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BASIC CONCEPTS

1.1 ARGUMENTS, PREMISES, AND CONCLUSIONS

Logic is the organized body of knowledge, or science, that evaluates arguments. An argument is a group of statements, the purport of which is that some of them (the premises) should support, imply, provide evidence for, or make reasonable to believe another particular one of them (the conclusion). The premises of an argument set forth the reasons for the conclusion; the conclusion is meant to follow from these reasons. The primary task of logic is to distinguish between good arguments (those in which the premises really do support, imply, provide evidence for, or make reasonable to believe the conclusion) and bad arguments (those in which the premises do not in fact support, etc. the conclusion, even though the argument purports that they do so).

In analyzing arguments, it is crucial to distinguish premises from conclusions. Sometimes premises precede the conclusion, but sometimes they do not. In order to distinguish premises from conclusions, one must understand the relation that the statements in an argument have to each other. This relation is often signaled by certain indicator words, such as “therefore,” “hence,” and “so,” which indicate conclusions, and “because,” “since,” and “for,” which indicate premises.

A first step in analyzing an argument is to restructure it, putting the premises first and the conclusion last. Thus, the argument “Socrates must be mortal, since he is a man and all men are mortal” may be restructured as:

Socrates is a man.  
All men are mortal.  

Therefore, Socrates is mortal.  

Notice that the clause “he is a man” in the original argument has been replaced by the sentence “Socrates is a man” in the restructured argument. This reflects the fact that in arguments statements are used to express propositions, the meaning-contents of statements. Thus, when the word “he” is used to refer to Socrates, the statements “he is a man” and “Socrates is a man” express the same proposition; that is, they have the same meaning-content. If we want to be subtle, we can say that arguments consist of propositions but they are expressed by statements. In practice, however, we can typically ignore the distinction between propositions and statements, provided that we are careful to understand and accurately reexpress the meanings of the statements in the argument.

Notice also that the word “must” in “Socrates must be mortal” is used as an indicator of the status of the statement “Socrates is mortal” as a conclusion. The premises are not meant to show that “Socrates has to be mortal,” in the sense that it is impossible that he be otherwise; what has to be is that he is mortal if he is a man and all men are mortal. The word “since” in the original argument is used as an indicator of both of the premises.
Sample Exercises from Exercise 1.1. Part I

1. Titanium combines readily with oxygen, nitrogen, and hydrogen, all of which have an adverse effect on its mechanical properties. As a result, titanium must be processed in their absence.

   **Restructured form:**

   \( P_1 \): Titanium combines readily with oxygen, nitrogen, and hydrogen.
   
   \( P_2 \): Oxygen, nitrogen, and hydrogen have an adverse effect on the mechanical properties of titanium.
   
   \( C \): Titanium must be processed in the absence of oxygen, nitrogen, and hydrogen.

   In this example, the words “as a result” indicate the conclusion. The student should realize that this example might be construed as an explanation of why titanium must be processed in the indicated way, rather than construed as an argument at all.

2. Since the good, according to Plato, is that which furthers a person’s real interests, it follows that in any given case, when the good is known, men will seek it.

   **Restructured form:**

   \( P \): The good is that which furthers a person’s real interests.
   
   \( C \): In any given case, when the good is known, men will seek it.

   In this example, the words “it follows that” indicate the conclusion of Plato’s argument; the word “Since” indicates the premise. Notice that in restructuring the argument, it is the argument attributed to Plato that is expressed. As we shall see in the following section, this entire example is really a report of Plato’s argument rather than being an argument itself.

3. As the denial or perversion of justice by the sentences of courts, as well as in any other manner, is with reason classed among the just causes of war, it will follow that the federal judiciary ought to have cognizance of all causes in which the citizens of other countries are concerned.

   **Restructured form:**

   \( P_1 \): The denial or perversion of justice by the sentences of courts, as well as in any other manner, is among the just causes of war.
   
   \( C \): The federal judiciary ought to have cognizance of all causes in which the citizens of other countries are concerned.

