Logic and Reasoning

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Critical Thinking
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Critical Thinking

Definition

Valid Reasoning

Common Errors in Reasoning

Case Study: The Harvard Dean[2ex]
Definition

Critical thinking is the process of evaluating a claim for the purpose of deciding whether to accept, reject, or suspend judgment about it.\(^1\)

It involves both the ability and the desire to ask the right questions.\(^2\)

It requires us to use valid logical principles to assess the arguments and evidence presented.

\(^1\)T.E. Damer in Attacking Faulty Reasoning.
\(^2\)Browne and Keeley, Asking the right questions: A guide to critical thinking
Questions to Ask

- What are the issues and the conclusions?
- What are the reasons and the evidence? Is the evidence valid?
- Are there errors in reasoning?
- What words or phrases are ambiguous?
- What significant information is omitted?
- What are the value assumptions and the value conflicts?
- Are they consistent with my own values?
- Are there rival explanations and conclusions?
Valid Reasoning

All reasoning starts with premises that are either facts or if...then statements. There are two simple, valid forms of reasoning, below.

- **Modus ponens** (the mode that affirms; the way of the bridge)
  
  If P, then Q. If you are very sick, you should stay home.
  
  P. You have a high fever and you are nauseous.
  
  Therefore, Q. Therefore, you should stay home.

- **Modus tollens** (the mode that denies)
  
  If P, then Q. To get credit, a student must come to class.
  
  Q is false. Jake is not coming to class.
  
  ∴ P is false. So Jake will not get credit for the course.
**A Good Argument**

It has been said that a proof is an argument that convinces another mathematician. What makes an argument convincing?

- All of the premises are true and you believe that they are true.
- Each premise is relevant to the issue.
- The collection of premises is sufficient; nothing important is missing.
- Valid steps of reasoning lead from the premises to the conclusion.
Common Errors in Reasoning

- Incorrect deduction steps. Incorrect use of implication.
- Incorrect application of negation to a premise with quantifiers.
- Errors arising from ambiguous use of words.
- Relying on faulty or untrue assumptions.
- Fallacies involving missing evidence.
- Causation confused with correlation.
- Irrelevant and distracting premises.
- Appeals to emotion, loyalty, or authority.
- Diversion from the main point.
- Circular arguments that assume the conclusion as a premise (beg the question).
Incorrect Deductive Inference

Arguments:

▶ All birds have wings.
▶ This creature has wings.
▶ Therefore, it is a bird.

Fallacy: Actually, the creature is a bat.

This fallacy comes from the mis-application of modus ponens: The premise is $Bird \rightarrow Wings$, but was taken as $Wings \rightarrow Bird$.

Speakers and writers often confuse implies, or $\rightarrow$, with equivalence and derive faulty arguments from that confusion.
Bad Logic: a Faulty Argument

The most common error in reasoning is to try to use Modus ponens backwards:

If P, then Q. If you are very sick, you should stay home.
Q. I am staying home
Therefore, P. Therefore, I am very sick.

▶ The speaker knows that Q is true.
▶ So he concludes that P is true.
▶ But this is not how if...then (implication) works; → is not the same as ≡ (equivalence).
Bad Placement of Quantifiers

The second most common error in reasoning is using quantifiers incorrectly:

All P are Q. All that glitters is not gold. (Shakespeare)
P. My ring glitters.
Therefore, Q. Therefore, my ring is not gold.

Fallacy: My ring is white gold with a diamond that glitters. This fallacy comes from the poetic misuse of *all* and *not*.

- The speaker put the “not” before the “all”, not after it.
- He should have said, “Things that glitter are not all gold”.
- After observing that my ring glitters, he could make no conclusion about whether it is gold or not.
An Error from Ambiguity

Argument:
- My Dell computer runs at a clock speed of 2.66 gigahertz.
- Your Mac Mini runs at 1.66 gigahertz.
- So my Dell will run Java faster than your Mac Mini.

Fallacy:
The words speed and fast are not measuring the same thing in the conclusion as in the premises. There is no direct connection between clock speed and the speed at which a program executes. (Many factors are involved in determining execution speed, including the width of the memory bus and the nature of the operating system.)
Unwarranted Assumptions

Argument:
- We tested this new software application for two weeks and in many ways.
- The testing did not reveal any remaining bugs.
- Therefore, there are no bugs in this software.

Fallacy:
It is erroneous to assume that the absence of evidence of an error means that no errors exist.
Missing Evidence

Argument:

- John is an excellent programmer.
- Rani is an excellent programmer.
- Chi-Fu is an excellent programmer.
- John, Rani, and Chi-Fu will make an excellent programming team.

