Quantitative Skills & Reasoning – Math 1001

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Logic Unit
Arguments, Fallacies,
Inductive and Deductive Reasoning
pp 407 - 425 in textbook

Arguments

A logical argument is a claim that a set of premises support a conclusion. There are two general types of arguments: inductive and deductive arguments.

- An **inductive** argument uses a collection of specific examples as its premises and uses them to propose a general conclusion.

- A **deductive** argument uses a collection of general statements as its premises and uses them to propose a specific situation as the conclusion.

Example 1

The argument “when I went to the store last week I forgot my purse, and when I went today I forgot my purse. I always forget my purse when I go the store” is an **inductive argument**.

The premises are:

I forgot my purse last week

I forgot my purse today

The conclusion is:

I always forget my purse

Notice that the **premises are specific situations**, while the **conclusion is a general statement**. In this case, this is a fairly weak argument, since it is based on only two instances.

Example 2

The argument “every day for the past year, a plane flies over my house at 2:00 P.M. A plane will fly over my house every day at 2:00 P.M.” is a stronger **inductive** argument, since it is based on a larger set of evidence. While it is not necessarily true—the airline may have cancelled its afternoon flight—it is probably a safe bet.

Evaluating inductive arguments

An inductive argument is never able to prove the conclusion true, but it can provide either weak or strong evidence to suggest that it may be true.

A **deductive** argument is more clearly valid or not, which makes it easier to evaluate.

Evaluating deductive arguments

A **deductive argument** is considered valid if, assuming that all the premises are true, the conclusion follows logically from those premises. In other words, **when the premises are all true, the conclusion *must* be true.**

Evaluating Deductive Arguments with Euler Diagrams

We can interpret a deductive argument visually with an Euler diagram, which is essentially the same thing as a Venn diagram. This can make it easier to determine whether the argument is valid or invalid.

Example 3

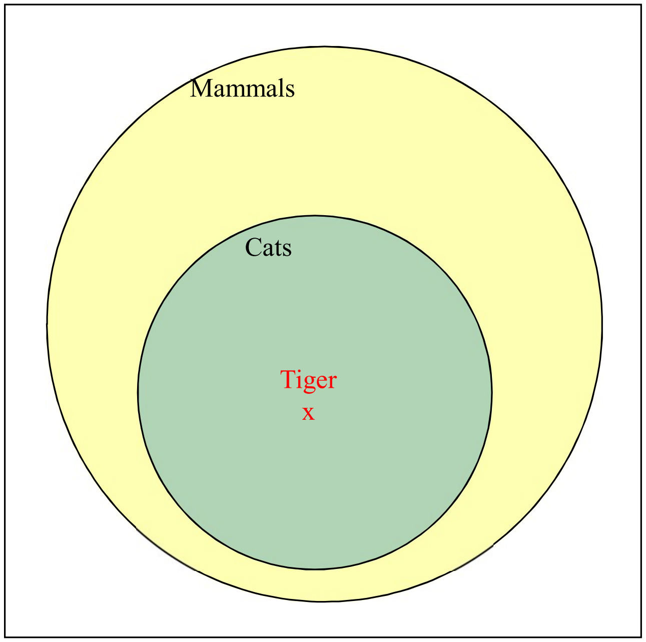
Consider the deductive argument "All cats are mammals and a tiger is a cat, so a tiger is a mammal." Is this argument valid?

The premises are:
All cats are mammals.
A tiger is a cat.

The conclusion is:
A tiger is a mammal.

Example 3 (cont)

Both the premises are true. To see that the premises must logically lead to the conclusion, we can use a Venn diagram. From the first premise, we draw the set of cats as a subset of the set of mammals. From the second premise, we are told that a tiger is contained within the set of cats. From that, we can see in the Venn diagram that the tiger must also be inside the set of mammals, so the conclusion is valid.



