

First-Order Logic = FOL = $\mathcal{L}_1$ and the First (Logic) Programmer

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Intro to Logic-based AI
10/1/2026



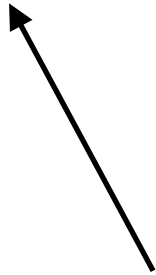
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Who is it?



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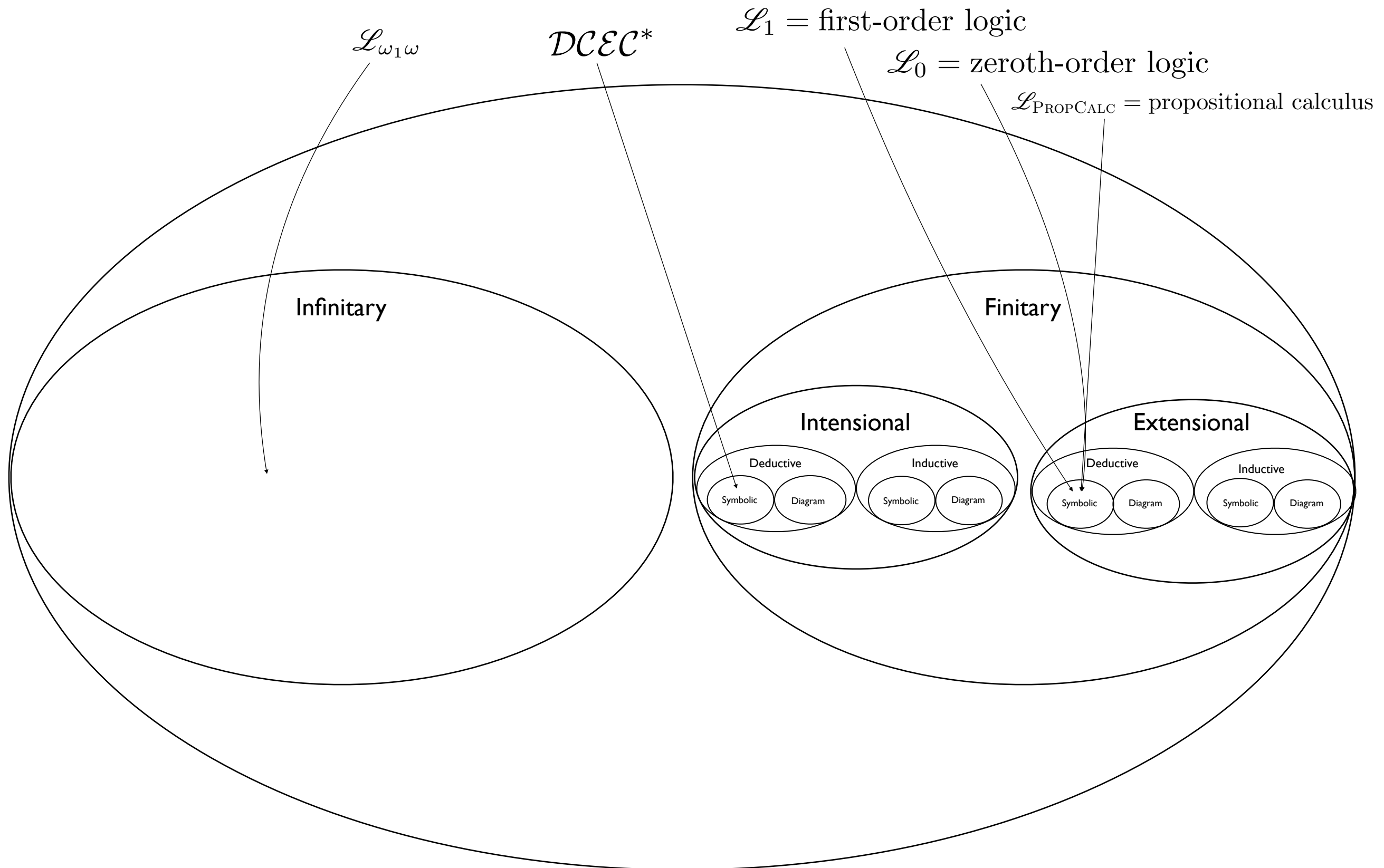


Who is it?

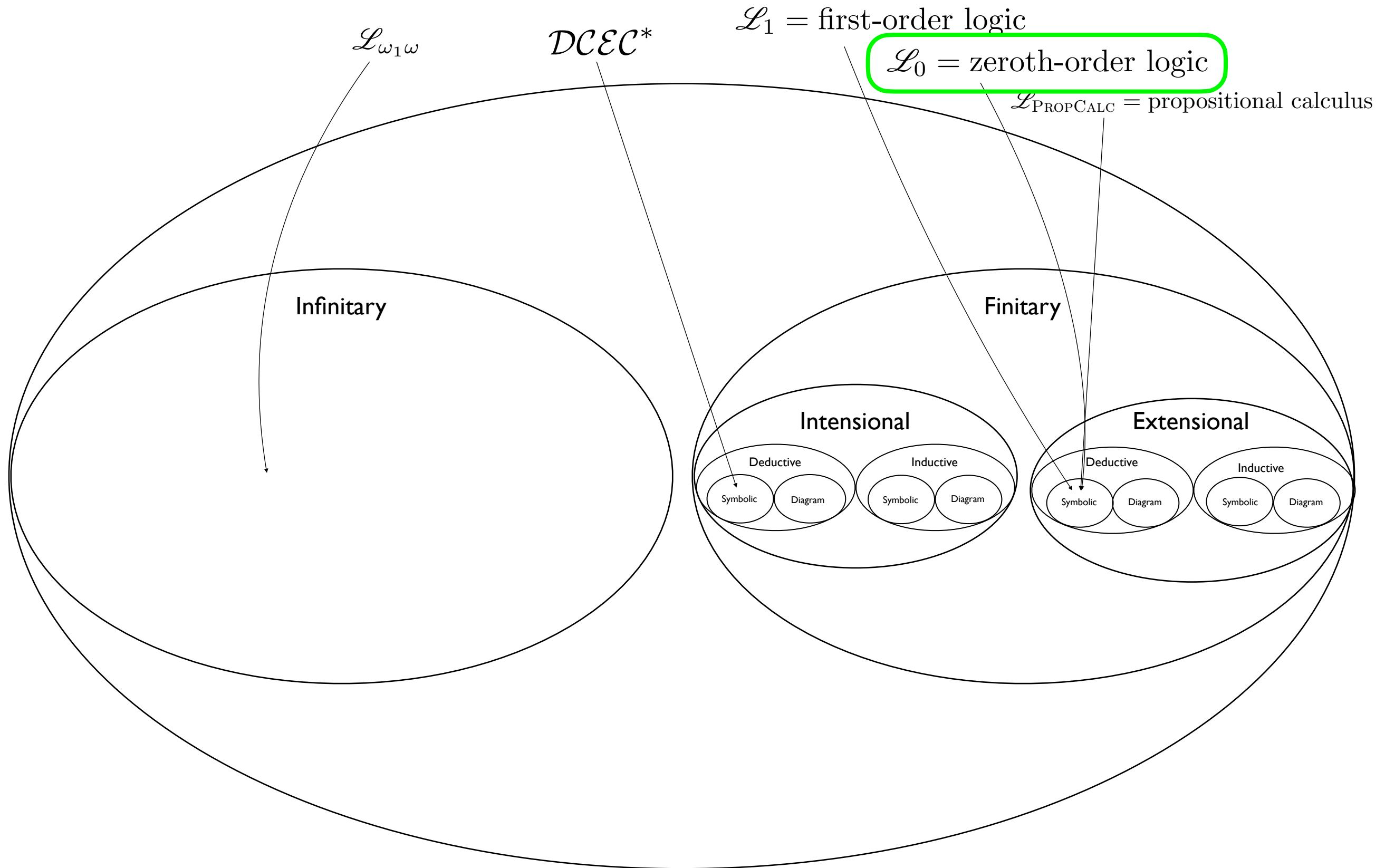
Aristotle
Leibniz
Lovelace
Church
Gödel

...
?

