Argument Evaluation

Telling Good Reasoning from Bad

Brendan Shea, PhD

Introduction to Logic

What is an Argument? Distinguishing Arguments from Other Forms of Discourse

- An **argument** is a set of statements where some (the premises) are offered as support for another (the conclusion).
- Arguments differ from explanations, which tell why something happened rather than trying to prove it's true.
- Arguments differ from mere opinions, which don't offer reasoned support for claims.
- Arguments can be explicit (clearly stated) or implicit (with unstated assumptions).

Key Insight

Not all text containing claims is an argument—arguments specifically attempt to establish the truth of a conclusion through reasoning.

The Building Blocks: Premises and Conclusions

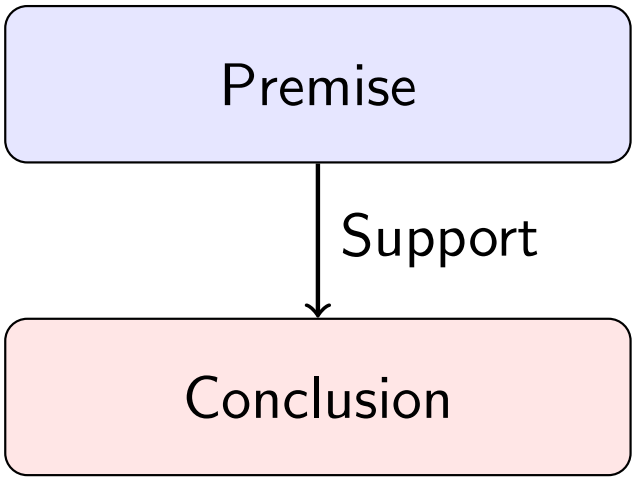
- **Premises** are the statements offered as reasons or evidence to support the conclusion.
- The **conclusion** is the statement that the premises are intended to establish or support.
- Every argument must have at least one premise and exactly one conclusion.
- The relationship between premises and conclusion constitutes the logical structure of the argument.

Example

Premise 1: All humans are mortal.
Premise 2: Socrates is human.
Conclusion: Therefore, Socrates is mortal.

Indicator Words: How to Identify Premises and Conclusions

- **Conclusion indicators** signal that a conclusion follows: "therefore," "thus," "hence," "so," "consequently."
- **Premise indicators** signal that a premise is being offered: "because," "since," "given that," "as."
- Indicator words provide clues but aren't always present in natural language arguments.
- Context often matters more than specific words when identifying premises and conclusions.



Converting Arguments to Standard Form: A Step-by-Step Process

- **Standard form** arranges an argument with premises listed first and the conclusion last.
- Step 1: Identify all statements that function as premises and the conclusion.
- Step 2: Eliminate irrelevant information and clarify ambiguous language.
- Step 3: Number the premises and label the conclusion for clear reference.

Standard Form Template

Premise 1: [Statement]
Premise 2: [Statement]
⋮
Premise n: [Statement]
Conclusion: [Statement]

Common Challenges in Identifying Arguments

- Arguments in everyday language often contain **implicit premises** that must be reconstructed.
- Multiple conclusions may appear, requiring identification of the main conclusion.
- **Subarguments** occur when some premises are supported by other premises before supporting the main conclusion.
- Argumentative text is often mixed with rhetorical questions, examples, and repetition.

Warning

When reconstructing arguments, be careful not to create straw men by misrepresenting the original reasoning.

The Dual Nature of Argument Evaluation

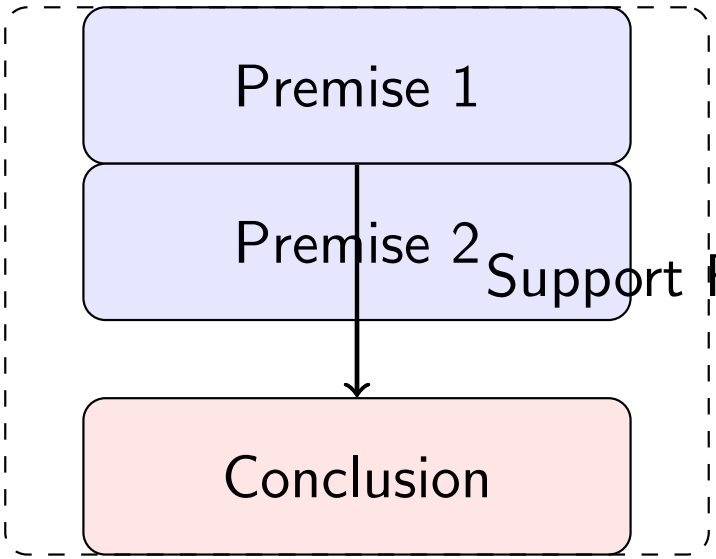
- Argument evaluation requires answering two distinct questions about any argument.
- We must separate questions of **logical structure** from questions of **factual accuracy**.
- An argument can have a strong logical structure but false premises, or true premises but a weak structure.
- Complete evaluation requires examining both aspects independently before making a final judgment.

