5. Inductive Arguments

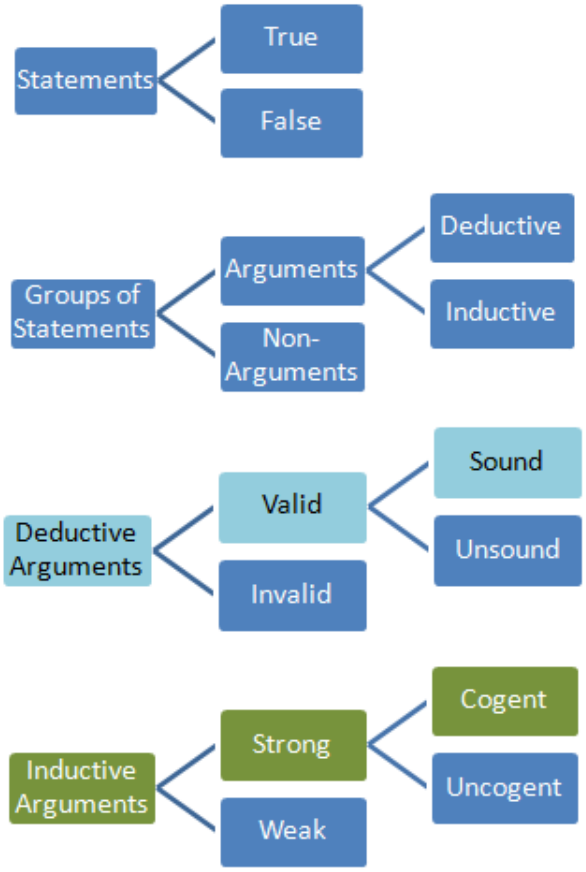
CONTENTS

Focus

With diligent study of this guide, you will learn...	
Ideas	inductive reasoning, statistical principles, sample sizes, target audiences, randomness, statistical generalizations, theories of causation, controlled studies, statistical significance, expert testimony, analogies
Skills	discerning the integrity of statistical research, identifying multiple causes of effects, avoiding hasty generalizations, evaluating the quality of a controlled study, using specific criteria to evaluate expert testimony, using Mill's methods of agreement and difference.

5.1 Inductive Reasoning

Key Ideas/Terms	Definition
deductive argument	An *argument* incorporating the claim that it is ***impossible*** for the *conclusion* to be false if the *premises* are true.
inductive argument	An *argument* incorporating the claim that it is ***improbable*** that the *conclusion* is false if the premises are true.



In general, the process of induction involves:

- Drawing generalizations from known facts, reliable research, and statistical data
- Finding truth by making observations and discerning patterns

In this form of reasoning, the evidence offered by reliable research and personal experience offers strong support but it is not 100% certain. In a strong inductive argument, the evidence offers sturdy support, but not certainty, for the conclusion. So, in general, the strength of a conclusion in an inductive argument is based on the quality of evidence used to support it.

5.1.1 Inductive and Deductive Argument Examples

Inductive Argument	Deductive Argument
T_1: Drive over bump and hear the engine misfire. T_2: Drive over bump and hear the engine misfire. T_3: Drive on smooth road and engine runs smoothly. T_4: Drive over bump and hear the engine misfire. **/ Driving over bumps is causing the engine to misfire.**	If the horn works, then the battery is charged. The battery is dead. **/ The horn does not honk.**
Every time Jimmy John eats peanuts, he gets a runny nose and Itching or tingling in his throat. **/ He very likely has a peanut allergy.**	If a person's immune system mistakenly identifies peanut proteins as something harmful, then eating peanuts could cause food-induced anaphylaxis. Allergy tests confirm that Jimmy John is highly allergic to peanuts. **/ Jimmy John could become anaphylactic when he eats peanuts.**

5.1.2 Basic Types of Inductive Reasoning

Key Ideas/Terms	Definition
prediction	An argument that proceeds from our knowledge of the past to a claim about the future. Nearly everyone realizes that the future cannot be known with certainty; thus, whenever an argument makes a prediction about the future, one is usually justified in considering the argument inductive.
argument from analogy	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. The argument depends on the existence of a similarity, or analogy, between the two things or states of affairs. The certitude attending such an inference is probabilistic at best.