The Universe of Logics



The Universe of Logics



Possible Game at $\mathcal{L}_0$ Level

MURDOKU

Car Repair

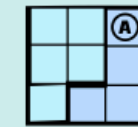
difficulty: easy

1

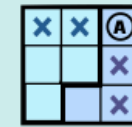
Vaughn was murdered!
Can you find out who did it?
Read each suspect's clue and find their exact location on the crime scene.
The killer was alone with the victim, in the same area.

2

Rule: One person per Row and Column



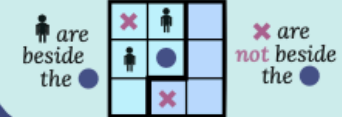
as soon as you place someone...



...block their entire row and column

3

What does "beside" mean?
to the left, right, above or under something, and in the same area



Can be occupied



Oil Slick



Car



Chair

Cannot be occupied



TV



Shelf



Table



Plant



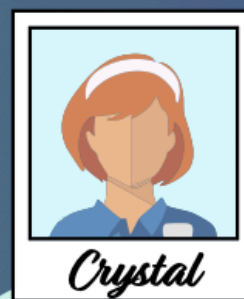
Anthony

He was in a car.



Brock

He was on an oil slick.



Crystal

She was sitting in a chair.



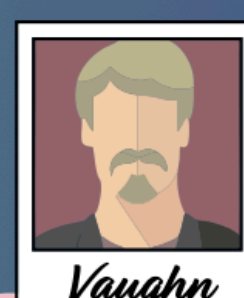
Diane

She was alone in the Waiting Area



Emilio

He was beside a shelf.



Vaughn

The Victim.
He was alone with the murderer.



**GET THE
BOOK
NOW!**



**more at
murdoku.com**
puzzle and concept
by Manuel Garand
art by Manuel Garand
& Valentyna Bezdushna

The murderer is...

Possible Game at $\mathcal{L}_0$ Level

MURDOKU

Car Repair

difficulty: easy

The murderer has been caught!

Here's where every
everyone was.

SOLUTION PAGE

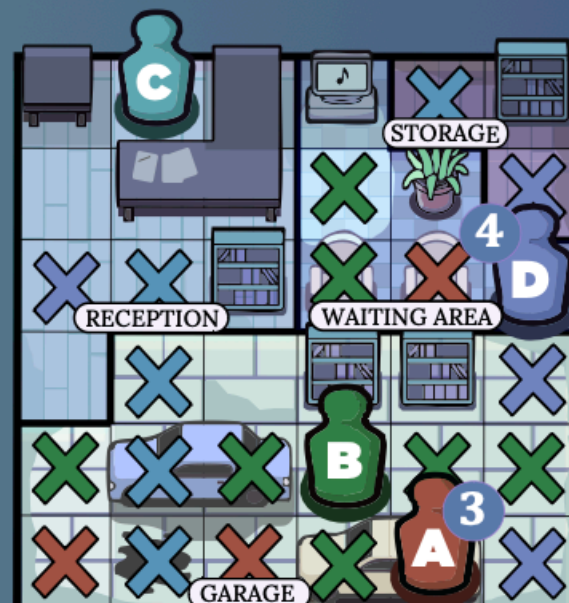
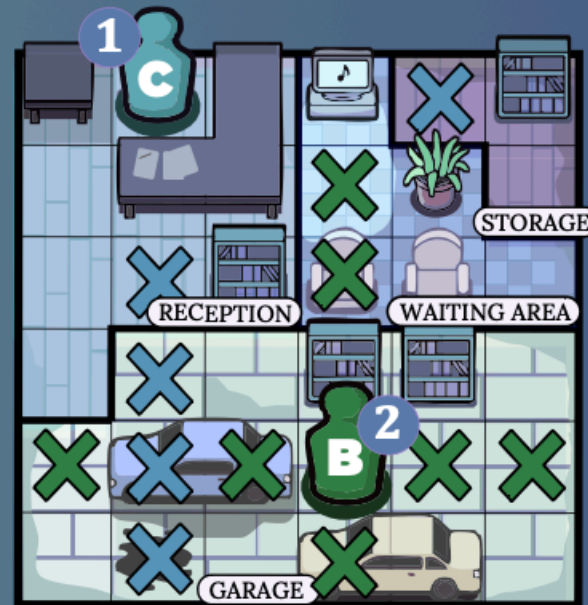
1. D is alone in the Waiting Room, so there is only one remaining chair C can sit on, in the Reception Hall. This isolates C; block her row and column.

2. There is now only one oil slick where B can be. This isolates B, block his row and column.

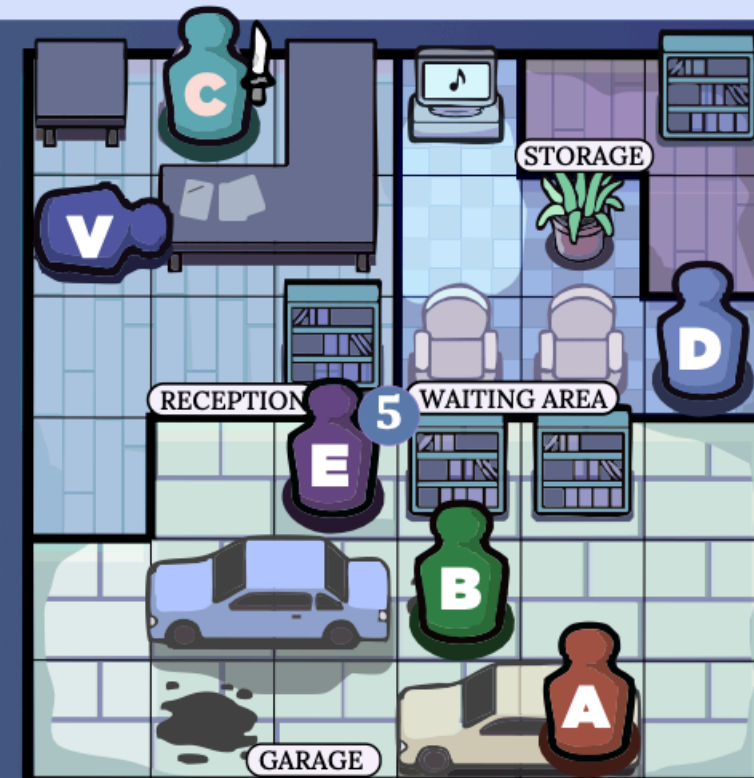
3. This isolates A in the last square inside a car. Block his row and column.

