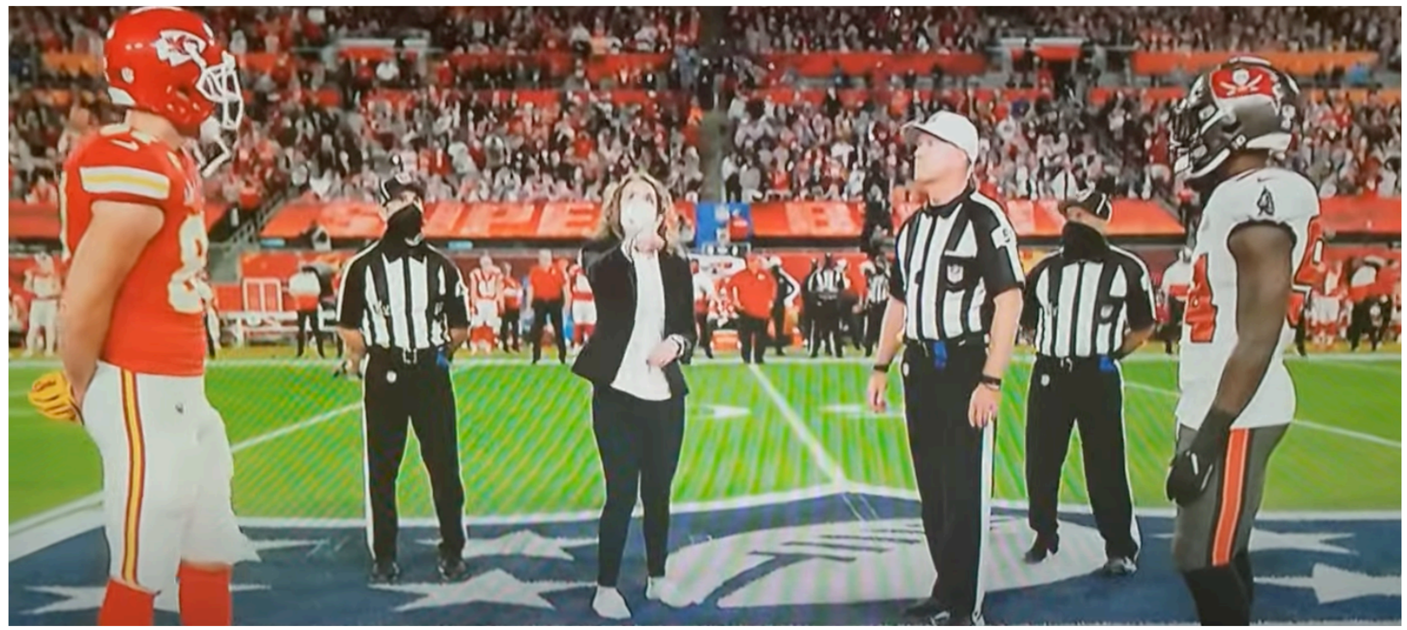
Portals to Inductive Logic: Single High-Stakes Coin Flips; The Paradox of Grue

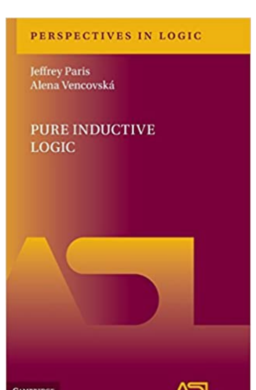
Selmer Bringsjord

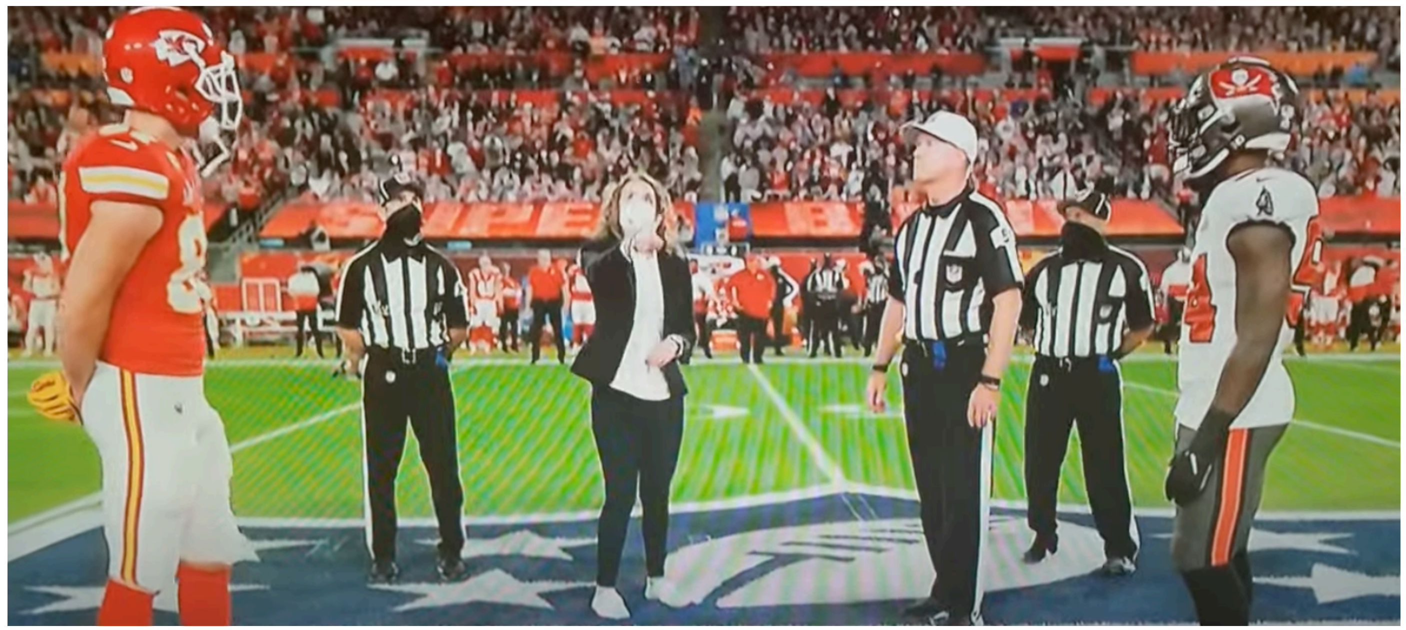
Rensselaer AI & Reasoning (RAIR) Lab
Department of Cognitive Science
Department of Computer Science
Lally School of Management & Technology
Rensselaer Polytechnic Institute (RPI)
Troy, New York 12180 USA

Intermediate Formal Logic & AI (IFLAI2)
10/13/2022 (`ver 1013221430`)

RAIR
Rensselaer AI and Reasoning Lab

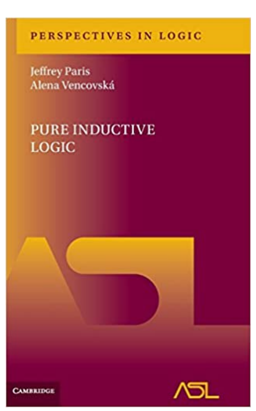



PERSPECTIVES IN LOGIC
Jeffrey Paris
Alena Vencovská
PURE INDUCTIVE
LOGIC
CAMBRIDGE
ASL



Is this a fair coin flip? Justify.

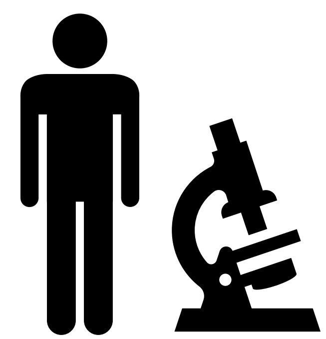
(Good luck if you don't know some formal *in*ductive logic.)



