Motivating Paradoxes, Puzzles, and $\mathcal{R}$,

Part I

Selmer Bringsjord

Intro to (Formal) Logic (and AI)

1/16/20

Selmer.Bringsjord@gmail.com

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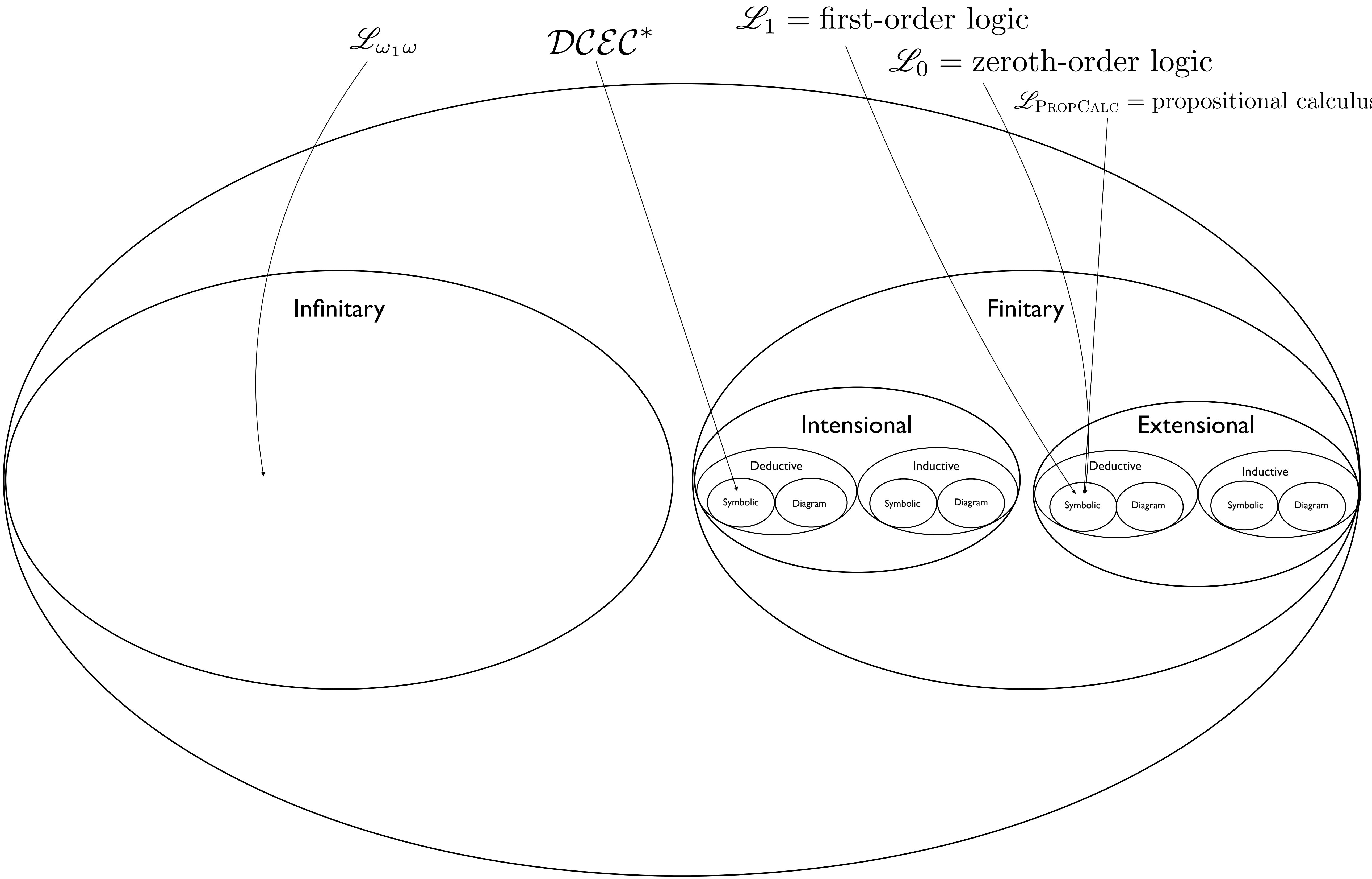

