An Intuitive Explainer for Logical Deduction

Contents

How to Use This Document

This document describes the basic process of logical deduction. It is inteded as a primer or basic aid to deduction. It will describe deduction, how to deduce, and how to spot bad logical deduction. It includes examples at the bottom of most pages which give practical examples of specific instances of deduction. More resources and a glossary of key terms can be found at the end of the document.

Introduction to Logical Deduction

Logic and *reasoning* are an important part of being human. This is because we, as humans, distinguish ourselves from animals through our faculty of *reasoning*. Interestingly, we already possess all the tools required for the process of *deductive reasoning*. However, since *deduction* is an abstract, specific, and unintuitive concept, it can be hard to grasp how to use the mind's tools effectively to reason *deductively*.

What is Deduction?

Deductive reasoning is the process of crafting an *argument* in a specific *valid form* which necessarily leads to a *conclusion*—given that the *premises* (reasons) for the *conclusion* are true.

How does one Deduce?

In *deduction*, we must consider two main factors: *validity* and *soundness*. A *valid argument* has a correct *logical form*. A *sound argument* has a correct *logical form,* and all the *premises* are true.

When we *deduce*, we first choose a *valid logical form*. This makes the *argument valid*. A *valid logical form* is necessary for any *deductive argument* and there are a limited number of *forms*. Some *logical forms* include modus ponens, hypothetical syllogism, and constructive dilemma.

Why is Deduction Useful?

Deduction is useful because it allows one to have complete *certainty* in a *conclusion*. When we have a *sound deductive argument*, it cannot be wrong, and we can rest assured the *conclusion* is always true.

For instance, we *deduce* when we think the following train of thought, "It's raining outside. Rain makes me wet. My raincoat keeps me dry. So, if I go outside and want to stay dry, I should take my raincoat."

We don't often think exactly in this sort of way, but it's often more of an intuition. We understand implicitly that we will get wet without a raincoat. And we know this to be 100% true because of the above sort of *reasoning*.

Note: a glossary of italicized terms can be found at the end of this document.

Examples 1: Deduction

An Example of Good Deduction (modus ponen*s*)

1. When it rains, the grass is wet.
2. It is raining outside.
3. Therefore, the grass is wet.

An Example of Bad Deduction (non-sequitu*r*)

1. This is a document about deduction.
2. You're reading this document.
3. Therefore, you will learn about painting.

What are some Common Logical Fallacies?

A *logical*, or formal, *fallacy* is a mistake in the *argument form*, or structure, of an *argument*. A bad structure does not allow the truth of the *conclusion* to flow naturally from the *premises*. Examples of a few common *logical fallacies* are found below.

Non-Sequitur

Non-sequitur is Latin for "it does not follow". This is when the *conclusion* is irrelevant to the *argument*. The "An Example of Bad Deduction" is a non-sequitur.

Denying the Antecedent

When we deny the *antecedent*, we are denying the *consequent* of a *conditional statement* because the *antecedent* is false. However, the *consequent* can be true by other means.

Affirming the Consequent

By affirming the *consequent* of a *conditional*, we also take the *antecedent* as true. However, the *consequent* can also be true with a different *antecedent*.

Scope Fallacy

This is when there is an ambiguity in scope of a claim. The scope is often used or *implied* in two ways: specific or universal. For example, in the claim "someone's doctor will retire," does "someone" refer to one person's specific doctor or everyone's doctor?

Equivocation

When we use a term in an *argument* in more than one way. For instance, bank can mean "riverbank", "money bank", or the verb "bank".

Examples 2: Fallacies

An Example of Denying the Antecedent

1. If I drink water, my thirst will be quenched.
2. I didn't drink water.
3. Therefore, my thirst isn't quenched.

Problem: I could have drunk tea, juice, or sports drink to quench my thirst instead.

An Example of Scope Fallacy

1. Every doctor is at some point a retiree.
2. This doctor exists at some point.
3. Therefore, this doctor is a retiree.

Problem: We equate the set of doctors to a specific doctor. "Some point" is ambiguous.

