Deductive versus Inductive Reasoning

Govier has pointed out that there are four basic types of argument: deductive, inductive generalization, analogical, and conductive. For our purposes, and at this point, it useful to consider the more basic distinction between two types of reasoning: deductive and inductive. Consider the following two passages:

A. Mr. Jones is a member of the Academy of Scholarly Fellows and only professors are members of the Academy of Scholarly Fellows. Therefore, Mr. Jones is a professor.

B. Mr. Jones commonly wears a tweed jacket, carries a briefcase, and is often seen around the university campus. It seems likely that Mr. Jones is a professor.

Both passages reach the same conclusion: “Mr. Jones is a professor.” But they reach this conclusion in very different ways. Passage A provides what we might think of as definitive proof for its conclusion while passage B provides only probable truth for its conclusion. These two passages reflect the difference between deductive patterns of reason (passage A) and inductive patterns of reasoning (passage B). With deductive patterns of reasoning, if you accept the premises as true, then you must necessarily accept the conclusion as true. If the premises are true in passage A (note that I am not asserting that they are true, only that if they are true) then the conclusion must be true. In passage B, however, all three premises may be true and yet the conclusion could still be false. It’s entirely possible that Mr. Jones wears a tweed jacket, carries a briefcase, and is often seen around the university campus, and yet he is not a professor. Perhaps he is a student or simply likes hanging out on college campuses dressed like a professor. Whatever may be the case, it’s possible for the premises to be true and the conclusion to be false. This is not possible when you have a successful deductive argument.

Another way to make this point is to think about the amount or degree of support that premises provide for their conclusion. Deductive arguments try to prove their conclusions with rigorous, inescapable logic. Inductive arguments try to show that their conclusions are plausible or likely given the premise(s). The conclusion to passage A flows from the premises with a kind of inescapable logic. Deductive arguments provide this kind of rigorous, airtight logical support for their conclusions. The support provided by the premises in passage B is not nearly so airtight.

The authors of Critical Thinking: A Student’s Introduction provide a handy list for distinguishing between deductive and inductive arguments:

Key Differences between Deductive and Inductive Arguments

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; if you accept the premises, you must accept 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.

They also point out that there are usually different indicator words employed in deductive and inductive reasoning.

Here are some other common deduction indicator words:
• certainly it logically follows that
• definitely it is logical to conclude that
• absolutely this logically implies that
• conclusively this entails that
• it necessarily follows that

These are some common induction indicator words:
• probably one would expect that
• likely it is a good bet that
• it is plausible to suppose that chances are that
• it is reasonable to assume that odds are that

We’ll also learn that many deductive arguments can be identified by identifying their common underlying pattern. The authors of *Critical Thinking: A Student’s Introduction* provide a handy list for distinguishing deductive from inductive arguments:

**How to Distinguish Deductive from Inductive Arguments**
1. If the conclusion follows necessarily from the premises, the argument should always be treated as deductive.
2. If the conclusion does not follow necessarily from the premises, the argument should be treated as inductive unless (a) the language or context of the argument makes clear that the argument is deductive or (b) the argument has a pattern of reasoning that is characteristically deductive.
3. If the argument has a pattern of reasoning that is characteristically deductive, the argument should be treated as deductive unless there is clear evidence that the argument is intended to be inductive.
4. If the argument has a pattern of reasoning that is characteristically inductive, the argument should be treated as inductive unless there is clear evidence that the argument is intended to be deductive.
5. Arguments often contain indicator words—words like *probably*, *necessarily*, and *certainly* — that provide clues in determining whether an argument is deductive or inductive. Keep in mind, however, that indicator words are often used loosely or improperly.

6. If there is significant doubt about whether an argument is deductive or inductive, always interpret the argument in the way most favorable to the arguer.

**Focusing on argument form: deductive entailment and validity**

As Govier points out, in deductive reasoning, the premises deductively entail their conclusion. “One statement deductively entails another if and only if it is impossible for the second one to be false, given that the first one is true” (178). This relationship is also known as logical entailment. {NOTE: If you haven’t yet read pages 178 – 180 and 216, please do so.} When logical entailment is applied to arguments, we say that the argument is deductively valid.