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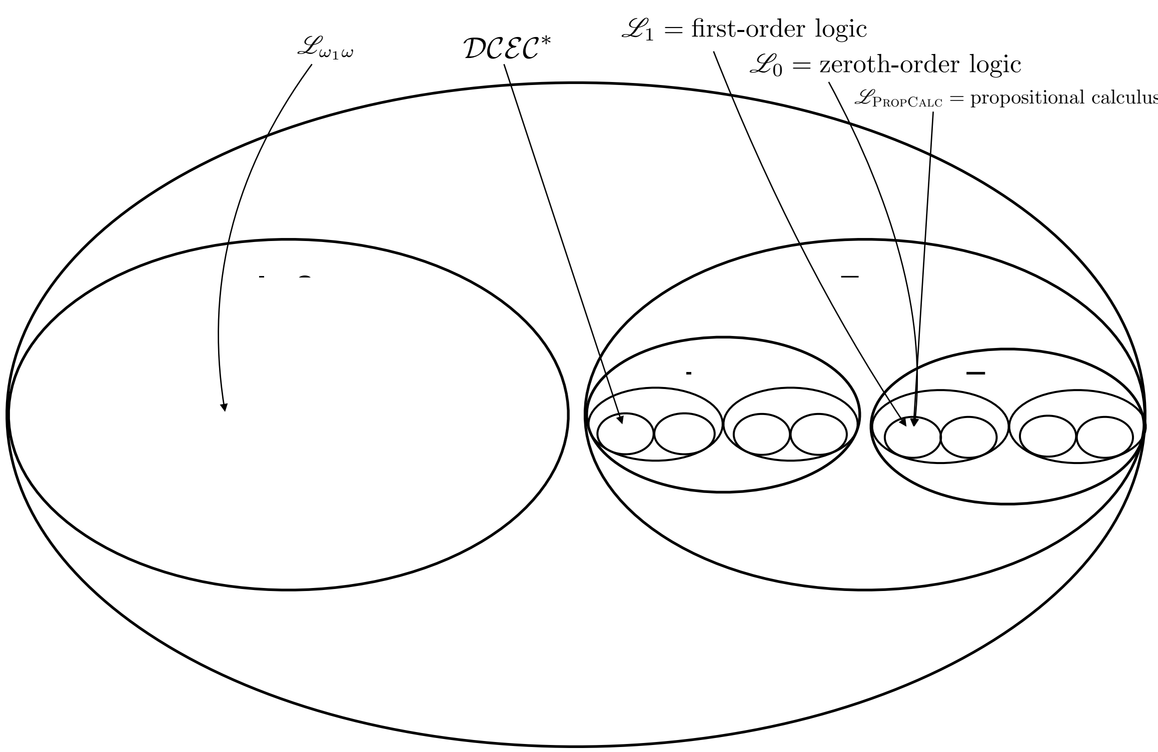

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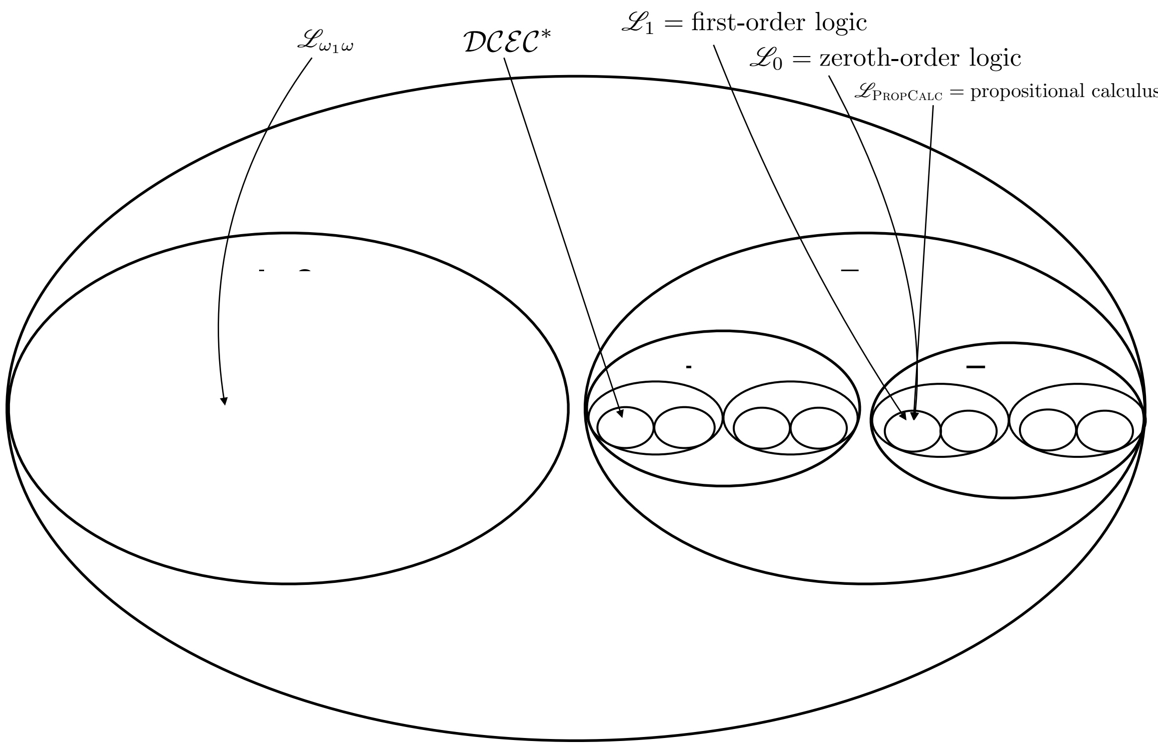