4. This isolates D in the last square in the Waiting Room area. Block her row and column.

Block her row and column.



5. This isolates E in the last square beside a shelf, then V in the last square. V was alone with C in the Reception Hall. Crystal is the murderer!



The murderer is...

Crystal

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more at
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puzzle and concept
by Manuel Garand
art by Manuel Garand
& Valentyna Bezdushna

Logic-&-AI in The News ...



Richard Scott, with his mother at home, turned to Google AI on his school laptop for answers and saw his grades fall. SHURAN HUANG FOR WSJ

TECH

Inside Google's AI Push Into Schools: 'It Slowed My Thinking Down'

The risks of cognitive and emotional dependence, along with falling test scores, are fueling a backlash

By Shalini Ramachandran, Georgia Wells and Molly Reinmann

Sept. 30, 2026 9:00 pm ET



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Faced with quadratic equations, Richard Scott couldn't resist the temptation.

The Pennsylvania eighth-grader knew that the Google search box on his school laptop was essentially an AI chatbot that would helpfully spit out answers. He started popping algebra questions into the search bar to quickly finish off his daily schoolwork.

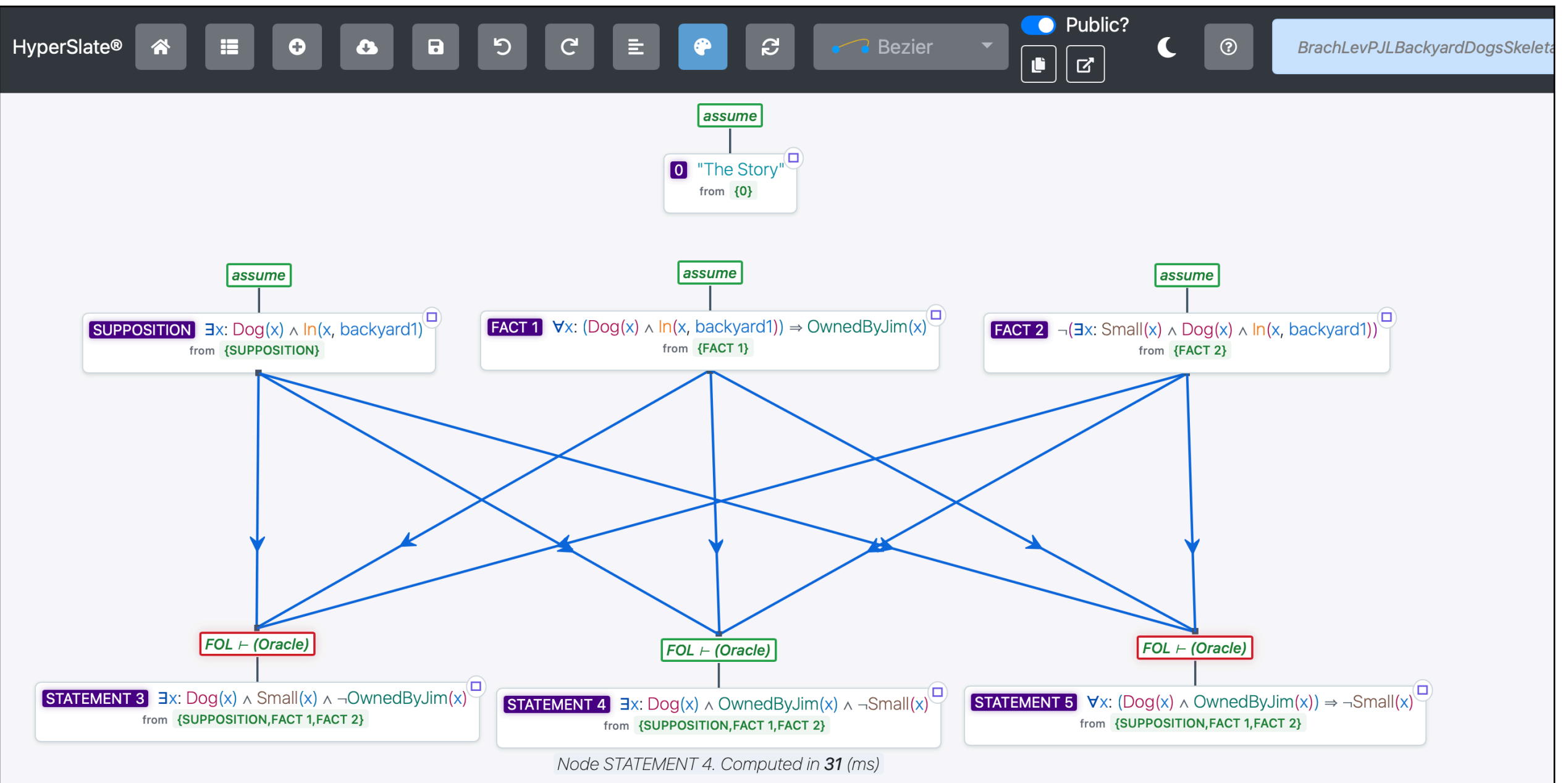
By the end of the school year, Scott's grades were tanking. He had started leaning on Google's AI-assisted search for other classes, like when he needed to label the parts of a volcano or write an essay about Edgar Allan Poe's "The Raven." His grades in math—a subject he'd done well at previously—suffered the worst. Even though he got mostly B's in the quarterly marking periods, according to his transcript, he failed the final.

"It slowed my thinking down," the now-15-year-old said. "When I was in a test and I couldn't use AI, it was hard to think."

Assuming neurobiological normality and completion of K–12 math today, what can human agents be assumed to be capable of in logic/logic programming, according to the Bringsjord-Fan theory of *common human reasoning/common human intelligence*?

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If AI doesn't make things worse per the WSJ piece on AI and learning, such an $\mathfrak{h}$ is capable of solving eg The Backyard Dogs Challenge.



Article

Formal Assessment of Brachman–Levesque Common Human Intelligence

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Abstract

The level of reasoning capacity seen in, for example, Kurt Gödel cannot be rationally called “common,” by any reasonable metric. Gödel, regarded by many to be the greatest human logician, was able to routinely discover solutions to reasoning challenges that, realistically, would perpetually paralyze most human beings, however high their educational level might reach. What then is the nature of *common* (=everyday) human reasoning (CHR)? Some scholars have proposed substantive answers to this question; for example, Johnson-Laird et al. have proposed what they declare to be an explicitly anti-logic one (according to which common reasoning is based on mental objects that are “iconic possibilities”). Very recently, in the context of an attempt on their part to contribute to the engineering of AIs with common-sense, or—as we prefer to say—*common human intelligence* (CHI), Brachman and Levesque (B&L) have ventured an extremely interesting logic-based answer to this question. We analyze their answer—CHR_{B-L}—herein, and find that it posits a level of intelligence too low to do justice to intuitive, pre-analytic concepts of CHR, and *much* too low to do justice to our own (admittedly elevated) CHR_{B-F}. At the heart of matters is the level of *expressivity* that a given reasoning challenge displays, and correspondingly, the level of expressivity that a given theory of common reasoning enjoys.

