

Logical Reasoning and Fallacies

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Snt

Master in Cybersecurity



What is Logical Reasoning?

Why we need logical reasoning in
Cybersecurity?

What is **Logical** Reasoning?

A word cloud featuring the words 'Rational', 'Logical', and 'Reasonable' in large, bold letters. 'Rational' is purple, 'Logical' is blue, and 'Reasonable' is maroon. Smaller words in various colors are scattered around and overlapping the larger ones: 'Systematic' (light blue), 'Coherent' (maroon), 'Inductive' (maroon), 'Deductive' (dark blue), 'Analytical' (light blue), 'Sound' (dark blue), 'Consistent' (maroon), and 'Lucid' (tan).

Rational
Logical
Reasonable
Systematic
Coherent
Inductive
Deductive
Analytical
Sound
Consistent
Lucid

What is Logical Reasoning?

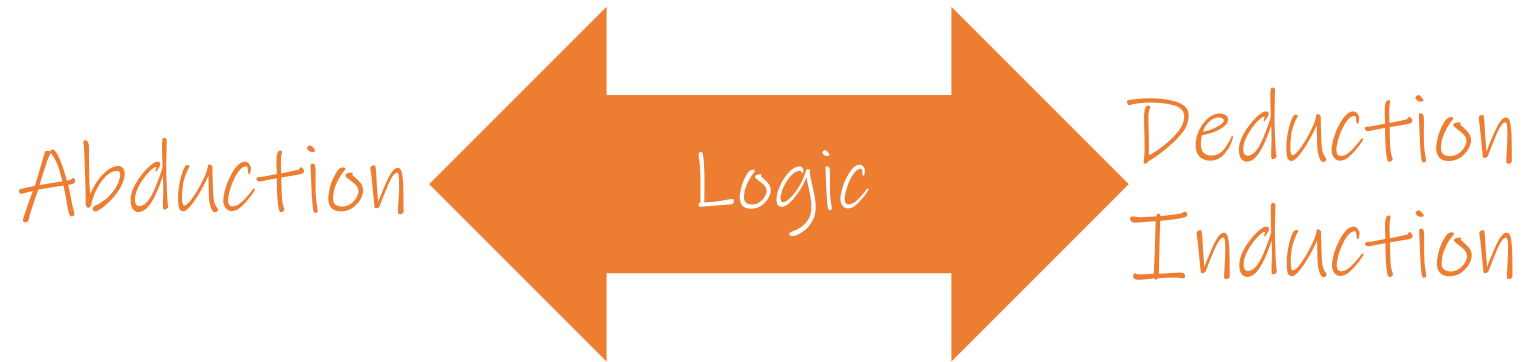
A word cloud centered around the word "Reason". The word "Reason" is the largest and most prominent, written in a reddish-pink color. Other large words include "Explanation" (purple), "Justification" (orange), "Cause" (purple), "Basis" (yellow), "Motive" (dark blue), "Purpose" (dark blue), and "Logic" (dark blue). Smaller words scattered around include "Intellect", "Understanding", "Argumentation", "Induction", "Inference", "Rationality", "Judgment", "Thought", and "Deduction". The words are arranged in a somewhat circular pattern around the central "Reason".

Explanation
Cause
Reason
Justification
Purpose
Logic
Basis
Motive
Deduction
Intellect
Understanding
Argumentation
Induction
Inference
Rationality
Judgment
Thought

What is **Logical Reasoning**?

I can not answer this question, but I give some logical forms for it

Premises



Conclusion

Deduction

Deductive reasoning is the process of drawing valid inferences. An inference is valid if its conclusion follows logically from its premises, meaning that it is impossible for the premises to be true and the conclusion to be false.

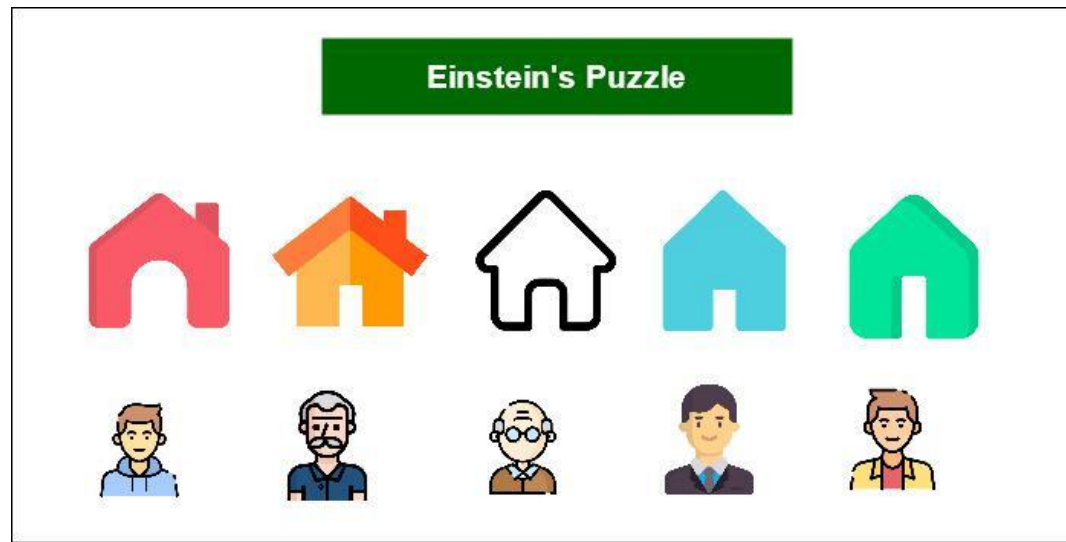
Example:

All humans are mortal;

Socrates is a human;

therefore,

Socrates is mortal.



There are five houses in a row, each with a different color. In each house lives a person of a different nationality. The five owners drink a certain type of beverage, smoke a certain brand of cigar, and keep a certain pet. No owners have the same pet, smoke the same brand of cigar, or drink the same beverage. We have to find out each of the respective persons with their respective belongings. (See <https://code.energy/solving-zebra-puzzle/>)

Abduction

Focuses on the **best** explanation for a set of **observations**, often used in **hypothesis** formation.

If the grass is wet, the best explanation is that it rained.

5	3			7				
6			1	9	5			
	9	8					6	
8				6				3
4			8		3			1
7				2				6
	6					2	8	
			4	1	9			5
				8			7	9

