Elementary Logic

The need for logic arises at the beginning of a rational investigation.

Objectives:
- To indicate the variety of logical forms which English sentences exhibit and the common words which determine these forms.
- To show how the logical form of an argument determines its validity.
- To present some of the more useable forms of valid reasoning.
- Through the introduction of logical rules, and such concepts as argument, validity, and proof, to draw attention to logic as a mature and independent subject of theoretical interest.

Sources of Factual Information

Logic is concerned with the relationships among facts and ideas. Sound logical reasoning is based on facts which are accurate and ideas which are valid.
- *Personal Experience and Observation* is probably our most reliable source of factual information. However, it is certainly not infallible.
- *Second-Hand Sources* include reading books, talking with other people, watching cable television, etc. While such sources may serve to convey information, we should exercise caution in using information from second-hand sources.

Types of Reasoning

Induction: that type of reasoning which proceeds from the particular to the general.

In induction, we begin with a number of particular facts and formulate a general statement or principle which “covers” them or indicates what they all have in common. Thus induction is commonly based directly on facts.

Types of Induction:

Reasoning by Analogy: observing particular similarities between two things and then generalizing, inferring that the two things are similar in other ways, too.

*Warning!* Reasoning by Analogy never constitutes genuine proof, but only indicates that the conclusion is likely to be true.

Reasoning by Cause and Effect: based on the assumption that like causes produce like effects.

- If we have often previously seen cause A followed by effect B, the next time we see cause A, we may expect to see B again.
  1. **Cause to Effect:** If you touch something hot, you burn your finger(s).
  2. **Effect to Cause:** A doctor will check symptoms (effect) to determine the nature of the disease (cause).
3. **Effect to Effect:** If a child is born into a family in which for two or three generations several members have been gifted musically, the child may be gifted in this way, also.

**Understanding cause and effect.**

- One way to understand the world is to notice the connection between cause and effect.
- Understanding how if-statements work is an important aspect of logic.

**Breaking down if-statements:**

- Every if-statement is made up of sub-statements: (1) the antecedent (follows the work *if*) and (2) the consequent (follows the word *then*)

  Ex. If it is 5:00 pm, then it’s time to go home.

**Stringing if-statements together**

- In many cases, the consequent of one if-statement becomes the antecedent of another.
- When this happens, you get a string of consequences which the Greeks called sorites (sore-it-tease).

  If it’s 5:00 pm, then it’s time to go home.

  If it’s time to go home, then it’s near dinner time.

  If it’s near dinner time, then I need to call my wife to make reservations at the restaurant.

  Which leads to: If it’s 5:00 pm, then I need to call my wife to make reservations at the restaurant.

**Deduction and the Syllogism**

Deduction is that kind of reasoning which proceeds from the general to the particular.

- In deduction we begin with a general statement or principle and apply it to a particular case.

**Example:** We know (as a general principle) that water freezes at any temperature below 32 degrees F. If we read in the paper that tonight’s temperature will fall below 32 degrees, we may decide to wrap our pipes.

- A syllogism is a conventional device used to test deductive reasoning. It consists of (1) a major premise, stating the general principle on which the logic is based, (2) a minor premise, indicating the particular case to which the general principle is applied, and (3) a conclusion, which completes the logic of the application.
Example:

All living men are must breathe. (major premise) I am a living man. (minor premise) Thus I must breathe. (conclusion)

A few logical words:

<table>
<thead>
<tr>
<th>If . . . Then</th>
<th>And</th>
<th>But</th>
<th>Or</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not</td>
<td>Unless</td>
<td>Though</td>
<td>Every</td>
</tr>
<tr>
<td>All</td>
<td>Each</td>
<td>There is</td>
<td>Some</td>
</tr>
<tr>
<td>There exists</td>
<td>There is no</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

Aspects of a Good Rhetorical Argument

Aristotle wrote that there are three interconnected aspects of a good rhetorical argument:

• **Logos** – as much as possible, getting one’s facts right.
• **Ethos** – establishing one’s credibility with the audience.
• **Pathos** – the ability to connect *emotionally* with the target audience.
  ❖ Aristotle is not talking about emotional manipulation, which is unethical. He is simply saying that you have to make people care about what you are saying.

Building Logical Arguments

Steps:

1. Figure out what we know to be true.
2. Spend some time thinking about it.
3. Find the best course of action.

Generating Premises

• The premises are the facts of the matter. (Statements you know or strongly believe to be true.)