4. When individuals voluntarily abandon property, they forfeit any expectation of privacy in it that they might have had. Therefore a warrantless search or seizure of abandoned property is not unreasonable under the Fourth Amendment.

   **Restructured form:**

   \( P \): When individuals abandon property, they forfeit any expectation of privacy in it that they might have had.
   
   \( C \): A warrantless search or seizure of abandoned property is not unreasonable under the Fourth Amendment.

   The indicator word “Therefore” makes this an easy example to restructure.
Put the following arguments into a reststructured form, indicating premises and conclusion and placing premises first.

1. Only a fool or a daredevil smokes cigarettes, since cigarette smoking is a leading cause of cancer.

2. If we had world enough and time, this coyness would not be a crime. But we don’t have world enough and time. So this coyness is a crime.

3. The square root of the number two is an irrational number. It follows that the hypotenuse of an isosceles right triangle is not commensurable with its side.

4. No man is an island. Every man is a piece of the continent, a part of the main. Therefore, no one should send to know for whom the bell tolls.

5. A free market is necessary for a free society. For without the freedom to buy and sell, the freedom to speak is absent. Moreover, in the absence of a free market, tyranny flourishes.

6. He jests at scars that never felt a wound. So Mercutio must never have felt a wound, since he jests at scars.

7. The French are the most intelligent people in the world. For it takes years and years for adult Americans to learn to speak the French language well. But in France even little children speak it well.

8. The world must have existed from eternity. For it not, then at some time there was nothing at all. And out of nothing at all nothing at all could come.

9. The world must have existed from eternity. Therefore, since eternity includes 6006 B.C., the world must have existed in 6006 B.C.

10. There are many average families in the United States. It follows that many U.S. families have parts of children in them, because the average U.S. family has 2.2 children and two-tenths of a child is a part of a child.

11. Comets may have been the ultimate originators of life on earth, since they contain the elements of the human body, and they contain them in almost exactly the same proportions.

12. The United States has vital economic and moral interests in Europe. It follows that the United States should intervene in European countries with genocidal dictators. For these interests are threatened by such dictators.

1.2 RECOGNIZING ARGUMENTS

It is important to distinguish arguments from nonargumentative passages. In an argument, two conditions must be fulfilled. First, in an argument at least one of the statements must present evidence, a factual claim. Second, in an argument there must be an inferential claim: that
something follows from the evidence. Words that are indicators of premises and conclusions are useful clues to, but not guarantees of, the presence of an argument. Typical indicator words can function to signal passages of sorts other than arguments, and arguments may contain no indicator words. “I don’t like ice cream because the cold hurts my teeth” contains the indicator word “because,” but it is an explanation, not an argument. “The banning of British beef is necessary; mad cow disease is highly contagious and extremely dangerous, and mad cow disease has appeared in British cattle” is an argument, even though it contains no indicator words.

Typical kinds of nonarguments are simple noninferential passages like warnings, pieces of advice, statements of belief or opinion, loosely associated statements, and reports; expository passages; illustrations, explanations; and conditional statements.

Illustrations, explanations and conditional statements, are the types of nonarguments most apt to be confused with arguments. Illustrations can be confused with arguments because they often contain the word “thus,” one of the typical indicator words. Here is an example: “Many painters have taken as their real subject some abstract theme. Thus, Goya and Picasso, each in his own way—Goya’s The Disasters of War series and Picasso’s painting Guernica—explores the pain and horror of warfare.” The idea of this passage is to illustrate a general point, not to prove it.

Explanations may be confused with arguments because they typically contain such indicator words as “because” or “for the reason that.” Also explanations, like arguments, consist of two components: The *explanandum* (the state or event that is explained—or, more precisely, the description of this state or event) and the *explanans* (the statements that do the explaining). Thus, in “I don’t like ice cream because the cold hurts my teeth,” the *explanandum* is “I don’t like ice cream” and the *explanans* is “the cold hurts my teeth.” Explanations are not arguments because they do not claim to prove or justify that something is the case. In “I don’t like ice cream because the cold hurts my teeth,” it is not being claimed that my not liking ice cream is proven or demonstrated. My not liking ice cream is taken for granted; what the explanation does is to account for why I don’t like ice cream. Arguments purport to prove something; explanations purport to shed light on something.