Analyzing arguments with Euler diagrams

To analyze an argument with an Euler diagram:

1) Draw an Euler diagram based on the premises of the argument

2) The argument is invalid if there is a way to draw the diagram that makes the conclusion false

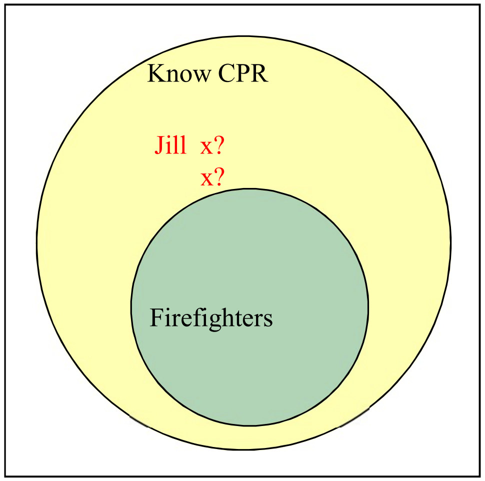
3) The argument is valid if the diagram cannot be drawn to make the conclusion false

4) If the premises are insufficient to determine the location of an element or a set mentioned in the conclusion, then the argument is invalid.

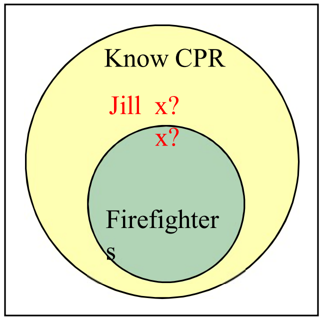
Example 4

Premise: All firefighters know CPR.

Premise: Jill knows CPR.
Conclusion: Jill is a firefighter.



Example 4 (cont)



From the first premise, we know that firefighters all lie inside the set of those who know CPR. (Firefighters are a subset of people who know CPR.) From the second premise, we know that Jill is a member of that larger set, but we do not have enough information to know whether she also is a member of the smaller subset that is firefighters.

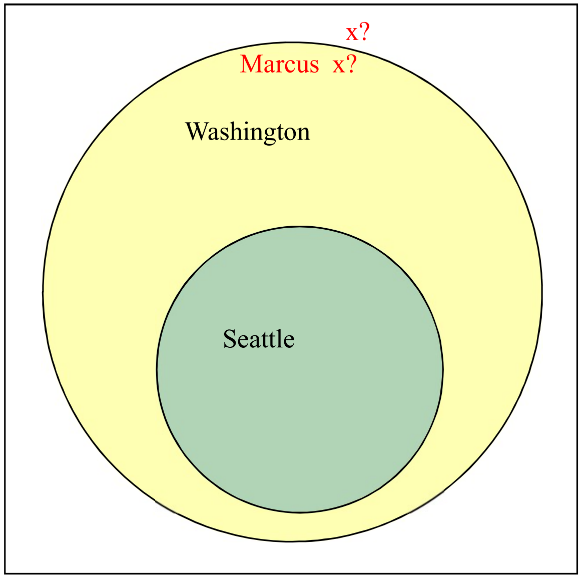
Since the conclusion does not necessarily follow from the premises, this is an invalid argument. It's possible that Jill is a firefighter, but the structure of the argument doesn't allow us to conclude that she definitely is.

It is important to note that whether or not Jill is actually a firefighter is not important in evaluating the validity of the argument; we are concerned with whether the premises are enough to prove the conclusion.

Example 5

Determine the validity of this argument:

Premise: If you live in Seattle, you live in Washington.
Premise: Marcus does not live in Seattle.
Conclusion: Marcus does not live in Washington.



We have insufficient information to know whether Marcus lives in Washington or not. This is an invalid argument.

The Fallacy of the Converse

There are two common forms that represent *invalid* arguments, which are also called *fallacies*.

- The fallacy of the converse arises when a conditional and its consequent are given as premises, and the antecedent is the conclusion. The general form is:

  Premise: $p \to q$

  Premise: q

  Conclusion: p

Example 6

Premise: If I drink coffee after noon, then I have a hard time falling asleep that night.