The Grue Paradox Constructed

source of minerals

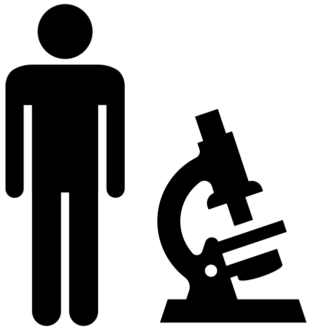
Mineralogist



The Grue Paradox Constructed

source of minerals

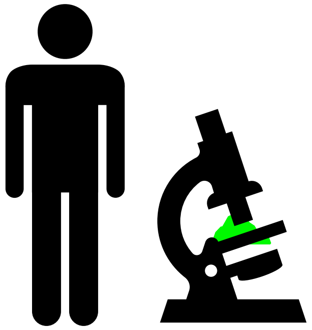
Mineralogist



The Grue Paradox Constructed

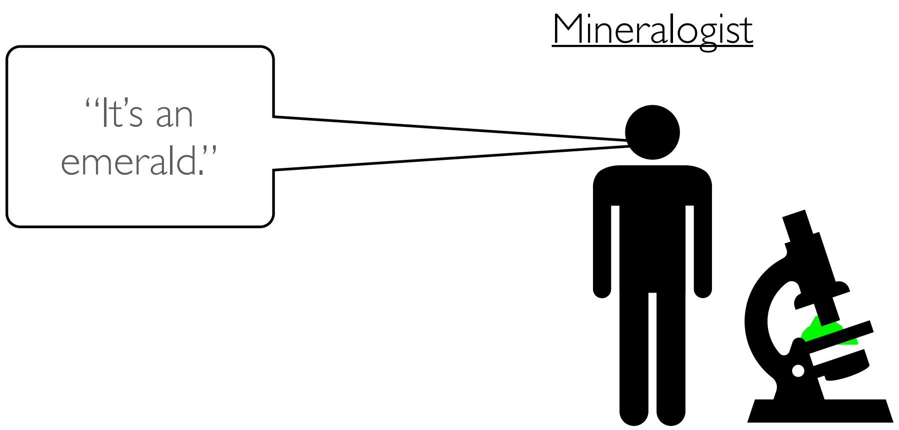
source of minerals

Mineralogist



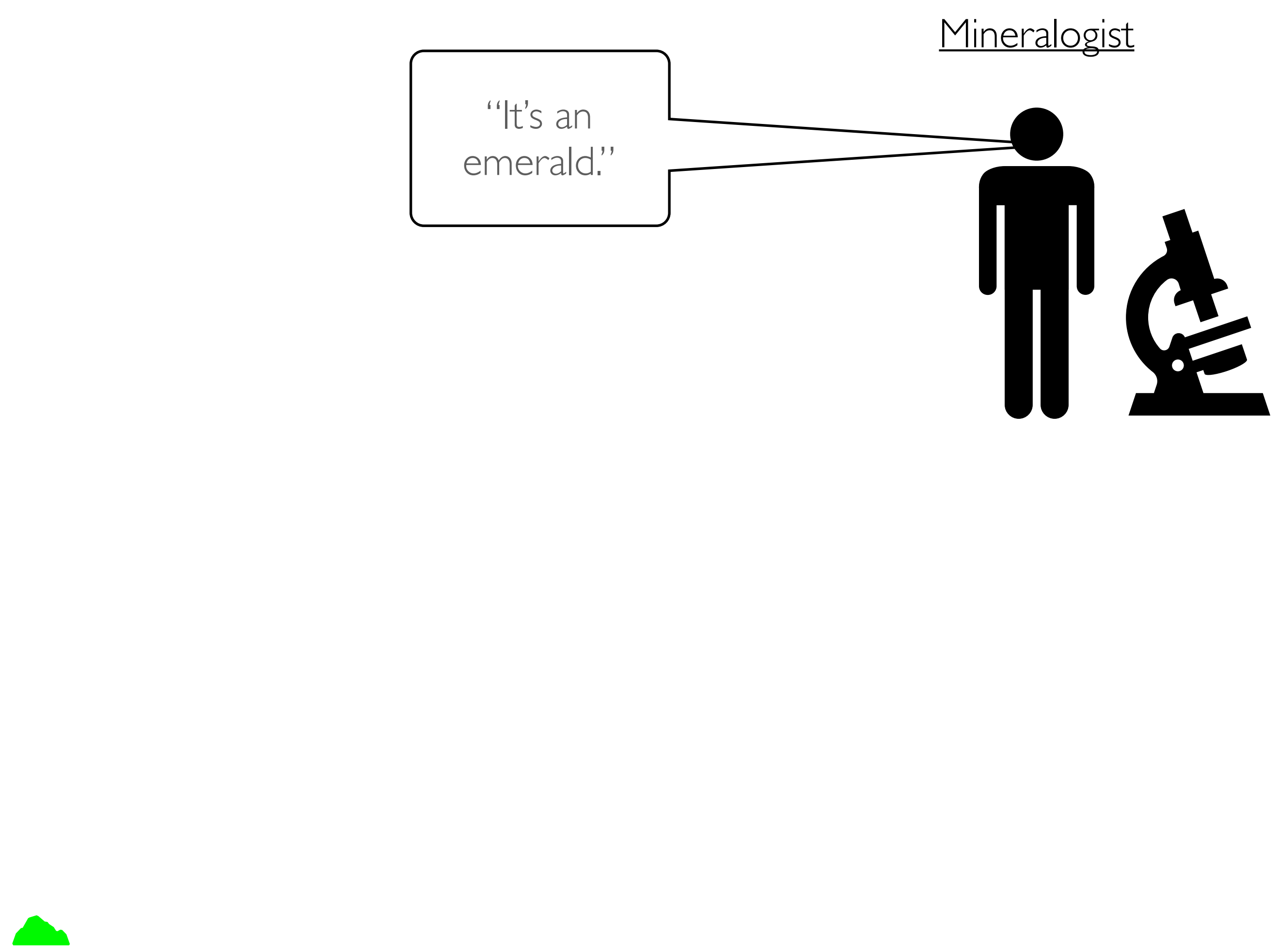
The Grue Paradox Constructed

source of minerals



The Grue Paradox Constructed

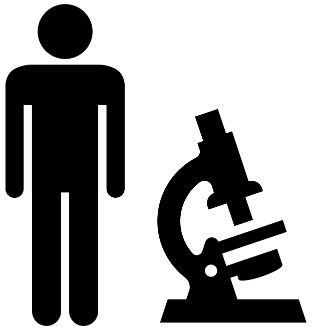
source of minerals



The Grue Paradox Constructed

source of minerals

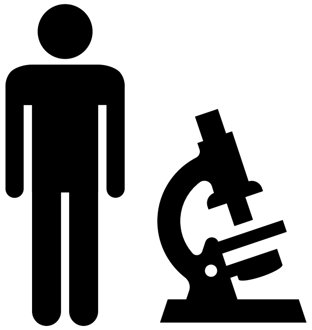
Mineralogist



The Grue Paradox Constructed

source of minerals

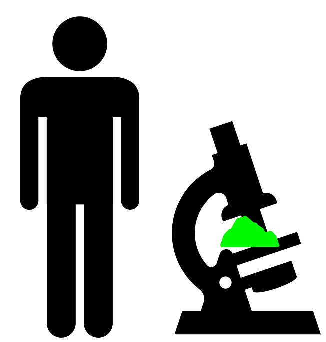
Mineralogist



The Grue Paradox Constructed

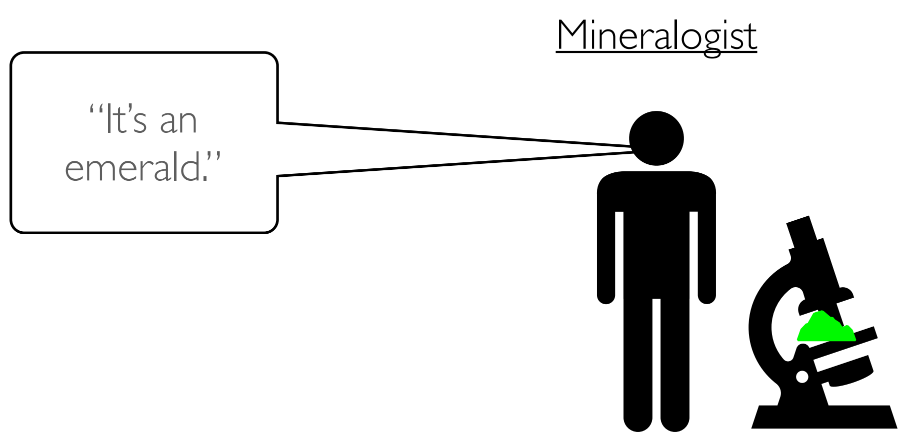
source of minerals

Mineralogist



The Grue Paradox Constructed

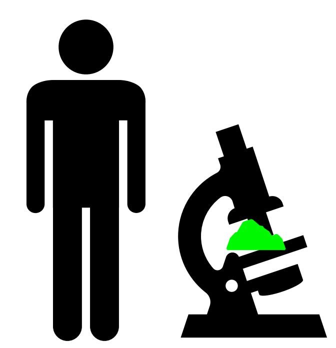
source of minerals



The Grue Paradox Constructed

source of minerals

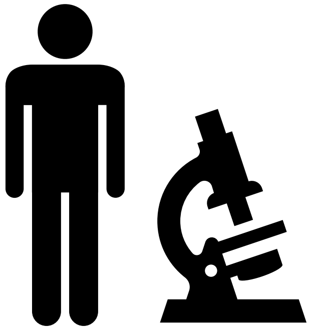
Mineralogist



The Grue Paradox Constructed

source of minerals

Mineralogist

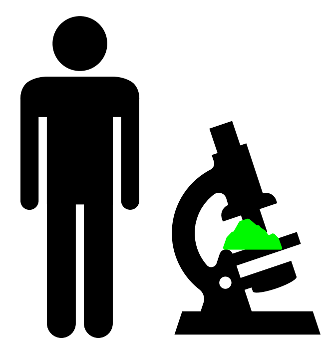


The Grue Paradox Constructed

The Grue Paradox Constructed

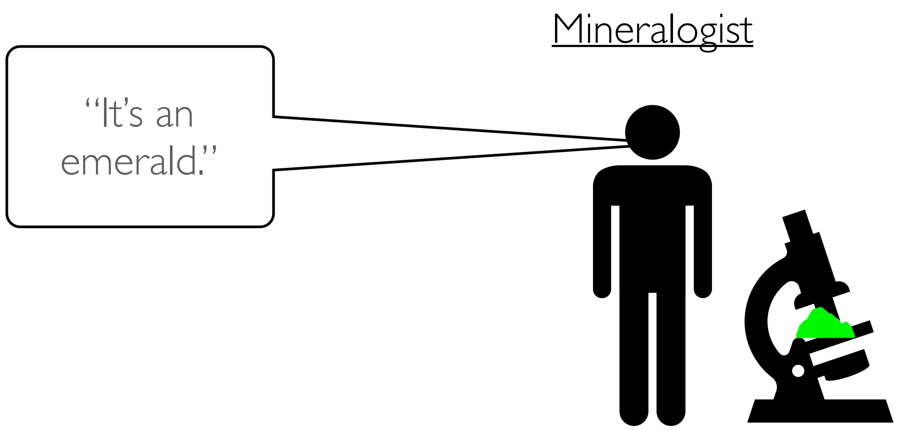
source of minerals

Mineralogist



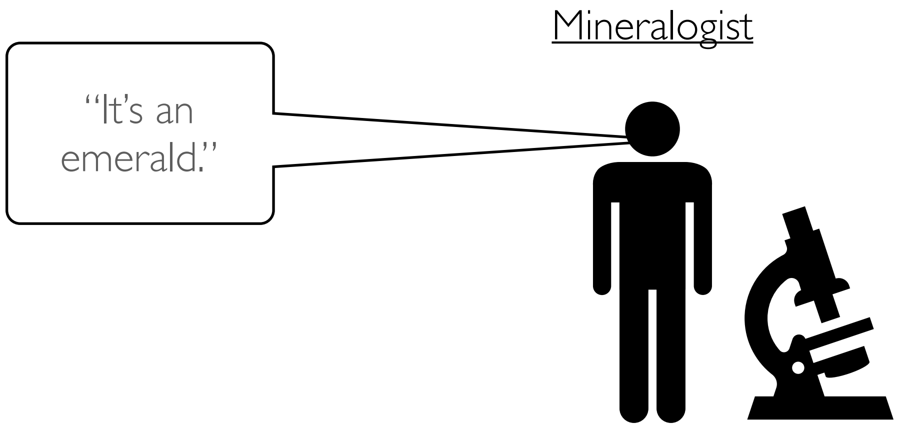
The Grue Paradox Constructed

source of minerals



The Grue Paradox Constructed

source of minerals

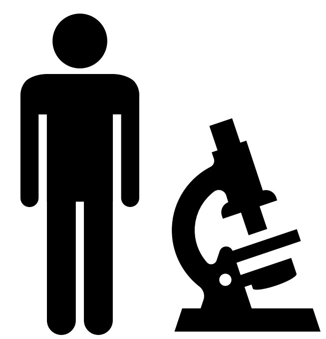




The Grue Paradox Constructed

source of minerals

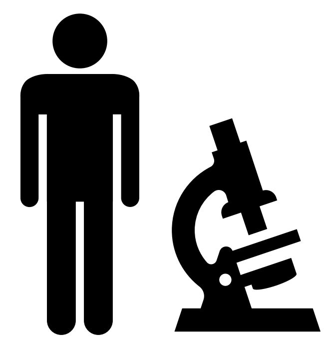
Mineralogist



The Grue Paradox Constructed

source of minerals

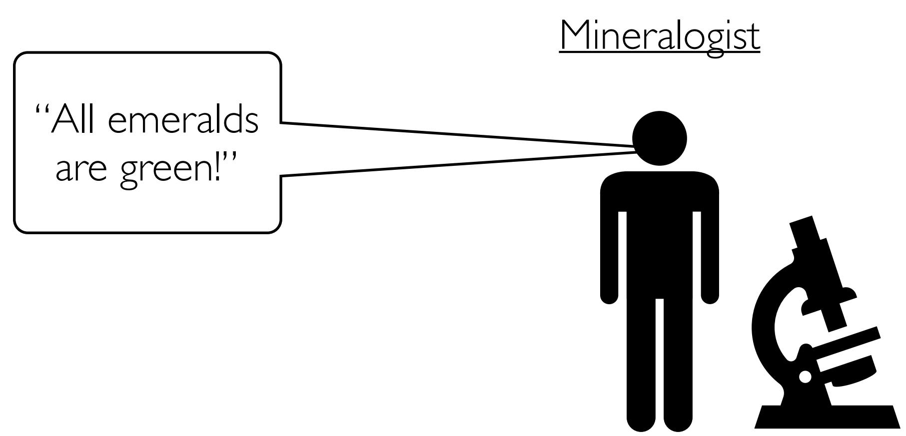
Mineralogist



$\ldots\ k, k \in \mathbb{Z}^{+},$ and all before time $t^{\star}$

The Grue Paradox Constructed

source of minerals



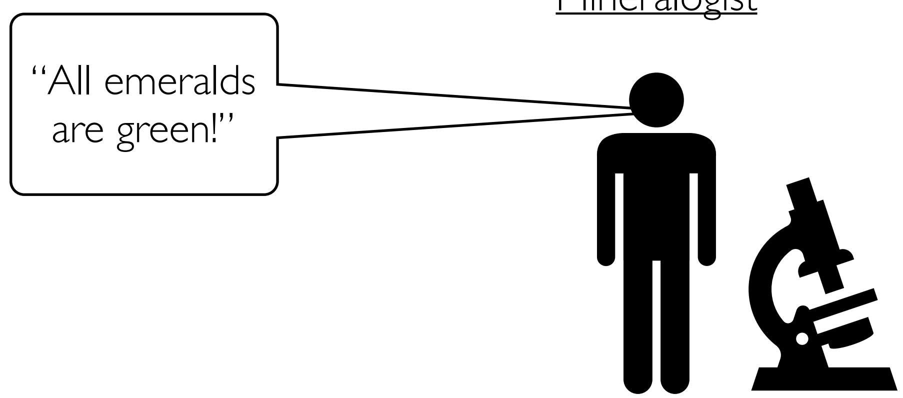
$\ldots\ k, k \in \mathbb{Z}^{+},$ and all before time $t^{\star}$

The Grue Paradox Constructed

source of minerals

The Paradox: First, we define the property *Grue*:

Mineralogist



$\ldots\ k, k \in \mathbb{Z}^+,$ and all before time $t^\star$

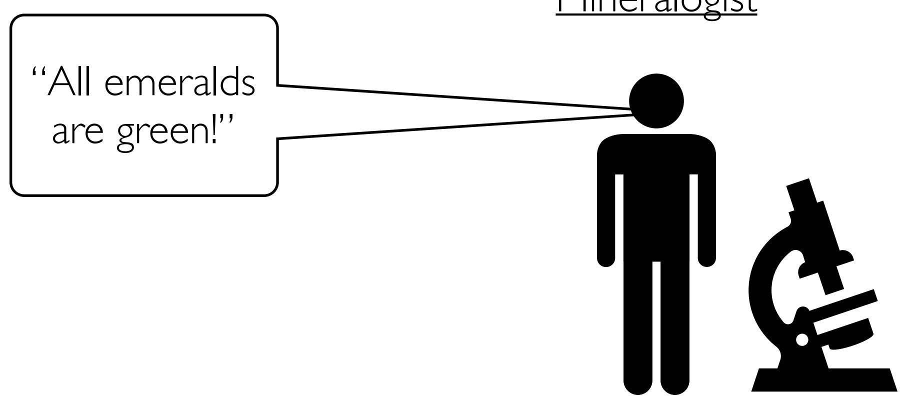
The Grue Paradox Constructed

source of minerals

The Paradox: First, we define the property *Grue*:

$$\forall x \ \forall t \ [Grue(x) \text{ iff } (t < t^\star \rightarrow Green(x,t) \wedge (t \geq t^\star \rightarrow Blue(x,t)]$$

Mineralogist



$\ldots \ k, k \in \mathbb{Z}^+,$ and all before time $t^\star$

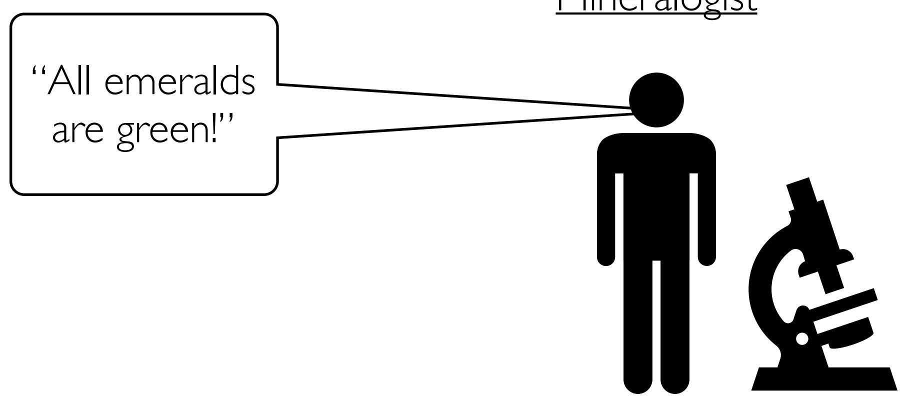
The Grue Paradox Constructed

source of minerals

The Paradox: First, we define the property *Grue*:

$$\forall x\ \forall t\ [Grue(x) \text{ iff } (t < t^{\star} \rightarrow Green(x,t)) \wedge (t \geq t^{\star} \rightarrow Blue(x,t))]$$

Mineralogist



$Green(o_1, t_1)$

$\ldots\ k, k \in \mathbb{Z}^{+},$ and all before time $t^{\star}$

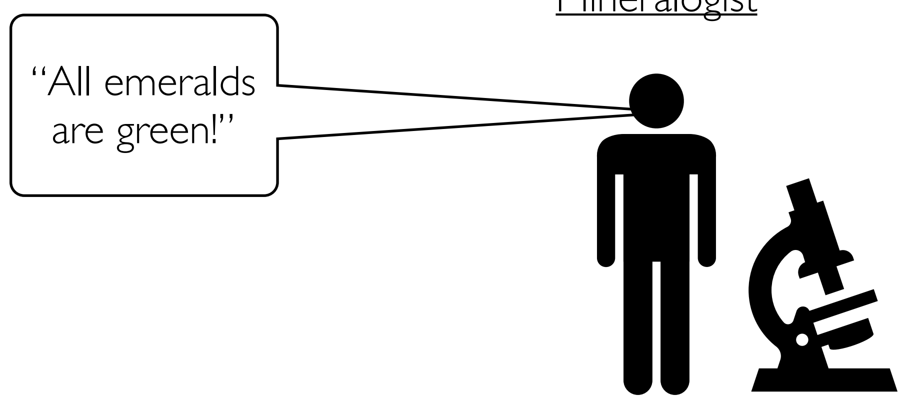
The Grue Paradox Constructed

source of minerals

The Paradox: First, we define the property *Grue*:

$$\forall x\ \forall t\ [Grue(x) \text{ iff } (t < t^\star \rightarrow Green(x,t) \wedge (t \geq t^\star \rightarrow Blue(x,t)]$$

Mineralogist



$Green(o_1, t_1)$ $Green(o_2, t_2)$

$\ldots\ k, k \in \mathbb{Z}^+,$ and all before time $t^\star$

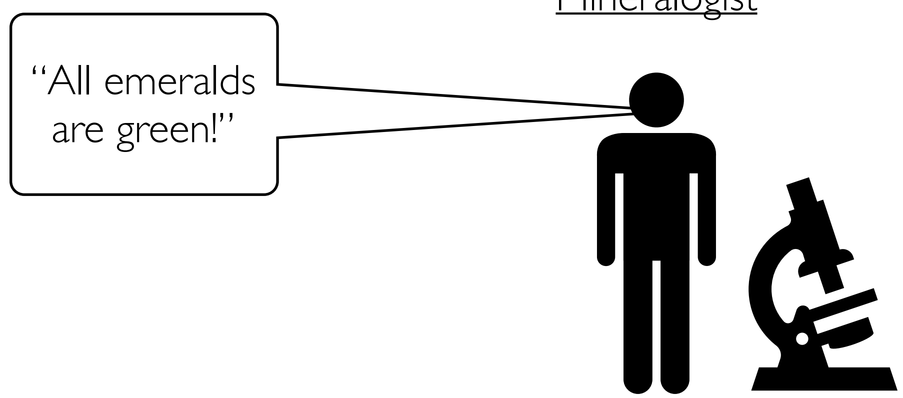
The Grue Paradox Constructed

source of minerals

The Paradox: First, we define the property *Grue*:

$$\forall x \; \forall t \; [Grue(x) \text{ iff } (t < t^\star \rightarrow Green(x,t) \wedge (t \geq t^\star \rightarrow Blue(x,t))]$$

Mineralogist



$Green(o_1, t_1)$ $Green(o_2, t_2)$ $Green(o_3, t_3)$ …

… $k, k \in \mathbb{Z}^+$, and all before time $t^\star$

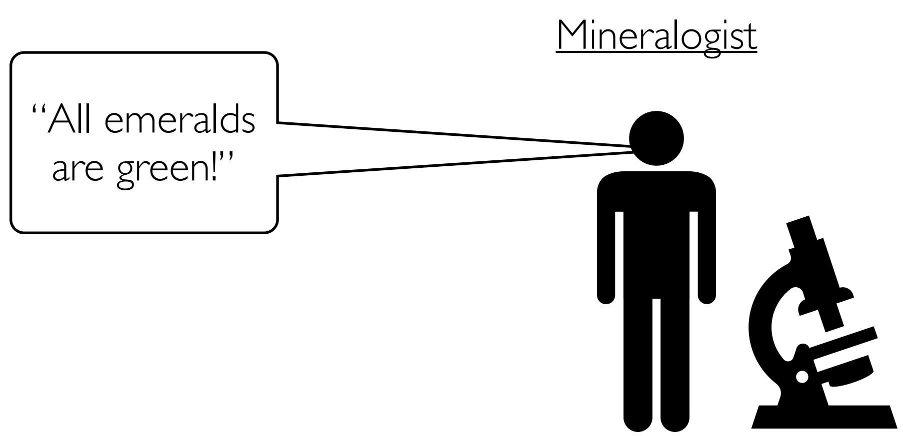
The Grue Paradox Constructed

source of minerals

The Paradox: First, we define the property *Grue*:

$$\forall x\ \forall t\ [Grue(x) \text{ iff } (t < t^\star \rightarrow Green(x,t) \wedge (t \geq t^\star \rightarrow Blue(x,t)]$$

The k atomic formulae, together, support the general mineralogical law affirmed by our mineralogist, who we assume to be a rational empirical scientist. But this scientist must *also* affirm the proposition that all emeralds are grue, since the very same atomic formulae support this proposition, and to the same degree. But surely this is absurd!



$Green(o_1, t_1)$ $Green(o_2, t_2)$ $Green(o_3, t_3)$ …



… $k, k \in \mathbb{Z}^+$, and all before time $t^\star$

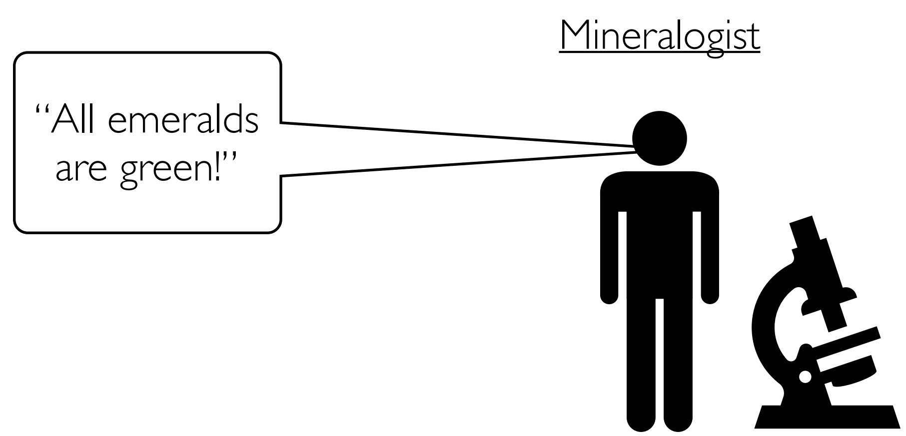
The Grue Paradox Constructed

source of minerals

The Paradox: First, we define the property *Grue*:

$$\forall x\ \forall t\ [Grue(x) \text{ iff } (t < t^\star \rightarrow Green(x,t) \wedge (t \geq t^\star \rightarrow Blue(x,t)]$$

The k atomic formulae, together, support the general mineralogical law affirmed by our mineralogist, who we assume to be a rational empirical scientist. But this scientist must *also* affirm the proposition that all emeralds are grue, since the very same atomic formulae support this proposition, and to the same degree. But surely this is absurd!



How can we solve this?!

$Green(o_1, t_1)$ $Green(o_2, t_2)$ $Green(o_3, t_3)$ $\ldots$

$\ldots\ k, k \in \mathbb{Z}^+,$ and all before time $t^\star$

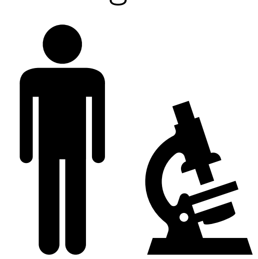
How can we solve this?!

The Paradox: First, we define the property *Grue*:

$$\forall x\ \forall t\ [Grue(x) \text{ iff } (t < t^\star \rightarrow Green(x,t) \wedge (t \geq t^\star \rightarrow Blue(x,t))]$$

The k atomic formulae, together, support the general mineralogical law affirmed by our mineralogist, who we assume to be a rational empirical scientist. But this scientist must *also* affirm the proposition that all emeralds are grue, since the very same atomic formulae support this proposition. But surely this is absurd!

Mineralogist



$Green(o_1, t_1)$ $Green(o_2, t_2)$ $Green(o_3, t_k)$ $\ldots$

$\ldots\ k, k \in \mathbb{Z}^+,$ and all before time $t^\star$

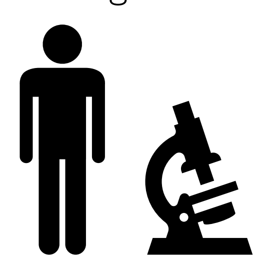
How can we solve this?!

The Paradox: First, we define the property *Grue*:

$$\forall x \ \forall t \ [Grue(x) \text{ iff } (t < t^\star \rightarrow Green(x,t) \wedge (t \geq t^\star \rightarrow Blue(x,t))]$$

The k atomic formulae, together, support the general mineralogical law affirmed by our mineralogist, who we assume to be a rational empirical scientist. But this scientist must *also* affirm the proposition that all emeralds are grue, since the very same atomic formulae support this proposition. But surely this is absurd!