**Logical Entailment:** One statement logically entails another statement if it is logically impossible for the second one to be false, given that the first one is true. For example:

1. John is someone’s brother.
2. John is the sibling of someone.

**Deductive Entailment:** Applying the notion of logical entailment to successful deductive arguments. In any successful deductive argument, if the premises are true, then the conclusion must be true and we say that the premises deductively entail the conclusion. This characteristic of successful deductive arguments is called “validity.” For example:

1. All human beings are mortal.
2. Socrates is a human being.
   Therefore
3. Socrates is mortal.

**Valid:** A valid deductive argument is an argument in which the premises support the conclusion in such a way that, if they are assumed to be true, it is logically impossible for the conclusion to be false. For example:

**Argument A:**
1. If it is raining outside, then everything is going to get wet.
2. It is raining outside.
   Therefore,
3. Everything is going to get wet.

**Argument B:**
1. All cats are mammals.
2. All mammals give birth to live young.
Therefore,
3. All cats are animals that give birth to live young.

Notice that in both of these examples, if the premises are true the conclusion must be true. It is inescapable as a matter of logic. Validity is a formal property of arguments that has to do with their underlying pattern and not the specific content of the arguments.

**Validity is a Formal Property:** The concept of validity applies to the underlying pattern or form of an argument, not its content. It is the pattern or form that we are interested in when determining validity.

| 1. If it is raining outside, then everything is going to get wet. | 1. If the moon is made of green cheese, then I’m a monkey’s uncle. | If P then Q. |
| 2. It is raining outside. | 2. The moon is made of green cheese. | P. |
| Therefore, | Therefore, | Therefore |
| 3. Everything is going to get wet. | 3. I’m a monkey’s uncle. | Q |

| 1. All cats are mammals. | 1. All dogs are cats. | All X are Y |
| 2. All mammals give birth to live young. | 2. All cats are animals that give birth to live Martians. Therefore, | All Y and Z |
| Therefore, | 3. All dogs are cats that give birth to live Martians. Therefore, | Therefore |
| 3. All cats are animals that give birth to live young. | 3. All dogs are cats that give birth to live Martians. | All X are Z |

Notice that the arguments in each row share a common underlying pattern. We can symbolize this pattern using variables such as P, Q, X, etc. It is by virtue of this underlying pattern that the arguments are valid. We say that the underlying pattern is a valid deductive argument pattern.

Because validity is a formal property, it is unrelated to the content of the argument, or the acceptability of the premises (A condition). The issue of the acceptability of the premises is completely independent of its deductive validity. A deductively valid argument is one in which the R and G conditions are satisfied automatically, by virtue of its being valid. If you can determine that an argument is valid, you know that it satisfies the R and G conditions.
Any argument having this underlying pattern will be valid and in Govier’s terms will satisfy the R and the G condition.

Valid Argument Pattern = R and G conditions are satisfied

Categorical versus Propositional form
Notice in the table above that we have two distinct kinds of deductively valid argument forms. The arguments in the first row of the table deal with the connections between propositions or statements (“It is raining” and “Everything is going to get wet”) while the arguments in the second row of the table deal with the connections between categories of things (cats, mammals, animals that give birth to live young). Deductive arguments come in two varieties:

Propositional Form: the deductive connection depends on the relationship holding between simple propositions or statements and their compounds.
- Relate one or more propositions commonly connected by a small class of “connectors”: and, not, either…or…, if…then,

Categorical Form: the deductive connection depends on the way in which the categories of things are related to each other in the premises and in the conclusion.
- Relate two classes or categories of things, a subject term (S) and a predicate term (P)
- Distinguished according to quality (affirmative or negative) and quantity (universal or particular)
- All categorical forms can begin only with all, no, or some
- The only copula permitted is are (or its negation are not)
- The subject and predicate must be classes or categories of things
- “Some” is taken to mean only “at least one”

Statements in categorical logic come in only four forms (often identified with a specific vowel):

<table>
<thead>
<tr>
<th></th>
<th>Affirmative</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal</td>
<td>A: All S are P</td>
<td>E: No S are P</td>
</tr>
<tr>
<td>Particular</td>
<td>I: Some S are P</td>
<td>O: Some S are not P</td>
</tr>
</tbody>
</table>

As you think about the issue of deductive validity, you’ll need to pay some attention to identifying whether a deductive argument is reasoning about propositions or categories.

