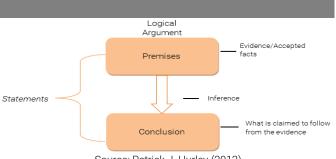# LOGICAL REASONING IN HUMANITARIAN ANALYSIS

LOGICAL REASONING - BRIEF SUMMARY

- *"Logic: The art of thinking and reasoning in strict accordance with limitations and incapacities of the human misunderstanding"* (Ambrose Bierce – American writer/satirist)
- *"Logic is the anatomy of thought"* (John Locke – 17th century English philosopher)

Getting from here to there – from ignorance to understanding – is one of the main reasons logic came into existence. Logic grew out of an innate human need to make sense of the world, to determine what is true and what is false, what is a good argument or a bad argument. Thus, logic may be defined as the organized body of knowledge, or science, that evaluates arguments. Analysts constantly encounter arguments in their day-to-day experience: reports, briefing notes, articles etc. As available humanitarian information and data has been exponentially increasing in the past decade, it has become more and more difficult to analyse it. The aim of logic is to develop a system of methods and principles that can be used as criteria for evaluating the arguments of others – and as guides in constructing arguments of our own. It is thus critically important for analysts to apply logical reasoning in order to provide good analytical products.

WHAT IS A LOGICAL ARGUMENT?

A logical argument is a connected series of statements, some of which are intended to provide support, justification, or evidence (the premises) for the truth of another statement (the conclusion) through the process of an inference. A logical argument usually consists of one or more premises and a conclusion.

Source: Patrick J. Hurley (2012)

Example: Suppose you're an education NGO trying to decide whether to support the construction of a new school that should open in September. Having the following information available (premises), you can formulate the following conclusion:

Premises: *The funds for the project won't be available until March. (1)*
Construction won't begin until payment is received. (2)
The entire project will take at least eight months to complete. (3)

Conclusion: *The building won't be complete before school begins.*
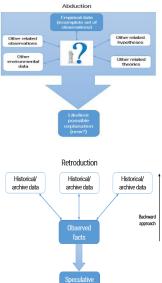
TYPES OF LOGICAL REASONING

Inference, the process of claiming that the premises support the conclusion, is also called logical reasoning. Deduction and induction are the two main types of inferences used in logic. In the past decades, two other forms, derived from deduction and induction, were introduced in logic: abduction and retroduction.

Abductive reasoning is an exploratory process: it typically begins with an incomplete set of observations and proceeds to the likeliest possible explanation of the set.

Example: When building scenarios in preparation for or during humanitarian crises, abduction is widely applied. All available observations, environmental data, hypotheses and theories are explored in order to find the most plausible scenarios of a current or upcoming crisis (the "chain of plausibility" approach).

Retroductive reasoning implies a reconstruction of past events that describes and explains the history of a case. It is like a backward approach to logic modelling.

Example: Retroduction is typically used in criminal investigations. When a crime occurs, retroduction is applied in police work to determine the initial suspects of a crime via *means*, *motive*,

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and *opportunity*. This type of logical reasoning can also be applied when searching for *underlying factors* of a humanitarian crisis using the means, motive and opportunity process.

Deductive reasoning works from the more general to the more specific. It is often informally called a "top-down" approach, a targeted and narrow approach.

Deduction

Theory → Hypothesis → Testing and Observation → Confirmation

"Top-down" approach

Example:

- *Poor sanitation and hygiene conditions cause fevers, diarrhoea, vomiting and eye and skin infections. (Premise 1 – the Theory)*
- *Poor sanitation and hygiene conditions are observed in Um Dukhun. (Premise 2 – the Observation)*
- *Thus, there are incidences of fevers, diarrhoea, vomiting and eye and skin infections in Um Dukhun. (Conclusion – the Confirmation)*

Inductive reasoning works from specific observations to broader generalisations and theories. It is a "bottom up" approach, a more open-ended and exploratory approach.
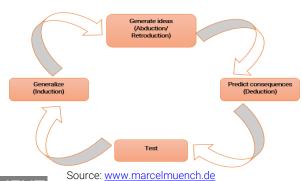
Induction

Theory ← Tentative Hypothesis ← Pattern ← Observation

"Bottom up" approach

Example:

- *Poor sanitation and hygiene conditions are observed in Um Dukhun.* (Premise 1 – the Observation)
- *There are incidences of fevers, diarrhoea, vomiting and eye and skin infections in Um Dukhun.* (Premise 2 – the Pattern)
- *Thus, poor sanitation and hygiene conditions cause fevers, diarrhoea, vomiting and eye and skin infections.* (Conclusion – the Theory)
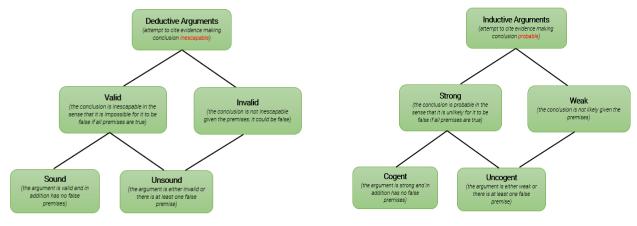
Those four reasoning processes do not exist in isolation, each with its own value. Together, the four stages of reasoning form the basic framework of any research and analysis, qualitative as well as quantitative:

1. Abduction and Retroduction to generate ideas (hypothesis).
2. Deduction to predict consequences.
3. Induction to generalize.

The Cycle of Logical Reasoning

Generate ideas (Abduction/Retroduction) → Predict consequences (Deduction) → Test → Generalize (Induction)

Source: www.marcelmuench.de

HOW TO EVALUATE A LOGICAL ARGUMENT

Every logical argument makes two basic claims: a claim that evidence or reasons exist (premise or factual claim) and a claim that the alleged evidence or reasons support something (conclusion or inferential claim). The evaluation of every logical argument is done through evaluation of these two claims: first the inferential claim and then the factual claim. Methodology has been developed to evaluate both deductive and inductive arguments.