<u>Mineralogist</u>

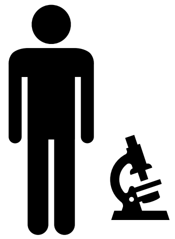


$Green(o_1, t_1)$ $Green(o_2, t_2)$ $Green(o_3, t_k)$ $\ldots$

$\ldots \ k, k \in \mathbb{Z}^+,$ and all before time $t^\star$

Mineralogist

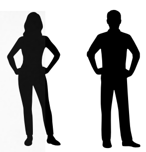


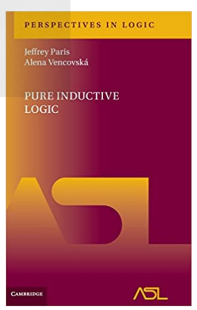
Solution Sketch

Let us insist that our scientist provide a cogent argument for why he believes that all emeralds are green — or, better, for the proposition that any agent with his epistemic status ought to believe that all emeralds are green. What is that status? First consider perception. The scientist has perceived the long list of atomic formulae that we have already introduced into the situation. In addition, the scientist has *not* perceived, for any other color property R [so we are here invoking $\mathscr{L}_3$, since we need to say that e.g. $C(Green)$], that any of those objects have R. Also, k is a very large number, and the objects are believed to be representative and uncontaminated. The upshot is that there is a rather elaborate inference schema I_{ei} for enumerative induction that is employed. Is any argument that uses this schema in place to support the proposition that the mineralogist ought to believe that all emeralds are grue? No. Well, then it's flatly incorrect to assert any such thing as that the scientist has an equally good basis to support an intellectual obligation to believe that all emeralds are grue as to believe that all emeralds are green. Paradox/problem solved.

The Grue Paradox Divides Hearts and Minds

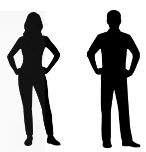
The Mathematicians/Logicians

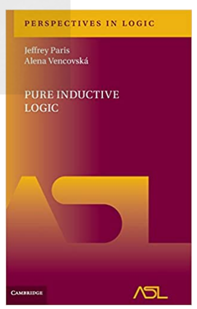




The Grue Paradox Divides Hearts and Minds

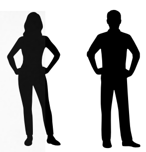
The Mathematicians/Logicians

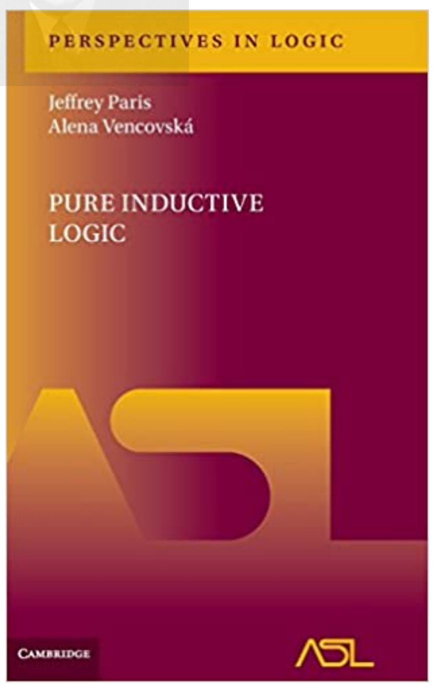




The Grue Paradox Divides Hearts and Minds

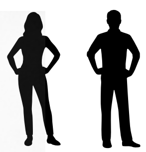
The Mathematicians/Logicians

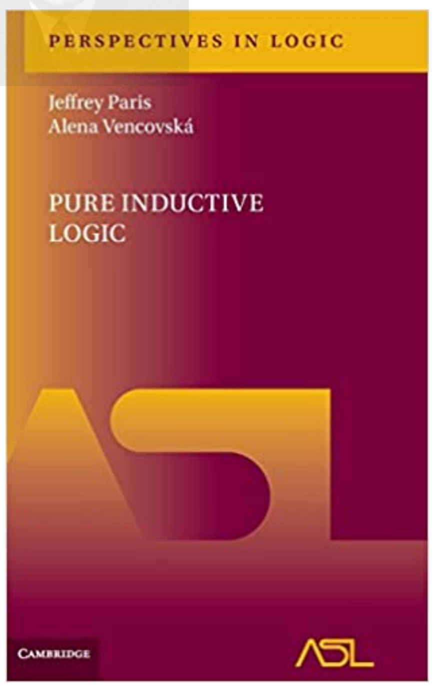




The Grue Paradox Divides Hearts and Minds

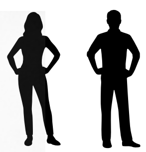
The Mathematicians/Logicians

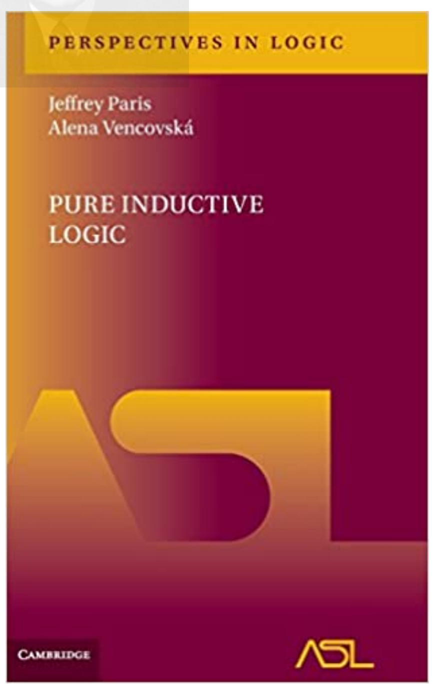




The Grue Paradox Divides Hearts and Minds

The Mathematicians/Logicians

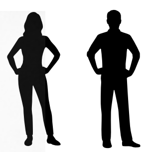


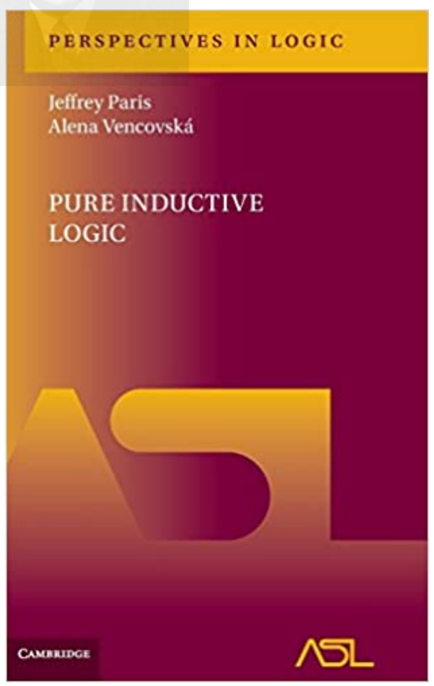


The Philosophers

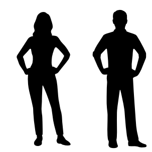
The Grue Paradox Divides Hearts and Minds

The Mathematicians/Logicians



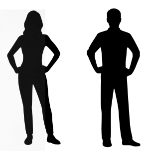


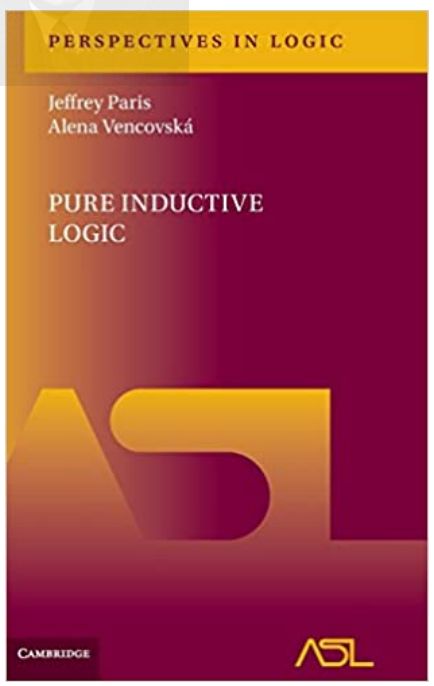
The Philosophers



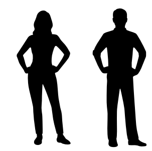
The Grue Paradox Divides Hearts and Minds

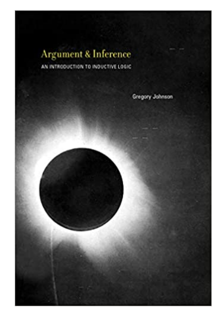
The Mathematicians/Logicians





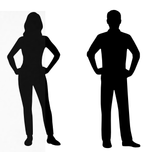
The Philosophers

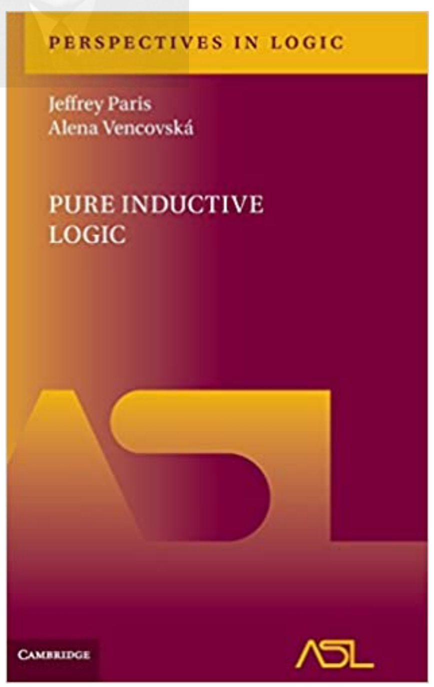




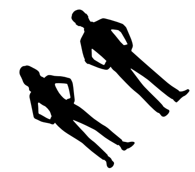
The Grue Paradox Divides Hearts and Minds

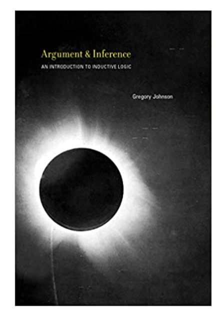
The Mathematicians/Logicians





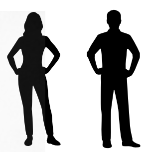
The Philosophers

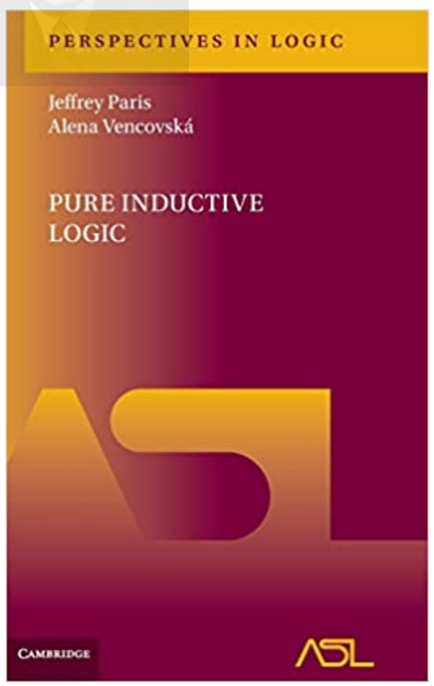




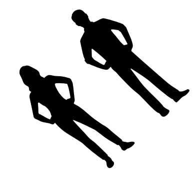
The Grue Paradox Divides Hearts and Minds

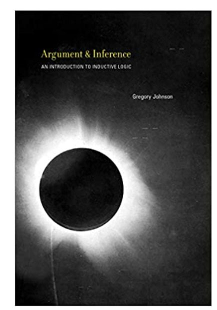
The Mathematicians/Logicians





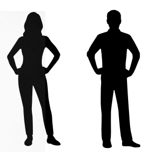
The Philosophers

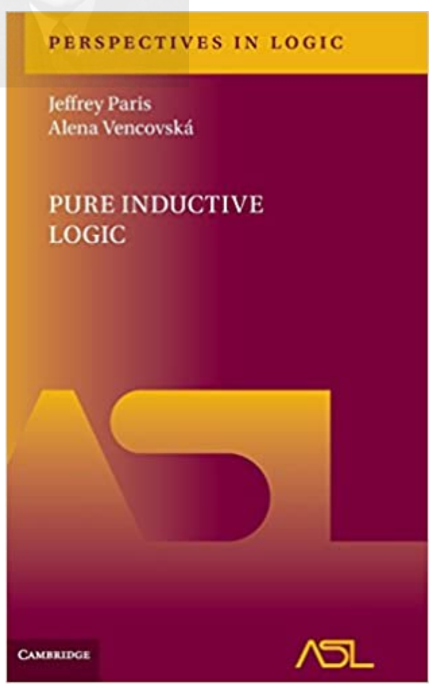




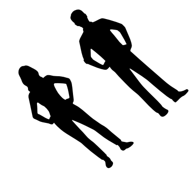
The Grue Paradox Divides Hearts and Minds

