

What is a logical argument?
What is inductive reasoning?

Fundamentals of Academic Writing

Logical relations

- Deductive logic
 - Claims to provide conclusive support for the truth of a conclusion
 - Valid argument, true premises yield true conclusion
- Inductive logic
 - Arguments support a conclusion, but do not claim to show that it is necessarily true.
 - Strong arguments suggest likely conclusions.

Logical relations

- “A great many arguments are not designed to demonstrate the truth of their conclusions [but] to establish them as probable.”
 - Irving Copi, *Introduction to Logic*

Inductive logic

- Does not seek to prove the conclusion
- Offers *support* for a *probable* conclusion
 - Statistical likelihood
 - Generalization
 - New data can strengthen (or weaken)

Syllogism

- Review: (deductive/categorical) syllogism
 - All P is M.
 - All M is Q.
 - Therefore, all P is Q.
- Categorical: Premises are either true or not.
- (Plus, the middle term must be true for “all” in at least one of the premises.)

Statistical syllogism

- Statistical syllogism
 - Like a syllogism, conclusion is inferred from two premises.
 - Unlike (deductive) syllogism, the premises are not categorical.
 - X portion of S is Q.
 - J is S.
 - Therefore, J has X likelihood of being Q.

Statistical syllogism

- X portion of S is Q.
- J is S.
- Therefore, J has X likelihood of being Q.

Most children who survive until their fifth birthday live to be over 70 years old.*

Kobayashi is over five years old.

Kobayashi will most likely live to be over 70.

Statistical syllogism

Most children who survive until their fifth birthday live to be over 70 years old.*

Kobayashi is over five years old.

Kobayashi will most likely live to be over 70.

*Note that statistical syllogisms don't have to use numerical statistics. Many use words like "most" or "few".

Statistical syllogism

*Stocks typically outperform bonds during the first recovery year after a recession. Japan experienced a recession during 2012-13, but is now experiencing recovery. Therefore, stocks will probably do better than bonds in 2014.**

*This is just an example. It is not actual investment advice.

Statistical syllogism

Ninety-two percent of Nagoya University students are from Japan.

Suzuki is a Nagoya University student.

Therefore, Suzuki is likely (92%) to be from Japan.

Statistical syllogism

Only 0.1% of Nagoya University students are from Brazil.

Silva is a Nagoya University student.

Therefore, Silva is not likely (only 0.1% likely) to be from Brazil.

Be careful!

- An individual may be a member of many classes.
- Arguing from an inappropriate class may yield a conclusion that appears strong, but is misleading or false.

Be careful!

Ninety-two percent of Nagoya University students are from Japan.

Chen is a Nagoya University student.

Therefore, Chen is likely (78%) to be from Japan.

- But Chen is a graduate student, and only 78% of Mei-Dai graduate students are from Japan.

Be careful!

- Don't confuse particular (*some, most, 92%*) for categorical (*all*) statements.

Most birds can fly.

This penguin is a bird.



Logic looks OK, but conclusion is false.

Therefore, this penguin most likely can fly.

- Particular cases may not follow general rule.
- Be careful to account for possible exceptions.

Be careful!

- Don't confuse particular (*some, most, 92%*) for categorical (*all*) statements.

Only 0.1% of Nagoya University students are from Brazil.

Silva is a Nagoya University student.

Therefore, Silva is not likely (only 0.1% likely) to be from Brazil.

But Silva is a common name in Brazil, and more Nagoya students come from Brazil than from other non-Asian countries.

Analogy

- Argument from analogy

P is similar to *Q* regarding property *a*, *b*, *c*

P has property *d*

Q probably has property *d*

Analogy

- Apples are deciduous trees. Pears are deciduous trees.
 - Apple trees flower in spring. Pear trees flower in spring.
 - Apples fruit in summer or fall. Pears fruit in summer or fall.
 - Apples are cold-hardy. Pears are cold-hardy.
 - Apples can grow at high altitude.
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- Therefore, it is likely that pears can grow at high altitude.

Analogy

The structure of atoms, with electrons orbiting nuclei, resemble planets orbiting stars. The electrical force that holds electrons near their nucleus is similar to the gravity that holds planets around their star. Both gravity and electrical force decrease in strength with the square of distance.

It follows that electrons should move around nuclei in the same way that planets move around stars.

Analogy

- Evaluating the strength of analogy
 - **Number**
 - More instances strengthen analogy; fewer instances weaken it.
 - More (relevant) similarities suggest stronger analogy.
 - Dissimilarities weaken the analogy; fewer dissimilarities suggest stronger analogy.
 - (Deductive reasoning is either valid or not; number doesn't strengthen it.)



Analogy

- Evaluating the strength of analogy
 - **Relevance**
 - Similarities must be relevant to the conclusion.
 - **Diversity**
 - More variety among instances and similarities suggests stronger analogy. If the points of similarity are the same type, analogy is less strong.

Generalization

- Inductive generalization

S_1 is P.

S_2 is P.

Therefore, it is likely that S_3 is P.

(OR) Therefore, it is likely that all S are P.

- Resembles analogy
- Strengthened by repeated measures

Generalization

Twenty-seven patients came to the hospital with yellow fever. Each of the 27 patients was bitten by mosquitoes. Therefore, it is likely that everyone with yellow fever was bitten by mosquitoes.

Generalization

- Statistical generalization

X % of S observed are P.

Therefore, it is probable X % of all S are P.

- “Margin of error” – chance conclusion is wrong
- Larger observed sample, smaller margin of error

Generalization

A sample of 1,054 voters were asked whether they approve of the government. Fifty-eight percent of people surveyed say they approve; 34% say they disapprove.

Therefore, it is likely that most voters approve of the government.

(Given the sample size, the margin of error is about 3%. For details, take a statistics class.)

Generalization

- Beware of hasty generalization: big conclusion based on a small sample.

Since entering this town, I have seen three people. All three were children. Therefore, people in this town are probably all children.

“Extraordinary claims require extraordinary evidence.”

-Carl Sagan

Be careful!

- How big the sample? Small samples mean less confidence, more chance of hasty generalization.
- Is the sample representative (typical) of the population?