Key Ideas/Terms	Definition
generalization	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. Note the use of statistical samples in inductive argumentation.
argument from authority	An argument that concludes something is true because a presumed expert or witness has said that it is. Because authorities or experts can be either mistaken or lying, such arguments are essentially probabilistic.
argument based on signs	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 an intelligent being. Because signs can be misplaced or in error, conclusions based on them are only probable.
causal inference	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. Because specific instances of cause and effect can never be known with absolute certainty, one may usually interpret such arguments as inductive.
scientific arguments	Arguments that occur in science can be either inductive or deductive, depending on the circumstances. In general, arguments aimed at the *discovery* of a law of nature are usually considered inductive.

5.2 Statistical Generalizations

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. Note the use of statistical samples in inductive argumentation.

Statistical Evidence	→	Statistical Generalizations
Data collected by polling sponsors (Gallup, Harris, BBC, etc.) and through reliable research studies.	Data patterns are detected / interpreted.	Inferences based on the statistical evidence are justified at a particular level of confidence (% probability).

5.2.1 Statistical Evidence

Many fields of study and diverse organizations use statistical data for a range of reasons:

- Control over the unknown
- To make predictions and decisions
- To anticipate accurate information
- Connect patterns in our lives

5.2.2 How Statistical Research is Done

Key Ideas/Terms	Definition	Example
characteristic of interest	What do we want to find out?	Who will win the next American presidential election?
target population	Whom do we want to know about?	Americans who are eligible to vote
sample	Whom can we study to get accurate answers?	At least 1,000 randomly selected Americans who are eligible to vote

5.2.3 Criteria for Statistical Samples

Criteria for Statistical Samples	Explanation
1. Must be large enough	Any sample studied must be sufficiently large to justify generalizations. A study that only covers a small sample or is based on a person's limited experience is unreliable. A *hasty generalization* refers to an inductive inference that is based on only a small sample.
2. Must be representative	If a sample is representative, the people or items studied must be like the members of the target population. The members of the sample must have the same significant characteristics in the same proportion as the target population. Otherwise, the sample is said to be *biased*.
3. Must be random	Random selection means that every member of the target population has an equal chance of being selected as part of the sample.

5.2.4 Evaluating Statistical Reports

Questions to Consider in Evaluating Statistical Reports	
❑ **What is the sample size?**	For national public opinion polls, 1,000 randomly selected individuals who are representative of the target population is considered a minimum number. For other, carefully designed studies (like clinical trials of experimental drugs), a smaller sample size can be justified.
❑ **Is the sample representative?**	If 25% of a state's voters are under the age of 30, are 25% of the sample in this age range?
❑ **Have all significant characteristics been considered?**	Sometimes it is difficult to determine which factors about a target population are important. For example, does the sex, or age, or ethnicity or educational level of the members of the sample matter?

Questions to Consider in Evaluating Statistical Reports	
❑ **If the statistical study is a poll, are the questions slanted or loaded?**	If a poll question is slanted to prompt a particular response, the results are unreliable. For example, consider this loaded question: "Do you believe the government has the right to invade people's private lives by taking a census?"
❑ **What is the credibility of the report's author or sponsor?**	Established polling organizations like Gallup, Harris, Roper, Pew, and Rasmussen are generally reliable. Research studies from universities and "think tank" organizations like the Rand Corporation are also generally reliable.
❑ **Could the survey be biased by the author's or sponsor's vested interest?**	If a company or organization is paying for a survey or research study to promote a product or service, there may be bias in the study design or the reporting of results. For example, a study funded by Dannon claimed that two out of three doctors who offer nutritional advice to their patients recommended that their patients eat more yogurt. Considering that the Dannon company makes yogurt, we should be skeptical about this study's results.

Sharpen Your Critical Thinking

- Analyze the quality of statistical evidence you would use to support the statement: "All/most people are ..."
- Take note of the size, representativeness, and randomness of the sample culled from your direct experience.
- Is there any reliable scientific or other relevant research to support your statement that " All/most people are ..."?

5.3 Causal Generalizations

Key Ideas/Terms	Definition
generalization	A mental process that abstracts from particular features to give a general form to something.
cause	A reason for the occurrence of an action or condition. Something that brings about an effect or a result.
effect	Something that inevitably follows a preceding event or condition. The result of an antecedent event or condition.
necessary condition	A is a necessary condition for B if B's occurrence requires A's occurrence. (B > A). In symbolic form, a necessary condition is expressed as the *consequent* of a conditional statement. For example, having air to breath is a necessary condition for human survival, or S > A (If you are Surviving, then you have Air to breathe.)