A conditional statement is an “if . . . then” statement, such as “If the air pressure lowers, then the barometer falls.” The statement immediately following the “if” (here “the air pressure lowers”) is called the *antecedent* of the conditional; the statement following the “then” (here “the barometer falls”) is called the *consequent*. Occasionally, the word “then” in a conditional statement may be omitted. Conditional statements look like arguments; that is, a conditional statement looks like an argument in which the antecedent is the premise and the consequent is the conclusion. But in a conditional statement no commitment is being made, even imaginatively, to the truth either of the antecedent or of the consequent. What the conditional asserts is merely that if the antecedent is true, the consequent is true. In an argument, however, some sort of commitment—even if only for the sake of arguing—is made to the truth of the premises.

One reason conditional statements look like arguments is that they express a transition in thought from one statement, the antecedent, to another, the consequent. An argument also expresses such a transition from its premises to its conclusion. In fact, the transition expressed in a conditional sentence may be reexpressed in the form of an argument that has the antecedent of the conditional as its premise and the consequent as its conclusion. For instance, the transition in the conditional “If the air pressure lowers, then the barometer falls” can be reexpressed in the form of an argument: “The air pressure lowers. Therefore, the barometer falls.”

Even though conditional statements are not by themselves arguments, they may serve as premises or conclusions of arguments. Here is an argument containing a conditional statement
as a premise:

If the air pressure lowers, then the barometer falls.
The air pressure just lowered.
Therefore, the barometer just fell.

Here is an argument containing a conditional statement as conclusion:
The higher the altitude, the lower the air pressure.
At higher altitudes the barometer falls.
We may conclude that if the air pressure lowers, then the barometer falls.

Sample Exercises from Exercise 1.2. Part I

1. Women tend to have higher pitched voices than men because they have shorter vocal chords. Shorter vocal chords vibrate at a higher frequency than longer ones.

This passage is not an argument, but rather an explanation of the fact that women tend to have higher pitched voices than men. A clue that we have an explanation rather than an argument is the fact that it would typically already be known that women tend to have higher pitched voices than men. So the point of the passage is not to establish this fact but rather to explain it.

2. If public education fails to improve the quality of instruction in both primary and secondary schools, then it is likely that it will lose additional students to the private sector in the years ahead.

Here no commitment is made to the truth of the statement that public education will fail to improve the quality of instruction in both primary and secondary schools. The passage simply states that if this happens then it is likely that public education will lose additional students to the private sector in the years ahead. The passage is not an argument but rather a conditional statement.

3. Freedom of the press is the most important of our constitutionally guaranteed freedoms. Without it, our other freedoms would be immediately threatened. Furthermore, it provides the fulcrum for the advancement of new freedoms.

This passage clearly claims to prove something, namely that freedom of the press is the most important of our constitutionally guaranteed freedoms. The first statement of the passage is thus the conclusion of the argument the passage constitutes, and the remaining two statements present the premises for this conclusion.

4. Water is a good solvent for many different substances, and it picks them up as it moves through the environment. Thus, rain water flowing over and under the ground dissolves minerals such as limestone.

This passage does not attempt to prove that rain water flowing over and under the ground dissolves minerals such as limestone. Rather, the second sentence of the passage exemplifies the general statement made by its first sentence.
Additional Exercises for Section 1.2

Determine whether the following passages constitute arguments. For each argument, identify its conclusion.