Fallacy:
It is a large jump of faith to say that three good programmers will make a good team. Does one of these people have team-leadership skills? Are the others able and willing to take a follower role? Do all three work well in a group? Do their skills and knowledge complement each other?
Bad Arguments

Causation vs. Correlation

Argument:

- I know five people who dropped out of school.
- They all had really high intelligence.
- High intelligence causes people to drop out of school.

Fallacy:
We can observe a pattern here. There is a correlation between high IQ and problems in school. But we cannot say that high IQ causes people to drop out. Much information is missing here.
Irrelevant Premises

Argument:

- Dr. Jones proposed teaching a new course on GUIs.
- If he teaches this new course, he won't have time to teach the service course.
- The service course is important.
- Therefore, we should not approve the new course proposal.

Fallacy:
The service course is not related to the issue of whether the new GUI course is good or bad, or whether we should approve the proposal. The service course is a distraction that diverts attention from the real issue: will the new course be beneficial?
Bad Arguments

An Appeal to Belief

Argument:

▶ John believes that the new software product is ready to release.
▶ Rani is convinced that it needs another month of testing to avoid the possibility of catastrophic failure.
▶ Everybody knows that compromise is a good idea.
▶ Therefore, we will do two more weeks of testing.

Fallacy:
The general statement about compromise might be correct, but does it apply in this situation? Another common example of this fallacy is the belligerent drunk who, when asked to leave the premises, shouts This is a free country; you cant tell me what to do.
Bad Arguments

Appeal to Emotion or Loyalty

Argument:

▶ You are Hispanic and your car was totaled by an unlicensed driver.
▶ The attorneys in our law firm are Hispanic.
▶ Hispanics should stick together.
▶ Therefore, you should hire us to handle your case.

Fallacy:
Belonging to the same group or club is not a sufficient qualification here. The track record of the Hispanic law firm is much more relevant, but is not supplied.
A Circular Argument

Argument:

- The criteria for patentability are originality, novelty, utility, and non-obviousness.
- My invention is clearly non-obvious.
- My invention is useful, original and novel.
- So my invention clearly deserves to be patented.

Fallacy:
This is no argument – it is just a restatement of the conclusions. When you apply for a patent, you are expected to supply facts and figures to demonstrate the required properties. A thorough search for preexisting work is necessary. It is not enough simply to assert that you are a good guy and invented a good thing.
Case Studies

The Harvard Dean of Divinity

The Ethics of War
The Harvard Dean of Divinity

Situation:

- The Dean had a home office with a computer on which he stored thousands of porn images.
- The Dean asked the Divinity Schools computer technician to service his machine.
- The technician discovered the images. They were tasteless but not explicitly illegal.
- The technician reported the images to his boss, who reported to the administration.
- The Dean was asked to resign his leadership position but remained at Harvard as a tenured faculty member.

Question: Privacy is a right guaranteed by our constitution. So was the technician right or wrong to report the images? Should he have kept silent?
Gathering Evidence

- Who owned the home and the computer? (Harvard).
- What was the disk problem? (Out of space to store files. The Dean asked for a new, larger, faster disk.)
- The existence of the files was discovered in the normal course of doing the requested disk upgrade.
- By law, an employee has no right to privacy when using a machine owned by his employer.
- The Harvard Divinity School handbook explicitly prohibits storing inappropriate, obscene, bigoted, or abusive material.
- Harvard policy restricts the use of university computers to job-related purposes.
- The technicians supervisor asked him why it was taking so long to upgrade the Dean’s disk.
- Every employee has a responsibility to his or her employer.
Your Conclusion?

- Is there evidence missing?
- Did the technician behave ethically?
- Why or why not?
The Question of War

The Position of the Union Theological Seminary

- We agree that killing is wrong.
- War involves killing.
- Therefore war is always wrong.

This is a simple, consistent argument based on basic principles. The problem comes in the application of the argument to reality, as is shown by the reasoning of the opposing side.

The question is... do we have an equal duty to avoid killing and prevent killing?
The Question of War

The Position of George W. Bush

- Killing is wrong.
- Many people have been and will be killed by terrorists.
- So terrorism is wrong
- It is our duty to oppose wrong wherever we see it.
- Therefore, it is our duty to fight terrorism.
- You can't fight terrorism passively; you must act.
- Many terrorist groups are led and organized in the Middle East by radicals, in the name of religion.
- Therefore, the war on terrorists must be taken to the Middle East where they originate.
Your Conclusion?

- Is there evidence missing?
- Was the war in Afghanistan and Iraq ethical?
- Why or why not?