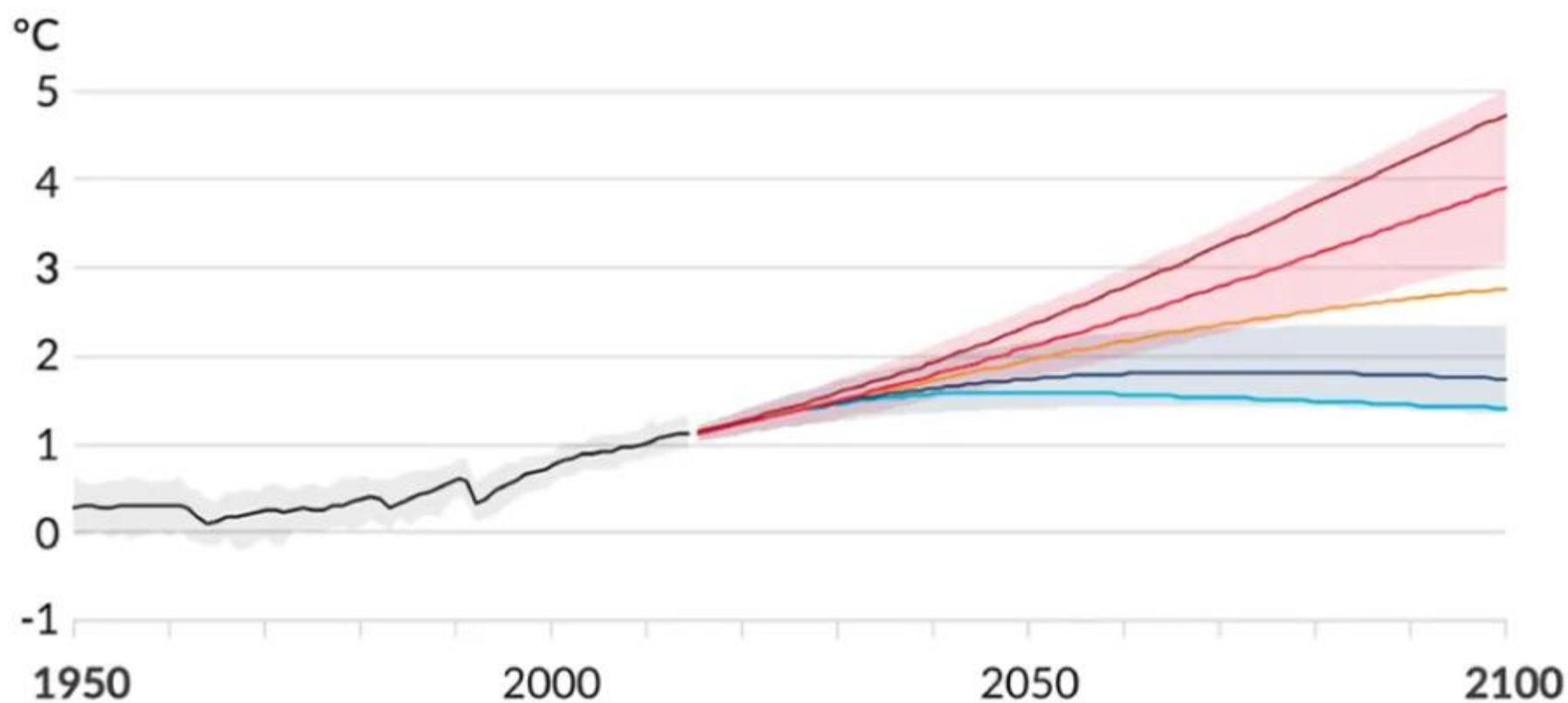
5	3	4	6	7	8	9	1	2
6	7	2	1	9	5	3	4	8
1	9	8	3	4	2	5	6	7
8	5	9	7	6	1	4	2	3
4	2	6	8	5	3	7	9	1
7	1	3	9	2	4	8	5	6
9	6	1	5	3	7	2	8	4
2	8	7	4	1	9	6	3	5
3	4	5	2	8	6	1	7	9

Induction

Involves making
generalizations based on
specific observations.

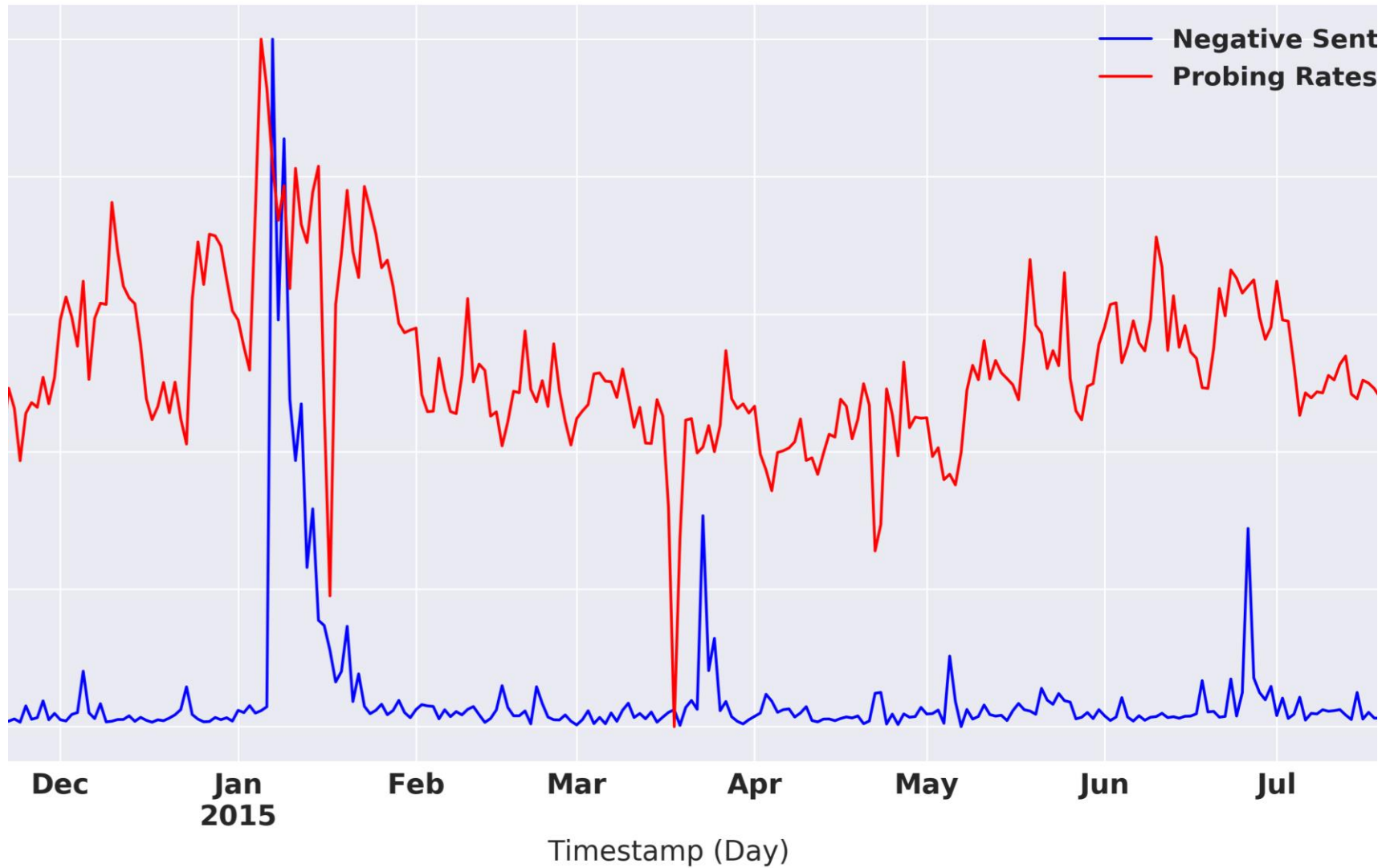
If every swan observed **so far**
is white, one might conclude
that **all** swans are white.