	True Premises	**False Premises**
Good Structure	Strong argument	Weak argument
Poor Structure	Weak argument	Weak argument

Table: Argument strength depends on both structure and truth

Question 1: Do the Premises Support the Conclusion? (Logical Structure)

- This question examines the **inferential relationship** between premises and conclusion.
- We evaluate whether the premises provide good reasons to accept the conclusion, regardless of their truth.
- Different argument types have different standards for what counts as "good support."
- This evaluation focuses on form and pattern rather than content.



Question 2: Are the Premises Actually True? (Factual Accuracy)

- This question examines the **truth value** of each individual premise.
- Truth assessment requires domain knowledge beyond pure logic.
- Premises may be certainly true, certainly false, or somewhere in between.
- For complex arguments, we should assess the likelihood of each premise independently.

Methods for Assessing Truth

- Direct observation
- Expert testimony
- Statistical evidence
- Established scientific knowledge

The Relationship Between Structure and Truth

- An argument with true premises but poor structure gives no good reason to accept the conclusion.
- An argument with excellent structure but false premises cannot establish a true conclusion.
- The strongest arguments combine true premises with strong logical structure.
- **Formal fallacies** occur in the structure, while **informal fallacies** often involve questionable premises.

The Logic Formula

Good argument = Valid/Strong structure + True premises

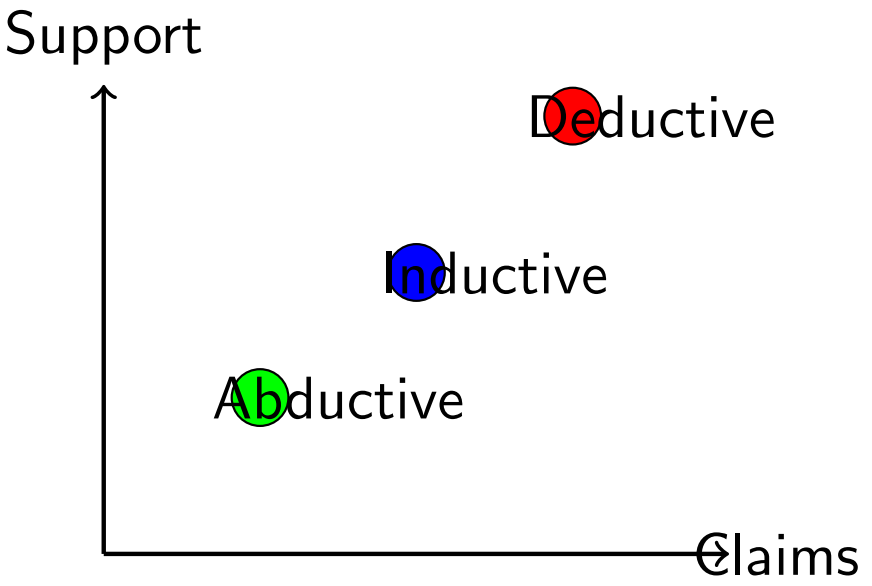
Three Major Categories of Arguments: An Overview

- Arguments can be classified into three major types based on the relationship claimed between premises and conclusion.
- Each type of argument makes a different kind of claim about how strongly its premises support its conclusion.
- The type of argument determines the appropriate standards for evaluating its logical structure.
- Recognizing argument type is the first step in proper evaluation.

Argument Type	**Claimed Support**	**Evaluation Terms**
Deductive	Necessity	Valid/Invalid
Inductive	Probability	Strong/Weak
Abductive	Best Explanation	Better/Worse

Deductive Arguments: Claiming Necessity

- **Deductive arguments** claim that if their premises are true, their conclusion must necessarily be true.
- They aim for certainty based on the logical form of the argument.
- Deductive reasoning moves from general principles to specific conclusions.
- Common forms include syllogisms, modus ponens, modus tollens, and mathematical proofs.