Keywords: common human intelligence; common human reasoning; artificial intelligence



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1. Introduction

The level of reasoning capacity seen in, for example, Kurt Gödel cannot rationally be called “common” across the human species. Gödel, regarded by many as the greatest human logician, was able to routinely discover solutions to reasoning challenges that, realistically, would perpetually paralyze most human beings, regardless of their level of education in matters logico-mathematical.¹

What then is the nature of *common* human reasoning (CHR)? Quite a few scholars have proposed deep answers to this question. The most prominent answer provided to this point is the one long defended by Johnson-Laird and his collaborators. A recent, comprehensive, and arguably definitive assertion from this camp that the nature of CHR inheres in conceptualization and reasoning over “possibilities” (upon perceiving relevant input from the environment), where these possibilities are iconic, or visual, in nature, can be found in [4]. Johnson-Laird et al. take great pains to claim, and argue, that, as such, CHR is not based upon logic. But very recently, in the context of an attempt on their part to

Quantifiers (etc) ...

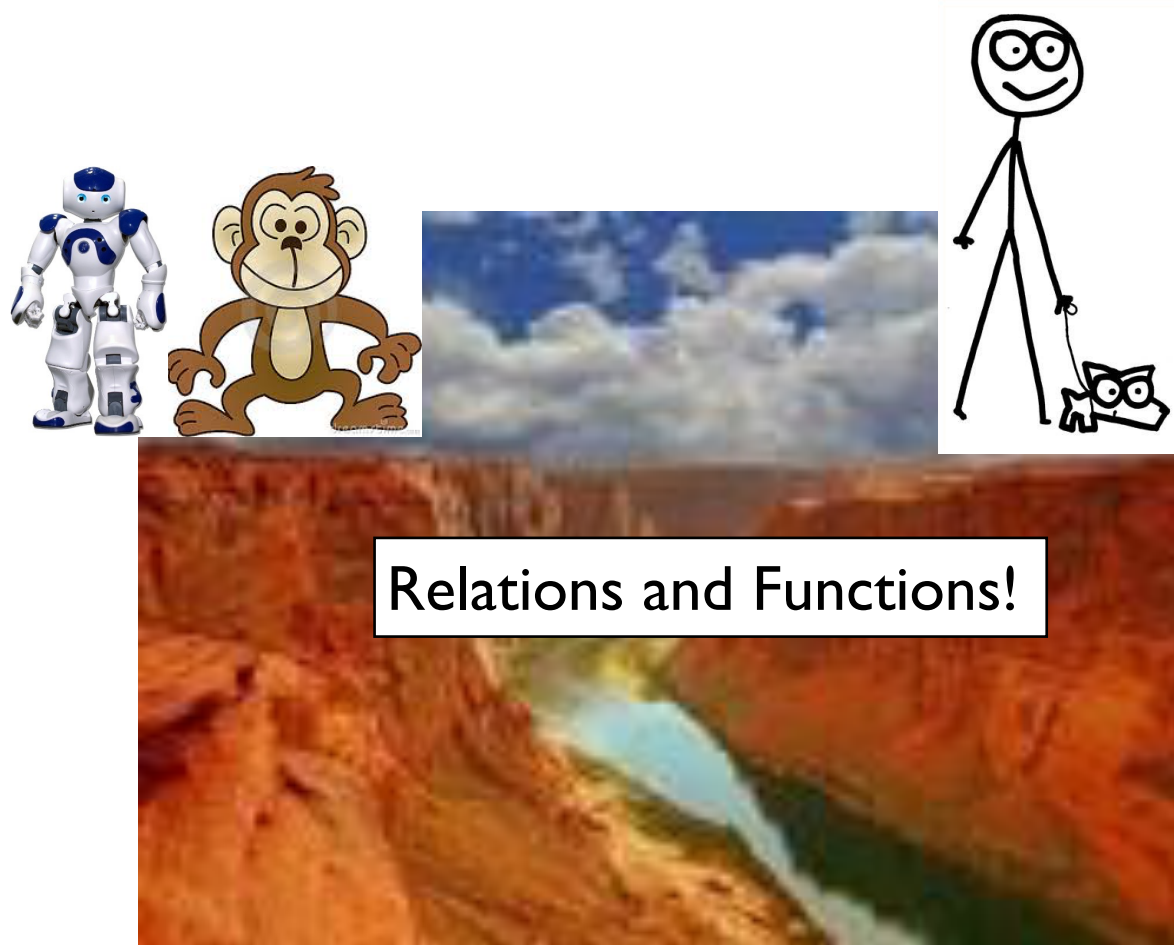
The Canyon of Discontinuity (or Darwin's Dread)