Deductive Arguments
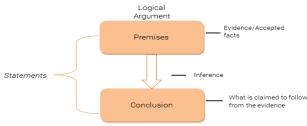*(attempt to cite evidence making conclusion inescapable)*

Valid
(the conclusion is inescapable in the sense that it is impossible for it to be false if all premises are true)

Invalid
(the conclusion is not inescapable given the premises; it could be false)

Sound
(the argument is valid and in addition has no false premises)

Unsound
(the argument is either invalid or there is at least one false premise)

Inductive Arguments
(attempt to cite evidence making conclusion probable)

Strong
(the conclusion is probable in the sense that it is unlikely for it to be false if all premises are true)

Weak
(the conclusion is not likely given the premises)

Cogent
(the argument is strong and in addition has no false premises)

Uncogent
(the argument is either weak or there is at least one false premise)

Source: www.thelogiccafe.net

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I. What Is a Logical Argument?

"If one doesn't value logic, what logical argument would you invoke to prove they should value logic?" (Sam Harris)

A Logical Argument is a connected series of *statements*, some of which are intended to provide support, justification, or evidence (*the premises*) for the truth of another statement (*the conclusion*) through the process of an *inference*. A logical argument usually consists of one or more premises and a conclusion.

Source: Patrick J. Hurley (2012)

In order to construct a good logical argument, it is important to have clear definitions of the terms statements, premises, conclusions and inferences are.

A Statement is a sentence that is either true or false – in other words, it is a declarative sentence[1] stating a fact. A logical argument is formed by a group of statements.

Examples of statements:
This earthquake is the strongest for decades in Ecuador.
Rains always trigger floods.

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[1] A *declarative sentence* states a fact and ends with a period. In a declarative sentence, the subject normally precedes the verb.

In this example, the first statement is true, whereas the second statement is false. *Truth* and *falsity* are called the two possible Truth Values of a statement. Thus, the truth value of the first statement is true and the truth value of the second is false.

Unlike declarative sentences, some types of sentences cannot be said to be true or false. Consequently, they cannot be considered as statements:

Examples of non-statements:
- Questions: *Where is Rangoon?*
- Proposals: *Let's go to Rangoon.*
- Suggestions: *We suggest urgent action to address these challenges.*
- Commands: *We demand a ceasefire!*
- Exclamations: *Fantastic!*

The Premise is the statement that sets forth the reasons or evidence supporting the conclusion, the facts of the matter.

The Conclusion is the statement that the evidence is claimed to support or imply, the outcome of the argument. In other words, the conclusion is the statement that is claimed to follow from the premises.

The Inference is the process of deriving the conclusion from the premises, the claim that the premises support the conclusion. This is what is called *logical reasoning* and will be further explained in the following chapter.

Example of a logical argument: Suppose you're an education NGO trying to decide whether to support the construction of a new school that should open in September.

Premises: *The funds for the project won't be available until March. (1) Construction won't begin until payment is received. (2) The entire project will take at least eight months to complete. (3)*
Conclusion: *The building won't be complete before school begins.*

The 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:

1. **The Law of Identity** states that any statement of the form "X is X" must be true. In other words, everything in the universe is the same as itself.

Example: *A landmine is a landmine. South Sudan is South Sudan.*

➔ Without any information about the world, you can see from logic alone that all of these statements are true.

2. **The Law of the Excluded Middle** states that in logic, every statement is either completely true or completely false, no third option is possible. It is a black-or-white structure; no grey areas are possible. Thus, statements can't be partially true/false.

Example: *This virus is called Zika virus. This forest's name is Zika.*

➔ Without any information about the world, you know logically that each of these statements is either completely true or completely false.

3. **The Law of Non-Contradiction** states that, given a statement and its opposite, one is true and the other is false.

Example: *Juba is in South Sudan. Juba is not in South Sudan.*

➔ Even if you don't know these places' names, you could be sure from logic alone that one of these statements is true and the other one is false.

To assist in distinguishing passages that contain logical arguments from those that do not, investigation of some typical kinds of nonarguments is useful.

There are **5 types of nonargument passages**:

1. In a **Simple Noninferential Passage**, even though it may contain premises and conclusions, there is **no inference being made** that the premises provide evidence or reasons supporting the conclusion.

Simple Noninferential passages can be:
 a) **A warning:** a form of expression that is intended to put someone on guard against a dangerous or detrimental situation. If no evidence is given to prove that such statements are true, that there actually is a danger, then there is no logical argument.

 b) **A piece of advice** is a form of expression that makes a recommendation about some future decision or course of conduct. If there is no evidence that the advice is intended to prove anything, then there is no logical argument.
 c) **A statement of belief or opinion** is an expression about what someone happens to believe or think about something. If there is no claim that the person's belief or opinion is supported by evidence, or that it supports some conclusion, there is no logical argument.
 d) **Loosely associated statements** may be about the same general subject, but they lack a claim that one of them is proved by the others. As there is no claim that any of these statements provides evidence or reasons for believing another, there is no logical argument.
 e) **A report** consists of a group of statements that convey information about some topic or event. These statements could serve as the premises of an argument, but as there is no claim made to support or imply anything, there is no logical argument.

2. **An Expository Passage** is a passage that begins with a topic sentence followed by one or more sentences that **develop or expand the topic sentence**. If the objective is not to prove the topic sentence but only to expand it, then there is no logical argument.

Example: *Between 25 April 2015 and 12 February 2016, a total of 850 girls and boys were intercepted by police from possible trafficking and other protection-related risks. At an average of 89 children per month, this number was higher than the 69 cases per month between July 2014 and July 2015.* (Source: UNICEF 2016 – Nepal)

However, if the purpose of the subsequent sentences in the passage is to develop the topic sentence and also to prove that it is true, an expository passage can be interpreted as a logical argument.