Testing for Validity
When testing for validity we are focusing not on the specific content of the argument but on its underlying form or pattern. Deductive arguments are valid by virtue of their form and any argument with the same form will be valid, even though the content may vary. If we can identify
the underlying pattern of an argument and if we have a list of valid patterns, we can determine when a deductive argument is valid and when it is invalid. Fortunately, there are some common valid and invalid deductive argument patterns by which we can determine whether most common deductive arguments are valid or not. You’ll find a list of common deductive patterns below.

**Proving Validity:** To determine if a deductive argument passes the R and G conditions, you must first determine if it is valid or invalid. To determine whether an argument is valid, you must identify the pattern of the argument and check to see whether the pattern is valid or invalid.

- Arguments may need to be re-structured in order to fit a specific pattern.
- Arguments may employ chains of argument patterns.
- The order of the premises is seldom important.

**Let’s consider some examples**

**Example 1**
If the President carries Ohio then she’ll certainly win the national election and she is going to carry Ohio, therefore her national election is guaranteed.

**Standardize the Argument:**

1. If the President carries Ohio then she’ll certain will the national election.
2. The President is going to carry Ohio.
   Therefore
3. The President will win the national election.

**Identify the underlying pattern:**

1. If P then Q
2. P
   Therefore
3. Q

**Determine whether the underlying pattern is valid:**
This is a propositional deductive argument. This argument’s underlying pattern is called Modus Ponens and it is a valid argument pattern. This argument satisfies the R and G conditions. All that you need do now is determine whether the premises are acceptable.
Example 2
Jan’s dog must be at least thirteen years old, and if it’s that old, Jan should take it to the veterinarian at least twice a year. So, Jan should take her dog to the vet at least twice a year.

Let’s standardize the argument:

1. Jan’s dog must be at least thirteen years old.
2. If Jan’s dog is that old, Jan should take it to the veterinarian at least twice a year.
   Therefore
3. Jan should take her dog to the vet at least twice a year

Identify the underlying argument pattern:

\( P = \text{Jan’s dog is at least thirteen years old.} \)
\( Q = \text{Jan should take the dog to the vet at least twice a year.} \)

\( P. \)
\( \text{If } P \text{ then } Q. \)
\( \text{Therefore, } Q. \)

This argument is also a propositional deductive argument. Name of pattern: Modus ponens (affirming the antecedent) – valid. Notice that the order of the premises is not relevant here.

Example 3
Everybody who is out after the curfew will be arrested. So, since nobody who gets arrested will be able to leave the country next week, nobody who is able to leave the country next week will be out after curfew.

Let’s standardize the argument:

1. All people out after the curfew are people who will be arrested.
2. No people who are arrested are people able to leave the country next week.
3. Therefore, no people are able to leave the country next week are people out after curfew.

Identify the underlying argument pattern:

All Xs are Ys.
No Ys are Xs.
Therefore, no Zs are Xs.
This pattern is a categorical deductive argument. Name of Pattern: Valid Syllogism No. 2

**Example 4**
Let’s consider a more complicated example:
If the zoo is well administered, the animals are well cared for. If the animals are well cared for, some animals will reproduce in captivity. If some animals reproduce in captivity, we can expect that there will be baby animals at the zoo. There are some baby animals at the zoo. Therefore, the zoo is well administered.

**Standardize the Argument:**
1. If the zoo is well administered, the animals are well cared for.
2. If the animals are well cared for, some animals will reproduce in captivity.
3. If some animals reproduce in captivity, we can expect that there will be baby animals at the zoo.
4. There are some baby animals at the zoo.
Therefore,
5. The zoo is well administered.

