I. Logic, Thinking, and Language

Logic is the study of good thinking: you determine and evaluate the standards of good thinking (i.e., rational thinking). One way to study thought and thinking would be through introspection, but this sort of approach is problematic for two reasons: (a) thought and thinking are ethereal and elusive when accessed that way, and so it is difficult to have much confidence in the results of one's inquiry, and (b) the results of the inquiry are ineliminably subjective, which will not be of much use to us if we wish to develop a general account of good thinking. Logicians opt for another method, a method that is grounded in the assumption that thoughts and thinking are expressible (in principle) in language. According to this method, you study the structure of language with a view to determining the structure of thought, and in particular, with a view to determining what separates a good argument from a bad one.

II. Arguments and Types of Arguments

Think of an argument as a sequence of claims, the last of which—call this the conclusion—is supposed to follow from the claims that precede it. Arguments understood in this way are what we construct as we solve problems, plan actions, make decisions, and reason our way through life. Our inquiry into good thinking invariably focuses on the arguments that are produced in the course of such thinking, and so arguments serve as the focus of logic. Logic, as it concerns us, is devoted to identifying the principles that distinguish good arguments from bad ones. From the perspective of these principles, good arguments are those whose reasons support their conclusions, whereas bad arguments are those that fail to offer their conclusions such support.

Arguments understood in this way—as rationales—are traditionally divided into two groups. In the first group, known as deductive arguments, the good ones are those whose reasons, when true, force their conclusion to be true as a matter of necessity. The second group, known as non-deductive arguments, covers good arguments whose conclusions are more likely true given the truth of their reasons.

III. Deductive Arguments

- **Principles**
  - An argument is valid if the conclusion is true whenever the sentences that precede it are true. (This notion of validity is the logician's theoretical analysis of the intuitive notion of following.)
  - An argument is sound if it is valid and the sentences that precede the conclusion are all true.

- **Good Arguments**: The following arguments are schematic representations of certain types of good arguments. (The capital letters are sentence variables, which is to say that to get actual examples of the arguments below, you would need to replace the variables
Modus ponens: If $A$, then $B$; $A$; therefore, $B$.

Modus tollens: If $A$, then $B$; not $B$; therefore, not $A$.

Together, *modus ponens* and *modus tollens* expose the fact that the conditional (i.e., "if ... then" claims) specifies both a *sufficient condition*--$A$ is sufficient for $B$--and a *necessary condition*--$B$ is necessary for $A$.

Proof by cases: (You would use this if you wanted to prove that a disjunctive sentence--i.e., an "or" sentence--implied the truth of some other sentence.) $A$ or $B$ or $C$; if $A$, then $D$; if $B$, then $D$; if $C$, then $D$; therefore, $D$.

Proof by contradiction: (You would use this indirect method if you had no direct way of proving your claim.) If $A$ is true, then we can derive an absurdity; therefore, $A$ must not be true, which implies that the sentence "not $A$" is true.

Existential Instantiation: If you know that someone did something, then you can refer to this person with a name *so long as you use a name that is not currently in circulation*. (This might be called the "Jack the Ripper Rule", for reasons that should be obvious.)

Universal Generalization: Say you wanted to prove that every member of a certain class has a property $P$. You could do this if you selected an arbitrary element of the class and demonstrated that it has $P$. *IMPORTANT*: in demonstrating this, you must only use those properties of your arbitrary element that it has in common with every other member of the class; that is, the element is to be treated as a *representative* of the class in question.

*Bad, or fallacious, arguments*: The following arguments are schematic representations of argument types that are bad; that is, argument types that don't convey you from reasons to a well-supported conclusion. Work through an example of each so as to convince yourself that these are fallacious.

Affirming the consequent: If $A$, then $B$; $B$; therefore, $A$.

Denying the antecedent: If $A$, then $B$; not $A$; therefore, not $B$.

Begging the Question: This fallacy is committed by anyone who responds to a challenge or a question with an argument that assumes an answer to that challenge. This is inadequate because the person advancing the challenge will want the argument to convince them of a certain resolution, and they will not be convinced if you straightaway assume a resolution without defense. (If you assume what you wish to prove, i.e., if you produce a circular argument, you will also beg the question in most contexts.)