1. The reason the beaker exploded is that it contained nitroglycerin and was shaken violently.
2. The reason it is undoubtable that there are flying saucers is that many people have seen them with their own eyes.
3. John did not feel very lively, so he probably ate something that did not agree with him.
4. John did not feel very lively, so he stayed home from the dance.
5. If you want a cup of coffee, you may have one.
6. If you want a cup of coffee, you are addicted to caffeine.
7. Several nations now possess the technology to manufacture nuclear weapons, even though they may not actually have built such weapons. Thus, South Africa, North Korea, Iraq, and Israel all have a number of atomic power plants and many laboratories in which fissionable material may be isolated.
8. Several nations now possess the technology to manufacture nuclear weapons, even though they may not actually have built such weapons. Thus, the world is in much greater danger of a nuclear confrontation than one might at first think.
9. Prices escalate almost daily. This inflationary tendency in our economy is one of its most disturbing features. No one wants to have to pay more for an item tomorrow than he or she pays for it today.
10. Prices escalate almost daily. This inflationary tendency in our economy is one of its most disturbing features. A government cannot be considered responsible if it does not deal with this problem.

1.3 DEDUCTION AND INDUCTION

Arguments may be divided into two classes: deductive and inductive. When the arguer claims that it is impossible for the conclusion to be false given that the premises are true, then the argument is best considered as a deductive argument. When the arguer merely claims that it is improbable that the conclusion be false given that the premises are true, then the argument is best considered as an inductive argument. We may express this idea also in the following way. An argument is deductive if its purport is that it is impossible that its premises be true and its conclusion false. An argument is inductive if its purport is merely that it is improbable that its premises be true and its conclusion false.

In deciding whether an argument is deductive or inductive, three criteria must be borne in mind. First, special indicator words should be taken into account. In drawing its conclusion, if the argument employs such words as “necessarily,” “certainly,” or “absolutely,” it is usually best regarded as deductive. If words such as “probably,” “likely,” or “plausibly” are employed, the argument is usually best regarded as inductive. Second, there is the nature of the link between premises and conclusion. If the conclusion follows, or is thought to follow, necessarily from the premises, the argument is best regarded as deductive. Otherwise it is usually better to regard the argument as inductive. Third, the form of the argument helps determine whether it is deductive or inductive. For example, arguments based on mathematics, arguments from
definition, and arguments framed as syllogisms (categorical syllogisms, hypothetical syllogisms, and disjunctive syllogisms, all of which will be studied later) are best treated as deductive.

There are several common types of inductive arguments, including predictions about the future, arguments from analogy, inductive generalizations, (many) arguments from authority, arguments based on signs, and causal inferences.

In a prediction about the future, the premises refer to matters in the present or past, and the conclusion is about some matter in the future. An argument from analogy depends on the existence of a similarity between two things or states of affairs. For example, someone might conclude that ostriches can fly because they have wings, and other creatures with wings are known to fly. An inductive generalization argues from knowledge about a sample of a group of things to a claim about the entire group. An (inductive) argument from authority appeals to some presumed authority, expert, or witness. An argument based on signs proceeds from the knowledge of a certain sign to a knowledge of the thing or situation that sign signifies. For example, from a sign saying "Danger" one might conclude that the area in which the sign is located contains something dangerous. Causal inferences argue from knowledge of causes to claims about effects, or conversely from knowledge of effects to claims about causes. If I conclude, from knowledge that a tornado hit a certain town, that the damage in the town was extensive, I argue from cause to effect. If I argue from the presence of ashes on the carpet to the claim that someone was smoking in the room, I argue from effect to cause.

A final point needs to be made. One should not use as a criterion for distinguishing deductive from inductive arguments the claim that deductive arguments go from general to particular, while inductive arguments go from particular to general.

Sample Exercises from Exercise 1.3. Part I

1. Because triangle A is congruent with triangle B, and triangle A is isosceles, it follows that triangle B is isosceles.