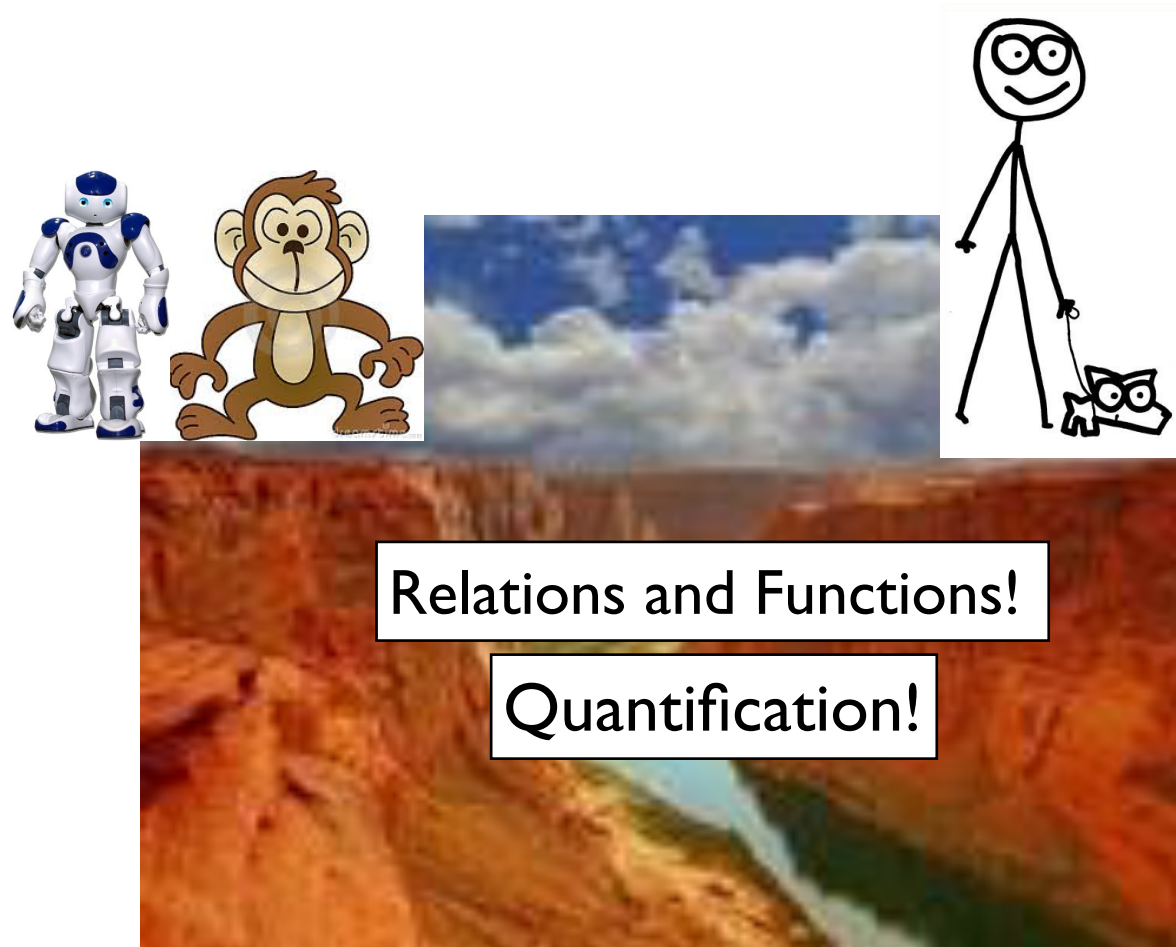
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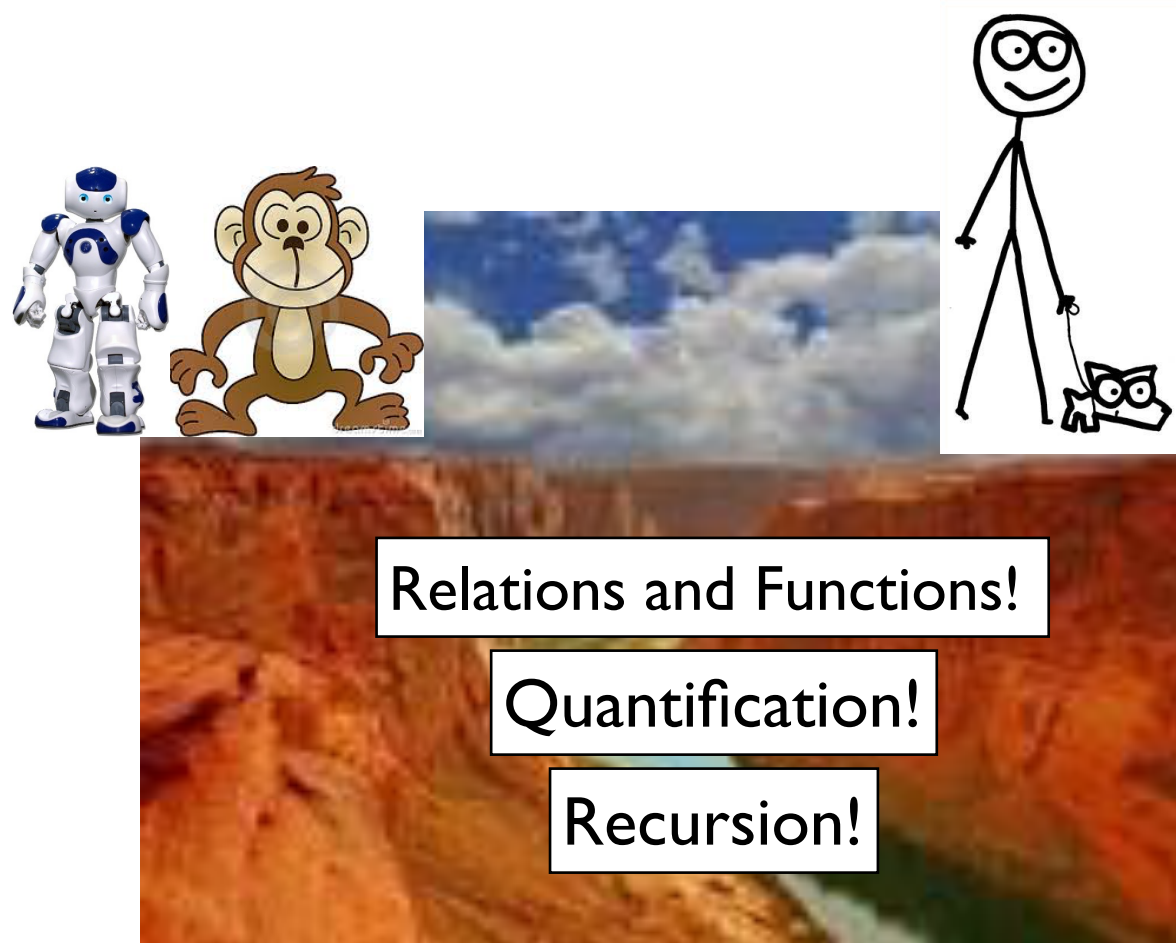
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Quantification!

Relations and Functions

Recursion!

Karkooking Problem ...

Everyone karkooks anyone who karkooks someone.

Alvin karkooks Bill.

Can you infer that everyone karkooks Bill?

ANSWER:

JUSTIFICATION:

Karkooking Problem ...

Everyone karkooks anyone who karkooks someone.

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Can you infer that everyone karkooks Bill?