Non-Physical

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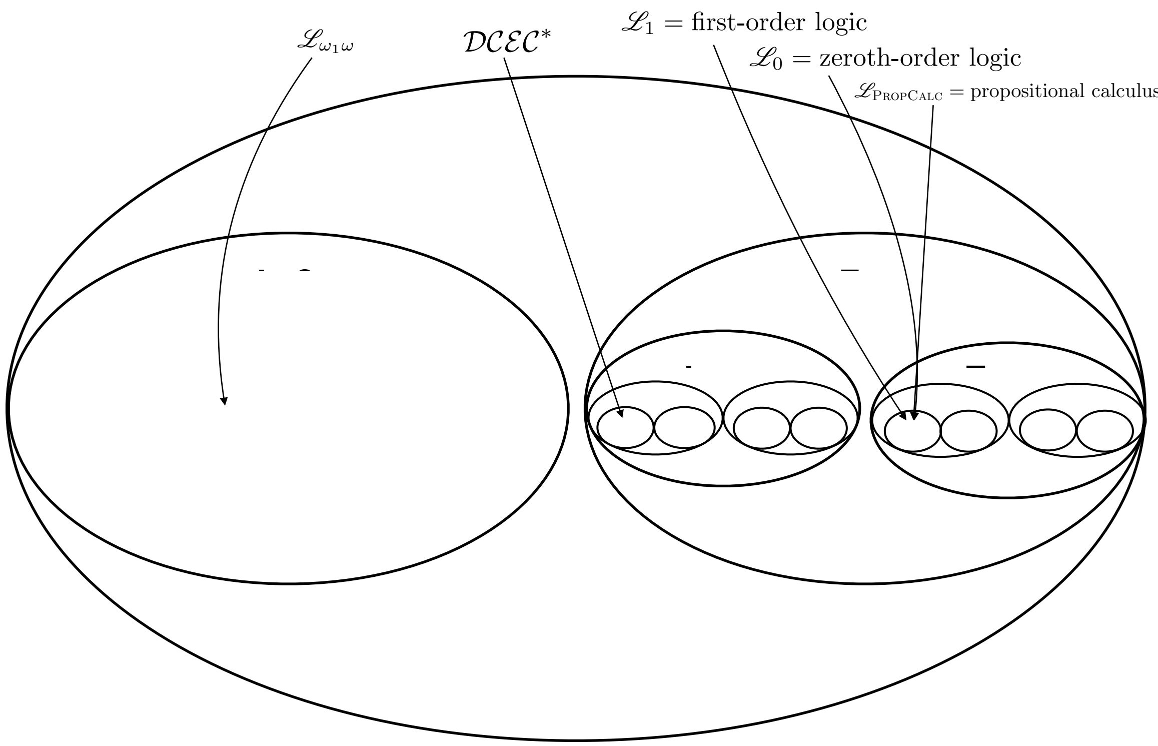