   This argument, like most arguments in mathematics, is best interpreted as deductive. The point of the argument is to provide absolutely that triangle B is isosceles, for it states that triangle A is isosceles and that triangle B coincides with it in every respect—that is, that B may be placed in A's position and they would coincide point for point (that is the meaning of the word "congruent"). Even though the likeness between A and B is appealed to in this argument, it is still not an argument from analogy, for the gist of the argument makes it clear that the conclusion is meant to follow necessarily from the premises.

2. The plaque on the Leaning Tower of Pisa says that Galileo performed experiments there with falling objects. It must be the case that Galileo did indeed perform those experiments there.

   This argument proceeds from a sign to what the sign signifies and is thus an inductive argument based on signs. It is not reasonably considered as deductive because it is not reasonably thought that a sign necessarily has to tell the truth. It is not a causal inference because it is not reasonably thought that Galileo's performing his experiments is the cause of the plaque's being in place.

3. The rainfall in Seattle has been over 15 inches every year for the past 30 years. Therefore, the rainfall next year will probably be over 15 inches.

   This argument is inductive, as the word "probably" indicates. It is a prediction about the future.
4. No E-mail messages are eloquent creations. Some love letters are eloquent creations. Therefore, some love letters are not E-mail messages.

This argument is best considered as a deductive argument because of its format. It has the form of a categorical syllogism (see text).

Additional Exercises for Section 1.3

Determine whether the following arguments are deductive or inductive; if an argument is inductive, identify its type.

1. Texans must all wear cowboy boots; I went to Houston last Thursday and everyone I saw on the street had boots on.

2. Even numbers yield even numbers when they are squared. It follows that the square roots of odd perfect squares are odd.

3. We can go out of the theater at the front; the Exit sign points in that direction.

4. Look at these footprints in the mud by the window. We must have a peeping tom.

5. This fish looks very similar to a trout or a salmon. Since those fish are tasty, this one must be tasty, too.

6. Of course the sun will rise tomorrow—it’s risen every day in human history.

7. Everyone who is well educated knows about the existence of the Roman Empire, and John is well educated. So he has to know something about the Roman Empire.

8. Everyone who has ever tried to climb the Matterhorn has experienced terror at some stage of the ascent. Just you wait, John; sooner or later on your climb you are going to be afraid.

9. If you found a model of the solar system, you’d know that someone made it. How much more obvious it is, then, that the real solar system must have been made by somebody.

10. This circle has an area of exactly 4 square inches. So a circle with an area of 1 square inch would have a radius half as long.

11. This drug has been used successfully to treat liver ailments in pigs for many years. We conclude that it will likely be an excellent medication for liver ailments in human beings too, since human beings and pigs have quite similar livers.

12. There is an underground electric cable buried right below this spot. You can be confident of that because this spot has one of the electric company’s markers on it.
A deductive argument is either valid or invalid. Validity does not admit of amount or degree: an argument is either valid, period, or invalid, period; there is no middle ground. A deductive argument is valid if it is impossible for the conclusion to be false given that the premises are true. Otherwise, a deductive argument is invalid. If there is any possibility that the premises could all be true and yet the conclusion false, then the argument is invalid.

Notice that true premises and a true conclusion are not required for validity. Indeed, there can be valid arguments with false premises and a false conclusion—for example, “Dogs have five legs; therefore, dogs have an odd number of legs.” The only possibility ruled out by the validity of an argument is that it have all true premises and a false conclusion. Also notice that true premises and a true conclusion do not by any means ensure validity. There are invalid arguments with true premises and a true conclusion—for example, “Dogs have four legs; therefore, birds have two legs.”

A sound argument is a deductive argument that is valid and has all true premises. Obviously, in a sound argument the conclusion will be true, too.

An inductive argument is either strong or weak. Unlike validity, the strength of an inductive argument does admit of amount or degree; an inductive argument A and an inductive argument B may both be strong and yet A may be stronger than B. For example, suppose A is “Ninety percent of the mice in Australia have been examined and found to be white; therefore probably all of the mice in Australia are white.” This is a strong argument. But if B is “Ninety-nine percent of the mice in Australia have been examined and found to be white; therefore, probably all of the mice in Australia are white,” then B is even stronger than A. An inductive argument is strong if on the basis of the assumption that its premises are true, its conclusion probably is true; otherwise, it is weak. An inductive argument having true premises but a probably false conclusion is weak; but aside from this fact strength and weakness have no more direct relation to the truth or falsity of premises and conclusion than do the validity and invalidity of deductive arguments.