Example: *The SRSG stresses the need for all Congolese political actors to demonstrate maximum restraint during this critical period in the political evolution of their country. He urges the Congolese authorities to do their utmost to scrupulously uphold the rule of law and desist from any actions that could impede political actors from exercising their constitutional rights and freedoms, including the freedom of expression, association and assembly.* (Source: MONUSCO 2016 - DRC)

3. An Illustration is a passage in which a statement is made about a certain subject (the topic sentence) and then specific examples are used to illustrate it, to show what it means or how it is done. If the objective is not to prove the topic sentence but only to illustrate it, then there is no logical argument.

Example: *The hot and dry climate is favourable to the outbreak of meningitis epidemics generally between November and May. In April 2015, following an escalation in meningitis cases (from December 2015) an epidemic was officially declared by the Ministry of Public Health. At the same time, measles outbreak was also confirmed in the Northern region of the country: Agadez, Maradi and Zinder being the worst affected.* (Source: IFRC 2016 – Niger)

Similar to expository passages, if the purpose of its examples is to provide evidence for the topic sentence, an illustration can be considered a logical argument. Such illustrations are called Arguments from Example.

Example: *Ebola Response partners remain vigilant throughout the country. They continue health screening activities in Forecariah and Kindia, bordering with Sierra Leone and in the Forest Region, bordering Liberia. Responding to the request of the Guinean government, IOM systematically screens all people crossing the 48 official and non-official points of entry (POEs) along the border with Sierra Leone.* (Source: IOM 2016 – Sierra Leone)

4. An Explanation is an expression that intends to shed light on a specific fact, to make sense of it. In an explanation, there is an attempt to explain why the fact might have happened or provide some of the causes for the fact. Thus, it is not intended for the explanation to prove that the fact is true, such as in the logical argument.

Example: *Dzud is a cyclical slow onset disaster unique to Mongolia. It consists of a summer drought, resulting in insufficient production of hay, followed by a very heavy winter snow (10 to 350 cm), winds and lower than normal temperatures (-40° C to -50° C). During this time an excessive number of livestock die causing basic services, and in the longer term, livelihoods to collapse in vulnerable herder communities.* (Source: OCHA & UN HCT in Mongolia 2016)

5. A Conditional Statement is an "if … then …" statement. Conditional statements are not logical arguments, as there is no claim that it presents evidence.

Nevertheless, while no single conditional statement is a logical argument, a conditional statement may serve as either the premise or the conclusion (or both) of a logical argument.

Example:
- *If Iran is developing nuclear weapons, then Iran is a threat to world peace.* (Conditional statement – Premise 1).
- *Iran is developing nuclear weapons* (Premise 2)
- *Therefore, Iran is a threat to world peace.* (Conclusion)

Conditional statements are especially important in logic as they express the relationship between necessary and sufficient conditions.

Sufficient Condition: A is said to be a sufficient condition for B whenever the occurrence of A is all that is needed for the occurrence of B.

Example: *In a humanitarian crisis, being in need is a sufficient condition for being affected.*

Necessary Condition: A is said to be a necessary condition for B whenever B cannot occur without the occurrence of A. A is necessary for B to occur, but it doesn't mean that B will necessarily occur then.

Example: *In a humanitarian crisis, being affected is a necessary condition for being in need.*

II. Types of Logical Reasoning

"Nothing can be more important than the art of formal reasoning according to true logic."
(Gottfried Wilhelm Leibniz)

Inference, the process of claiming that the premises support the conclusion, is also called *logical reasoning*. *Deduction* and *induction* are the two main types of inferences used in logic. In the past decades, two other forms of inference, derived from these main ones, were introduced: *abduction* and *retroduction*.

These four forms of logical reasoning are used in every type of research (qualitative and quantitative alike). Together with *observation*, they create the basis of all research and analysis. As they represent the intellectual building blocks of analysis, analysts are compelled to take a close look at the logic of their own thought processes.

a) Abductive Reasoning

"When you dismiss the impossible, whatever you have left, however improbable, is the answer." (Sherlock Holmes, Sir Arthur Conan Doyle)

Abductive reasoning is a natural and instinctive process, a series of educated guesses, building upon observed phenomena and previous studies. This process is usually triggered whenever old theories or hypotheses can no longer explain certain observed facts, and when a new combination of old and partly familiar ideas, or the discovery of a completely new idea is necessary.
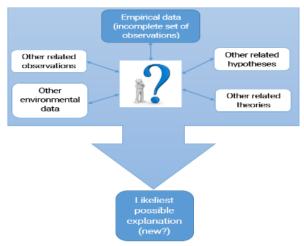
Abductive reasoning is an exploratory process: it typically begins with an incomplete set of observations and proceeds to the likeliest possible explanation of the set. It implies examination of an array of possibilities or explanations and selection of the most reasonable and credible one.

Example: When building scenarios in preparation for or during humanitarian crises, abduction is widely applied. All available observations, environmental data, hypotheses and theories are explored in order to find the most plausible scenarios of a current or upcoming crisis (the "chain of plausibility" approach).

The starting point for any abduction is empirical data[2] (usually incomplete). Analysts interpret the empirical data by de- and recontextualizing it, absorbing the greatest possible amount of environmental data – other related observations, theories or hypotheses – and in doing so arrive at the likeliest possible explanation and maybe new ideas or links (hypothesis or theories) that can be tested later on using other approaches.

Abduction does not follow rules of formal logic in the sense that it offers a plausible interpretation rather than a logical conclusion derived from premises.

[2] **Empirical data** is data derived from reliable measurement or observation (facts etc.).
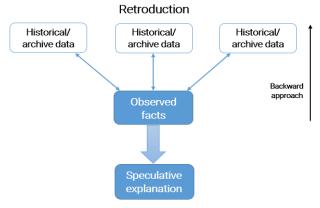

Abductive approaches are commonly applied in qualitative and mixed methods studies where the goal is to generate a hypothesis or theory rather than to generalize from a sample to a population.

b) Retroductive Reasoning

Retroductive reasoning implies a reconstruction of past events that describes and explains the history of a case.