Projected Temperature Increase (°C)



Five Scenarios of Fossil Fuel Burning

- Highest CO₂ amounts
- Medium to high CO₂ amounts
- Medium CO₂ amounts
- Smaller CO₂ amounts, then no increase in CO₂ late in the 21st century
- No increase in CO₂ beginning in 2050



Hammouchi et al. Predicting probing rate severity by leveraging twitter sentiments, IWCMC 2019

Formal Logic

Mainly focus on formal
methods:

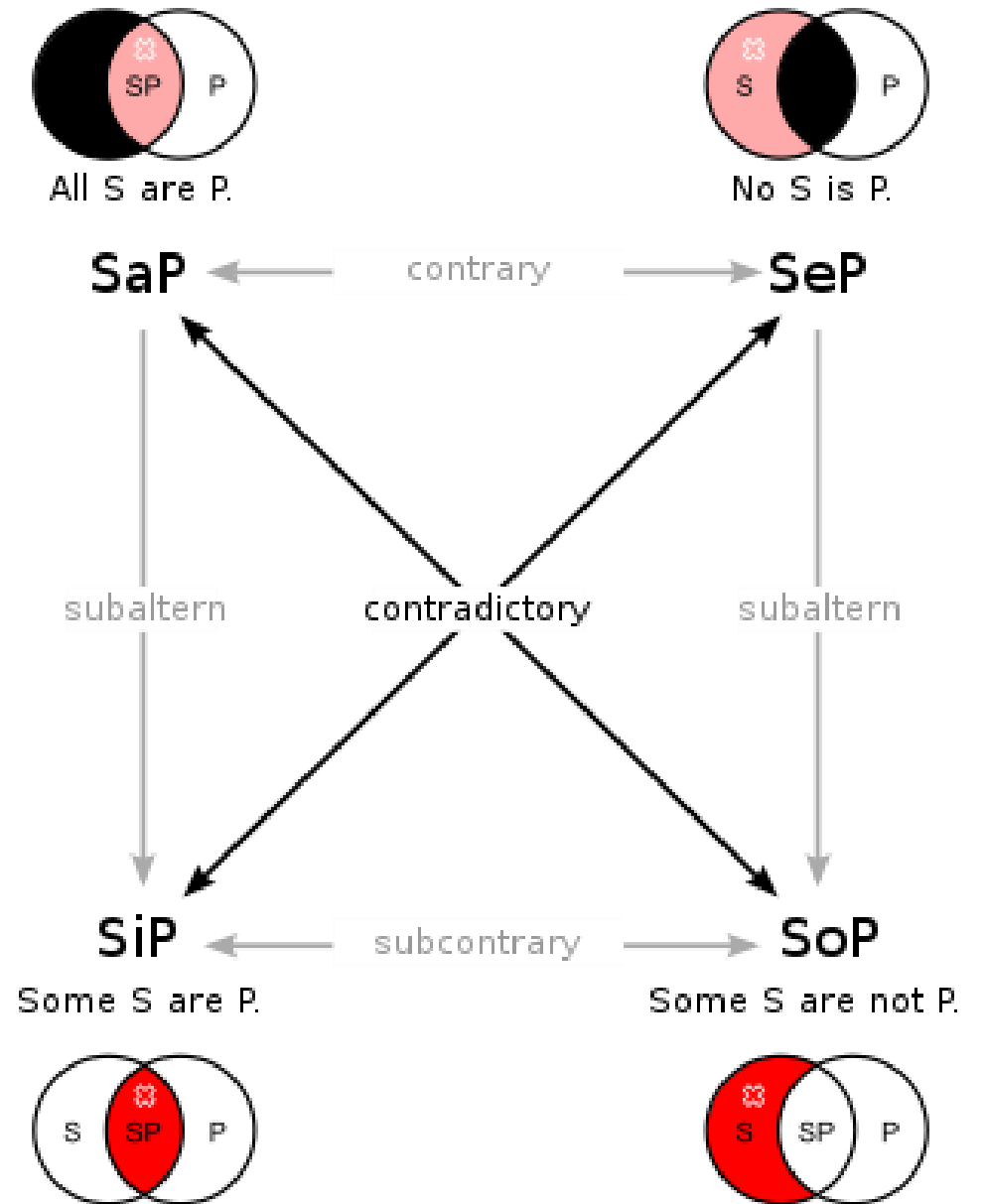
propositional logic,
truth tables,
syllogisms,
the predicate calculus

Informal Logic

studies arguments
as they occur in
natural language
discourse

Syllogism

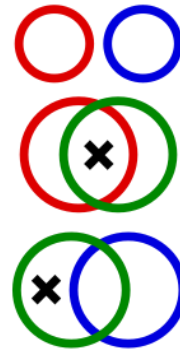
Major premise: All M are P.
Minor premise: All S are M.
Conclusion: All S are P.



No homework is fun. (MeP)

Some reading is homework. (SiM)

∴ Some reading is not fun. (SoP)



EIO-1

Modus Ferio

M e P

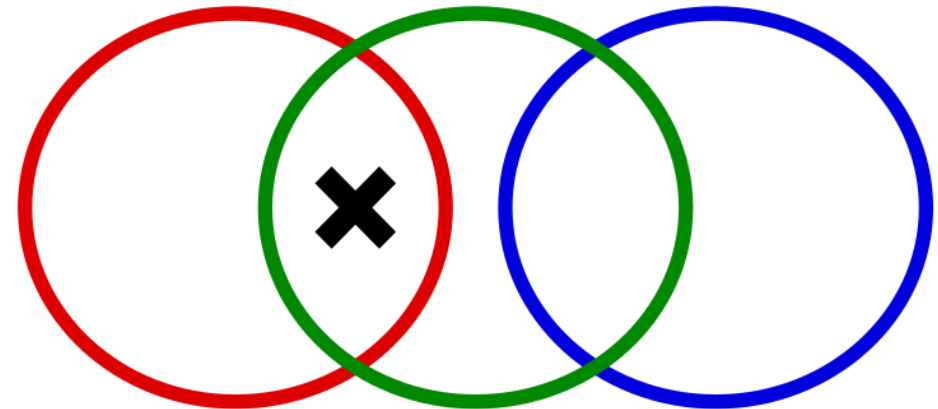
No M is P,

S i M

and some S are M;

S o P

thus some S are not P.



All P is M.

All M is S.

∴ All S is P.

All P is M.

Some S is M.

∴ Some S is P.

No P is M.

Some S is M.

∴ Some S is not P.

All P is M.

No S is M.

∴ No S is P.

Propositional Logic

Truth Table Generator

This tool generates truth tables for propositional logic formulas. You can enter logical operators in several different formats. For example, the propositional formula $p \wedge q \rightarrow \neg r$ could be written as $p \wedge q \rightarrow \sim r$, as p and $q \Rightarrow$ not r , or as $p \ \&\& \ q \rightarrow !r$. The connectives \top and \perp can be entered as T and F.

P / \ Q => P

P	Q	$((P \wedge Q) \rightarrow P)$
F	F	T
F	T	T
T	F	T
T	T	T

modus ponens

1. If today is Tuesday, then John will go to work.
2. Today is Tuesday.
3. Therefore, John will go to work.

Modus tollens

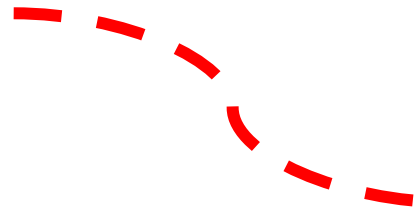
1. If the dog detects an intruder, the dog will bark.
2. The dog did not bark.
3. Therefore, no intruder was detected by the dog.

p	q	$p \rightarrow q$
T	T	T
T	F	F
F	T	T
F	F	T

Step-by-Step Outline of Analysis of Competing Hypotheses

- 1. Identify the possible hypotheses to be considered. Use a group of analysts with different perspectives to brainstorm the possibilities.*
- 2. Make a list of significant evidence and arguments for and against each hypothesis.*
- 3. Prepare a matrix with hypotheses across the top and evidence down the side. Analyze the “diagnosticity” of the evidence and arguments—that is, identify which items are most helpful in judging the relative likelihood of the hypotheses.*

Arguments



Hypotheses

Psychology — of — Intelligence Analysis

by
Richards J. Heuer, Jr.