Case Study: Atticus Finch (Deductive Legal Reasoning)

From "To Kill a Mockingbird"

Atticus's defense of Tom Robinson centers on the physical impossibility of him committing the crime.

Standard Form:

- Premise 1: The person who assaulted Mayella Ewell primarily used their left hand.
- Premise 2: Tom Robinson's left hand is completely disabled (paralyzed).
- Premise 3: A person cannot primarily use a hand that is disabled.
- Conclusion: Therefore, Tom Robinson could not have assaulted Mayella Ewell.

Analysis: This is a valid deductive argument based on physical impossibility. The evidence supports all premises, making it sound. However, the jury rejects it due to racial prejudice, demonstrating how social biases can override logical reasoning in practice.

Inductive Arguments: Claiming Probability

- **Inductive arguments** claim that if their premises are true, their conclusion is probably true.
- They aim for likelihood rather than certainty, allowing for exceptions.
- Inductive reasoning typically moves from specific observations to general conclusions.
- Common forms include generalizations, statistical arguments, and analogical reasoning.

Inductive Example

Premise 1: Swan 1 is white.
Premise 2: Swan 2 is white.
Premise 3: Swan 3 is white.
⋮
Premise 100: Swan 100 is white.
Conclusion: Probably, all swans are white.

Case Study: Pride and Prejudice (Inductive Reasoning)

From "Pride and Prejudice"

Elizabeth forms an opinion of Mr. Darcy based on their initial encounters and his treatment of others.

Standard Form:

- Premise 1: Mr. Darcy refused to dance with anyone at the ball and called Elizabeth "not handsome enough."
- Premise 2: Mr. Darcy appears to have wronged Mr. Wickham, denying him his rightful inheritance.
- Premise 3: Mr. Darcy separated Mr. Bingley from Jane, ruining her happiness.
- Conclusion: Therefore, Mr. Darcy is proud, disagreeable, and morally deficient.

Analysis: This is an inductive argument that generalizes about Darcy's character from specific instances. While initially strong (the evidence supports the conclusion), it proves weak as Elizabeth later discovers her premises contain falsehoods and misinterpretations, particularly regarding Wickham.

Abductive Arguments: Seeking the Best Explanation

- **Abductive arguments** claim that their conclusion is the best explanation for the evidence presented in the premises.
- They aim to identify the most plausible cause or reason among competing hypotheses.
- Abductive reasoning moves from observations to likely explanations.
- Common in scientific discovery, medical diagnosis, and detective work.

Characteristics of Good Explanations

- Simplicity (Occam's Razor)
- Explanatory scope
- Consistency with background knowledge
- Lack of ad hoc elements

Case Study: Hermione Granger (Abductive Reasoning)

From "Harry Potter and the Chamber of Secrets"

Hermione solves the mystery of the Chamber of Secrets monster.

Standard Form:

- Premise 1: Students are being petrified but not killed.
- Premise 2: Harry hears a voice in the walls that others cannot hear.
- Premise 3: Spiders are fleeing from the castle.
- Premise 4: A basilisk is a snake that can kill with its gaze, causes spiders to flee, and its voice would only be heard by a Parselmouth.
- Conclusion: The monster in the Chamber of Secrets is most likely a basilisk, and victims are seeing it indirectly (reflections, etc.).

Analysis: This is an abductive argument seeking the best explanation for the evidence. Hermione identifies a hypothesis that comprehensively explains all observations more coherently than alternatives, demonstrating strong inference to the best explanation.

Clues for Identifying Argument Types in Natural Language

- Deductive arguments often use terms like "necessarily," "certainly," "must be," or "it follows that."
- Inductive arguments often use terms like "probably," "likely," "tends to," or "in most cases."
- Abductive arguments often use terms like "best explains," "most reasonable account," or "most plausible reason."
- Context and content also provide clues about the intended argument type.