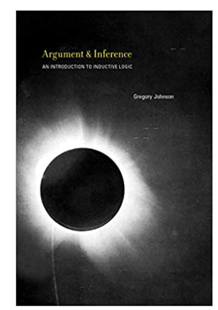
The Mathematicians/Logicians





The Philosophers

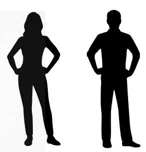


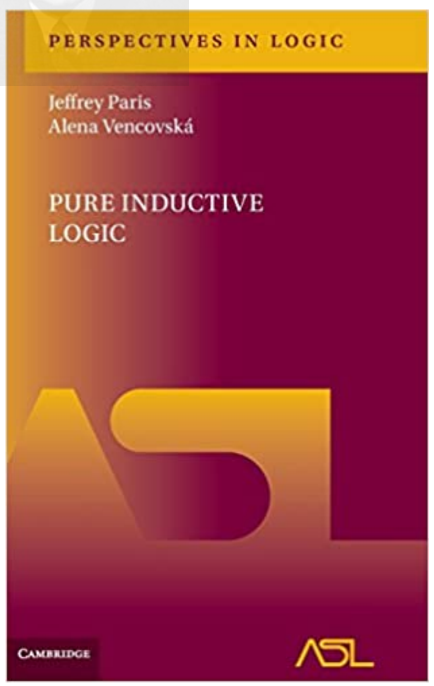


The Logicist AI Folks/
Computational Logicians

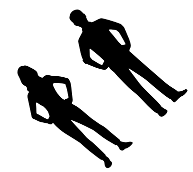
The Grue Paradox Divides Hearts and Minds

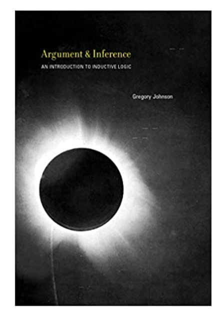
The Mathematicians/Logicians



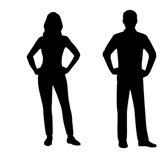


The Philosophers



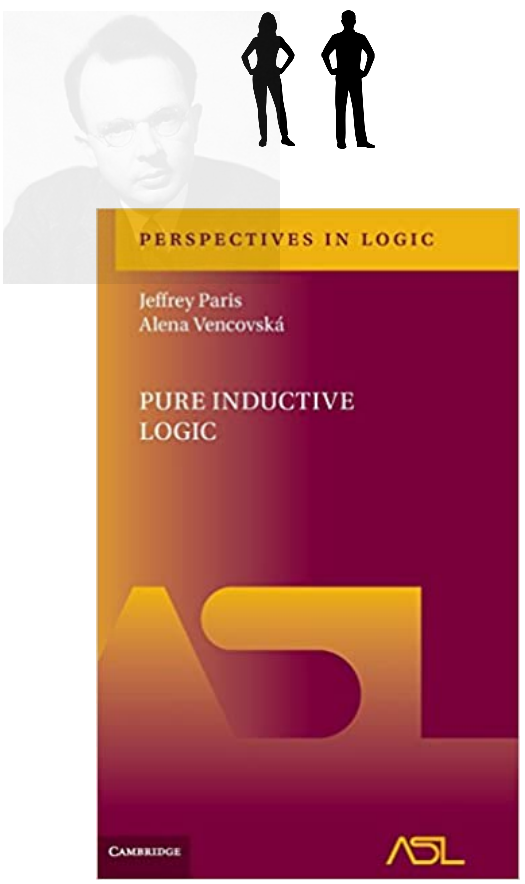


The Logicist AI Folks/
Computational Logicians

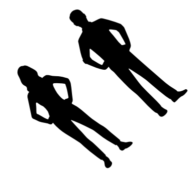


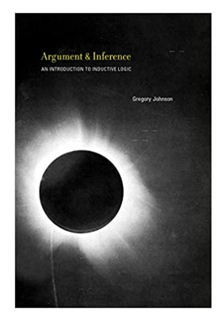
The Grue Paradox Divides Hearts and Minds

The Mathematicians/Logicians

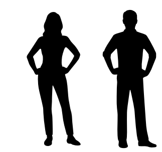


The Philosophers



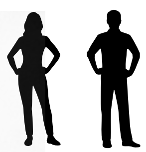


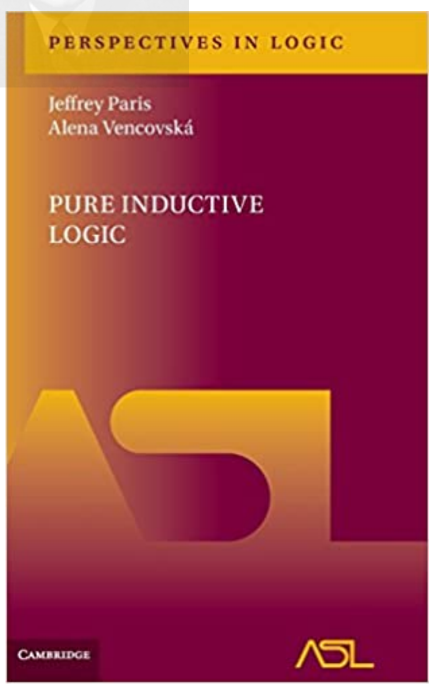
The Logicist AI Folks/
Computational Logicians



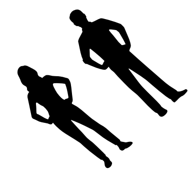
The Grue Paradox Divides Hearts and Minds

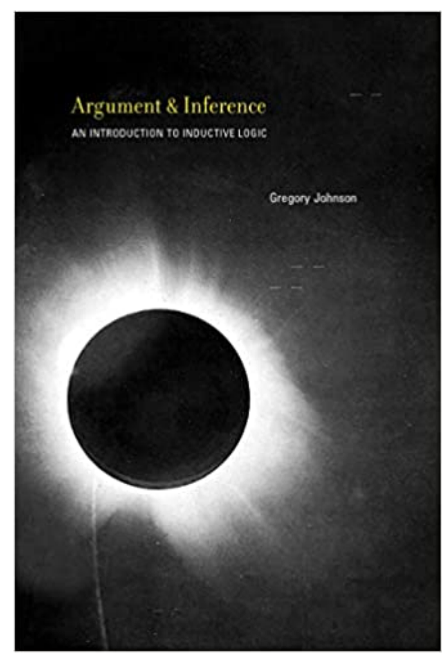
The Mathematicians/Logicians



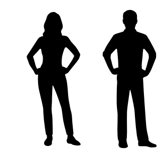


The Philosophers



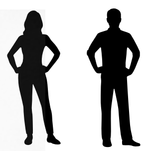


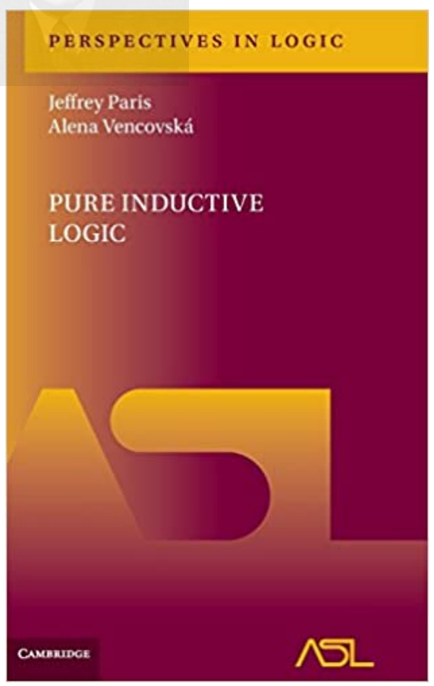
The Logicist AI Folks/
Computational Logicians



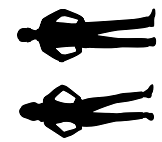
The Grue Paradox Divides Hearts and Minds

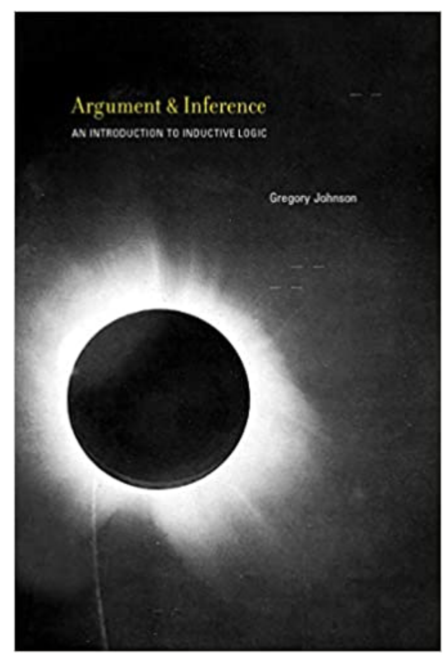
The Mathematicians/Logicians



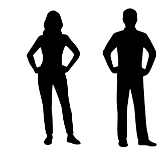


The Philosophers





The Logicist AI Folks/
Computational Logicians

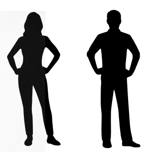


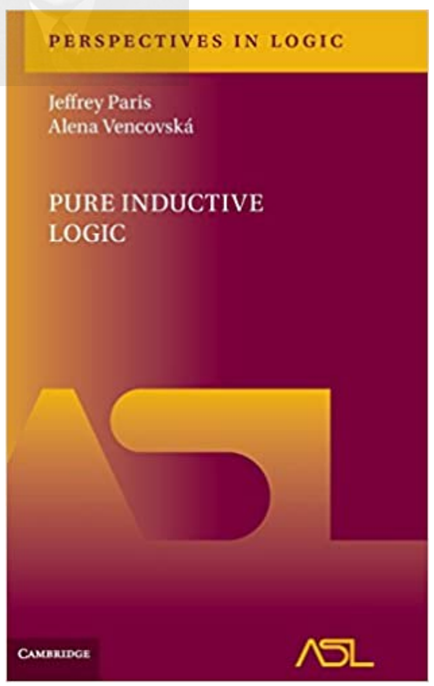
The Grue Paradox Divides Hearts and Minds

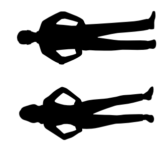
The Mathematicians/Logicians

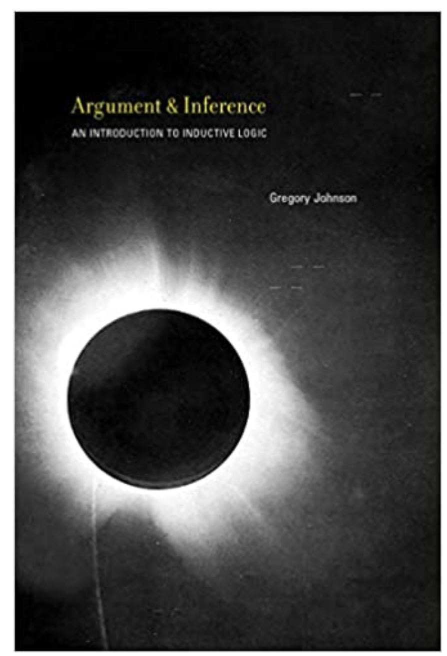
The Philosophers

The Logicist AI Folks/
Computational Logicians

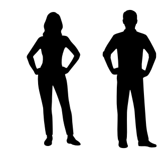






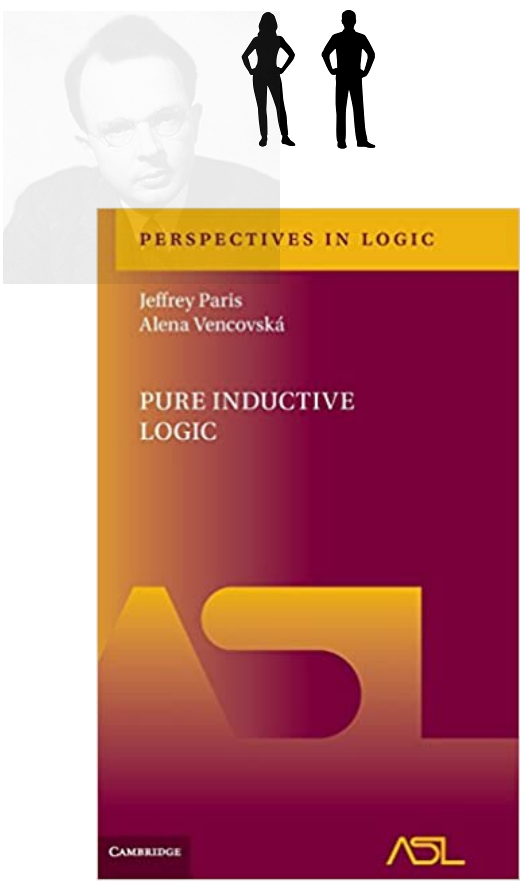


Yours truly

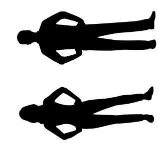


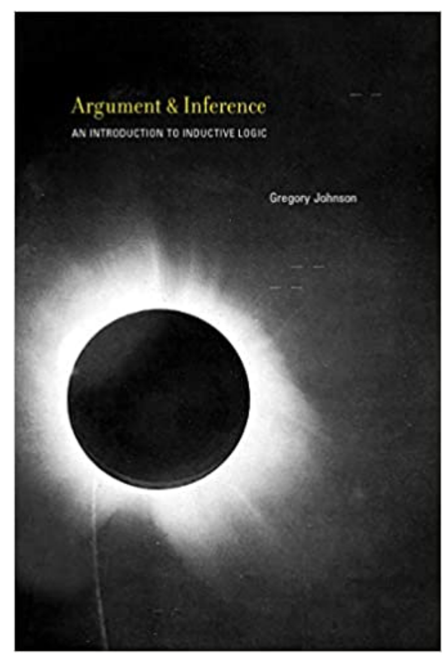
The Grue Paradox Divides Hearts and Minds