Argumentation Theory

Argumentation theory is a broad interdisciplinary field that studies real life

argument.

related disciplines: cognitive psychology, computational modeling, semiotics, discourse analysis, the history of art, AI, and so on.

Argument

Premise

Conclusion

Small businesses are important because they provide opportunities for entrepreneurs and create meaningful jobs with greater job satisfaction than positions with larger, traditional companies.

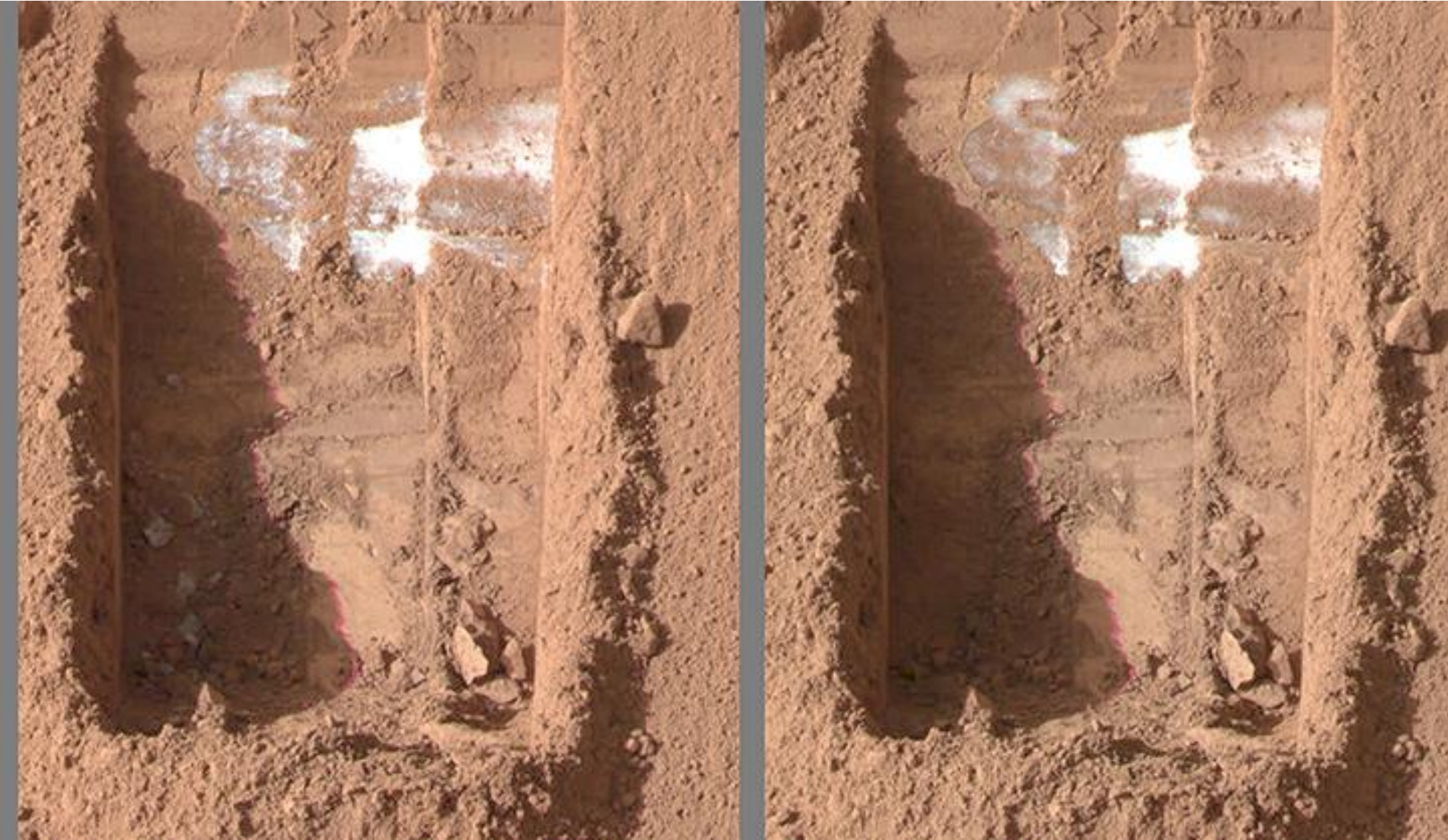
Premise 1: Small businesses provide opportunities for entrepreneurs.

Premise 2: Small businesses create meaningful jobs.

Premise 3: Jobs in small businesses offer greater job satisfaction than positions in larger, traditional companies.

Conclusion: Therefore, small businesses are important.

The two photographs taken by NASA Mars rover Phoenix to show there is water in Mars



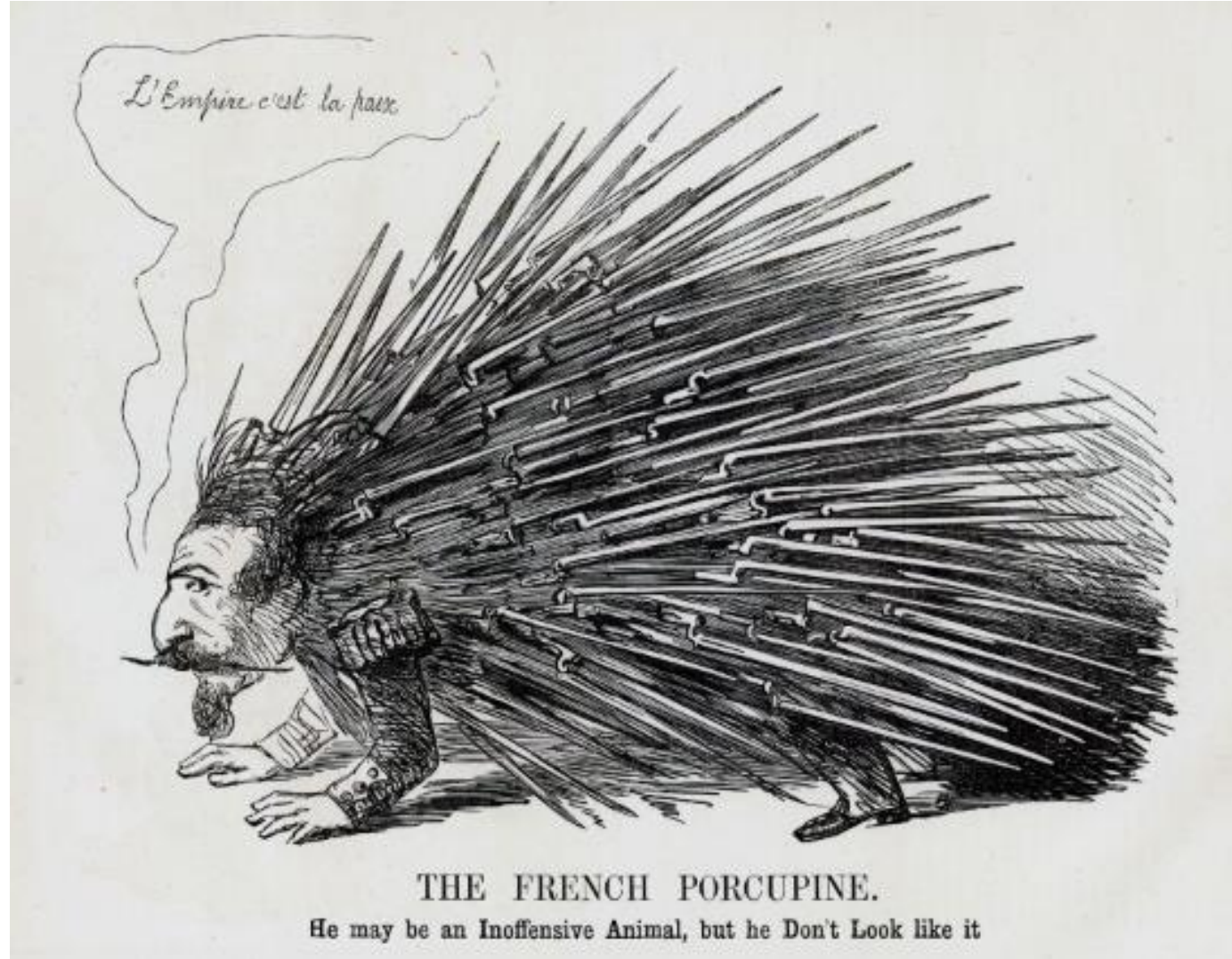
(Visual) Premise: What we see in the bottom left hand corner of the first photograph of the dig.