Language Used	**Likely Argument Type**
"All X are Y"	Deductive
"Most X are Y"	Inductive
"The evidence suggests..."	Inductive or Abductive
"This would explain why..."	Abductive

Practice: Classifying Arguments by Type

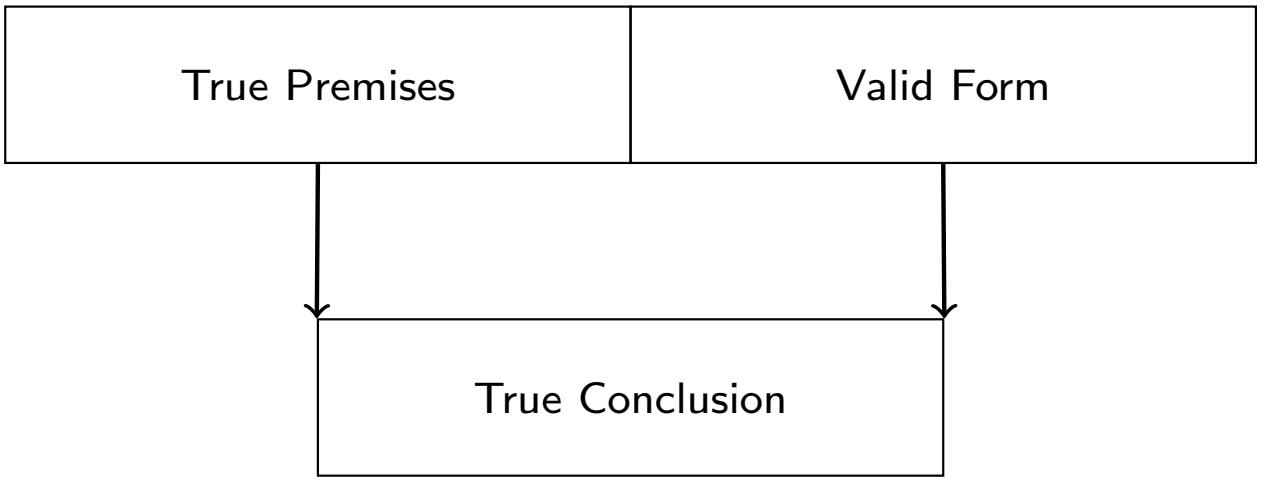
- Identifying argument type is a skill that improves with practice.
- Consider both the language used and the intended strength of the conclusion.
- Arguments may combine elements of different types or be ambiguous.
- When in doubt, consider what standards the arguer would accept as appropriate for evaluation.

Common Mistake

Don't confuse the actual strength of an argument with its intended type. A weak deductive argument is still deductive in type, even if it fails to establish necessity.

The Ideal of Deductive Reasoning: Guaranteeing Truth Preservation

- Deductive reasoning aims to **preserve truth** from premises to conclusion.
- If the premises are true and the reasoning is valid, the conclusion must be true.
- Truth preservation is binary: either an argument preserves truth or it doesn't.
- This provides certainty but requires meeting a high standard of evidence and reasoning.



Sound Deductive Argument (Valid with True Premises)

Validity: What It Means and What It Doesn't

- An argument is **valid** if and only if it's impossible for its premises to be true while its conclusion is false.
- Validity is about the logical structure of the argument, not about the truth of its premises.
- A valid argument with false premises can lead to a false conclusion.
- Validity doesn't guarantee truth—it guarantees that truth flows from premises to conclusion if the premises are true.

Valid Argument with False Premises

Premise 1: All lizards have six legs.
Premise 2: Komodo dragons are lizards.
Conclusion: Therefore, Komodo dragons have six legs.
This argument is valid but unsound because Premise 1 is false.

Counterexamples: The Power of a Single Case

- A **counterexample** is a scenario where the premises are true but the conclusion is false.
- Finding even one counterexample proves an argument is invalid.
- Counterexamples show that the logical form of the argument allows for exceptions.
- Constructing counterexamples is one of the most powerful tools for evaluating deductive arguments.

How to Construct a Counterexample

1. Accept all premises as true (for the sake of argument)
2. Imagine a situation where the conclusion is false
3. Verify that this situation doesn't contradict any premises
4. If successful, you've found a counterexample

Finding Counterexamples: Systematic Strategies

- Replace terms in the argument with variables, then find substitutions that invalidate it.
- Consider extreme or boundary cases that satisfy the premises but not the conclusion.
- Use analogical reasoning to construct parallel arguments with obviously false conclusions.
- For categorical arguments, use Venn diagrams to find possible counterexamples.

Example

Original: "All doctors are educated. Sarah is educated. Therefore, Sarah is a doctor."
Counterexample structure: "All A are B. C is B. Therefore, C is A."
Substitute: "All dogs are mammals. Cats are mammals. Therefore, cats are dogs."
This shows the original argument form is invalid.