The Mathematicians/Logicians



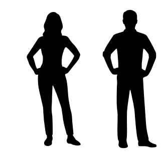
The Philosophers





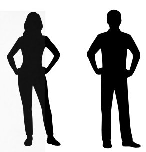
Yours truly

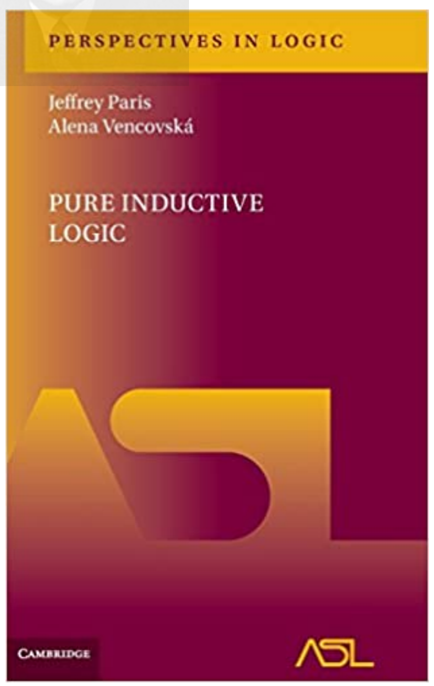
The Logicist AI Folks/
Computational Logicians



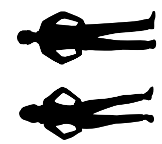
The Grue Paradox Divides Hearts and Minds

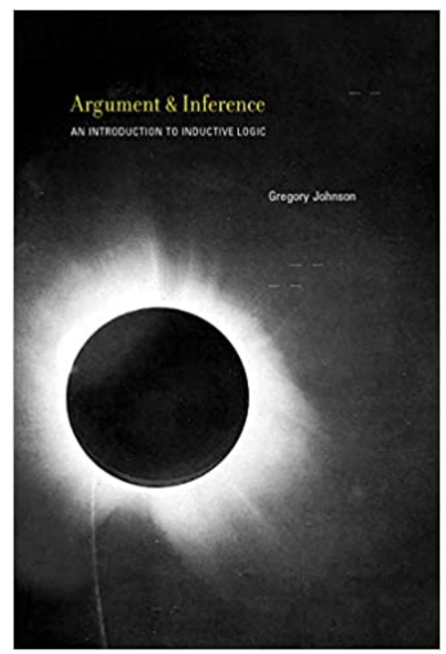
The Mathematicians/Logicians





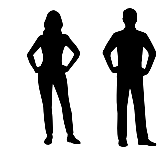
The Philosophers





Yours truly

The Logicist AI Folks/
Computational Logicians



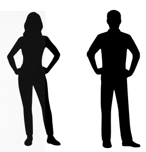
And there is another important camp:

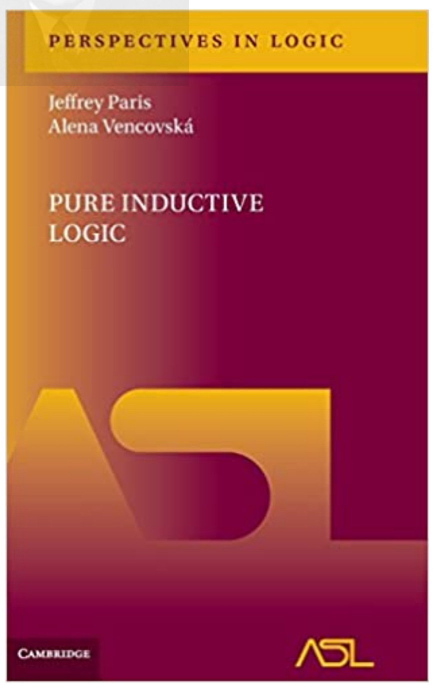
The Grue Paradox Divides Hearts and Minds

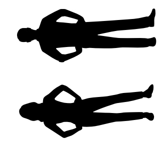
The Mathematicians/Logicians

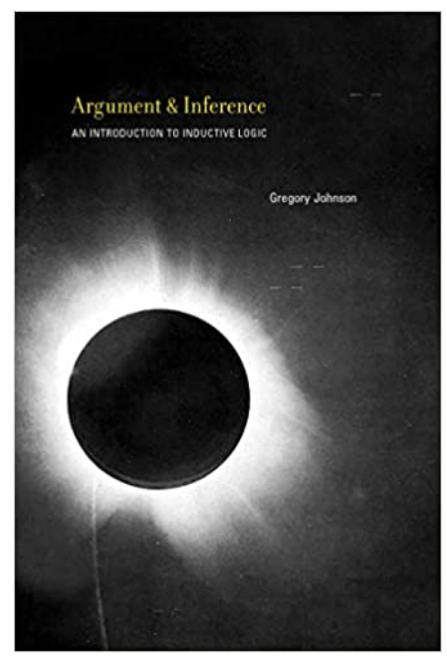
The Philosophers

The Logicist AI Folks/
Computational Logicians

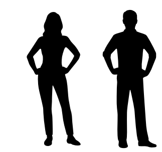








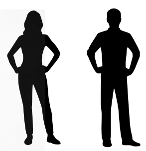
Yours truly

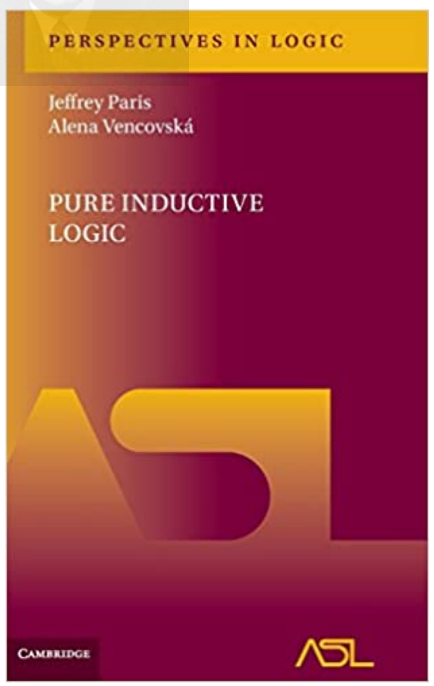


And there is another important camp: The Bayesians

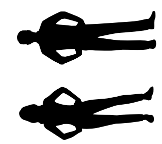
The Grue Paradox Divides Hearts and Minds

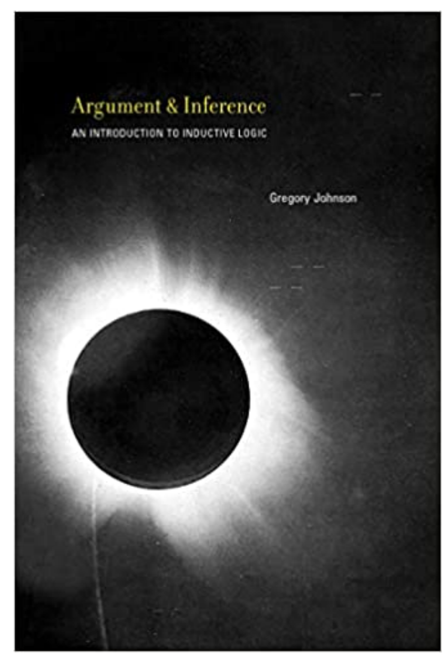
The Mathematicians/Logicians





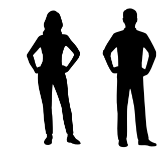
The Philosophers





Yours truly

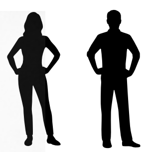
The Logicist AI Folks/
Computational Logicians

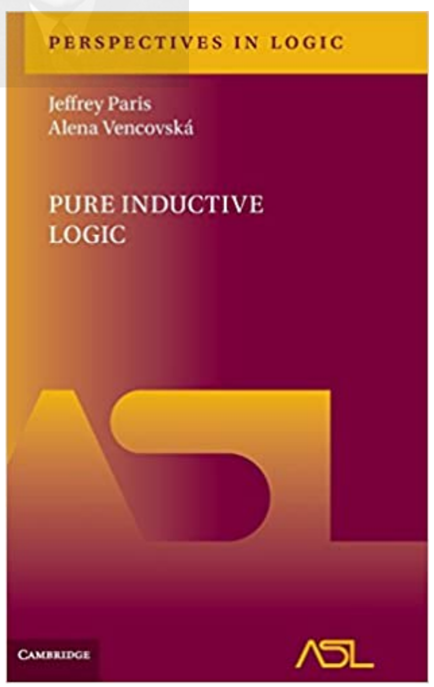


And there is another important camp:

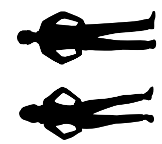
The Grue Paradox Divides Hearts and Minds