(Visual) Premise: What we see in the bottom left hand corner of the second photograph of the dig.

(Verbal) Premise: The most plausible way to explain the changes we see (the disappearance of the white crust) is by understanding it as water ice.

Conclusion: There is water on the planet Mars.

The cartoon of Napoleon III appeared in Punch on 1859.

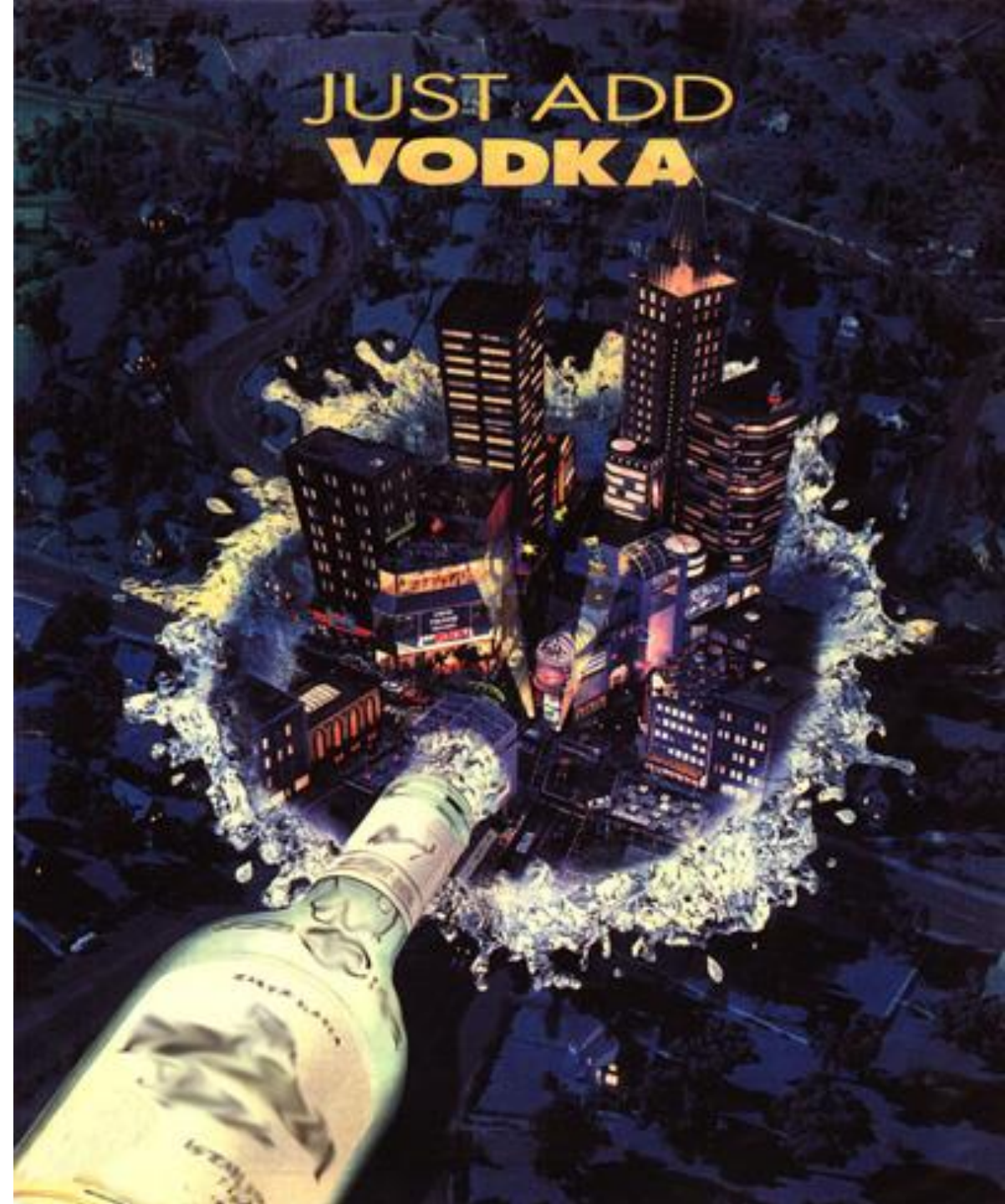


Premise: Napoleon declares that "The Empire embodies peace" ("L'Empire c'est la paix").

Premise: Napoleon has surrounded himself with many armaments.

Conclusion: Napoleon may sound inoffensive when he says that "The Empire embodies peace," but his build up of armaments suggests we should be wary of the empire he has built.

Implicit Premises and Conclusions



(Visual) Premise: If you drink our vodka, it can transform your night life in the way it transforms the village in the photograph: into an exciting major city.

Implicit Premise: A life of urban excitement is preferable to the quiet life of a village.

Conclusion: You should "Just Add Vodka" to your life.

What's argumentation?

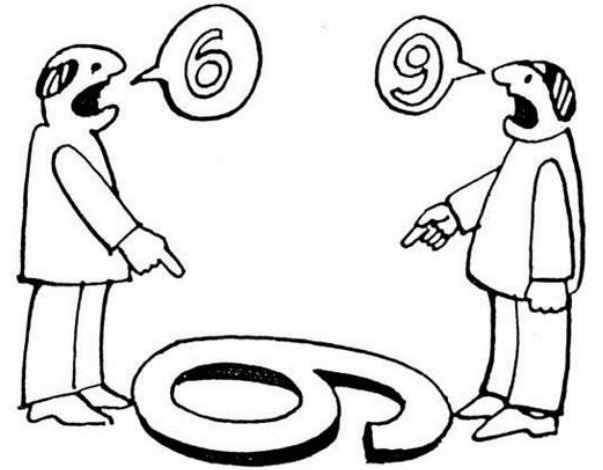
"Argumentation, a phenomenon we are all familiar with, arises in response to, or in anticipation of, a real or imagined difference of opinion. It comes into play in cases when people start defending a view they assume not to be shared by others".

(Handbook of Formal Argumentation)

We distinguish two cases:

1: You agree with the claim
(no proof is needed)

2: You disagree. Then you should
argue against it.



What's argumentation theory?

Argumentation theory is the umbrella term used to denote the study of argumentation in all its manifestations and varieties, irrespective of the intellectual backgrounds, primary research interests and angles of approach of the theorists.