Formal Methods of Argument Evaluation: Logic Systems and Rules

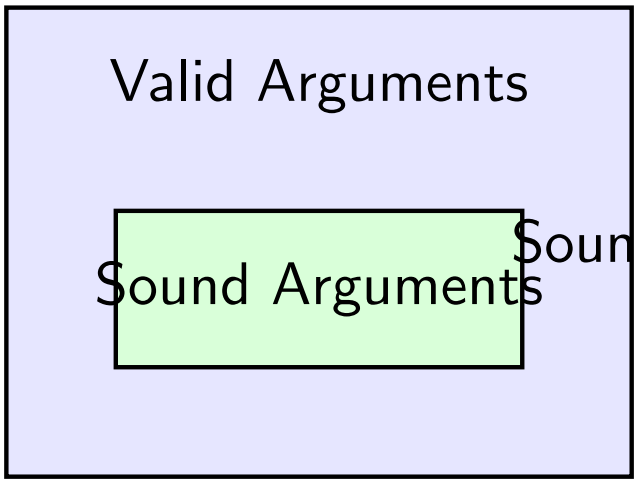
- **Formal logic** provides systematic methods for evaluating deductive arguments.
- Propositional logic uses truth tables to test validity by examining all possible truth value combinations.
- Predicate logic uses quantifiers and relations to analyze more complex arguments.
- Rule-based systems employ rules of inference like modus ponens and modus tollens.

Basic Rules of Inference

Modus Ponens: If $P \rightarrow Q$ and P, then Q
Modus Tollens: If $P \rightarrow Q$ and not Q, then not P
Hypothetical Syllogism: If $P \rightarrow Q$ and $Q \rightarrow R$, then $P \rightarrow R$
Disjunctive Syllogism: If P or Q and not P, then Q

Soundness: When Valid Arguments Have True Premises

- A deductive argument is **sound** if and only if it is valid and all its premises are true.
- Soundness is the gold standard for deductive arguments—it guarantees a true conclusion.
- An argument can be valid but unsound if any of its premises are false.
- Soundness requires both logical and factual evaluation.



Sound $\subset$ Valid

Case Study: Jean-Luc Picard (Ethical Deductive Reasoning)

From "Star Trek: The Next Generation" - "The Measure of a Man"

Captain Picard argues that the android Data deserves rights as a sentient being.

Standard Form:

- Premise 1: All sentient beings have the right to self-determination.
- Premise 2: Sentience is defined by intelligence, self-awareness, and consciousness.
- Premise 3: Data demonstrates intelligence, self-awareness, and consciousness.
- Conclusion: Therefore, Data has the right to self-determination and cannot be dismantled against his will.

Analysis: This is a valid deductive argument. Its soundness hinges on whether the definition of sentience is adequate and whether Data truly meets all criteria. The argument challenges us to consider what makes someone a "person" with rights.

The Nature of Inductive Strength: Degrees of Support

- Unlike validity, **inductive strength** is a matter of degree rather than all-or-nothing.
- An inductively strong argument makes its conclusion probable but not certain.
- The strength of an inductive argument increases with more relevant evidence.
- Inductive arguments can be undermined by new evidence without being completely defeated.

Evaluating Sample Size: When Is Evidence Sufficient?

- The **sample size** of an inductive argument directly affects its strength.
- Larger samples generally provide stronger support for generalizations.
- The required sample size depends on the population variability and claim specificity.
- Sample size requirements increase when making precise or counter-intuitive claims.

Claim Type	**Small Sample**	**Large Sample**
General trend	Weak support	Strong support
Precise percentage	Very weak	Moderate support
Universal claim	Extremely weak	Moderate support