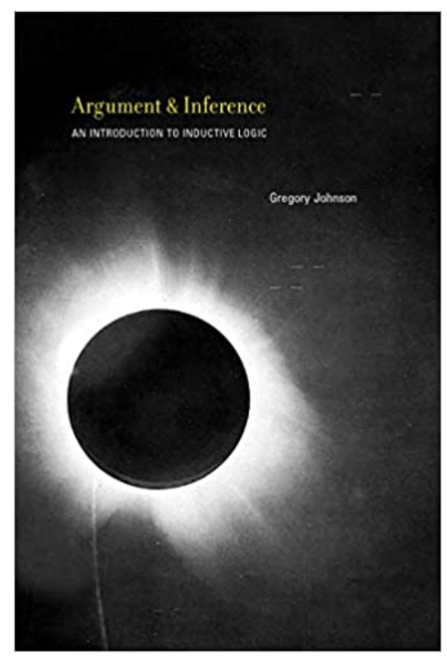
The Mathematicians/Logicians





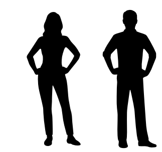
The Philosophers

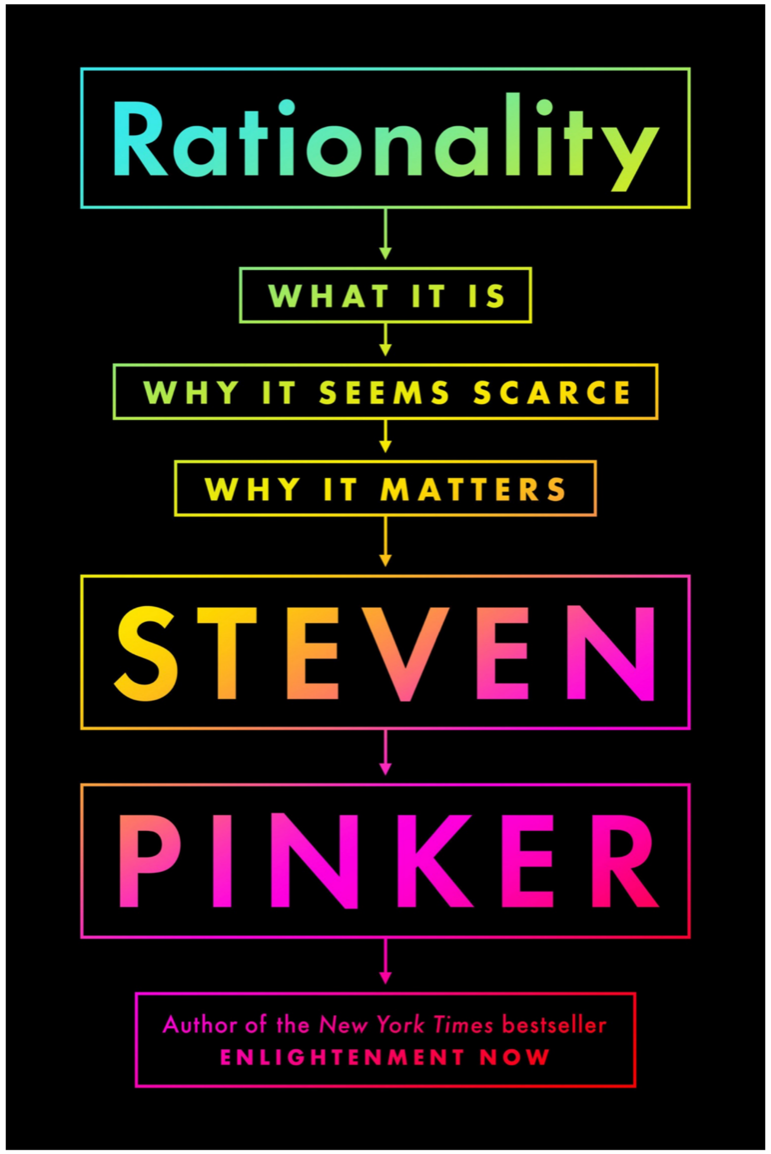




Yours truly

The Logicist AI Folks/
Computational Logicians



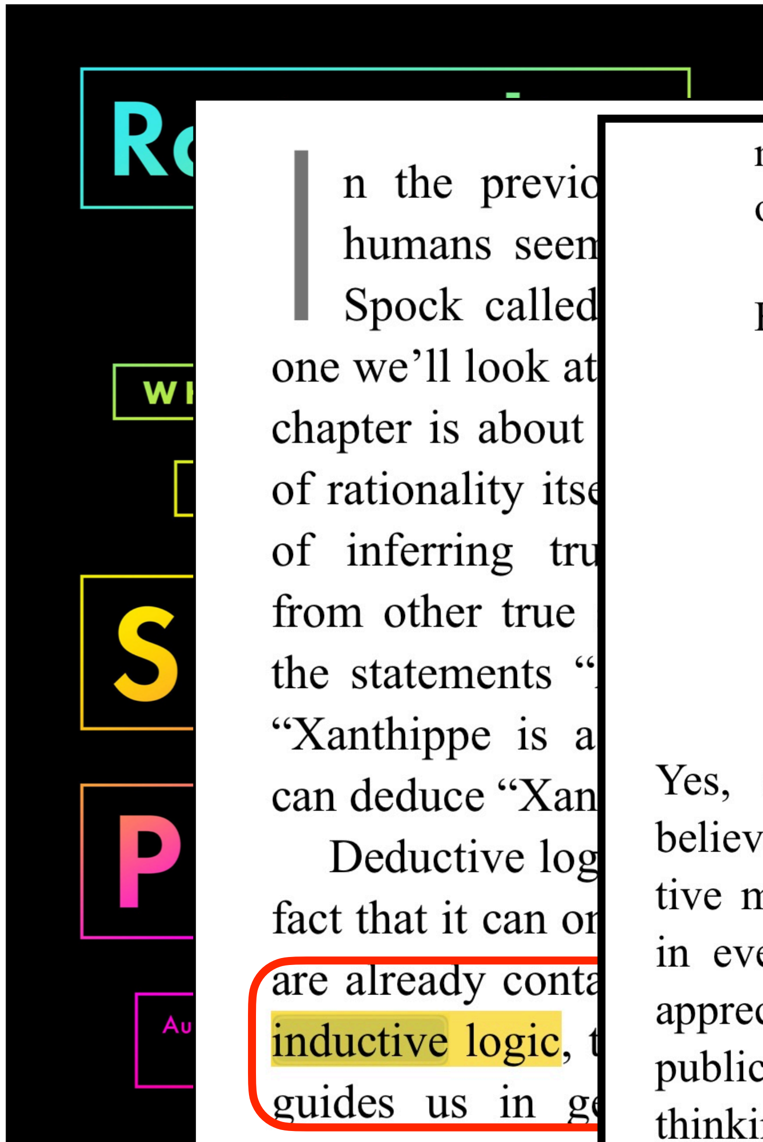

Rationality
WHAT IT IS
WHY IT SEEMS SCARCE
WHY IT MATTERS
STEVEN
PINKER
Author of the New York Times bestseller
ENLIGHTENMENT NOW

In the previous chapter, we asked why humans seem to be driven by what Mr. Spock called "foolish emotions." In this one we'll look at their irritating "illogic." The chapter is about logic, not in the loose sense of rationality itself but in the technical sense of inferring true statements (conclusions) from other true statements (premises). From the statements "All women are mortal" and "Xanthippe is a woman," for example, we can deduce "Xanthippe is mortal."

Deductive logic is a potent tool despite the fact that it can only draw out conclusions that are already contained in the premises (unlike inductive logic, the topic of chapter 5, which guides us in generalizing from evidence). Since people agree on many propositions—all women are mortal, the square of eight is sixty-four, rocks fall down and not up, murder is wrong—the goal of arriving at new, less obvious propositions is one we can all embrace. A tool with such power allows us to discover new truths about the world from the comfort of our armchairs, and to resolve disputes about the many things people don't agree on. The philosopher Gottfried Wilhelm Leibniz (1646–1716) fantasized that logic could bring about an epistemic utopia:

In the previous chapter, we asked why humans seem to be driven by what Mr. Spock called "foolish emotions." In this one we'll look at their irritating "illogic." The chapter is about logic, not in the loose sense of rationality itself but in the technical sense of inferring true statements (conclusions) from other true statements (premises). From the statements "All women are mortal" and "Xanthippe is a woman," for example, we can deduce "Xanthippe is mortal."

Deductive logic is a potent tool despite the fact that it can only draw out conclusions that are already contained in the premises (unlike inductive logic, the topic of chapter 5, which guides us in generalizing from evidence). Since people agree on many propositions—all women are mortal, the square of eight is sixty-four, rocks fall down and not up, murder is wrong—the goal of arriving at new, less obvious propositions is one we can all embrace. A tool with such power allows us to discover new truths about the world from the comfort of our armchairs, and to resolve disputes about the many things people don't agree on. The philosopher Gottfried Wilhelm Leibniz (1646–1716) fantasized that logic could bring about an epistemic utopia:



In the previo
humans seem
Spock called
one we'll look at
chapter is about
of rationality itse
of inferring tru
from other true
the statements "
"Xanthippe is a
can deduce "Xan
Deductive log
fact that it can or
are already conta
inductive logic, t
guides us in ge
Since people ag
all women are m
sixty-four, rocks
der is wrong—t
less obvious pro
embrace. A tool
discover new tru
comfort of our a
putes about the
agree on. The ph
Leibniz (1646–1
could bring abou

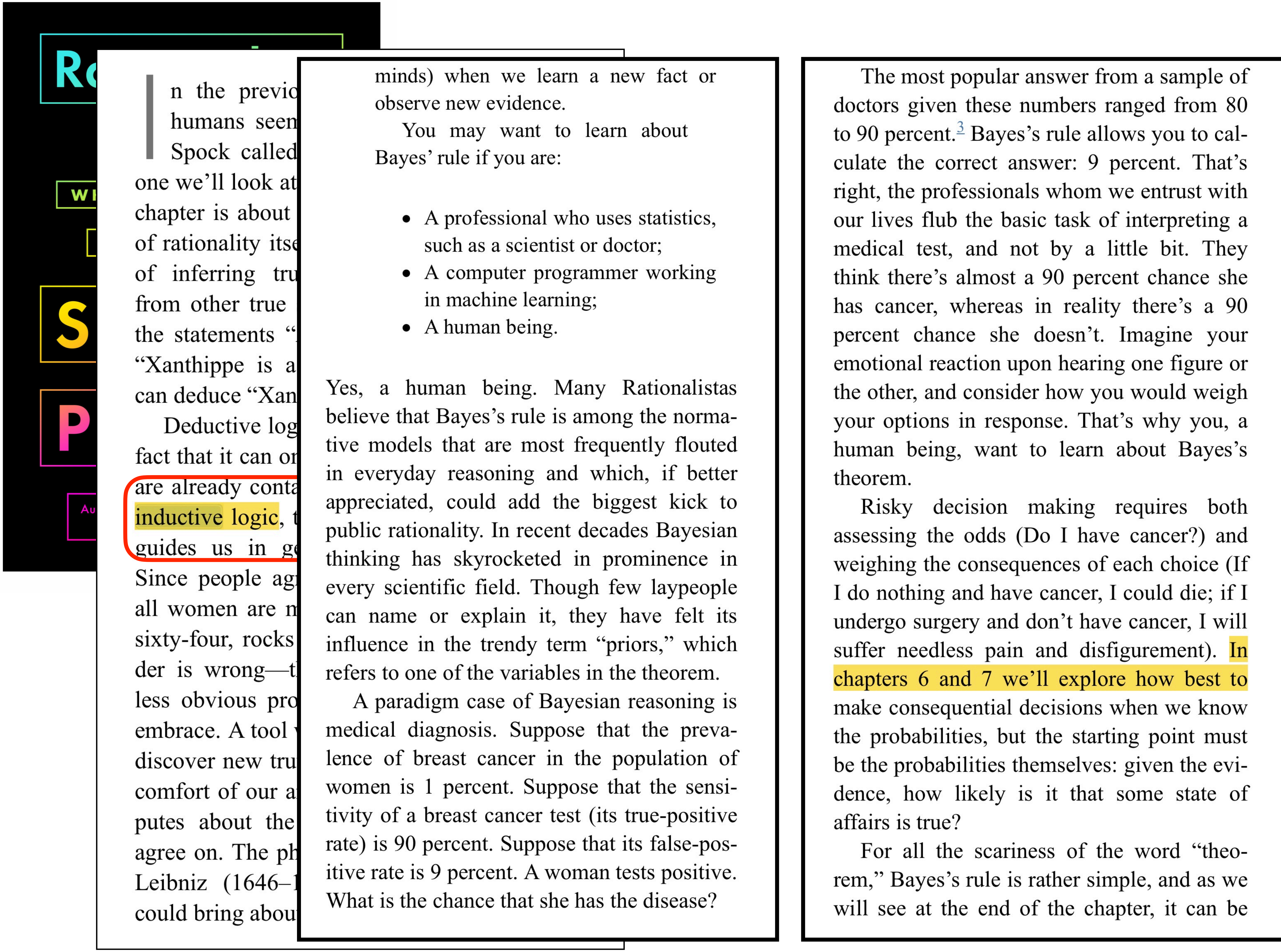
minds) when we learn a new fact or observe new evidence.

You may want to learn about Bayes' rule if you are:

- A professional who uses statistics, such as a scientist or doctor;
- A computer programmer working in machine learning;
- A human being.

Yes, a human being. Many Rationalistas believe that Bayes's rule is among the normative models that are most frequently flouted in everyday reasoning and which, if better appreciated, could add the biggest kick to public rationality. In recent decades Bayesian thinking has skyrocketed in prominence in every scientific field. Though few laypeople can name or explain it, they have felt its influence in the trendy term "priors," which refers to one of the variables in the theorem.

A paradigm case of Bayesian reasoning is medical diagnosis. Suppose that the prevalence of breast cancer in the population of women is 1 percent. Suppose that the sensitivity of a breast cancer test (its true-positive rate) is 90 percent. Suppose that its false-positive rate is 9 percent. A woman tests positive. What is the chance that she has the disease?



n the previ
humans seen
Spock called
one we'll look at
chapter is about
of rationality itse
of inferring tru
from other true
the statements "
"Xanthippe is a
can deduce "Xan
Deductive log
fact that it can or
are already conta
inductive logic, t
guides us in ge
Since people ag
all women are m
sixty-four, rocks
der is wrong—t
less obvious pro
embrace. A tool
discover new tru
comfort of our a
putes about the
agree on. The ph
Leibniz (1646–1
could bring abou

minds) when we learn a new fact or observe new evidence.