Key Ideas/Terms	Definition
sufficient condition	A is a sufficient condition for B if A's occurrence requires B's occurrence. (A > B). In symbolic form, a sufficient condition is expressed as the *antecedent* of a conditional statement. For example, having the flu is a sufficient condition for feeling crummy, or F > C (If you have the Flu, then you feel Crummy.)
correlation	A relation existing between phenomena or things, or between mathematical or statistical variables which tend to vary, be associated, or occur together in a way not expected on the basis of chance alone.
causal inference	"Causal inferences are the only way we can go beyond the evidence of our senses and memories. In making them, we suppose there is some *connection* between present facts and what we infer from them." (https://plato.stanford.edu/entries/hume/#Cau)

Begonia obliqua

In ordinary English language, the word *cause* can have various meanings. For example, if you say that watering your begonias will cause them to grow, you mean that water is necessary for their growth. And you could elaborate that water alone does not cause their growth; sunshine and healthy soil and air are also necessary. So, for your Begonias to grow, there are at least four necessary conditions: Water, Sunshine, Healthy soil, and Air. We can symbolize these necessary conditions for the growth of your begonias as: B > [(W & S) & (H & A)]

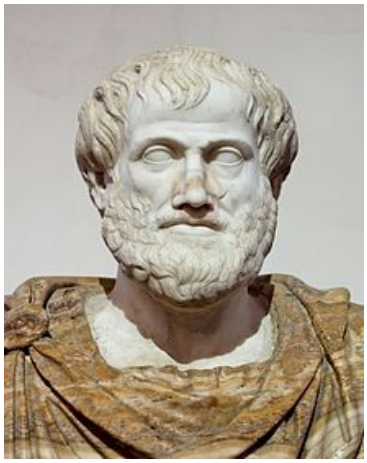
Now, what if you say that you are going for a swim in the pool which will cause you to cool off on a hot summer day. In this context, you mean that a dip in the pool will be sufficient to cool off. So, a Swim in the pool is a sufficient condition for Cooling down, or: S > C.

5.3.1 Aristotle's Insights

In *Physics* II 3 and *Metaphysics* V 2, Aristotle (384–322 BCE) recognizes four kinds of things that can be given in answer to a *why* question:

- The **material cause**: “that out of which”, e.g., the bronze of a statue.
- The **formal cause**: “the form”, “the account of what-it-is-to-be”, e.g., the shape of a statue.
- The **efficient cause**: “the primary source of the change or rest”, e.g., the artisan, the art of bronze-casting the statue, the man who gives advice, the father of the child.
- The **final cause**: “the end, that for the sake of which a thing is done”, e.g., health is the end of walking, losing weight, purging, drugs, and surgical tools.

(https://plato.stanford.edu/entries/aristotle-causality/)



Aristotle — Roman copy in marble of a Greek bronze bust

by Lysippos, c 330 BCE.

For Aristotle, scientific knowledge was knowledge of causes. To explain something scientifically was to demonstrate (prove), the necessary connection between a cause and its effect. This could be done from intuitively obvious premises that did not depend on experience for their truth to be determined.

During the medieval period in Europe, Thomas Aquinas (1224–74), adopted and synthesized Aristotle's science and metaphysics with Christian theology, and the Aristotelian theory of causation remained unchallenged until the emergence of modern science and philosophers like David Hume (1711–1776).

5.3.2 Hume's Conditions

When the English philosopher, David Hume, enters the debate, he translates the traditional distinction between knowledge and belief into his own terms, dividing 'all the objects of human reason or enquiry' into two exclusive and exhaustive categories: relations of ideas and matters of fact." (https://plato.stanford.edu/entries/hume/)

For Hume, our understanding of causation was nothing more than a "***constant conjunction***" between what we perceive to be a cause and its effect. In general, for Hume, there is no causal connection—only correlation between one observed event and another.

Hume's insights about causes lead us to understand that it is easier to observe connections and associations in time and space between two conditions than it is to prove that one of the conditions caused the other.

David Hume by Allan Ramsay, 1766, Scottish National Portrait Gallery, Edinburgh.

Hume's Conditions	Interpretation
1. The cause (X) preceded the effect (Y) in time.	If one thing is the cause, then it must precede (come before) the effect.
2. X and Y are contiguous (in contact with each other) in time and place.	Causes and effects take place at particular space-time coordinates.
3. There is a history (set) of observations of X preceding Y, and of X & Y related in space-time.	Future outcomes can be predicted depending on the quality/quantity of observations.