A cogent argument is an inductive argument that is strong and has all true premises. Obviously, in a cogent argument the conclusion will probably be true, too.

Sample Exercises from Exercise 1.4. Part I

1. Since *Moby Dick* was written by Shakespeare, and *Moby Dick* is a science fiction novel, it follows that Shakespeare wrote a science fiction novel.

Both premises of this argument are false; therefore, the argument is clearly not sound. However, the argument is nevertheless valid, because if it were the case that Shakespeare wrote *Moby Dick* and that *Moby Dick* were a science fiction novel, then it would have to be the case that Shakespeare wrote a science fiction novel.

2. Since London is north of Paris and south of Edinburgh, it follows that Paris is south of Edinburgh.

It is true that London is north of Paris and south of Edinburgh. Moreover, it is not possible that this premise be true without Edinburgh being north of Paris. In other words
it is not possible that this premise be true without Paris being south of Edinburgh. So the argument is valid. because its single premise is true, the argument is also sound.

3. If George Washington was beheaded, then George Washington died. George Washington died. Therefore, George Washington was beheaded.

We may safely regard both premises of this argument to be true. The conclusion, however, is false. No valid argument can have true premises and a false conclusion, so this argument is invalid. All invalid arguments are unsound, so this one is unsound.

Sample exercises from Exercise 1.4. Part II

1. The grave marker at Arlington National Cemetery says that John F. Kennedy is buried there. It must be the case that Kennedy really is buried in that cemetery.

   This is a typical argument based on signs, and its strength depends on the trustworthiness of the sign—the grave marker—to which the appeal is being made in the premise. We can presume that signs in the Arlington National Cemetery are reliable, so this is a fairly strong inductive argument. because it has a true premise, it is also cogent.

2. The ebb and flow of the tides has been occurring every day for millions of years. But nothing lasts forever. Therefore, probably the motion of the tides will die out within a few years.

   This argument is extremely weak, because even if it were true that nothing lasts forever, one could not conclude that it is probable that a particular “thing”—like the ebb and flow of the tides—will not last for a long time. because the argument is weak, it is not cogent, even if it were to be true that nothing lasts forever. Even if the argument were strong, the doubtfulness of the premise that nothing lasts forever would make this argument not a cogent one.

Additional Exercises for Section 1.4

Determine whether the following arguments are deductive or inductive. If the argument is deductive, determine whether it is valid or invalid. If the argument is inductive, determine whether it is strong or weak.

1. This is a standard deck of playing cards. So probably if I draw a card at random from it, that card will be a king.

2. This is a standard deck of playing cards. So if I draw a card at random from it, fifty-one cards will remain.

3. This is a standard deck of playing cards. So if I draw a card at random from it, that card will probably not be a spade.

4. We know that the murderer was either Jackson or Harrison. We also know the murderer could not have been Harrison. so the murderer had to be Jackson.
5. We know that the murderer was either Jackson or Harrison. So probably the murderer was Jackson.

6. Every number evenly divisible by 4 is evenly divisible by 2. Therefore, no number evenly divisible by 4 is odd.

7. If dogs have more than five legs, then they have more than four legs. Dogs do not have more than five legs. Therefore, dogs do not have more than four legs.

8. John has a favorite color among those in the spectrum. So it is probably red.

9. For quite a while every fourth United States president has died while in office. Ronald Reagan is the fourth president after Kennedy, who died in office. It is likely, then, that Ronald Reagan will die in office.

10. Every sample of copper ever examined conducts electricity. So it is a safe bet that this particular piece of copper will conduct electricity when we examine it.