Thinking retroductively is imaginatively yet logically reconstructing how a particular outcome may have come about. Background research and knowledge of the past helps place the present conditions into context.

Retroduction is like a backward approach to logic modelling where an attempt is made to work out the components and steps that must have been necessary to lead to a current phenomenon. Where possible, speculative explanations are assessed against historical or archival data.

Example: Retroduction is typically used in criminal investigations. When a crime occurs, retroduction is applied in police work to determine the initial suspects of a crime via *means*, *motive*, and *opportunity*. Respectively, they refer to: the ability of

the defendant to commit the crime (the means), the reason the defendant committed the crime (motive), and whether the defendant had the chance to commit the crime (opportunity)[3].
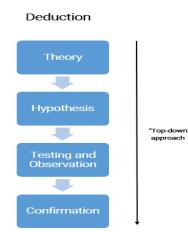
Thus, the police investigate each suspect retroductively to put together all the facts and to find out who is the criminal.

This type of logical reasoning can also be applied when searching for **underlying factors** of a humanitarian crisis using the means, motive and opportunity process.

c) Deductive Reasoning

Deductive reasoning works from the more general to the more specific. It is often informally called a "top-down" approach, a targeted and narrow approach.

It starts with thinking up a theory about the topic of interest. Then the theory is narrowed down into more specific hypotheses that can be tested. Eventually those hypotheses are narrowed down even further when we collect observations to address the hypotheses. This ultimately leads to hypotheses testing with specific data: a confirmation (or not) of the original theory. Thus, deductive reasoning involves pursuing curiosity by interrogating available data (e.g. extracts from focus group discussion or a dataset from field assessment) to substantiate or refute the analyst's hypothesis.

In logical reasoning, deductive reasoning allows sifting through a body of factual statements (*premises*), ruling out plausible but inaccurate statements (*invalid conclusions*), and getting to the truth (*valid conclusions*).

A deductive argument is an argument incorporating the claim that it is impossible for the conclusion to be false given that the premises are true. The premises are supposed to provide absolute support

for the conclusion and thus the conclusion is claimed with certainty.

Example:
- *Poor sanitation and hygiene conditions cause fevers, diarrhoea, vomiting and eye and skin infections.* (Premise 1 – the Theory)
- *Poor sanitation and hygiene conditions are observed in Um Dukhun.* (Premise 2 – the Observation)
- *Thus, there are incidences of fevers, diarrhoea, vomiting and eye and skin infections in Um Dukhun.* (Conclusion – the Confirmation)

The main types of deductive reasoning are as follows:

1. An argument based on mathematics is an argument in which the conclusion depends on some purely arithmetic or geometric computation or measurement. An exception to this are arguments that depend on statistics. As statistics involve probabilities, the conclusion cannot be formulated with certainty. Such arguments are usually best interpreted as inductive.

Example: *We have the following information about a particular district: there are originally 25,745 IDPs in the district; meanwhile 5,236 IDPs came to the district and 985 fled the district. We deduct that there are currently 29,996 IDPs in this district.*

2. An argument from definition is an argument in which the conclusion is claimed to depend merely on the definition of some word or phrase used in the premise or conclusion.

Example: As Japan is situated on an active fault considered hazardous and that active hazardous faults are expected to provide strong earthquakes; it follows that Japan is expected to experience strong earthquakes.

3. A categorical syllogism[4]: is a syllogism in which each statement begins with one of the words "all", "no" or "some".

Example:
- *All malnourished children experience health problems.* (Premise 1 – the Theory)
- *Some children are malnourished.* (Premise 2 – the Observation)

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[3] Source: Wikipedia. Last modified on 21 May 2015.
https://en.wikipedia.org/wiki/Means,_motive,_and_opportunity

[4] A **syllogism**, in general, is an argument consisting of exactly two premises and one conclusion.

- *Therefore, some children experience health problems.* (Conclusion - the Confirmation)

4. A hypothetical syllogism: is a syllogism having a conditional ("if … then …") statement for one or both of its premises.

Example:
- *If the conflict ceases, then insecurity decreases.* (Premise 1 – Theory 1)
- *If insecurity decreases, then humanitarian access increases.* (Premise 2 – Theory 2)
- *The conflict ceases.* (Premise 2 – the Observation)
- *Therefore, humanitarian access will increase.* (Conclusion – the Confirmation)

5. A disjunctive syllogism: is a syllogism having a disjunctive ("either … or …") statement.

Example:
- Either global warming will be stopped, or hurricanes will become more intense. (Premise 1 – the Theory)
- *Global warming will not be stopped.* (Premise 2 – the Observation)
- *Therefore, hurricanes will become more intense.* (Conclusion – the Confirmation)

d) Inductive Reasoning

Inductive reasoning works the other way, moving from specific observations to broader generalizations and theories. This is called the **"bottom up" approach,** a more open-ended and exploratory approach.

In inductive reasoning, we begin with specific observations and measures, attempting to detect patterns and regularities. Then we formulate some tentative

hypotheses that we can explore, and can eventually end up developing some general conclusions or theories. Thus, inductive reasoning is about using analysis to determine the relationships that exist within raw information materials and to recognize the most important and relevant associations.

Unlike deductive reasoning, premises in the inductive reasoning are supposed to provide some support to the conclusion. An inductive argument is an argument incorporating the claim that it is improbable that the conclusion can be false given that the premises are true. The conclusion is thus **probable**.

Example:
- *Poor sanitation and hygiene conditions are observed in Um Dukhun.* (Premise 1 – the Observation)
- *There are incidences of fevers, diarrhoea, vomiting and eye and skin infections in Um Dukhun.* (Premise 2 – the Pattern)
- *Thus, poor sanitation and hygiene conditions cause fevers, diarrhoea, vomiting and eye and skin infections.* (Conclusion – the Theory)

The main types of inductive reasoning are as follows:

1. A prediction is an argument that proceeds from our knowledge of the past to a claim about the future.

Example: Someone might argue that because certain meteorological phenomena have been observed to develop over a certain disaster prone region, a storm will occur there in six hours.