Representative Samples: Quality Matters as Much as Quantity

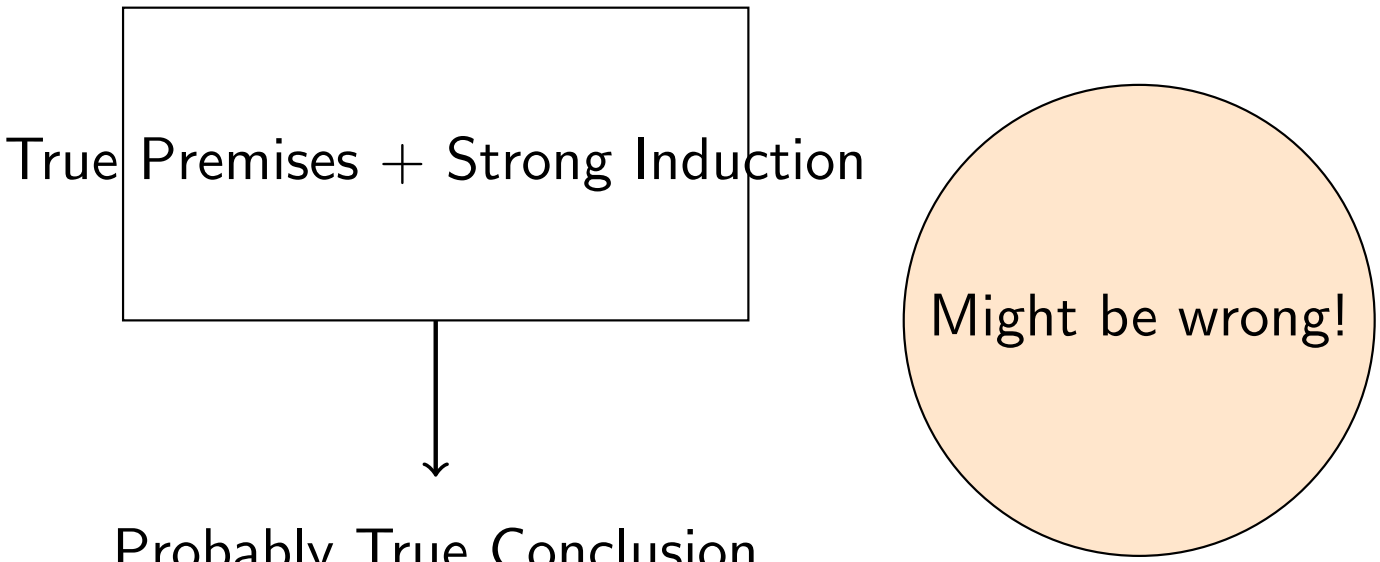
- A **representative sample** accurately reflects the relevant characteristics of the whole population.
- Biased sampling can lead to false generalizations even with large sample sizes.
- Common biases include selection bias, volunteer bias, and confirmation bias.
- Random sampling helps ensure representativeness but doesn't guarantee it.

Warning Signs of Poor Samples

- Sample drawn from a convenience population
- Self-selected participants
- Narrow demographic representation
- High dropout or non-response rates

Cogency: The Inductive Counterpart to Soundness

- An inductive argument is **cogent** if it is strong and all its premises are true.
- Cogency is to inductive arguments what soundness is to deductive arguments.
- A cogent argument provides good but not conclusive reasons to accept its conclusion.
- Even cogent arguments may be overturned by new evidence.



Inductive Generalizations vs. Statistical Syllogisms

- **Inductive generalizations** move from observed instances to a general claim about a class (Some $\rightarrow$ All).
- **Statistical syllogisms** move from a general statistical claim to a prediction about a specific case (All $\rightarrow$ Some).
- Both forms depend on sample representativeness but in different ways.
- Potential fallacies differ depending on the direction of inference.

Two Directions of Inductive Reasoning

Generalization: "80% of observed swans were white, so approximately 80% of all swans are white."
Statistical Syllogism: "Approximately 80% of swans are white, so this particular swan is probably white."

Common Inductive Fallacies and How to Avoid Them

- The **hasty generalization** fallacy occurs when conclusions are drawn from too few examples.
- The **biased sample** fallacy occurs when evidence is not representative of the population.
- The **gambler's fallacy** incorrectly assumes that past random events influence future ones.
- The **appeal to anecdote** fallacy treats personal stories as statistically significant evidence.

Preventing Inductive Fallacies

- Ensure adequate sample size
- Check for sample representativeness
- Look for potential confounding variables
- Consider alternative explanations

Case Study: Ellen Ripley (Inductive Risk Assessment)

From "Aliens"

Ripley argues for the complete destruction of the alien-infested colony.