Premise: I had a hard time falling asleep last night.

Conclusion: I drank coffee after noon yesterday.

If we let c = I drink coffee after noon and h = I have a hard time falling asleep, then our argument looks like this:

Premise $c \rightarrow h$

Premise h

Conclusion: c

The Fallacy of the Inverse

The fallacy of the inverse occurs when a conditional and the negation of its antecedent are given as premises, and the negation of the consequent is the conclusion. The general form is:

Premise: $p \rightarrow q$

Premise: $\sim p$

Conclusion: $\sim q$

Example 7

Premise: If you listen to the Grateful Dead, then you are a hippie.
Premise: Sky doesn't listen to the Grateful Dead.
Conclusion: Sky is not a hippie.

If we let g = listen to the Grateful Dead and h = is a hippie, then this is the argument:
Premise $g \rightarrow h$
Premise $\sim g$
Conclusion: $\sim h$

This argument is invalid because it uses inverse reasoning. The first premise does not imply that all hippies listen to the Grateful Dead; there could be some hippies who listen to Phish instead.

Logical Fallacies in Common Language

In the previous discussion, we saw that logical arguments can be invalid **when the premises are not true**, **when the premises are not sufficient to guarantee the conclusion**, or **when there are invalid chains in logic**. There are a number of other ways in which arguments can be invalid, a sampling of which are given here.

Ad hominem

An **ad hominem** argument attacks the person making the argument, ignoring the argument itself.

“Jane says that whales aren’t fish, but she’s only in the second grade, so she can’t be right.”

Here the argument is attacking Jane, not the validity of her claim, so this is an ad hominem argument.

Appeal to ignorance

This type of argument assumes something it true because it hasn't been proven false.

"Nobody has proven that photo isn't of Bigfoot, so it must be Bigfoot."

Appeal to authority

These arguments attempt to use the authority of a person to prove a claim. While often authority can provide strength to an argument, problems can occur when the person's opinion is not shared by other experts, or when the authority is irrelevant to the claim.

"A diet high in bacon can be healthy; Doctor Atkins said so."

Appeal to consequence

An appeal to consequence concludes that a premise is true or false based on whether the consequences are desirable or not.

- "Humans will travel faster than light: faster-than-light travel would be beneficial for space travel."

False dilemma

A false dilemma argument falsely frames an argument as an “either or” choice, without allowing for additional options.

- “Either those lights in the sky were an airplane or aliens. There are no airplanes scheduled for tonight, so it must be aliens.”
- This argument ignores the possibility that the lights could be something other than an airplane or aliens.

Circular reasoning

Circular reasoning is an argument that relies on the conclusion being true for the premise to be true.

- “I shouldn’t have gotten a C in that class; I’m an A student!”
- In this argument, the student is claiming that because they’re an A student, though shouldn’t have gotten a C. But because they got a C, they’re not an A student.

Post hoc (post hoc ergo propter hoc)

A post hoc argument claims that because two things happened sequentially, then the first must have caused the second.

“Today I wore a red shirt, and my football team won! I need to wear a red shirt every time they play to make sure they keep winning.”

Straw man

A straw man argument involves misrepresenting the argument in a less favorable way to make it easier to attack.

- “Senator Jones has proposed reducing military funding by 10%. Apparently he wants to leave us defenseless against attacks by terrorists”
- Here the arguer has represented a 10% funding cut as equivalent to leaving us defenseless, making it easier to attack Senator Jones’ position.

Correlation implies causation

Similar to post hoc, but without the requirement of sequence, this fallacy assumes that just because two things are related one must have caused the other. Often there is a third variable not considered.

- “Months with high ice cream sales also have a high rate of deaths by drowning. Therefore, ice cream must be causing people to drown.”
- This argument is implying a causal relation, when really both are more likely dependent on the weather; that ice cream and drowning are both more likely during warm summer months.