(Handbook of Formal Argumentation)

Rhetoric:

emphasis on the production of effective argumentation for an audience when the subject matter does not lend itself to a logical demonstration of certainty (persuasion).





Four Freedoms Speech

Freedom of speech and expression
Freedom of worship
Freedom from want
Freedom from fear



Free
Software
Movement



Open Source:

The freedom to run the program as you wish

The freedom to study how the program works, and change it

Easy to distribute:

The freedom to redistribute copies

The freedom to distribute copies of your modified versions to others

Dialogue:

cooperative assessment of claims by eliciting commonly accepted starting points (premises), drawing implications, determining compatibility with the claims (claims can be revised in case of contradictions).



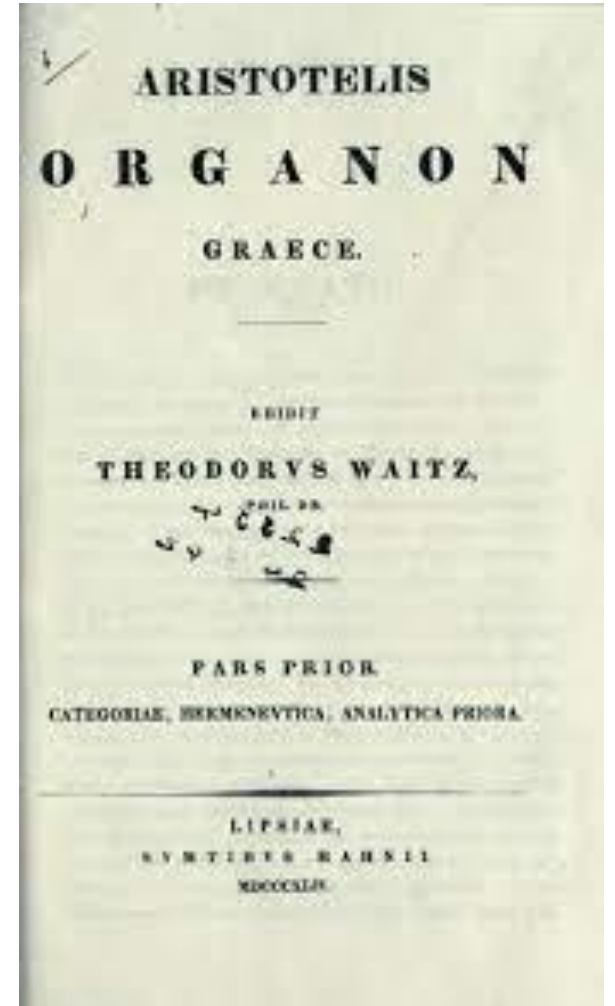
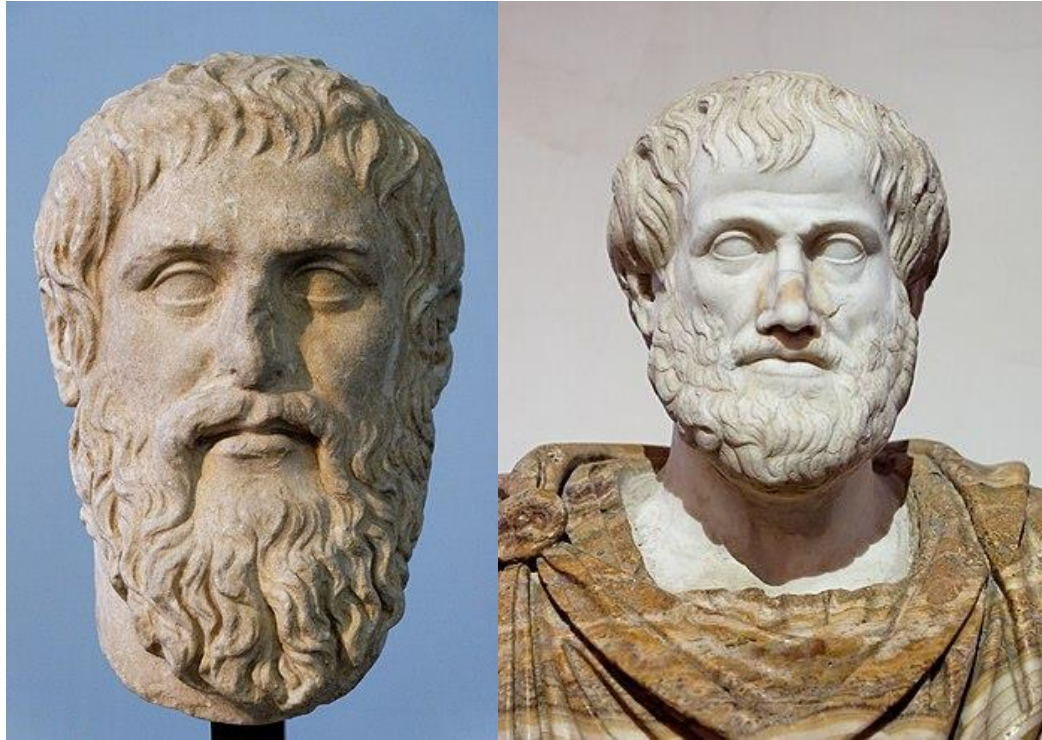
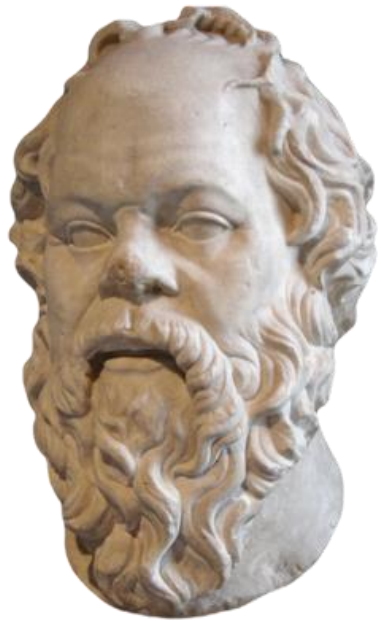
Type	Situation	Arguers' Goal	Dialogue Goal
Persuasion	Conflict of Opinion	Persuade Other Party	Resolve Issue
Inquiry	Need to Have Proof	Verify Evidence	Prove Hypothesis
Discovery	Need for Explanation	Find a Hypothesis	Support Hypothesis
Negotiation	Conflict of Interests	Secure Interests	Settle Issue
Information	Need Information	Acquire Information	Exchange Information
Deliberation	Practical Choice	Fit Goals and Actions	Decide what to Do
Eristic	Personal Conflict	Attack an Opponent	Reveal Deep Conflict

A major idea is that the validity of an argument is not (only) related to its syntactic form, but it depends on whether the argument it can be **defended** in a properly conducted dispute