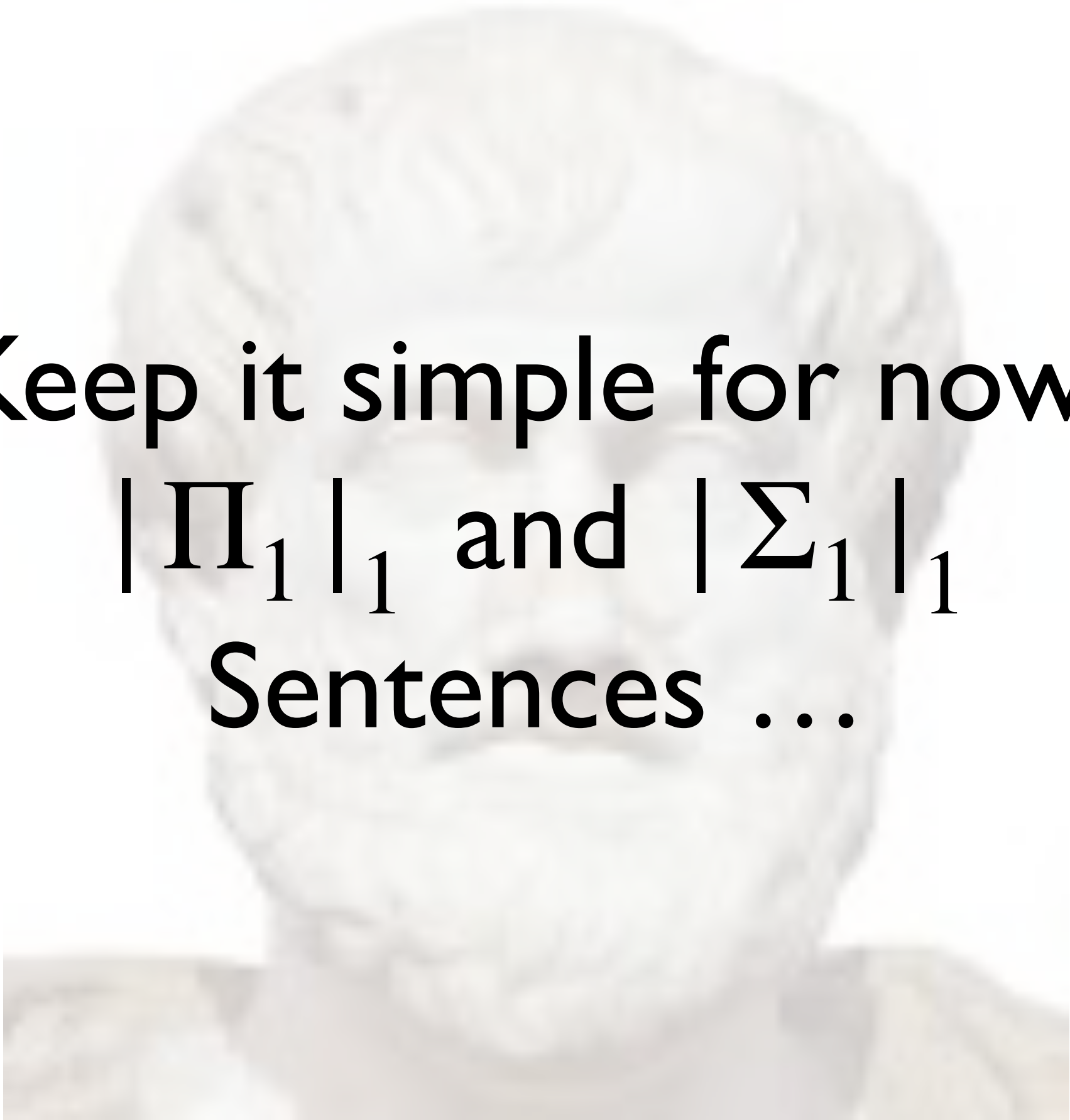
ANSWER:

JUSTIFICATION:

Relations and Functions!

Quantification!

Recursion!

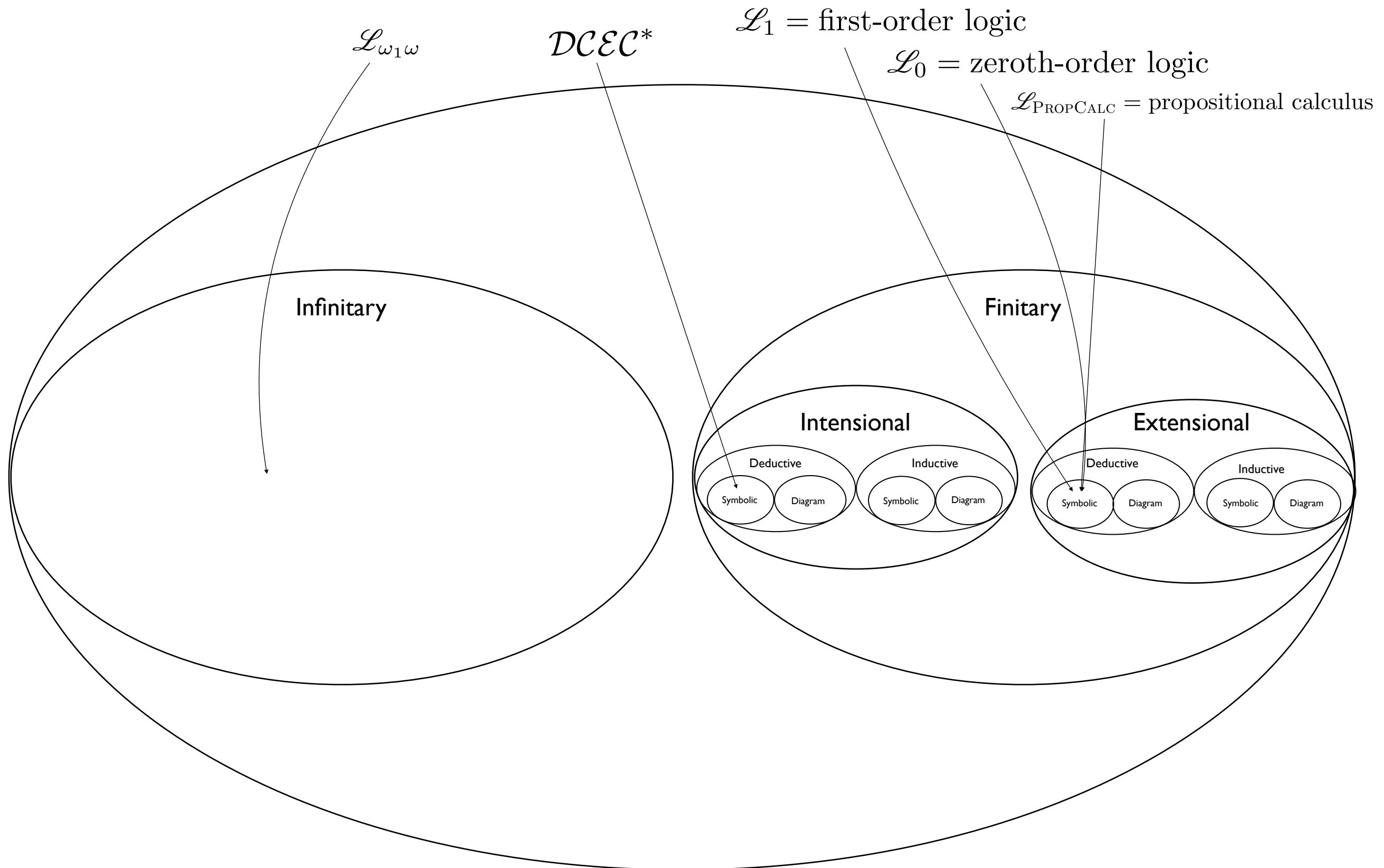


Keep it simple for now!