Everything and more

• As you begin to develop an understanding of the world you begin to make more general statements about it.
  All dogs are friendly.
  Every time the phone rings, it’s for my wife.
• Words like all and every allow you to categorize things into sets (groups of objects) and subsets (groups within groups).
Existence itself

- You can discover the world by figuring out what exists and what doesn’t exist.
  No one at the bridge club can beat us.
  There is no such thing as a Martian.
  Some Peer Leaders are handsome.
- Words like *some*, *there is*, and *there exists* show an overlapping of sets called an intersection.
- Similarly, words like *no*, *there is no*, and *none* show that there’s no intersection between sets.

New Terms: “Assertive Sentences”, “Argument”, “Premise”, “Conclusion”

Arguments are formed by combining sentences. Sentences themselves may be divided into two groups.
- **Assertive** sentences are either true or false. These are the sentences that occur in arguments.
- **Non-assertive** sentences are neither true nor false. They do not occur as either premises or conclusions in arguments.

Questions, commands, and exclamations are examples of non-assertive sentences.

To ask, “What is the time?” is not to make a true or false assertion, though the answer, “It is 5:00 pm.” certainly is.

**Argument**: any series of sentences, one of which is claimed to be implied by the others

**Premises**: those sentences which in the argument itself are assumed to be true.

**Conclusion**: the sentence claimed to be true if the premises are taken to be true.

Premise 1  Uncle Albert is either at home or he has left for the city.
Premise 2  Uncle Albert is not at home.
Conclusion: Uncle Albert has already left for the city.

New Terms: Validity and Invalidity

Logicians classify an argument as valid or invalid, depending on whether its premises do or do not imply its conclusion.
Examples: (1) An Invalid Argument

P – 1  If you visited France, you learned French.
P – 2  You learned French.
C  Therefore, you must have visited France.

Arguments wherein the premises each are true, yet the possibility remains that the conclusion could be false, are thus invalid.

*As a guide in separating premises from conclusions, it helps to note that premises are often introduced by such words as: ‘for,’ ‘since,’ and ‘because.’

*Conclusions may be linked to premises by such words as: ‘thus,’ ‘so,’ ‘hence,’ and ‘therefore.’

Deciding whether the argument is valid

• To test an argument’s validity, assume that all the premises are true and then see whether the conclusion follows automatically from them.
• If the conclusion automatically follows, it’s a valid argument.
• If not, the argument is invalid.

• If at any time we find that a valid argument has reached a false conclusion, we know that at least one of our premises must be false.

At this point, one might start to suspect that the validity or invalidity of an argument has no connection whatever with the truth or falsity of the sentences it contains!

• There is one case, however, where the relationship is of extreme importance: Any argument in which the premises are true and the conclusion is false must be invalid.
• Herein lies logic’s very reason for being. For if we can tolerate moving from true premises to false conclusions, we have no need for logic.
• This is of considerable utility in the testing of hypotheses of all kinds.
Validity Chart

<table>
<thead>
<tr>
<th>Sentences comprising the argument</th>
<th>Validity or invalidity of the argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premises</td>
<td>Conclusion</td>
</tr>
<tr>
<td>All true</td>
<td>True</td>
</tr>
<tr>
<td>All true</td>
<td>False</td>
</tr>
<tr>
<td>Some (or all) false</td>
<td>True</td>
</tr>
<tr>
<td>Some (or all) false</td>
<td>False</td>
</tr>
</tbody>
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Making Logical Conclusions Simple with the Laws of Thought

Bertrand Russell’s three laws of thought allow you to make logical conclusions about statements even if you aren’t familiar with the real-world circumstances that they’re discussing.

- The law of identity states that every individual thing is identical to itself.
  
  ex. The Miller Mansion is the Miller Mansion.
  
  X is X

- The law of the excluded middle states that every statement is either true or false. (No 3rd option!)
  
  ex. My name is Gary.
  My name is Algernon.

- The law of non-contradiction states that given a statement and its opposite, one is true and the other is false. (No alternative facts!)
  
  ex. My name is Gary.
  My name is not Gary.

Combining Logic and Math

Math is good for understanding logic.

- In math, a statement is always either true or false.
  
  ex. The number 7 is less than the number 8.
  
  Five is an even number.

- However, sometimes random facts about the world may be more subjective.
• Thus, the accuracy of our conclusions may be skewed by opinions and/or value judgments posing as factual premises.

ex. George Washington was a great president.

*War and Peace* is a terrible book.

Classical Logic

Aristotle invents syllogistic logic:
• Before Aristotle (382-322 BC), logical argument was applied intuitively where appropriate in math, science, and philosophy.
  • Thales and Pythagoras applied logical argument to mathematics.
  • Socrates and Plato applied similar types of reasoning to philosophical questions.