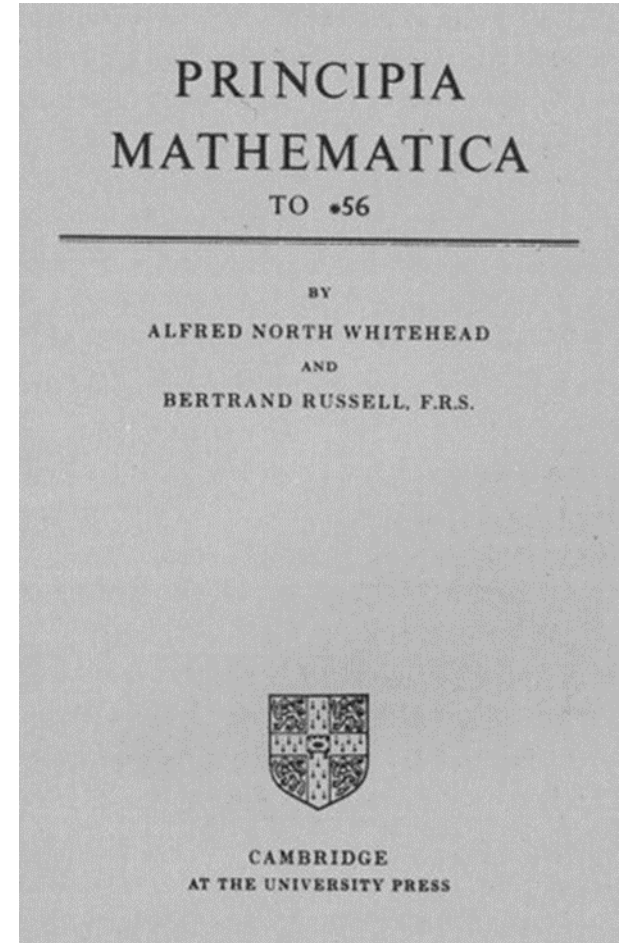
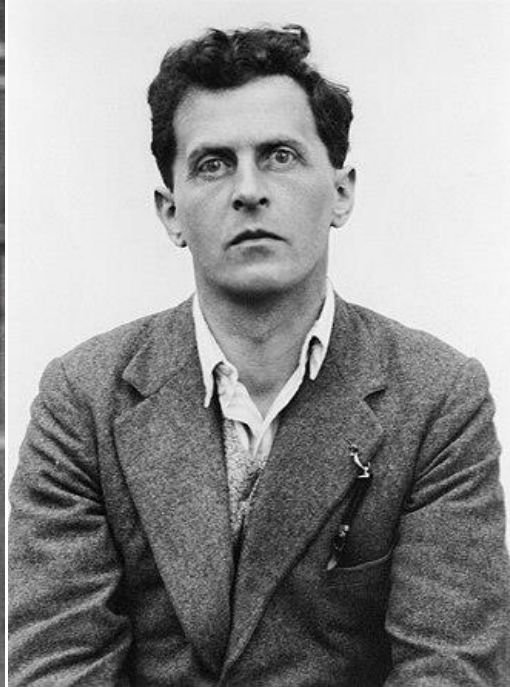
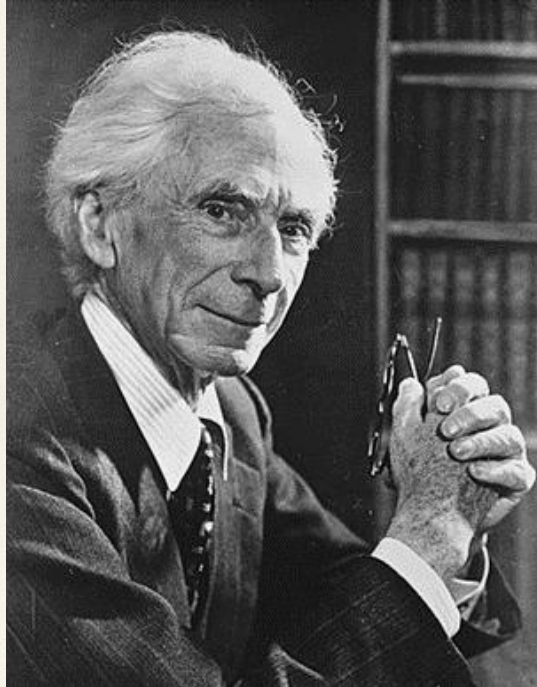
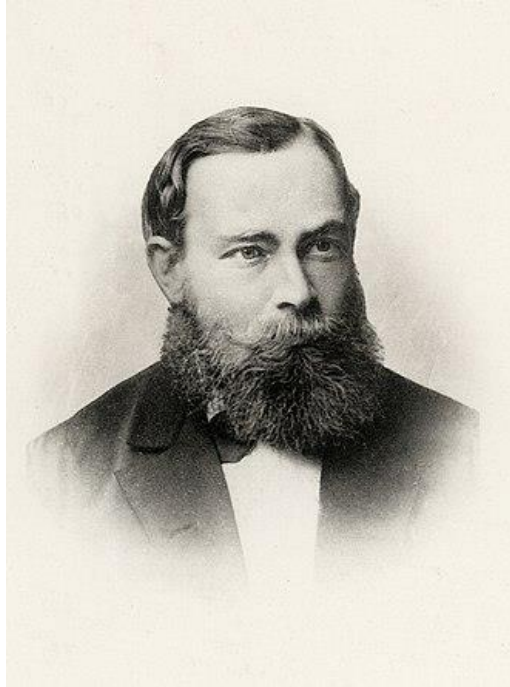


Why we need logical reasoning in
Cybersecurity?

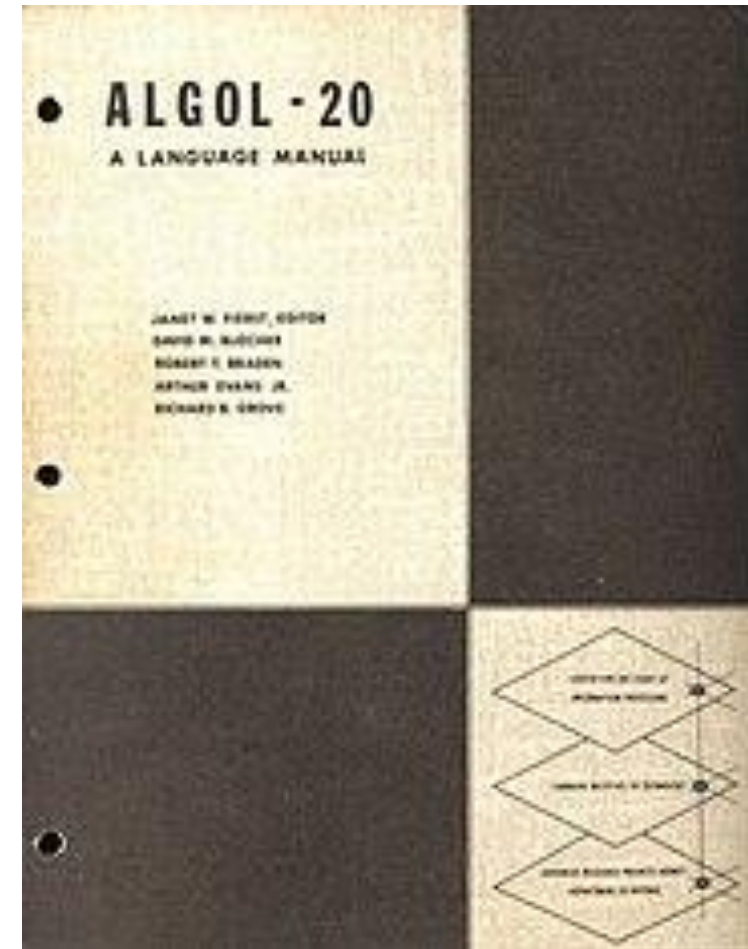
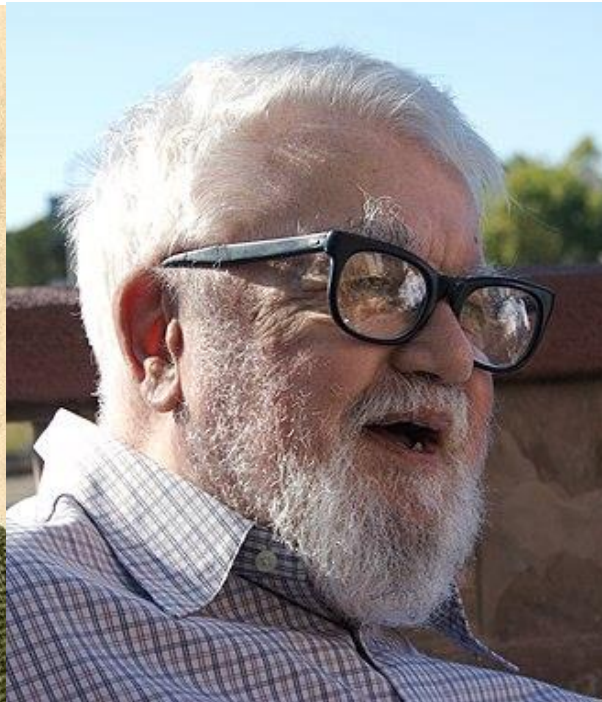
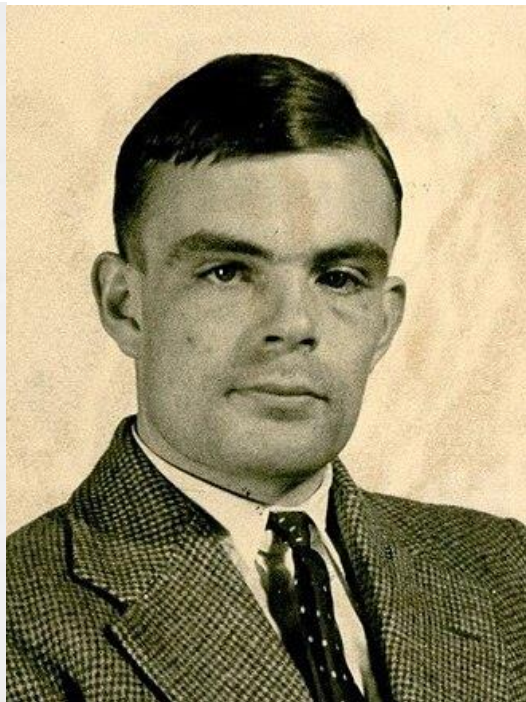
Shaping the Foundation of Philosophy and Science