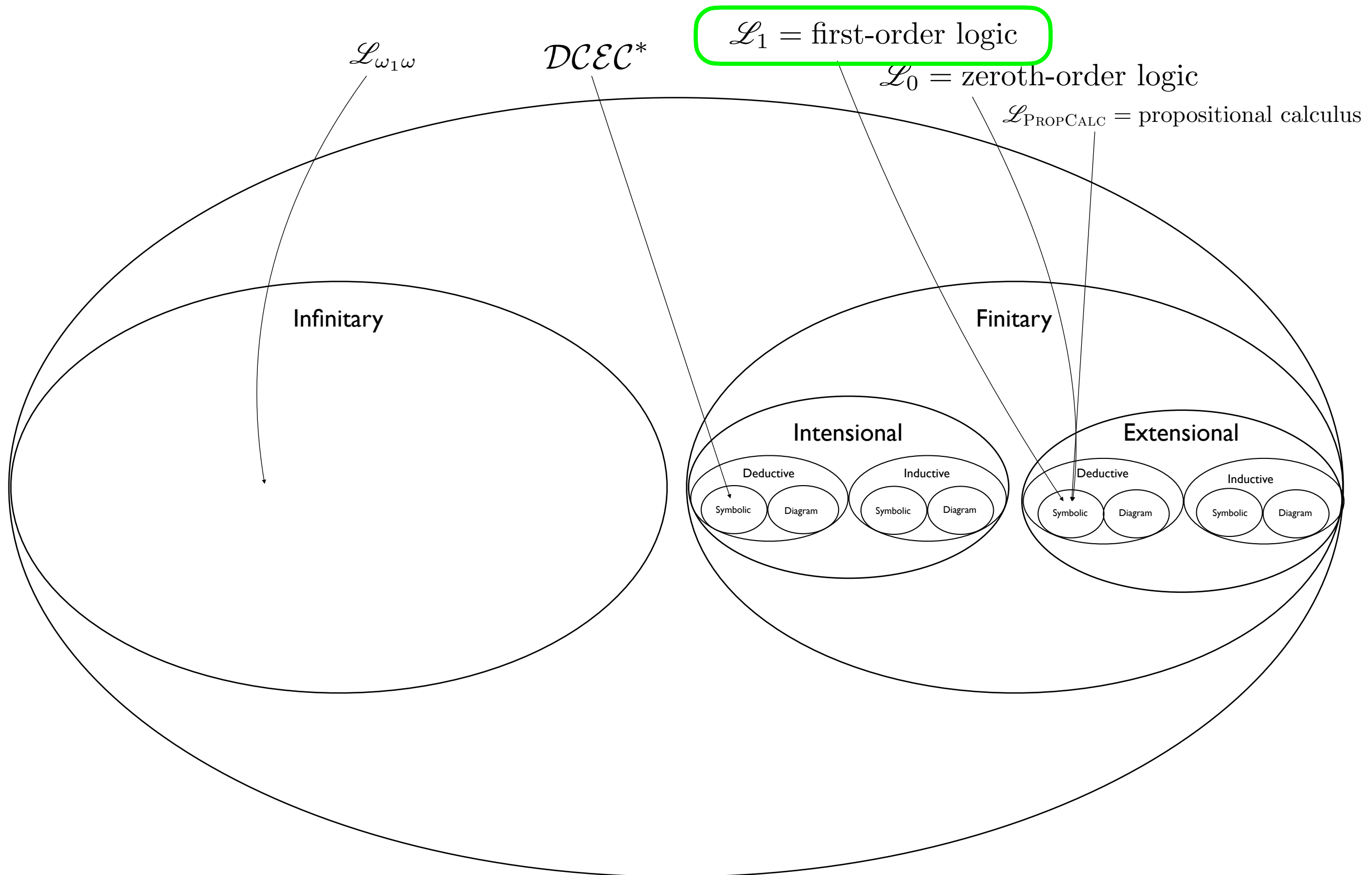
$|\Pi_1|_1$ and $|\Sigma_1|_1$

Sentences ...

The Universe of Logics



The Universe of Logics



Two Proposed Arguments; Valid?

- All mammals walk.
- Whales are mammals.
- Therefore:
- Whales walk.
- All of the Frenchmen in the room are wine-drinkers.
- Some of the wine-drinkers in the room are gourmets.
- Therefore:
- Some of the Frenchmen in the room are gourmets.



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We can of course easily symbolize and settle the matter in HyperSlate® (PC oracle permitted now)! (You should do this now & save the problem in your library.) Doing so is *impossible* in the prop calc, and likewise impossible in zeroth-order logic!

Two Proposed Arguments; Valid?

- All mammals walk. $\forall x[M(x) \rightarrow W(x)]$

- Whales are mammals. $\forall x(Wh(x) \rightarrow M(x))$

- Therefore:

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$$\forall x(Wh(x) \rightarrow W(x))$$

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- All of the Frenchmen in the room are wine-drinkers. $\forall x(F(x) \rightarrow W(x))$
- Some of the wine-drinkers in the room are gourmets. $\exists x(W(x) \wedge G(x))$
- Therefore:
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First-Order Logic Programming

Hand-picked for relevance to Lean 4 and OpenAI's use thereof for cracking Navier-Stokes.

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Hand-picked for relevance to Lean 4 and OpenAI's use thereof for cracking Navier-Stokes.

```
(and (forall (x) (if (Mammal x) (Walk x)))  
      (forall (x) (if (Whale x) (Mammal x))))
```

First-Order Logic Programming

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$$\mathbb{P}_7 \quad (\text{and} \quad (\text{forall} \quad (x) \quad (\text{if} \quad (\text{Mammal} \ x) \quad (\text{Walk} \ x))) \\ (\text{forall} \quad (x) \quad (\text{if} \quad (\text{Whale} \ x) \quad (\text{Mammal} \ x))))$$

First-Order Logic Programming

Hand-picked for relevance to Lean 4 and OpenAI's use thereof for cracking Navier-Stokes.

$\mathbb{P}_7$ (and (forall (x) (if (Mammal x) (Walk x)))
 (forall (x) (if (Whale x) (Mammal x))))

$\mathfrak{q}_{10} :$ (forall (x) (Whale x) (Walk x))