2. An argument from analogy is an argument that depends on the existence of an analogy, or similarity, between two things or states of affairs. Because of the existence of this analogy, a certain condition that affects the better-known thing or situation is concluded to affect the similar, lesser-known thing or situation.

Example: In besieged areas in Syria, massive violations of human rights are observed. By analogy, observations are expected to be the same in besieged areas in Iraq.

3. A generalization is an argument that proceeds from the knowledge of a selected sample to some claim about the whole group. Because the members of the sample have a certain characteristic, it is argued that all the members of the group have that same characteristic.

Example: It might be arguable that, as El Niño has a measurable impact on Lesotho, it also impacts the

South African whole region and all its countries, such as Mozambique and Zimbabwe.

4. An argument from authority is an argument that concludes something is true because a presumed expert or witness has said that it is.
Example: On 1 February 2016, the WHO Director-General declared the Zika virus a "Public Health Emergency of International Concern." The Zika virus is then considered a big concern. (Source: WHO 2016)

5. An argument based on signs is an argument that proceeds from the knowledge of a sign to a claim about the thing or situation that the sign symbolizes. The word "sign", as it is used here, means any kind of message (usually visual) produced by a human being.

Example: When driving on an unfamiliar highway one might see a sign indicating that the road makes several sharp turns one mile ahead.

6. A causal inference is an argument that proceeds from knowledge of a cause to a claim about an effect, or conversely, from knowledge of an effect to a claim about a cause.

Example: "A huge landslide hit a camp for construction workers in a remote part of northeast India on Friday, killing at least 16." (Source: Agence France-Presse 2016). Heavy rains were observed in that region. The heavy rains caused the landslide in the remote area of northeast India. (cause to effect)

The types of inductive reasoning listed above are not intended to be mutually exclusive. Overlaps can and do occur. For example, many causal inferences that proceed from cause to effect also qualify as predictions.
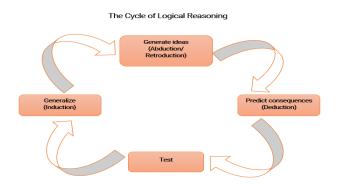
e) The Cycle of Logical Reasoning

These four reasoning processes do not exist in isolation, each with its own value. They also make sense together when utilized in a certain order.

The practice of employing the four types of reasoning one after the other has proven itself in research and analysis. Together, the four stages of reasoning form the basic framework of any research, qualitative as well as quantitative:

1. *Abduction* and *Retroduction* to generate ideas (hypothesis).
2. *Deduction* to predict consequences.
3. *Induction* to generalize.

Abduction needs no justification, but that is not the case for the product of abduction, hypothesis. It can be and must be tested, and with the hypothesis so too stands or falls the abduction. The same reasoning can be applied to retroductive products.
Source: www.marcelmuench.de

The Cycle of Logical Reasoning

III. How to Evaluate a Logical Argument?

"All men are mortal.
Socrates was mortal.
Therefore, all men are Socrates." (Woody Allen)

We have seen that every logical argument makes two basic claims: a claim that evidence or reasons exist (premise) and a claim that the alleged evidence or reasons support something (conclusion). The first is a factual claim[5], the second an inferential claim[6].

The evaluation of every logical argument is done through evaluation of these two claims. It starts with evaluation of the inferential claim, because if the premises fail to support the conclusion, meaning that the reasoning is bad, the argument is worthless. If, and only if, the premises do support the conclusion will we test the factual claim to verify that the premises present genuine evidence, or are true.
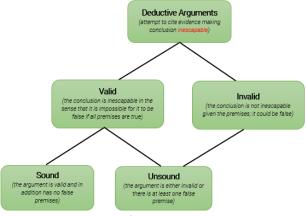
Methodology has been developed to evaluate both deductive and inductive arguments.

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[5] A *factual claim* provides facts rather than theories or personal interpretations.
[6] An *inferential claim* implies that the premises are logically connected to the conclusion so it is safe to infer the truth of the conclusion from the truth of the premises.

a) Deductive Arguments

In a deductive argument, the premises are supposed to provide absolute support for the conclusion and the conclusion is claimed with certainty. Thus, evaluation of a deductive argument consists in attempting to cite evidence making the conclusion inescapable:
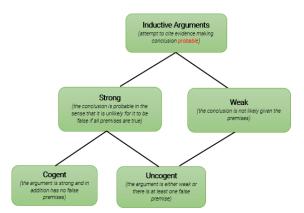

Source: www.thelogiccafe.net

1. **Validity:** testing of the inferential claim. If the conclusion is inescapable in the sense that it is impossible for it to be false if all premises are true, the argument is said to be valid. Otherwise it is considered invalid, as the conclusion could be false given the premises.
2. **Soundness:** testing of the factual claim. If the argument is valid and has no false premises, it is said to be sound. If it is valid, but there is at least one false premise, it is considered unsound. All invalid arguments are said to be unsound.

b) Inductive Arguments

In an inductive argument, the premises are supposed to provide some support to the conclusion and the conclusion is claimed with a certain probability. Thus, evaluation of an inductive argument consists in attempting to cite evidence making the conclusion probable:

1. **Strength:** testing of the inferential claim. If the conclusion is probable in the sense that it is unlikely for it to be false if all premises are true, the argument is said to be strong. Otherwise it is considered weak, as the conclusion is not likely given the premises.
2. **Cogency:** testing of the factual claim. If the argument is strong and has no false premises, it is said to be cogent. If it is strong, but there is at least one false premise, it is considered *uncogent*. All weak arguments are said to be *uncogent*.

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Annex 1. Logical Fallacies

A logical fallacy occurs when reasoning is illicitly applied in the construction of a logical argument and leads to a false impression that something has been established with great care and rigour. Indeed, it involves ways of lending the appearance of evidence where there is little or none. Around 300 logical fallacies have been identified so far. However, only the top 25 most encountered fallacies are shown here (Source: Bo Bennett 2012).