The word *cause* can be defined in different ways and can mean different things, depending on the context. So, for example, we can distinguish between the *immediate* or *proximate cause* of an effect, and *remote causes* or factors that do not immediately precede the effect. To clear up the ambiguity that can affect the word *cause*, it is useful to employ the distinction between *necessary* and *sufficient* conditions:

Types of Causes	Example	Explanation

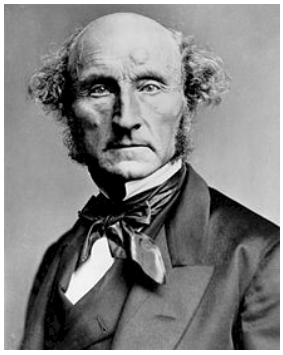
Types of Causes	Example	Explanation
sufficient condition	Electrocution by high voltage will cause you to Die. **E > D**	Electrocution by high voltage is certainly a sufficient cause for death. Note that there are other *sufficient* conditions for death like poisoning and drowning.
necessary condition	The Clouds will cause Rain. **R > C**	Here, *cause* means that the clouds are a *necessary* condition for rain. Of course, there are other necessary conditions like temperature and barometric pressure that are also necessary. The conjunction of all the necessary conditions is the sufficient condition that produces an event. Note that Aristotle's four causes are necessary conditions or causes that, taken together, are the sufficient cause of a being's existence.
sufficient & necessary condition	An increase in Voltage causes an increase in Electrical current and vice versa. **(V >E) & (E > V)**	Here, *cause* means that, for an electrical current to increase through a resistive circuit, nothing more and nothing less is required than an increase in voltage. See: https://en.wikipedia.org/wiki/Ohm%27s_law

5.3.3 Mill's Methods

Following in Hume's footsteps in the English empiricist tradition, the British philosopher, John Stuart Mill (1806-1873), devised several specific methods for helping in the systematic discovery of causes.

In his *System of Logic*, Mill argues that deductive argumentation is largely useless—it cannot produce new knowledge. One side of an equation simply says the same thing as the other side of the equation. All real knowledge is reducible to sense experience. Accordingly, Mill gave inductive logic the leading role in scientific discovery.

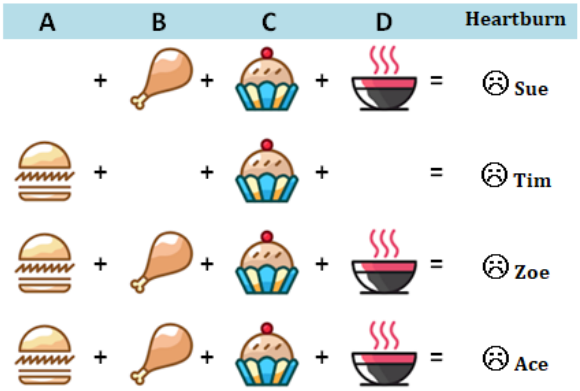
The ***method of agreement*** and the ***method of difference*** are two of Mill's techniques for discovering cause.

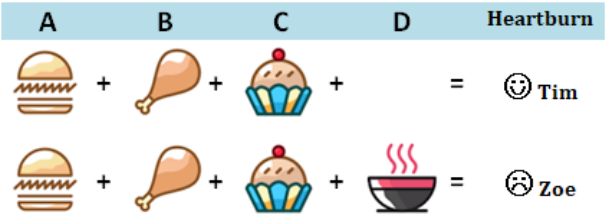


John Stuart Mill by London Stereoscopic Company, c 1870.

Method of Agreement	Method of Difference

Method of Agreement	Method of Difference
X is the only factor that it is always present when Y occurs.	**If X is present, then Y occurs. And if X is not present, then Y does not occur.**





5.3.3 General Scientific Method

General Scientific Method	
Observe	All scientific inquiry begins with observation of the natural world. As our instruments of observation become more powerful and sensitive, we are now able to observe aspects of reality that were undetectable before.
Construct	Using imagination, insight, and logic, create one or more hypotheses (possible explanations) for what was observed. If a hypothesis does not account for all the phenomena it is intended to explain, it is inadequate and should be disqualified.
Deduce	Predict some testable outcome or specific state of affairs that is entailed by the hypothesis. To be testable, a hypothesis must predict something more than what is already assumed by its background theory.
Test	Each hypothesis by checking out the deduced implications. If a hypothesis cannot be tested, there is no way to determine whether it is true or false. Hypotheses have observable consequences only in the context of a background theory.