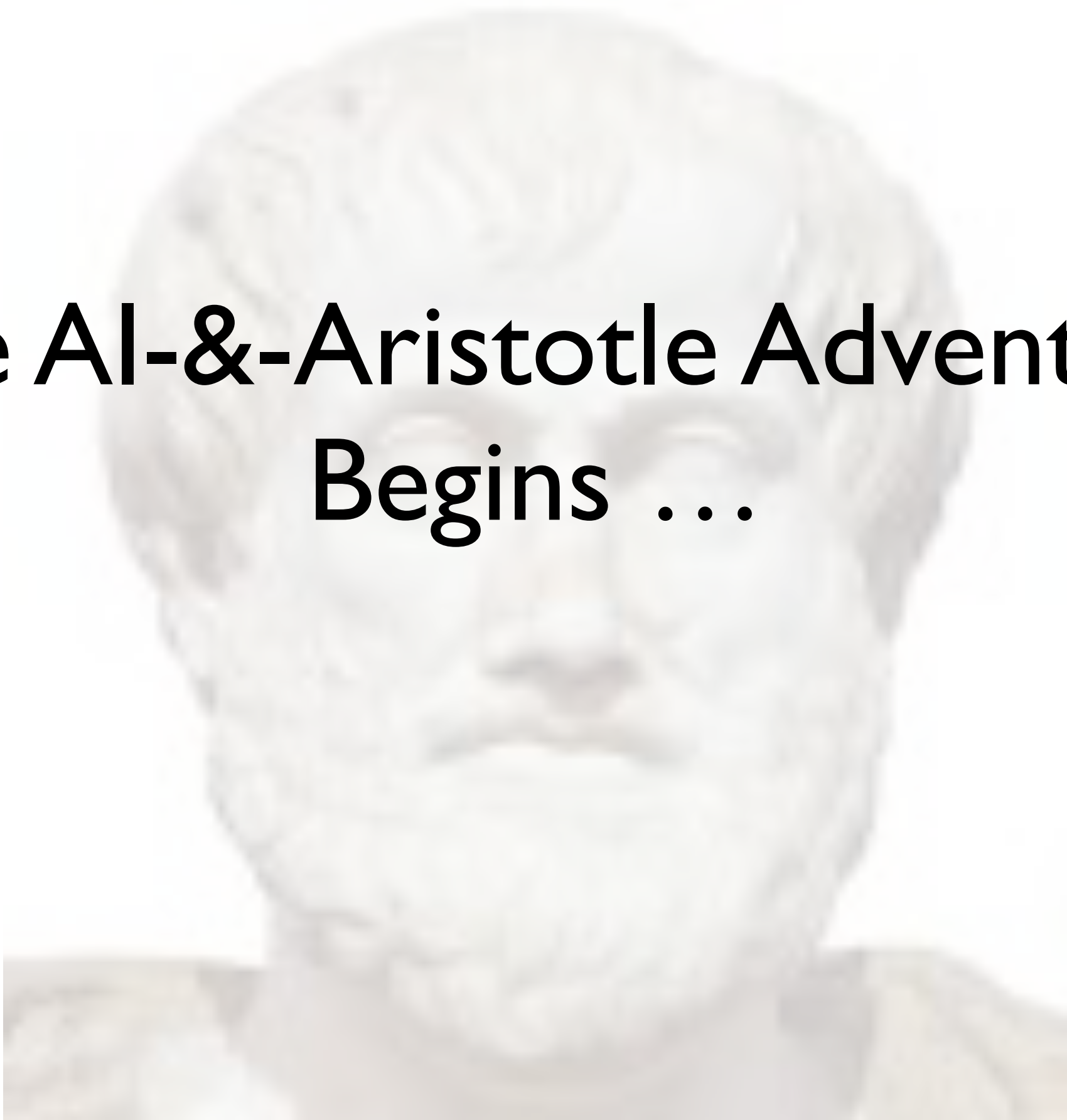
First-Order Logic Programming

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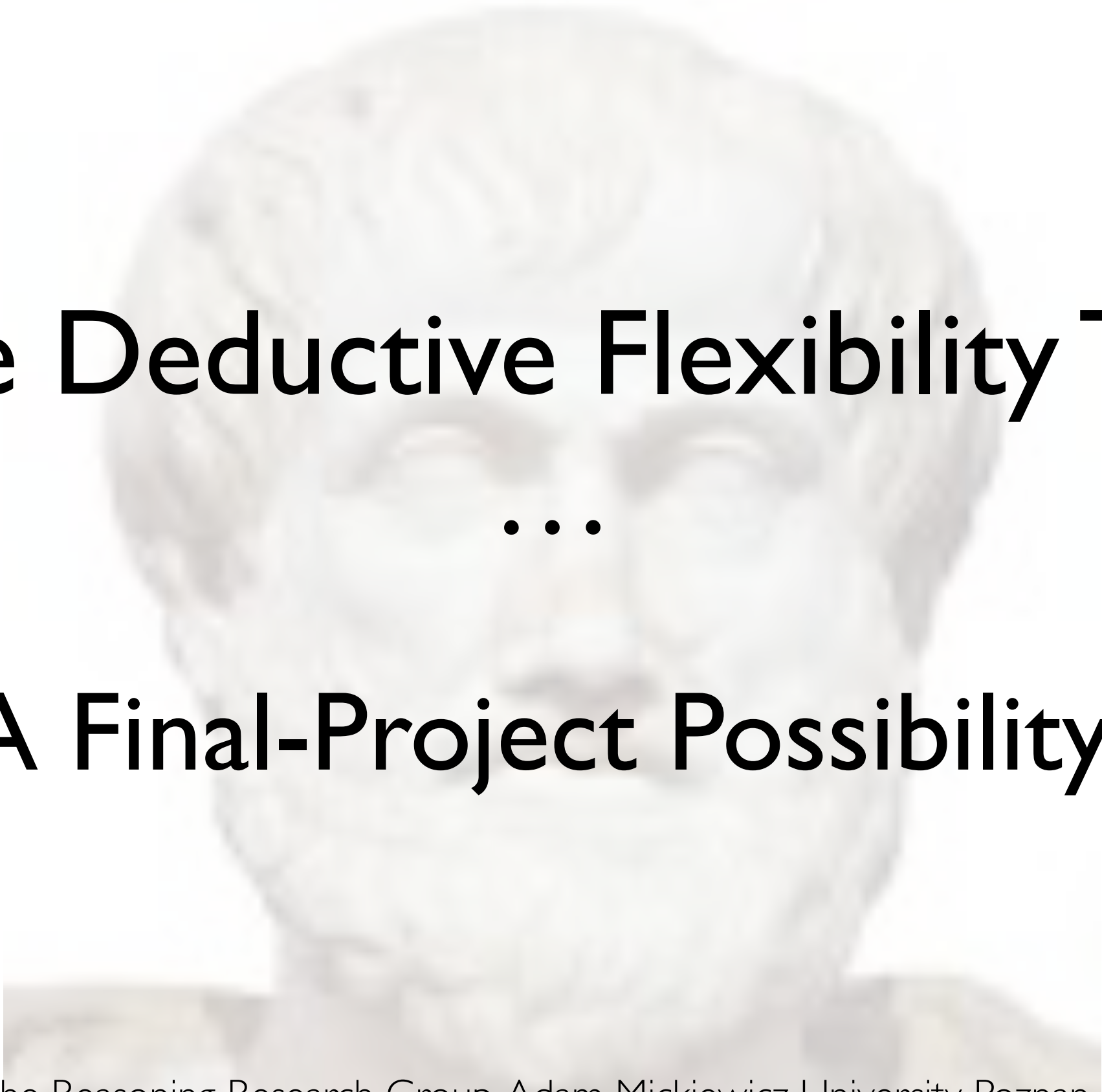
The AI-&-Aristotle Adventure Begins ...



The Deductive Flexibility Test

...

From the Reasoning Research Group, Adam Mickiewicz University, Poznan, Poland
<http://murbansk-rrg.home.amu.edu.pl/research-projects/deductive-flexibility-test>



The Deductive Flexibility Test

...

(A Final-Project Possibility!)

From the Reasoning Research Group, Adam Mickiewicz University, Poznan, Poland
<http://murbansk-rrg.home.amu.edu.pl/research-projects/deductive-flexibility-test>

Example with correct answer:

- (1) Some nedges are dwens.
- (2) Some strimes are dwens.
- (3) Every nedge is a strime.
- (4) Every nedge is a dwen.
- (5) This is not the case, that no dwen is a strime.
Some dwens are strimes.

Answer: (2); (5); (3 and 4); (1 and 4)

Correct? To HyperSlate® ...

- I (1) Every faub is a non-veece.
 (2) No phodd is a veece.
 (3) No veece is a phodd.
 (4) Every veece is a non-faub.
 (5) Every faub is a phodd.
 No faub is a veece.

Answer:_____

*Den rasjonelle delen av
menneskesinnet er
basert på logikk.*