All trees have bark.
All dogs bark.
Therefore, all dogs are trees.
The fallacy of barking up the wrong tree. (thegaps.org)

Fallacy	Description	Logical Form	Example	Exception/Variation	Tip
Ad Hominem (argumentum ad hominem)	Attacking the person making the argument, rather than the argument itself, when the attack on the person is completely irrelevant to the argument the person is making.	*"Person 1 is claiming Y. Person 1 is a moron. Therefore, Y is not true."*	"My opponent suggests that lowering taxes will be a good idea – this is coming from a woman who drinks a bottle of wine each night!"	**Exception:** when the attack on the person is relevant to the argument, it is not a fallacy. **Variation:** *Needling* is attempting to make the other person angry, taking attention off of the argument and perhaps even making the other person look foolish.	When others verbally attack you, take it as a compliment to the quality of your argument. It is usually a sign of desperation on their part.
Appeal to Common Belief (argumentum ad populum)	When the claim that most or many people in general or of a particular group accept a belief as true is presented as evidence for the claim. Accepting another person's beliefs, without demanding evidence as to why that person accepts the belief, is lazy thinking and a dangerous way to accept information.	*"A lot of people believe X. Therefore, X must be true."*	"Up until the late 16th century, most people believed that the earth was the centre of the universe. This, of course, is not true."	**Exception:** sometimes there is good reason to think that if a good number of key informants say that food is the biggest need, it is likely that they are on to something.	History has shown that those who break away from common beliefs are the ones who change the course of history.
Appeal to Faith	This is an abandonment of reason in an argument and a call to faith, usually when reason clearly leads to disproving the conclusion of an argument. It is the assertion that one must have (the right kind of) faith in order to understand the argument.	*"X is true. If you have faith, you will see that."*	Tina: So please explain how Jesus can also be God, yet two separate persons who talk to each other. St. Bingo: My child, you will only see that answer clearly through the eyes of faith.	**Exception:** no exceptions – the appeal to faith is always a fallacy when used to justify a conclusion in absence of reason.	
Ambiguity Fallacy	When an unclear phrase with multiple definitions is used within the argument, therefore not supporting the conclusion. Some will say single words count for the ambiguity fallacy, which is really a specific form of a fallacy known as	*"Claim X is made. Y is concluded based on an ambiguous understanding of X."*	"It is said that we have a good understanding of our universe. Therefore, we know exactly how it began and exactly when."	**Exception:** Ambiguous phrases are extremely common in the English language and a necessary part of informal logic and reasoning. As long as these ambiguous phrases mean exactly	When you suspect an ambiguity fallacy, substitute the word with the exact same definition for all uses and see if it makes sense.

	equivocation.			the same thing in all uses of phrase in the argument, this fallacy is not committed. **Variation:** the **type-token fallacy** is committed when a word can refer to either a type (e.g. cars) or token (e.g. Prius, RAVC4, Camry) is used in a way that makes it unclear which it refers to. Thus, the statement is ambiguous.	
Anonymous Authority	When an unspecified source is used as evidence for the claim. This is commonly indicated by phrases such as "They say that…", "It has been said…", "I heard that…", "Studies show…", or generalized groups such as, "scientists say…". When we fail to specify a source of the authority, we can't verify the source, thus the credibility of the argument. Appeals to anonymous sources are more often than not, either a way to fabricate, exaggerate, or misrepresent "facts" in order to deceive others into accepting your claim. At times, this deception is done subconsciously.	*"Person 1 once heard that X was true.* *Therefore, X is true."*	"You know, they say that if you swallow gum it takes 7 years to digest. So whatever you do, don't swallow the gum!"	**Exception:** at times an accepted fact uses the same indicating phrases as the ones used for the fallacy, therefore, if the anonymous authority is actually just a statement of an accepted fact, it should be accepted as evidence.	Be very wary of "they".
Argument by Emotive Language	Substituting facts and evidence with words that stir up emotion, with the attempt to manipulate others into accepting the truth of the argument.	*"Person A claims that X is true. Person A uses very powerful and emotive language in the claim.* *Therefore, X is true."*	"If children are not taught evolution, big bang, and relativism, it will be disastrous."	**Exception:** language is powerful and should be used to draw in emotions, but never at the expense of valid reasoning and evidence.	
Argument from Ignorance (ad ignorantium)	The assumption of a conclusion or fact based primarily on lack of evidence to the contrary. Usually best described by, "absence of evidence is not evidence of absence."	*"X is true, because you cannot prove that X is false."* *"X is false, because you cannot prove that X is true."*	"Although we have proven that the moon is not made of spare ribs, we have not proven that its core cannot be filled with them. Therefore, the moon's core is filled with spare ribs."	**Exception:** the assumption of a conclusion or fact deduced from evidence of absence, is not considered a fallacy, but valid reasoning.	Look at all your existing major beliefs and see if they are based more on the lack of evidence than evidence. You might be surprised as to how many actually are.
Begging the Question (petitio principii)	Any form of argument where the conclusion is assumed in one of the premises. Many people use the phrase "begging the question" incorrectly when they use it to mean, "prompts one to ask the question". That is NOT the correct usage. Begging the question is a form of **circular reasoning**.	*"Claim X assumes X is true. Claim X is therefore, true."*	"Paranormal activity is real because I have experienced what can only be described as paranormal activity."	**Exception:** some assumptions that are universally accepted could pass as not being fallacious.	

Biased Sample Fallacy	Drawing a conclusion about a population based on a sample that is biased, or chosen in order to make it appear the population on average is different than it actually is. This differs from the **hasty generalization fallacy**, where the biased sample is specifically chosen from a select group, and the small sample is just a random sample, but too small to get any accurate information.	*"Sample S, which is biased, is taken from population P. Conclusion C is drawn about population P based on S."*	"Based on a survey of 1,000 American homeowners, 99% of those surveyed have two or more automobiles worth on average $100,000 each. Therefore, Americans are very wealthy."	**Exception:** what exactly is "biased" is subjective, but some biases are very clear.	Be very wary of statistics. Look at the source and details of the studies which produced the statistics. Very often you will find some kind of bias.