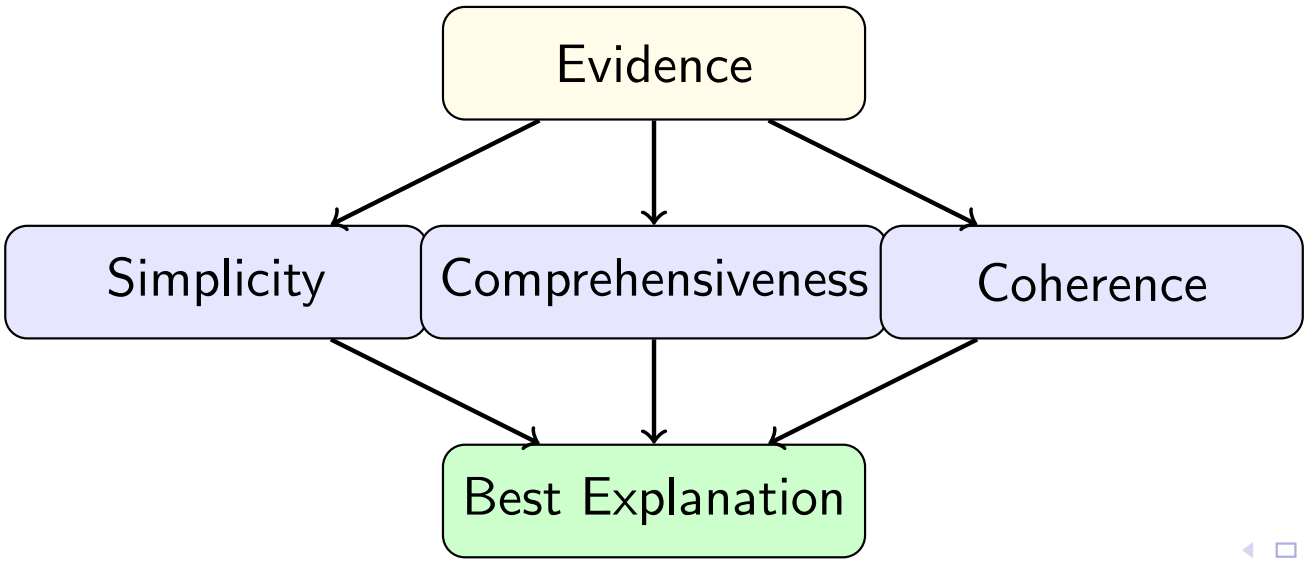
Standard Form:

- Premise 1: On the Nostromo, a single alien killed the entire crew except me.
- Premise 2: The colony has gone silent after reporting finding the alien ship.
- Premise 3: There are likely many aliens in the colony now.
- Premise 4: Previous containment attempts have failed catastrophically.
- Conclusion: Therefore, the only way to ensure safety is to destroy the entire colony from orbit.

Analysis: This is an inductive argument based on past experience and risk assessment. The strength lies in extrapolating from known alien behavior and previous failures. While strong, company representative Burke rejects it due to different values (valuing specimens over safety).

The Logic of Explanation: What Makes an Explanation Good?

- **Abductive reasoning** seeks the best explanation for a set of observations or facts.
- Good explanations must account for the evidence more effectively than alternatives.
- Abductive arguments compare competing hypotheses rather than testing a single hypothesis.
- The "best explanation" is judged according to multiple criteria, not just one.



Criteria for Evaluating Explanations: Simplicity

- **Simplicity** (also called parsimony) favors explanations that make fewer assumptions.
- Occam's Razor states that we should not multiply entities beyond necessity.
- Simpler explanations are less likely to include false assumptions.
- Simplicity must be balanced against explanatory power—overly simple explanations may miss important factors.

Balancing Simplicity and Explanatory Power

Consider two explanations for a patient's symptoms:
Explanation 1: The patient has one common disease that explains most symptoms.
Explanation 2: The patient has three rare diseases that collectively explain all symptoms.
Unless Explanation 1 fails to account for critical symptoms, it is preferable due to its simplicity.

Criteria for Evaluating Explanations: Comprehensiveness

- **Comprehensiveness** refers to how much of the evidence an explanation accounts for.
- A good explanation should explain all or most of the relevant facts.
- Unexplained anomalies weaken an explanation's plausibility.
- Explanations that need frequent modifications to accommodate new evidence are suspect.

Comprehensive vs. Selective Explanations

- Comprehensive: Explains all the evidence
- Moderately comprehensive: Explains most key evidence
- Selective: Cherry-picks favorable evidence
- Ad hoc: Requires different mechanisms for each piece of evidence

Criteria for Evaluating Explanations: Coherence with Background Knowledge

- Good explanations should be **consistent** with well-established theories and facts.
- Extraordinary claims require extraordinary evidence.
- Background knowledge provides a prior probability for competing explanations.
- Coherence measures how well an explanation fits with our broader understanding.