**Identify the underlying pattern:**
1. If P then Q.
2. If Q then R.
3. If R then S.
4. S
Therefore
5. P

Is this argument valid or invalid? Notice that the argument uses a series of chain argument: If P lead to Q and Q leads to R and R leads to S, then P leads to S. SO: If P then S. I also have as a premise S, so I know:

1. If P then S
2. S
   Therefore
3. P

Is this a valid argument pattern?
**Common Patterns of Deductive Arguments**

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Premise</th>
<th>Conclusion</th>
<th>Valid/Invalid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modus Ponens</strong></td>
<td>If P then Q</td>
<td>P</td>
<td>Valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Therefore, Q</td>
<td></td>
</tr>
<tr>
<td><strong>Modus Tollens</strong></td>
<td>If P then Q</td>
<td>Not-Q</td>
<td>Valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Therefore, not-P</td>
<td></td>
</tr>
<tr>
<td><strong>Chain Argument (also called Hypothetical Syllogism)</strong></td>
<td>If P then Q</td>
<td>If Q then R</td>
<td>Therefore, If P then R</td>
</tr>
<tr>
<td><strong>Disjunctive Dilemma</strong></td>
<td>Either P or Q</td>
<td>Not P</td>
<td>Valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Therefore, Q</td>
<td></td>
</tr>
<tr>
<td><strong>Affirming the Consequent</strong></td>
<td>If P then Q</td>
<td>Q</td>
<td>Invalid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Therefore, P</td>
<td></td>
</tr>
<tr>
<td><strong>Denying the Antecedent</strong></td>
<td>If P then Q</td>
<td>Not-P</td>
<td>Invalid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Therefore, not-Q</td>
<td></td>
</tr>
<tr>
<td><strong>Valid Conversion 1</strong></td>
<td>No Xs are Ys</td>
<td>Therefore, no Ys are Xs</td>
<td>Valid</td>
</tr>
<tr>
<td><strong>Valid Conversion 2</strong></td>
<td>Some Xs are Ys</td>
<td>Therefore, some Ys are Xs.</td>
<td>Valid</td>
</tr>
<tr>
<td><strong>Invalid Conversion 1</strong></td>
<td>All Xs are Ys</td>
<td>Therefore, all Ys are Xs</td>
<td>Invalid</td>
</tr>
<tr>
<td><strong>Invalid Conversion 2</strong></td>
<td>Some Xs are not Ys</td>
<td>Therefore, some Ys are not Xs</td>
<td>Invalid</td>
</tr>
<tr>
<td><strong>Unnamed Invalid Inference</strong></td>
<td>Some Xs are Ys</td>
<td>Therefore, some Xs are not Ys</td>
<td>Invalid</td>
</tr>
<tr>
<td><strong>Valid Syllogism 1</strong></td>
<td>All Xs are Ys</td>
<td>All Ys are Zs</td>
<td>Valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Therefore, all Xs are Zs</td>
<td></td>
</tr>
<tr>
<td><strong>Valid Syllogism 2</strong></td>
<td>All Xs are Ys</td>
<td>No Ys are Zs</td>
<td>Valid</td>
</tr>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Therefore, no Ys are Zs</td>
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</table>
Exercise 1

Identify the argument pattern in the following arguments and determine if the argument is valid or invalid.

1. If the mayor will hire six hundred new police officers, then he must believe that crime is a major problem in New York; and this he does believe. So he will hire six hundred new police officers.

2. The Bureau of Engraving and Printing is gearing up to print new bills with polyester filament that cannot be duplicated by copiers, so you know that counterfeiting has become a major problem for the government.

3. If the allies honor their commitments to pay for the Gulf War, then the war won’t cost the U.S. anything. But they won’t, so the U.S. will have to pony up.

4. Some of the tribes that aren’t in revolt are not opponents of the Mengistu regime. Therefore, as likely as it seems, some of the tribes that oppose Mengistu are not revolutionaries.

5. America’s largest consumer electronics manufacturers all sell computers, and none of America’s premier distribution systems for technological products are among the country’s largest consumer electronics manufacturers. So, no American computer is a premier distribution system for technological products.

6. Overheard: “If drunk-driving checkpoints continue, then next there will be checkpoints for driver’s licenses, infant car seats, you name it. And if we have checkpoints for all those things, we’re going to wish we hadn’t allowed drunk-driving checkpoints in the first place.”

7. There were some people who were disappointed when Ted Kennedy announced he wouldn’t run for president, but they aren’t what you’d call the old-school liberals. So, none of the old-school liberals were disappointed.
8. “At the station bookstall, Jim bought himself a *Rude Pravo* and boarded the Brno train. If they had wanted to arrest him, they would have done so by now.”
   —John Le Carre, *Tinker, Tailor, Soldier, Spy*

9. From an editorial: “Any instance of censorship is wrong, and the Soviet attempt to squelch the ABC miniseries *Amerika* is the worst kind of censorship—that imposed by another country. ABC executives should not cave in to the Soviet pressure.”

