previous popes have been men
  - Therefore, probably the next pope will be a woman

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## Inductive Strength, 3

Inductively strong arguments can have combinations of truth or falsity in the premises and conclusion

- Some inductively strong arguments have:
  - False premises and a probably false conclusion
    - Example: All previous U.S. presidents have been electricians. Hence, it is likely that the next U.S. president will be an electrician.
  - False premises and a probably true conclusion
    - Example: Every previous U.S. president has flown on Air Force One. So, the next U.S. president probably will fly on Air Force One.

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## Inductive Strength, 4

- True premises and a probably true conclusion
  - Example: No previous U.S. president has been a native Alaskan. So, the next U.S. president probably will not be a native Alaskan.
- No strong inductive argument can have true premises and a probably false conclusion

Weak inductive arguments can have any combination of truth or falsity in the premises and conclusion

- Example: Most U.S. presidents have been married. Therefore, probably the next U.S. president will be a politician.

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## Inductive Strength, 5

The examples show that inductive strength or weakness of an argument has nothing to do with the truth or falsity of its premises

- Depends on whether the conclusion would probably be true if the premises were true
  - If the answer is yes, the argument is strong
  - If the answer is no, the argument is weak

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## Inductive Strength Comes in Degrees, 1

This argument...

- The last five presidents were male
- Therefore, the next president will be male

...is weaker than this one:

- All the presidents have been male
- Therefore, the next president will be male

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## Inductive Strength Comes in Degrees, 2

Recall that a deductive argument is either valid or invalid

- No two valid arguments differ in “how valid” they are

Some inductively strong arguments are inductively stronger than others

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## Cogency

- Even if an argument is inductively strong, it can still have a false premise and be a “bad argument”
- **Cogent argument:** An argument that is inductively strong and has all true premises
- **Uncogent argument:** An inductive argument that is either weak or has at least one false premise, or both