Recognizing and Avoiding Common Fallacies in Reasoning

Common Fallacies in Inductive Reasoning
• **Inadequate Sampling:** may occur when we generalize on the basis of too few particulars or when we ignore other particulars which actually show our generalization to be unsound.

Example: One may see two or three noisily-intoxicated homeless people and conclude: “All those homeless people are either drunks or drug addicts.”

*Inadequate sampling may account for some prejudices that people have a tendency to adopt.*

*Under any circumstances it is best for us to observe and consider as many particulars as possible in order to reach reliable conclusions.*

• **Faulty Analogy:** may occur when from particular similarities between two things we infer a further or more general similarity which does not really exist.

Example: Although a new film/book may be similar in a number of ways to one we have previously seen/read and enjoyed; it may still disappoint us.

• If we either fail to compare enough similarities or fail to compare important similarities, faulty analogy may occur; however, reasoning by analogy only indicates a probable conclusion and never constitutes proof.

• **Faulty Causal Relationships:** may occur when the cause-and-effect relationship that is inferred does not actually exist or when more complex relationships are involved.
Examples:

*Post hoc ergo propter hoc*(after this; therefore, because of this): presuming that if one event happens after another, the second one is necessarily caused by the first. “Having a black cat cross in front of you, breaking a mirror, walking under a ladder.”

A particular effect may be caused by one of several different causes or by a combination of different causes. “The straw that breaks the camel’s back” is a common example.

- **The Round Trip Fallacy:** occurs when two assertions which are seemingly (but not really) equivalent in meaning are substituted for each other.

  Example: “Almost all terrorists are Moslems.”

  “Almost all Moslems are terrorists.”

  *Assume the first statement is true, that 99% of terrorists are Moslems. This would mean that about .001% of Moslems are terrorists since there are more than one billion Moslems compared to perhaps 10,000 terrorists, one in 100,000.

  *The two statements are not, in fact, logically equivalent.

**Common Fallacies in Deductive Reasoning**

- **Faulty Premises:** If there is something wrong with either or both of the premises in a syllogism – or with the implied premises (enthymemes) in an informal deduction – then the conclusion may be false even if the logic itself is airtight.

  Example: All red-headed gentlemen are cheerful.

  Ralph is a red-headed gentleman.

  Therefore, Ralph is cheerful.

- **Non Sequitur:** The non sequitur (“it does not follow”) fallacy is an error in the logic itself. When the major premise is not a universal generalization, it cannot include the particular instance cited in the minor premise.

  Example: Some red-headed gentlemen are cheerful.

  Ralph is a red-headed gentleman.

  Therefore Ralph is cheerful.
False and Irrelevant Issues: A few other Fallacies

Appeal to Authority

If I wish to support the view that fracking poses major ecological risks, and I cite Rory McElroy as sharing (and so justifying) this view, I have appealed to authority fallaciously.

It is not that to rely on authority is invariably wrong; indeed, it is unavoidable. The fallacy is to rely on an authority in one field, in this case, golf, when deciding a question in a different field altogether.

* Reasoning which is logically taboo may well be extremely effective rhetorically; advertising relies on such fallacy.

Ignoring the Question

To ignore the question is to prove something else besides the point at issue.

Ad Hominem (arguing against the man):

Instead of trying to demonstrate a weakness in the opponent’s reasoning, I assail his character.

Example:

“We should not support the passing of this bill; and you will know how little you can believe my crazy opponent’s argument in favor of it when I tell you that his son was recently under threat of prosecution for illegally using campaign contributions.”

* Again, though clearly invalid, this form of argument may be rhetorically effective.

Begging the Question

Giving a false appearance of proof may be the effect of begging the question or arguing in a circle.

• In begging the question, the person actually assumes in his argument the truth of what he is trying to prove. The argument made is valid, but trivial in that it offers no independent proof of the conclusion.

Examples:

“These guilty men committed the crime for which they are on trial.”

“Men cheat because they’re genetically programmed cheat.”

• Arguing in a circle is a closely similar fallacy: the reasonor makes a statement and then justifies it by saying what amounts to the same thing in different words.
Examples:

“Miss California should win the beauty contest because she is clearly the best-looking girl among the contestants.”

“I’ll tell you why you have to clean your room: because I say so!”

*When we evaluate an argument, we should ask ourselves whether the reasoning is more than just word-juggling and, if so, whether it proves the real point at issue.*