10. There are few actors who work for humanitarian causes, so some humanitarians are actors.

11. If complex technology leads to occasional bizarre accidents, then complex technology sometimes has unpredictable effects. Complex technology does lead sometimes to bizarre accidents. Therefore, it sometimes has unpredictable effects.

12. No vacation is complete without a tropical beach. All tropical beaches come with some risk of sunburn. Thus no vacation is complete without some risk of sunburn.

13. Men without money are men without power. Men without power are men without self-esteem. Therefore, men without money are men without self-esteem.

14. Letter to the Editor: “I would just like to say, in response to the blatantly anti-Christian letter that appeared on your editorial page on March 11, in which it was alleged that Christians aren’t racists, but are bigots, just how is that supposed to be? All racists are bigots, so if we Christians aren’t racists, then it follows that we aren’t bigots either. The writer is not only anti-Christian, he’s anti-logic.”

15. “Either human actions are entirely governed by causal laws or they are not. If they are, then they are necessary. That is, given our heredity and environment we could not act otherwise than we do. If they are not, then they must occur by chance. If they occur by chance, they are not necessary. But equally we have no control over them. In neither case can we help ourselves.” (A. J. Ayer, “Fatalism”)
Exercise 2

Carefully read the following op-ed and attempt to standardize the core argument as a deductive argument employing some of the common deductive argument patterns then assess the argument using the ARG conditions.

*Abortion and Violence*

At a time when access to safe, medical abortion is being threatened by murderous attacks on doctors providing this service, it would be worthwhile to recapitulate the enormous benefits brought about by legal abortion. I think one of the most important consequences is the declining violent crime rate. This decline has lasted for six years in Canada and the United States.

Is there a relationship between the statistically proven decline in crime rates and access to abortion? For the last six years, in both the United States and Canada, the crime rate has steadily decreased—especially for crimes of violence, such as assault, rape, and murder. Some demographers explain this by the fact that there are fewer young men around, and it is mostly young men who commit crimes. No doubt this is true, but what is even more important is that, among these young men likely to commit offenses, there are fewer who carry an inner rage and vengeance in their hearts from having been abused or cruelly treated as children.

Why is that? Because many women who a generation ago were obligated to carry any pregnancy to term now have the opportunity to choose medical abortion when they are not ready to assume the burden and obligation of motherhood. It is well documented that unwanted children are more likely to be abandoned, neglected, and abused. Such children inevitably develop an inner rage that in later years may result in violent behavior against people and society. Crimes of violence are very often perpetrated by persons who unconsciously want revenge for the wrongs they suffered as children. This need to satisfy an inner urge for vengeance results in violence against children, women, members of minority groups, or anyone who becomes a target of hate by the perpetrator.

Children who are given love and affection, good nurturing, and a nice supportive home atmosphere usually grow up to become caring, emotionally responsible members of the community. They care about others because they have been well cared for. Children who have been deprived of love and good care, who have been neglected or abused, suffer tremendous harm that may cause mental illness, difficulty in living, and an inner rage that eventually corrupts in violence when they become adolescents and adults.

Most serial killers were neglected and abused children, deprived of love. Both Hitler and Stalin were cruelly beaten by their fathers and carried so much hate in their hearts that, when they attained power, without remorse they caused millions of people to die. It is accepted wisdom that prevention is better than a cure. To prevent the birth of unwanted children through family planning, birth control, and abortion is preventive medicine, preventive psychiatry, and prevention of violent crime.

I predicted a decline in crime and mental illness thirty years ago when I started my campaign to make abortion in Canada legal and safe. It took a long time for this prediction to come true. I expect that things will get better as more and more children are born into families that want and desire them and receive them with joy and anticipation.

*Dr. Henry Morgentaler is a prominent Canadian abortion provider and the 1975 Humanist of the Year. This column is adapted from an editorial that appeared in numerous Canadian newspapers on November 5, 1998. Reprinted by permission of the author.*