Sharpen Your Critical Thinking

- It has been said that holding elections is a necessary but not a sufficient condition for establishing a democracy. What do you believe would be other necessary factors that would become sufficient for establishing a democratic government?
- Explain a couple of ways that we could determine what is causing an outbreak of spontaneous singing among some students in class.
- Jen says that, so far, all the philosophers she has encountered have been white European men. Jen says that this leads her to think that probably all philosophers are white men in the Western wisdom tradition. What do you make of Jen's argument?

5.4 Arguments from Authority

Key Ideas/Terms	Definition
expert	A person who has relevant educational and/or significant experience in a specific area. The testimony of experts can be used to support conclusions in arguments.
opinion leaders	People who are well informed, often through the media, about specific information and issues.

An argument from authority concludes that something is true because a presumed expert or witness has said that it is. Because authorities or experts can be either mistaken or lying, such arguments are essentially probabilistic.

5.4.1 Example Argument from Authority

Multiple studies published in peer-reviewed scientific journals (1) show that 97 percent or more of actively publishing climate scientists agree: Climate-warming trends over the past century are extremely likely due to human activities. In addition, most of the leading scientific organizations worldwide have issued public statements endorsing this position. The following is a partial list of these organizations, along with links to their published statements and a selection of related resources. (https://climate.nasa.gov/scientific-consensus/)

(1)

J. Cook, et al, "Consensus on consensus: a synthesis of consensus estimates on human-caused global warming," *Environmental Research Letters* Vol. 11 No. 4, (13 April 2016); DOI:10.1088/1748-9326/11/4/048002

J. Cook, et al, "Quantifying the consensus on anthropogenic global warming in the scientific literature," *Environmental Research Letters* Vol. 8 No. 2, (15 May 2013); DOI:10.1088/1748-9326/8/2/024024

W. R. L. Anderegg, "Expert Credibility in Climate Change," *Proceedings of the National Academy of Sciences* Vol. 107 No. 27, 12107-12109 (21 June 2010); DOI: 10.1073/pnas.1003187107.

P. T. Doran & M. K. Zimmerman, "Examining the Scientific Consensus on Climate Change," *Eos Transactions American Geophysical Union* Vol. 90 Issue 3 (2009), 22; DOI: 10.1029/2009EO030002.

N. Oreskes, "Beyond the Ivory Tower: The Scientific Consensus on Climate Change," *Science* Vol. 306 no. 5702, p. 1686 (3 December 2004); DOI: 10.1126/science.1103618.

5.4.1 Evaluating Arguments from Authority

When evaluating arguments that incorporate expert testimony, consider these common problems related to the putative expert:

- From the **wrong field of expertise** (a brain surgeon is a bad expert for a cardiac issue)
- **Not recognized** as an expert (by peer and/or general public)
- **Paid** for their testimony (an obvious form of bias)
- Personally or professionally **biased** (facts presented from a special point of view)
- **Failure to acknowledge the limits** of their expertise (lacking in intellectual humility)
- **Testimony contradicted** by equally expert testimony (broad disagreement is required)

Men are apt to mistake the strength of their feeling for the strength of their argument. The heated mind resents the chill touch and relentless scrutiny of logic. - William Gladstone

5.5 Arguments from Analogy

To say that two things (or cases) are analogous is to say that they are comparable in some relevant respect. Many analogies are used to better explain a difficult, obscure, or abstract concept in terms of something that is easier to understand, less mysterious, and concrete.

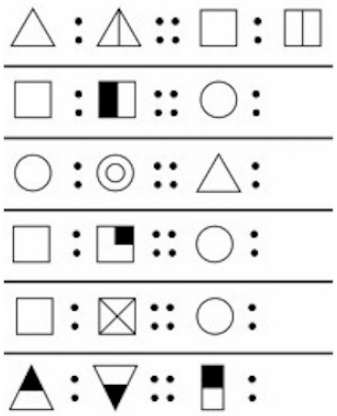
"Mama always said life was like a box of chocolates.
You never know what you're gonna get."
Forest Gump

An argument from analogy depends on the existence of a 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. The certitude attending such an inference is probabilistic at best.