Similarly, be very wary of reports that claim to be representative, when in fact they have used convenience or purposive sampling, without adding that as a limitation. |
Equivocation	Using an ambiguous term in more than one sense, thus making an argument misleading.	*"Claim X is made. Y is concluded based on an ambiguous understanding of X."*	"The sign said "fine for parking here", and since it was fine, I parked there."	**Exception:** equivocation works great when deliberate attempts at humour are being made.	When you suspect equivocation, substitute the word with the exact same definition for all uses and see if it makes sense.
Failure to Elucidate (obscurum per obscurius)	When the definition is made more difficult to understand than the word or concept being defined.	*"Person 1 makes a claim. Person 2 asks for clarification of the claim, or a term being used. Person 1 restates the claim or term in a more confusing way."*	"An object is beautiful if and only if it is aesthetically successful." (The term "aesthetically successful" is harder to understand than the term "beautiful")	**Exception:** some may actually just lack the vocabulary needed – this is not your fault, but you should do your best to attempt to elucidate using words understandable to your audience.	Are there any concepts that you feel you understand, when really you can just define the concept with words?
False Dilemma	When only two choices are presented yet more exist, or a spectrum of possible choices exist between two extremes. False dilemmas are usually characterized by "either this or that" language, but can also be characterized by omissions of choices. Another variety is the **false trilemma**, which is when three choices are presented when more exist.	*"Either X or Y is true. X is not true. Y must then be true."* *"Either X, Y or Z is true."*	"If we don't reduce public spending, our economy will collapse." (a third option can be possible; however, it is omitted)	**Exception:** there may be cases when the number of options really is limited. For example, if an ice cream man just has chocolate and vanilla left, it would be a waste of time insisting he has mint chocolate chip.	Be conscious of how many times you are presented with false dilemmas, and how many times you present yourself with false dilemmas.
Hasty Generalization	Drawing a conclusion based on a small sample size, rather than looking at statistics that are much more in line with the typical or average situation.	*"Sample S is taken from population P. Sample S is a very small part of population P. Conclusion C is drawn from sample S."*	"An environmental group illegally blocked loggers and workers at a nuclear plant. Therefore, environmentalists are radicals who take the law into their own hands."	**Exception:** a statistics of a larger population are not available, and decision must be made or opinion formed, if the small sample size is all you have to work with, then it is better than nothing. **Variation:** the **hasty conclusion** is leaping to a conclusion without carefully considering the alternatives – a tad different than drawing a conclusion from too small of a sample.	Only base decisions on small sample sizes when time is of essence and no reliable data exists, but be aware of the limitations

Magical Thinking	Making causal connections or correlations between two events not based on logic or evidence, but primarily based on superstition. Magical thinking often causes one to experience irrational fear of performing certain acts or having certain thoughts because they assume a correlation with their acts and threatening calamities.	*"Person 1 thought of X today. X happened today. According to superstition, Person 1 thought about X today made it happen."*	"I refuse to stay on the 13th floor of any hotel because it is bad luck. However, I don't mind staying on the same floor as long as we call it the 14th floor."	**Exception:** if you can empirically prove your magic, then you can use your magic to reason.	*Magical thinking* may be comforting at times, but reality is always what's true.
Moving the Goalposts	Demanding from an opponent that he or she address more and more points, after the initial counter-argument has been satisfied, refusing to concede or accept the opponent's argument.	*"Issue A has been raised, and adequately answered. Issue B is then raised, and adequately answered. ..... Issue Z is then raised, and adequately answered."* (despite all issues adequately answered, the opponent refuses to concede or accept the argument)	"Susan: Taking Vitamin C prevents the common cold. Mark: What about that time you took Vitamin C, and still got sick? Susan: Well, I would have gotten much sicker if I had not taken the Vitamin C."	**Exception:** his fallacy should not be confused with an argument or set of arguments, with multiple propositions inherent in the argument. The reason for the difference between this kind of argument and the moving the goal posts fallacy, is a subtle one, but indicated by a strong initial claim ("has to be", "must", "required for", etc.) that gets answered and/or what appears to be *ad hoc* objections that follow eventually leading to an impossible request for proof.	
Poisoning the Well	To commit a pre-emptive ad hominem attack against an opponent. That is, to prime the audience with adverse information about the opponent from the start, in an attempt to make your claim more acceptable, or discount the credibility of your opponent's claim. Much used in politics where one candidate tries to smear another on a general basis without linking it to a specific argument.	*Adverse information (be it true or false) about person 1 is presented. Therefore, the claim(s) of person 1 will be false.*	"I hope I presented my argument clearly. Now, my opponent will attempt to refute my argument by his own fallacious, incoherent, illogical version of history."	**Exception:** remember that if a person states facts relevant to the argument, it is not an ad hominem attack. In the first example, if the other "poison" were left out, no fallacy would be committed.	
Prejudicial Language	Loaded or emotive terms used to attach value or moral goodness to believing the proposition.	*"Claim A is made using loaded or emotive terms. Therefore, claim A is true."*	"Students who want to succeed in life will do their homework each and every night."	**Exception:** this is often used for motivation, even if the intent is honourable, it is still fallacious.	
Questionable Cause (cum hoc ergo propter hoc)	Concluding that one thing caused another, simply because they are regularly associated.	*A is regularly associated with B, therefore, A causes B.*	"Every time I go to sleep, the sun goes down. Therefore, my going to sleep causes the sun to set."	**Exception:** when strong evidence is provided for causation, it is not a fallacy. **Variation:** The *juxtaposition fallacy* is putting two items/ideas together,	