You may want to learn about Bayes' rule if you are:

- A professional who uses statistics, such as a scientist or doctor;
- A computer programmer working in machine learning;
- A human being.

Yes, a human being. Many Rationalistas believe that Bayes's rule is among the normative models that are most frequently flouted in everyday reasoning and which, if better appreciated, could add the biggest kick to public rationality. In recent decades Bayesian thinking has skyrocketed in prominence in every scientific field. Though few laypeople can name or explain it, they have felt its influence in the trendy term "priors," which refers to one of the variables in the theorem.

A paradigm case of Bayesian reasoning is medical diagnosis. Suppose that the prevalence of breast cancer in the population of women is 1 percent. Suppose that the sensitivity of a breast cancer test (its true-positive rate) is 90 percent. Suppose that its false-positive rate is 9 percent. A woman tests positive. What is the chance that she has the disease?

The most popular answer from a sample of doctors given these numbers ranged from 80 to 90 percent.[3] Bayes's rule allows you to calculate the correct answer: 9 percent. That's right, the professionals whom we entrust with our lives flub the basic task of interpreting a medical test, and not by a little bit. They think there's almost a 90 percent chance she has cancer, whereas in reality there's a 90 percent chance she doesn't. Imagine your emotional reaction upon hearing one figure or the other, and consider how you would weigh your options in response. That's why you, a human being, want to learn about Bayes's theorem.

Risky decision making requires both assessing the odds (Do I have cancer?) and weighing the consequences of each choice (If I do nothing and have cancer, I could die; if I undergo surgery and don't have cancer, I will suffer needless pain and disfigurement). In chapters 6 and 7 we'll explore how best to make consequential decisions when we know the probabilities, but the starting point must be the probabilities themselves: given the evidence, how likely is it that some state of affairs is true?

For all the scariness of the word "theorem," Bayes's rule is rather simple, and as we will see at the end of the chapter, it can be

Example 1, My Approach

By *Dis*analogy, Cyberwarfare is Utterly New

Selmer Bringsjord
Rensselaer AI & Reasoning (RAIR) Lab
Department of Cognitive Science
Department of Computer Science
Rensselaer Polytechnic Institute (RPI)
Troy NY 12180 USA
`selmer@rpi.edu`

John Licato
Rensselaer AI & Reasoning (RAIR) Lab
Department of Cognitive Science
Department of Computer Science
Rensselaer Polytechnic Institute (RPI)
Troy, NY 12180 USA
`licatj@rpi.edu`

Abstract:
We provide an underlying theory of argument by *dis*analogy, in order to employ it to show that cyberwarfare is fundamentally new (relative to traditional kinetic warfare, and espionage). Once this general case is made, the battle is won: we are well on our way to establishing our main thesis: that Just War Theory itself must be modernized. Augustine and Aquinas (and their predecessors) had a stunningly long run, but today's world, based as it is on digital information and increasingly intelligent information-processing, points the way to a beast so big and so radically different, that the core of this duo's insights needs to be radically extended.

Keywords:* *cyberwarfare, analogy, disanalogy, AI, future

Contents

Example 1, My Approach

Table 1: Generic Schema $\mathscr{A}$ of Analogical Argument

SOURCE		TARGET
$\mathcal{P}$	$\longrightarrow$	$\mathcal{P}^*$
$\mathcal{A}$	$\not\longleftrightarrow$	$\neg\mathcal{A}^*$
$\neg\mathcal{B}$	$\not\longleftrightarrow$	$\mathcal{B}^*$
proposals		*proposals*
χ		
		χ^*

Table 2: Instantiation $\mathscr{A}^{w\rightarrow c}$ of Generic Schema of Analogical Argument

SOURCE		TARGET
$\mathcal{P}_{\text{war}}$	$\longrightarrow$	$\mathcal{P}^*_{\text{cyberwar}}$
$\mathcal{A}_{\text{war}}$	$\not\longleftrightarrow$	$\neg\mathcal{A}^*_{\text{cyberwar}}$
$\neg\mathcal{B}_{\text{war}}$	$\not\longleftrightarrow$	$\mathcal{B}^*_{\text{cyberwar}}$
proposals		*proposals*
$\mathbf{JWT}_{\text{war}}$		
		$\mathbf{JWT}_{\text{cyberwar}}$

again the larger stroke '/' in Figure 1). We turn now to a characterization of the range in question.

4. The Instantiated Generic Argument Schema

This section is devoted to presenting the instantiation of the generic schema $\mathscr{A}$ for analogical argumentation, for the purpose of showing that cyberwarfare, from the standpoint of JWT, is nothing new.

We assume a domain of discourse for both the SOURCE and the TARGET (D_{war} and D^*_{cyberwar}, resp.), and suppose as well that there is a set of sets of formulae (in $\mathcal{L}^1_{\text{war}}$ and $\mathcal{L}^2_{\text{cyberwar}}$, resp.) for each of both the SOURCE and TARGET; these formulae express information, of course, regarding the SOURCE and TARGET. In addition, there is a key particular formula $\mathbf{JWT}_{\text{war}}$ that holds of the SOURCE, whose analogue, $\mathbf{JWT}_{\text{cyberwar}}$, is inferred to hold about the target. The formula $\mathbf{JWT}_{\text{cyberwar}}$ represents the overall claim that JWT applies to cyberwarfare, in a direct "carry over" from its application to conventional war and espionage. The situation is shown schematically in tabular form in Table 1.

Table 1: Generic Schema $\mathscr{A}$ of Analogical Argument

SOURCE		TARGET
$\mathcal{P}$	$\longrightarrow$	$\mathcal{P}^*$
$\mathcal{A}$	$\not\longrightarrow$	$\neg\mathcal{A}^*$
$\neg\mathcal{B}$	$\not\longrightarrow$	$\mathcal{B}^*$
proposals		*proposals*
χ		
		χ^*

Table 2: Instantiation $\mathscr{A}^{w \to c}$ of Generic Schema of Analogical Argument

SOURCE		TARGET
$\mathcal{P}_{\text{war}}$	$\longrightarrow$	$\mathcal{P}^*_{\text{cyberwar}}$
$\mathcal{A}_{\text{war}}$	$\not\longrightarrow$	$\neg\mathcal{A}^*_{\text{cyberwar}}$
$\neg\mathcal{B}_{\text{war}}$	$\not\longrightarrow$	$\mathcal{B}^*_{\text{cyberwar}}$
proposals		*proposals*
$\mathbf{JWT}_{\text{war}}$		
		$\mathbf{JWT}_{\text{cyberwar}}$

again the larger stroke '/' in Figure 1). We turn now to a characterization of the range in question.

4. The Instantiated Generic Argument Schema

This section is devoted to presenting the instantiation of the generic schema $\mathscr{A}$ for analogical argumentation, for the purpose of showing that cyberwarfare, from the standpoint of JWT, is nothing new.

We assume a domain of discourse for both the SOURCE and the TARGET

$$\forall s \ [(Motive(s) \land Means(s) \land Opp(s) \land Intent(s)) \rightarrow Guilty(s)]$$

https://plato.stanford.edu/entries/evidence-legal

Wigmore!!!

Background Reading …

The Original Publication Introducing The Grue Paradox

Goodman, N. (1955) *Fact, Fiction, and Forecast* (Cambridge, MA: Harvard University Press).
4th edition 1983, also HUP.

From "Nelson Goodman" in SEP (https://plato.stanford.edu/entries/goodman)

Here comes the riddle. Suppose that your research is in gemology. Your special interest lies in the color properties of certain gemstones, in particular, emeralds. All emeralds you have examined before a certain time t were green (your notebook is full of evidence statements of the form "Emerald x found at place y date $z(z \leq t)$ is green"). It seems that, at t, this supports the hypothesis that all emeralds are green (L3).

Now Goodman introduces the predicate "grue". This predicate applies to all things examined before some future time t just in case they are green but to other things (observed at or after t) just in case they are blue:

(DEF1) x is grue $=_{df}$ x is examined before t and green $\vee$ x is not so examined and blue

Until t it is obviously the case that for each statement in your notebook, there is a parallel statement asserting that the emerald x found at place y date $z(z \leq t)$ is grue. Each of these statements is analytically equivalent with the corresponding one in your notebook. All these grue-evidence statements taken together confirm the hypothesis that all emeralds are grue (L4), and they confirm this hypothesis to the exact same degree as the green-evidence statements confirmed the hypothesis that all emeralds are green. But if that is the case, then the following two predictions are also confirmed to the same degree:

(P1) The next emerald first examined after t will be green.
(P2) The next emerald first examined after t will be grue.

However, to be a grue emerald examined after t is not to be a green emerald. An emerald first examined after t is grue iff it is blue. We have two mutually incompatible predictions, both confirmed to the same degree by the past evidence. We could obviously define infinitely many grue-like predicates that would all lead to new, similarly incompatible predictions.

The immediate lesson is that we cannot use all kinds of weird predicates to formulate hypotheses or to classify our evidence. Some predicates (which are the ones like "green") can be used for this; other predicates (the ones like "grue") must be excluded, if induction is supposed to make any sense. This already is an interesting result. For valid inductive inferences the choice of predicates matters.

It is not just that we lack justification for accepting a general hypothesis as true only on the basis of positive instances and lack of counterinstances (which was the old problem), or to define what rule we are using when accepting a general hypothesis as true on these grounds (which was the problem after Hume). The problem is to explain why some general statements (such as L3) are confirmed by their instances, whereas others (such as L4) are not. Again, this is a matter of the lawlikeness of L3 in contrast to L4, but how are we supposed to tell the lawlike regularities from the illegitimate generalizations?

Wikipedia Entry
“New Riddle of Induction” Isn’t Half Bad!

(https://en.wikipedia.org/wiki/New_riddle_of_induction)

Tutorial by Paris on Pure Inductive Logic:

http://fitelson.org/few/paris_notes.pdf

(Paris explains that the mathematicians just assumed the reasoning in the grue paradox is invalid, and then continued on their way to erect upon Carnap's work a robust formal edifice (= *pure inductive logic*).)

See "Inductive Logic" in SEP for an excellent overview, and in particular nice coverage of Carnap's seminal contributions, which PIL extends. (https://plato.stanford.edu/entries/logic-inductive)

Inductive Logic

First published Mon Sep 6, 2004; substantive revision Mon Mar 19, 2018

An inductive logic is a logic of evidential support. In a deductive logic, the premises of a valid deductive argument *logically entail* the conclusion, where *logical entailment* means that every logically possible state of affairs that makes the premises true *must* make the conclusion truth as well. Thus, the premises of a valid deductive argument provide *total support* for the conclusion. An inductive logic extends this idea to weaker arguments. In a good inductive argument, the truth of the premises provides some *degree of support* for the truth of the conclusion, where this *degree-of-support* might be measured via some numerical scale. By analogy with the notion of deductive entailment, the notion of inductive degree-of-support might mean something like this: among the logically possible states of affairs that make the premises true, the conclusion must be true in (at least) proportion *r* of them—where *r* is some numerical measure of the support strength.

If a logic of *good inductive arguments* is to be of any real value, the measure of support it articulates should be up to the task. Presumably, the logic should at least satisfy the following condition:

> **Criterion of Adequacy (CoA)**:
> The logic should make it likely (as a matter of logic) that as evidence accumulates, the total body of true evidence claims will eventually come to indicate, via the logic's *measure of support*, that false hypotheses are probably false and that true hypotheses are probably true.

The CoA stated here may strike some readers as surprisingly strong. Given a specific logic of evidential support, how might it be shown to satisfy such a condition? Section 4 will show precisely how this condition is satisfied by the logic of evidential support articulated in Sections 1 through 3 of this article.

This article will focus on the kind of the approach to inductive logic most widely studied by epistemologists and logicians in recent years. This approach employs conditional probability functions to represent measures of the degree to which evidence statements support hypotheses. Presumably, hypotheses should be empirically evaluated based on what they *say* (or imply) about the likelihood that evidence claims will be true. A straightforward theorem of probability theory, called Bayes' Theorem, articulates the way in which what hypotheses *say* about the likelihoods of evidence claims influences the degree to which hypotheses are supported by those evidence claims. Thus, this approach to the logic of evidential support is often called a *Bayesian Inductive Logic* or a *Bayesian Confirmation Theory*. This article will first provide a detailed explication of a Bayesian approach to inductive logic. It will then examine the extent to which this logic may pass muster as an adequate logic of evidential support for hypotheses. In particular, we will see how such a logic may be shown to satisfy the Criterion of Adequacy stated above.

Med nok penger, kan logikk løse alle problemer.