Shaping the Foundation of Mathematics



Shaping the Foundation of Computer Science



Shaping the Foundation of Cybersecurity



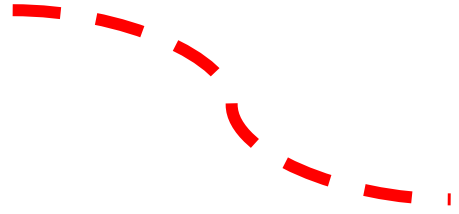
Cybersecurity is a young research discipline and needs to be shaped

Argument

Information

Logical Fallacy (Next Course)

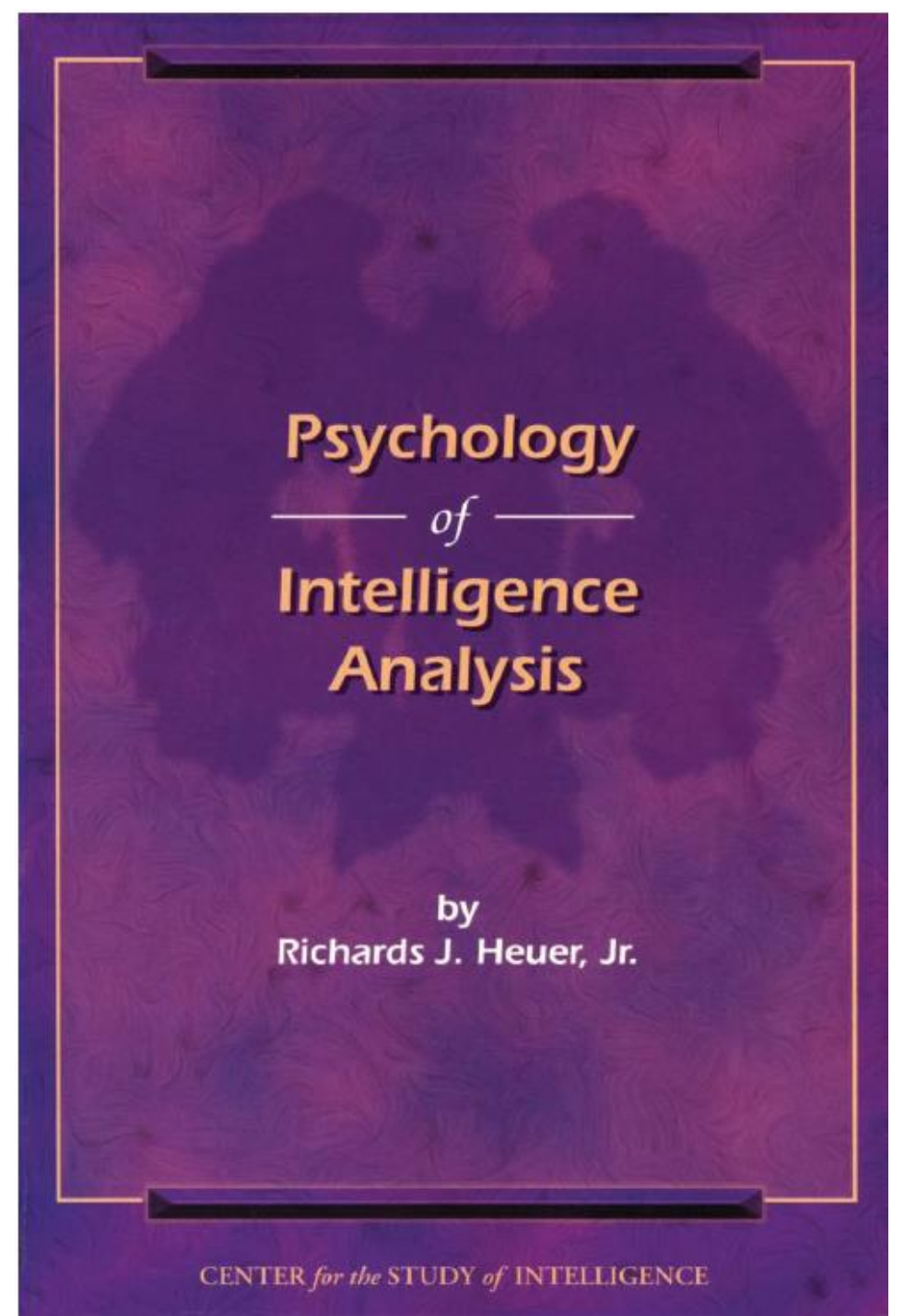
Arguments



Hypotheses

We are not "free" to make
the hypothesis (**Biases**)

We are not "free" to evaluate
our hypothesis (**Fallacies**)



Logic \neq
Formal
Method

Logic \neq
Psychology

Logic have its own faculty

References and More to Read:

Groarke, Leo, "Informal Logic", The Stanford Encyclopedia of Philosophy (Spring 2024 Edition), Edward N. Zalta & Uri Nodelman (eds.).

Van Eemeren, Frans H., et al. Fundamentals of argumentation theory: A handbook of historical backgrounds and contemporary developments. Routledge, 2013.