				implying a causal connection, but never actually stating that one exists. *Reversing causality or wrong direction* is just what it sounds like – it is still a false cause, but the specific case where one claims something like the sun sets because night time is coming.	
Red Herring (ignoratio elenchi)	Attempting to redirect the argument to another issue, to which the person doing the redirecting can better respond. While it is similar to the **avoiding the issue fallacy**, the red herring is a deliberate diversion of attention with the intention of trying to abandon the original argument.	*"Argument A is presented by person 1. Person 2 introduces argument B. Argument A is abandoned."*	"Mother: It's bedtime Jane Jane: Mom, how do ants feed their babies? Mother: Don't know dear. Close your eyes now. Jane: But mama, do ant babies cry when hungry?"	**Exception:** using a red herring to divert attention away from your opponent's red herring, might work. But do two wrongs make a right? **Variation:** using *judgmental language* is using insulting, compromising or pejorative language to influence the recipient's judgment, and take the attention off the real argument.	Impress your friends by telling them that there is no such fish species as a "red herring"; rather it refers to a particularly pungent fish—typically a herring but not always—that has been strongly cured in brine and/or heavily smoked. (→ form of diversion)
Reductio ad Hitlerum	The attempt to make an argument analogous with Hitler or the Nazi party. Hitler is probably the most universally despised figure in history, so any connection to Hitler, or his beliefs, can (erroneously) cause others to view the argument in a similar light. However, this fallacy is becoming more well-known, as is the fact that it is most often a desperate attempt to render the truth claim of the argument invalid, out of lack of a good counter-argument.	*"Person 1 suggests that Y is true. Hitler liked Y. Therefore, Y is false."* *"Person 1 suggests that Y is true. Person 1's rhetoric sounds a bit like Hitler's. Therefore, Y is false."*	"The God of the Old Testament was big into religious cleansing. Hitler was big into ethnic cleansing. Therefore, God is like Hitler."	**Exception:** when the Hitler reference cannot reasonably be avoided.	When others verbally attack your argument by making it analogous with Hitler or the Nazi party, take it as a compliment to the quality of your argument. It is usually a sign of desperation on their part.
Slippery Slope	When a relatively insignificant first event is suggested to lead to a more significant event, which in turn leads to a more significant event, and so on, until some ultimate, significant event is reached, where the connection of each event is not only unwarranted, but with each step it becomes more and more improbable. Many events are usually present in this fallacy, but only two are actually required – usually connected by "the next thing you know…".	*"If A, then B, then C, … then ultimately Z!"*	Concept of a "bad day": you wake up in the morning and you discover that you are out of coffee. From there, you fallaciously reason that this means you will be grumpy, late for work, therefore, behind all day in work, therefore, have to stay late, therefore, miss dinner with the family, therefore, cause more friction at home, *etc*. This is only true if you act it out as if it is true. And of course, with an already bad attitude, you look back on the	**Exception:** when a chain of events has an inevitable cause and effect relationship, as in a mathematical, logical, or physical certainty, it is not a fallacy.	

		day, block out the good and wallow in the bad, just so you can tell yourself, that you were right all along about having a "bad day".		
Special Pleading	Applying standards, principles, and/or rules to other people or circumstances, while making oneself or certain circumstances exempt from the same critical criteria, without providing adequate justification. Special pleading is often a result of strong emotional beliefs that interfere with reason.	*"I do think that X is true. But, this case is special. Thus in this case X doesn't apply."*	"Yes, I do think that all drunk drivers should go to prison, but your honour, he is my son! I know him, he is a good boy who just made a mistake!"	**Exception:** "Adequate justification" is subjective, and can be argued.	If you are accused of special pleading, take time to honestly consider if the accusation is warranted. This is a fallacy that is easy to spot when others make it, yet difficult to spot when we make it.
Strawman Fallacy	Substituting a person's actual position or argument with a distorted, exaggerated, or misrepresented version of the position of the argument.	*"Person 1 makes claim Y. Person 2 restates person 1's claim (in a distorted way). Person 2 attacks the distorted version of the claim. Therefore, claim Y is false."*	"Zebedee: What is your view on the Christian God? Mike: I don't believe in any gods, including the Christian one. Zebedee: So you think that we are here by accident, and all this design in nature is pure chance, and the universe just created itself? Mike: You got all that from me stating that I just don't believe in any gods?"	**Exception:** at times, an opponent might not want to expand on the implications of his or her position, so making assumptions might be the only way to get the opponent to point out that your interpretation is not accurate, then they will be forced to clarify.	Try to differentiate the person from the argument; always go back to the original source.
Weak Analogy	When an analogy is used to prove or disprove an argument, but the analogy is too dissimilar to be effective - it is unlike the argument more than it is like the argument.	*"X is like Y. Y has property P. Therefore, X has property P." (but X really is not too much like Y)*	"How can you possibly look at something so elegant as a rose, and not see that it must have been designed by an intelligent designer? That is like walking on the beach, finding a watch, and not recognizing that it had an intelligent designer!"	**Exception:** it is important to note that analogies cannot be "faulty" or "correct", and even calling them "good" or "bad" is not as accurate as referring to them as either "weak" or "strong". The use of an analogy is an argument in itself, the strength of which is very subjective. What is weak to one person, is strong to another.	Analogies are very useful, powerful, and persuasive ways to communicate ideas. Use them – just make them strong.
Wishful Thinking	When the desire for something to be true is used in place of/or as evidence for the truthfulness of the claim. Wishful thinking, more as a cognitive bias than a logical fallacy, can also cause one to evaluate evidence very differently based on the desired outcome.	*"I wish X were true. Therefore, it is true."*	"Because I have played the lottery the past 10 years, I am due to win it any week now."	**Exception:** when wishful thinking is expressed as a hope, wish, or prayer, and no belief is formed as a result, then it is not a fallacy because no direct or indirect argument is being made.	Wishing for something to be true is a powerful technique when and only when, a) you have influence on what it is you want to be true and b) you take action to make it come true – not just wish for it to be true.