Equivocation: This is committed by anyone who uses two senses of an ambiguous term in an argument that requires the term to be used in only one way.
• These are arguments that are not valid by their very nature, but can nevertheless qualify as good.
  
  o They are good when the truth of their reasons increases the likelihood that their conclusion is true.
  
  o The nature of the specific principles varies with the type of argument

Types of Non-Deductive Arguments

  o Inductive Arguments: Inductive inferences begin with the observation that certain events or conditions cause to other events or conditions; armed with this observation, one infers from the presence of the same type of events or conditions to the conclusion that the events or conditions they cause will also obtain.

  ▪ These are not valid, since one might just get lucky in one's observations; that is, one might make a number of observations where event A leads to event B, but as a matter of fact, B does not depend on A and only follows accidentally from A in these circumstances. Thus, any general inference to B based on these observations will be fallacious.

  ▪ However, if you increase the number and variety of observations, then confidence in the inference will increase.

  ▪ Examples: the water example above; I've seen hundreds of white swans and not swans of different colors, so all swans must be white; FDA testing of drugs.

  o Argument By Analogy: When one argues by analogy for a certain conclusion, one tells a story that is supposed to parallel the issue in the relevant structural respects---this is what makes the story an analogy. This story has the relevant structure, but it lacks elements that muddy the water on a straight consideration of the issue. One points out that in the story a certain conclusion follows, and so because the story and the issue have parallel structure, one should also be able to derive that conclusion when considering the issue.

  ▪ This is also clearly invalid, since an analogous story must be different from the issue in question in several, if not many, respects, and so there is quite a lot of room for dispute. Once again, the conclusion one reaches is not deductively forced.

  ▪ An argument by analogy will be more forceful the more parallel the story is to the issue, where this can be increased by an increase either in detail or spread. It also helps if the story used is not too far-fetched.

  ▪ Examples: the acorn/oak tree analogy used to argue for the permissibility of abortion; "My son said something like that to my daughter when he was trying to trick her into giving him her allowance; are you trying to swindle me?"

  o Inference to the Best Explanation: When one makes an inference to the best
might call them---that you wish to explain. As it is, there is nothing about this data that forces a single explanation on you, since a wide variety of explanations are available (some more far-fetched than others). In this case, you infer the explanation that makes the most coherent sense out of the data you have.

- Clearly this is invalid, since there are any number of possible explanations available that are consistent with the data---the truth of a particular conclusion is not forced on you. If one conclusion is forced, then you would be better served representing this as a deductive inference.

- The more data an explanation accommodates, the better it will be; furthermore, if the explanation can account for apparent relationships between the data, that will also recommend it as a good one. It may be the case that no available explanation accounts for all the data, but this could simply be because the data set contains noise.

- *Examples:* Most Sherlock Holmes stories and the game Clue gives you many examples; "There is dirt on the floor by the plants and one of the kids' stuffed animals is ripped up on the floor---the dog must have gotten loose again."

  - *Hypothesis Testing Arguments, or Confirmation Arguments:* This type of inference is employed to test hypotheses that are not themselves observable. One deductively derives an observable implication O from the hypothesis H, and then sets up an experiment to determine if O obtains in the predicted circumstances; if it does, then this provides non-deductive support for H; if not, then that refutes H by modus tollens.

    - This type of inference is obviously invalid; in fact, it corresponds to the famous fallacy "Affirming the Consequent". (For this reason, it is particularly important to determine that an argument is non-deductive if it embodies this inference, since it will be dismissed as fallacious if it is deemed deductive.)

    - Support for this inference is increased if the prediction is complex and detailed, and if the background factors are strictly controlled. And while it is true that failure of a prediction is a serious problem, one can often avoid the force of modus tollens by claiming that the prediction failed because of failure to properly attend to a background condition or an auxiliary hypothesis.

    - *Examples:* scientific practice; if you know calculus, you would be able to solve this integration problem---you can solve it, therefore you must know calculus; if you are who you say you are, you should remember that time when we went out to the dam ...---you do remember, so it must be you!