An Example of Equivocation

1. If I paint fences, then I'm a painter.
2. I painted a fence.
3. Therefore, I'm a painter—and I should enroll in art school.

Problem: We're equating fence painting with artistic fine art painting.

What are Some Common Logical Forms?

This section will highlight three common *deductive argument forms*. The *forms* use the placeholder variables, such as *p* and *q*, which stand in for different *statements*. We can substitute the variables for any *statement* to make a *valid argument*.

For example, in Examples 3, for the "An Example of Modus Tollens", *p* stands for "I touch the stove" and *q* "my hand will burn".

Modus Ponens

Modus Ponens is the simplest and most common *deductive argument*. It contains a *conditional premise*, where one *condition*, *p*, causes some effect or *consequent*, *q*. It affirms the *antecedent* and by *implication*, the *consequent*.

Modus Tollens

Modus Tollens is like *modus ponens* but instead denies the *consequent* and affirms the *antecedent*.

Hypothetical Syllogism

Hypothetical syllogism is another common *argument form*. It's like a double modus ponens, where the effect of one *conditional* links to a second *conditional*. Because they are linked, we can claim the first *condition* produces the second *conditional's* effect.

Constructive Dilemma

A constructive dilemma is also like a double modus ponens. However, instead of working in a chain, it has two affirmed *antecedents*.

Examples 3: Valid Argument Forms

An Example of Modus Ponens

1. If *p*, then *q*
2. *p*
3. Therefore, *q*

**An example of modus ponens can be found In Example 1 "Example of Good deduction"

An Example of Modus Tollens

1. If *p*, then *q*
2. Not *q*
3. Therefore, not *p*

If I touch the stove, then my hand will burn.
My hand didn't burn.
I didn't touch the stove.

An Example of Hypothetical Syllogism

1. If *p*, then *q*
2. If *q*, then *r*
3. Therefore, if *p*, then *r*

Foxes are mammals.
Mammals are animals.
A fox is an animal.

An Example of Constructive Dilemma

1. *p* or *q*
2. If *p*, then *r*
3. If *q*, then *s*
4. Therefore, *r* or *s*

It will either snow or rain tomorrow.
If it snows tomorrow then it will below 0º.
If it rains tomorrow, then it will be above 0º.
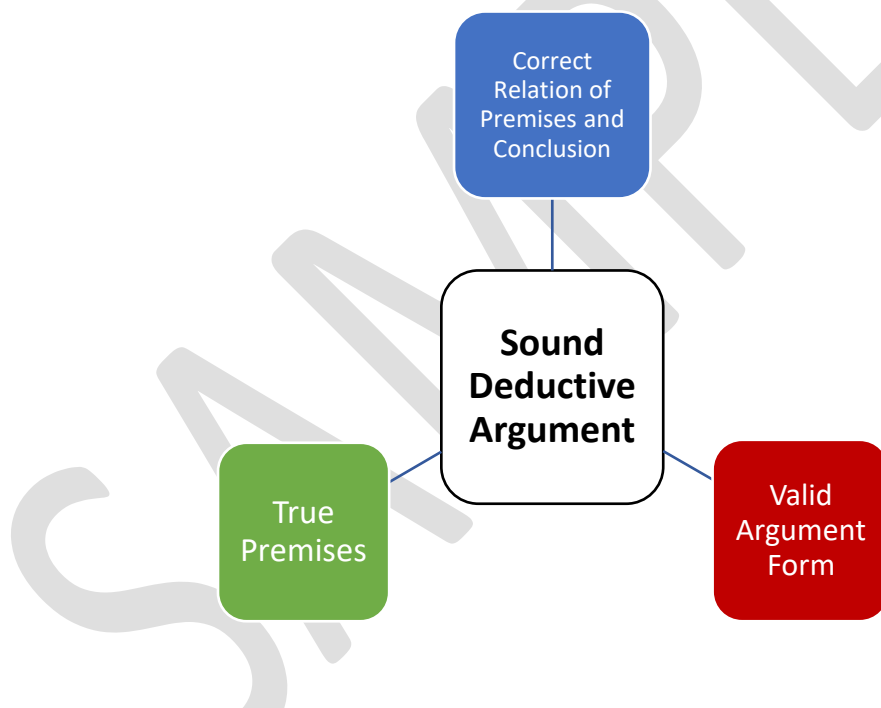So, tomorrow will either be above or below 0º.