Every analogy can be symbolized:

A is to **B** as **C** is to **D**, or **A:B :: C:D**

5.5.1 Example Analogies



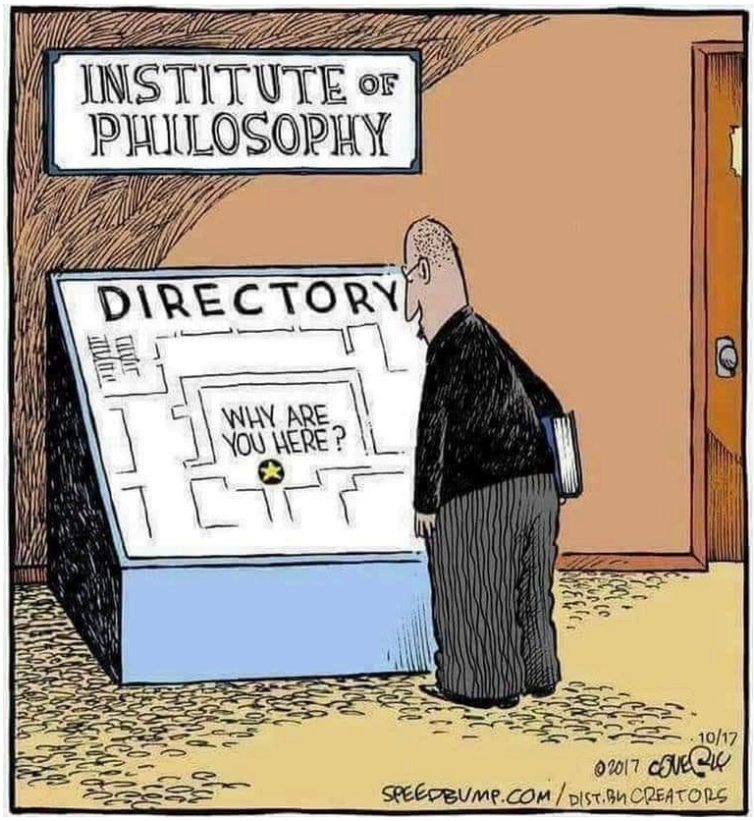
▶ The universe is a complex system like a watch. We wouldn't think that a watch can come about by accident. Something so complicated must have been created by someone. The universe is a lot more complicated.
/ So it must have been created by a being who is a lot more intelligent.

▶ This painting is like those others in its colors, forms, brushwork, etc. Those other paintings were painted by Rubens.
/ This painting was (probably) also painted by Rubens.

▶ Putting the situation like that is like rearranging the deck chairs on the Titanic.
/ You are trivializing the problem.

5.5.2 Evaluating Analogical Arguments

- The **more similarities** (between two domains), the stronger the analogy.
- The **more differences, the weaker** the analogy.
- The greater the **extent of our ignorance** about the two domains, the weaker the analogy.
- Analogies involving **causal relations are more plausible** than those not involving causal relations.
- **Structural analogies are stronger** than those based on superficial similarities.
- The **relevance of the similarities and differences** to the conclusion must be taken into account.
- **Multiple analogies** supporting the same conclusion make the argument stronger.



5.6 Assessing My Critical Thinking

Exercise 5	
If a friend or fellow student is not available to help you with this exercise, simply imagine someone asking you to explain these ideas and answer these questions. ▶ If you are confident in the clarity, accuracy, and completeness of your explanations, continue forward on the path. Otherwise, go back and study the areas where you have stumbled, and then return to this exercise.	▪ **What makes induction different from deduction?** ▪ **In general, how does inductive reasoning work?** ▪ **According to Hume, what is causation?** ▪ **What is a *necessary* condition? *Sufficient* condition?** ▪ **What are some possible weaknesses in statistical generalizations?** ▪ **What are some possible weaknesses in arguments from authority?** ▪ **What are some possible weaknesses in arguments from analogy?**

Quiet Reflection 5	
Self-reflection requires mental focus and personal honesty. At steps 2 and 3 especially, silence is very important. You must be able to hear your inner voice. Find a place that is quiet and comfortable. Turn off your phone and eliminate other distractions if possible.	
1. Observe/Study	▪ Continue your library and online research for learning more about the issue or problem you identified in Worksheet 1 for your ICT Letter.
2. Judge/Evaluate	▪ Have I encountered or constructed any inductive arguments in support of my ICT Letter's position? ▪ Have I encountered or constructed any inductive arguments against my ICT Letter's position? ▪ Am I becoming more intellectually humble as I continue to research my ICT Letter? If not, why not?
3. Act/Decide	▪ Identify the inductive arguments you will be discussing in your ICT Letter. ▪ Identify the strengths and weaknesses of these arguments. ▪ Cite or construct one or more counter arguments in support of the position you are taking on the issue covered in your ICT Letter. Use statistical data to support your argument. ▪ Continue to reflect on how your commitment to always seek the truth affects your family, neighborhood, community, and the whole planet.