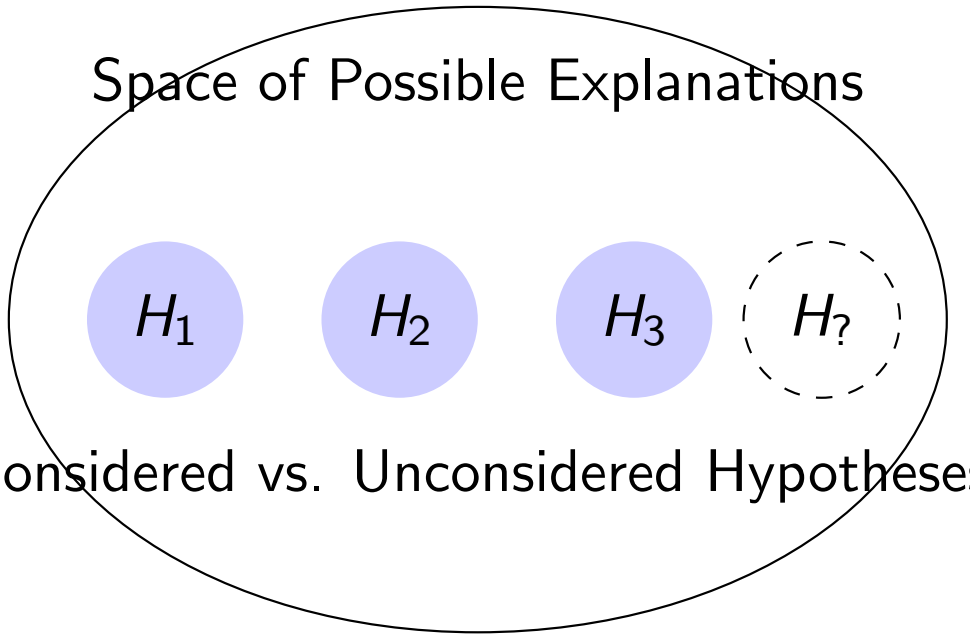
Weighing Coherence Against Evidence

When evidence strongly suggests an explanation that conflicts with background knowledge, we face three options:

- Question the reliability of the new evidence
- Revise our background knowledge
- Seek a third explanation that reconciles both

The Problem of Alternative Explanations

- Abductive reasoning is limited by our ability to generate alternative explanations.
- The "best explanation" is only the best among those we've considered.
- **Underconsideration** occurs when we fail to consider a wide enough range of hypotheses.
- Strong abductive arguments explicitly address and eliminate viable alternatives.



Uniting the Methods: Choosing the Right Evaluation Strategy

- Different argument types require different evaluation methods.
- Deductive arguments should be evaluated for validity and soundness.
- Inductive arguments should be evaluated for strength and cogency.
- Abductive arguments should be evaluated by comparing the quality of competing explanations.

If the argument is...	**Ask these questions...**	**Using these methods...**
Deductive	Is it valid? Are premises true?	Counterexamples, formal logic
Inductive	Is it strong? Are premises true?	Sample analysis, verification
Abductive	Is it the best explanation?	Comparative hypothesis testing

Common Mistakes in Argument Evaluation

- Evaluating an argument using criteria meant for a different argument type.
- Focusing only on structure without verifying premises (or vice versa).
- Dismissing an argument due to minor flaws rather than evaluating its core reasoning.
- Accepting an argument based on agreeing with its conclusion rather than its logic.

Evaluation Mistake Example

Criticizing an inductive argument for not being deductively valid:
"This argument about climate patterns based on decades of data isn't valid because there could theoretically be exceptions."
This misapplies deductive standards to an inductive argument.

Summary: The Complete Toolkit for Argument Evaluation

- Begin by identifying the argument type: deductive, inductive, or abductive.
- Evaluate the logical structure according to the appropriate standards for that type.
- Independently verify the truth or acceptability of the premises.
- Consider the argument as a whole—is it valid/strong AND sound/cogent?

The Critical Thinker's Checklist

1. Reconstruct the argument in standard form
2. Identify the argument type
3. Evaluate logical structure (validity/strength/best explanation)
4. Assess premise truth
5. Deliver verdict on overall argument quality