How to Determine the Logical Consistency of a Deductive Argument

There are three steps in determining if a *logical argument* is *sound*. Follow each of the steps in turn. If you answer "no" for any of the steps, then the argument is not sound.

1. Observe the *form* of the *argument*. Is the *argument* in a *valid form*? If not, then it cannot be *sound*.

2. Check the *premises* of the *argument*. Are they all true? If not, then the *argument* cannot be *sound*.

3. Observe the relation of the *premises* and *conclusion*. Does the *conclusion* follow from the *premises*? Does it contain no more than what is contained in the *premises*?

By following these steps, you will be able to determine whether a *deductive argument* is *sound*.

Figure 1: The Three Necessary Conditions for Soundness

Examples 4: Conditional Statements

Conditional Statements

A *conditional statement* is an *implication* in the form:

$$p \rightarrow q$$

Where one factor, p necessarily produces some effect q.

We term this **if p, then q**, or "**if it rains, then I get wet**", or "**rain produces wetness**".

Conclusion

After reading this document, you should know the basics of *logical deduction*. You should be able to *deduce*, learn to spot bad *deduction*, and understand the overall process of *logical deduction*.

Deduction is useful to find *certainty* or truth in a claim, and requires a valid *form*, true *premises*, and a proper *premise-conclusion* relation.

So, get out there and *deduce*!

More Resources

A Master List of Logical Fallacies – University of Texas at El Paso

Validity and Soundness – Internet Encyclopedia of Philosophy

Classical Logic – Stanford Encyclopedia of Philosophy

Other forms of *inferential reasoning*:

- o Induction – Internet Encyclopedia of Philosophy
- o Abduction – Stanford Encyclopedia of Philosophy

Glossary of Key Terms

Antecedent: The *condition* which produces an effect in a *conditional statement*.

Argument: A set of *premises* meant to support some *conclusion*. *Arguments* are presented in a specific *form*.

Argument form: How the *premises* and *conclusion* are presented and relate; the *argument* structure.

Certainty: A property of *reasoning* which states that a *conclusion* is 100% true.

Conclusion: A *statement* which is supported by *premises*, or evidence.

Condition: A specific circumstance or fact which holds true.

Conditional: A *statement* which has both an *antecedent*, some cause which produces an effect, the *consequent*.

Consequent: The effect of a *conditional statement*.

Deduce: The act of doing *Deduction*.

Deduction: A mode of *reasoning* which provides *certainty* and guarantees a *conclusion*.

Deductive form: The *logical form* of an *argument*. See also "*Logical form*".

Fallacy: An unreliable or *unsound argument*; mistakes in *reasoning*.

Implication: A set of *premises* directly pointing to another *statement* or *conclusion*.

Inference: The act of a person reaching a *conclusion* based on some *premises*.

Logic: The study of correct rules of *inference* or a system of rules of *inference*.

Logical form: The *argument form* of a *deductive argument*. See also "*Argument form*".

Premise: A *statement* meant as evidence which provides support for another *statement*, often a *conclusion*.

Reasoning: A faculty of thought or mind that humans possess which allows us to consciously analyze ideas and concepts through providing reasons.

Soundness: A property of an *argument*. *Sound arguments* prove their *conclusions* because they have a *valid form* and all true *premises*.

Statement: What is claimed to be true.

Validity: A property of the structure of an *argument*. An *argument* is *valid* when it adheres to a structure, or *form*, where the *conclusion* cannot be false if all the *premises* are true.