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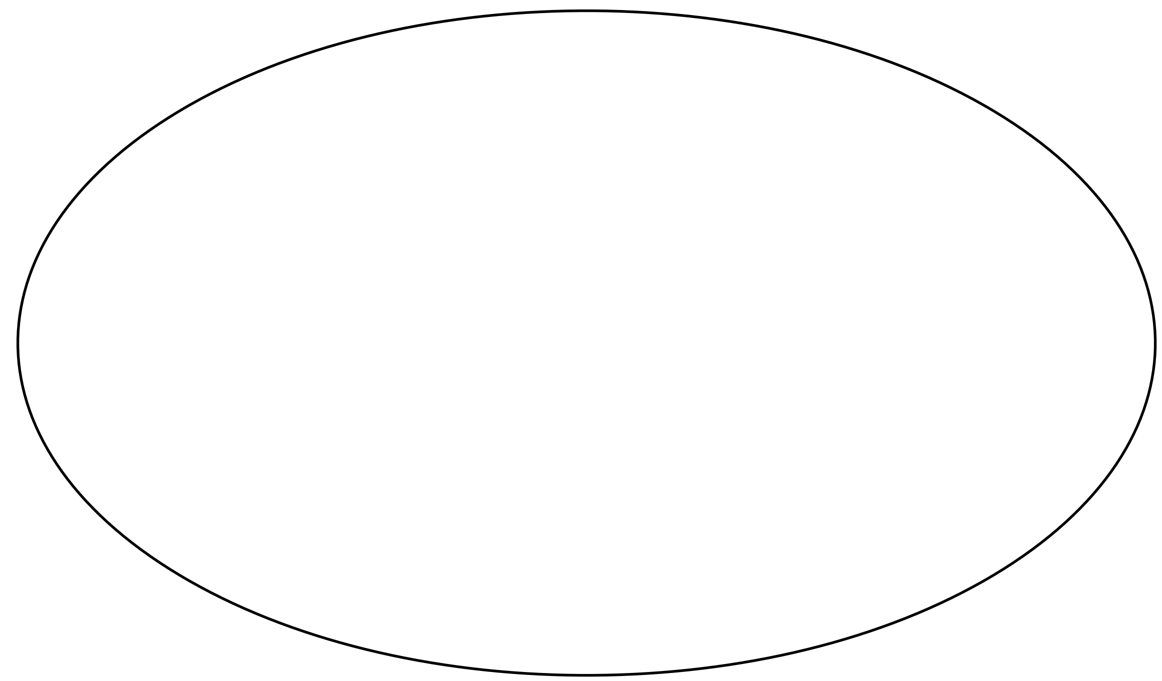

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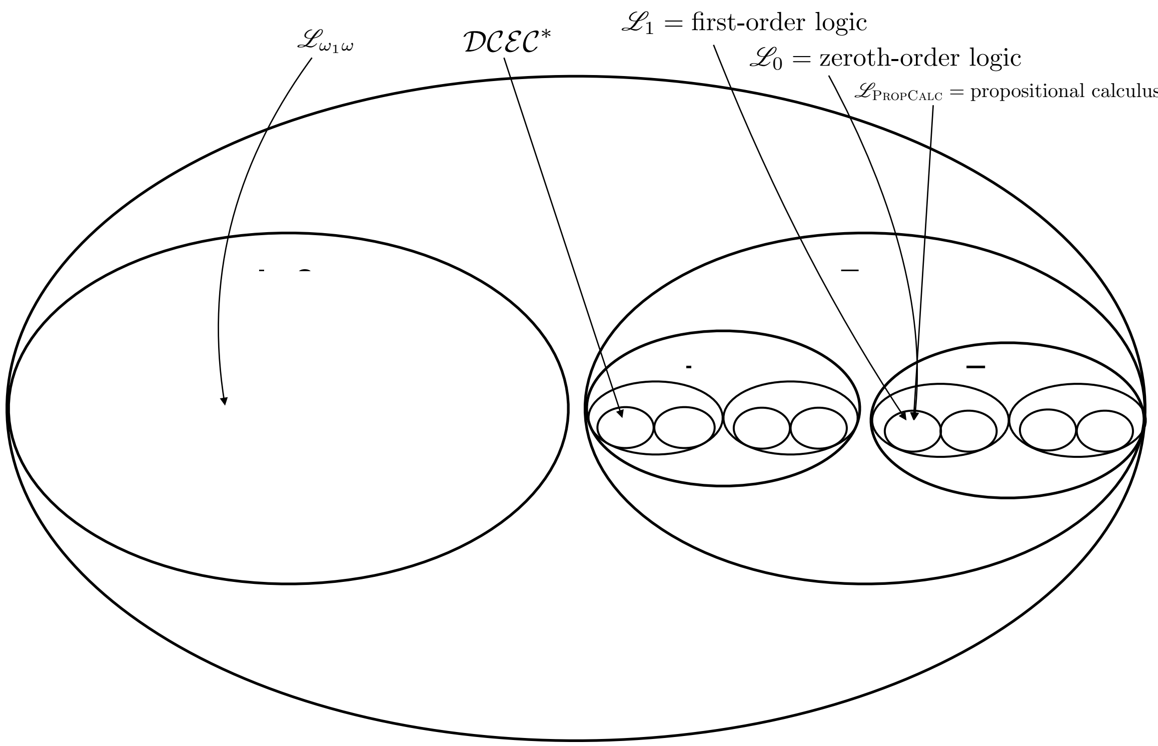

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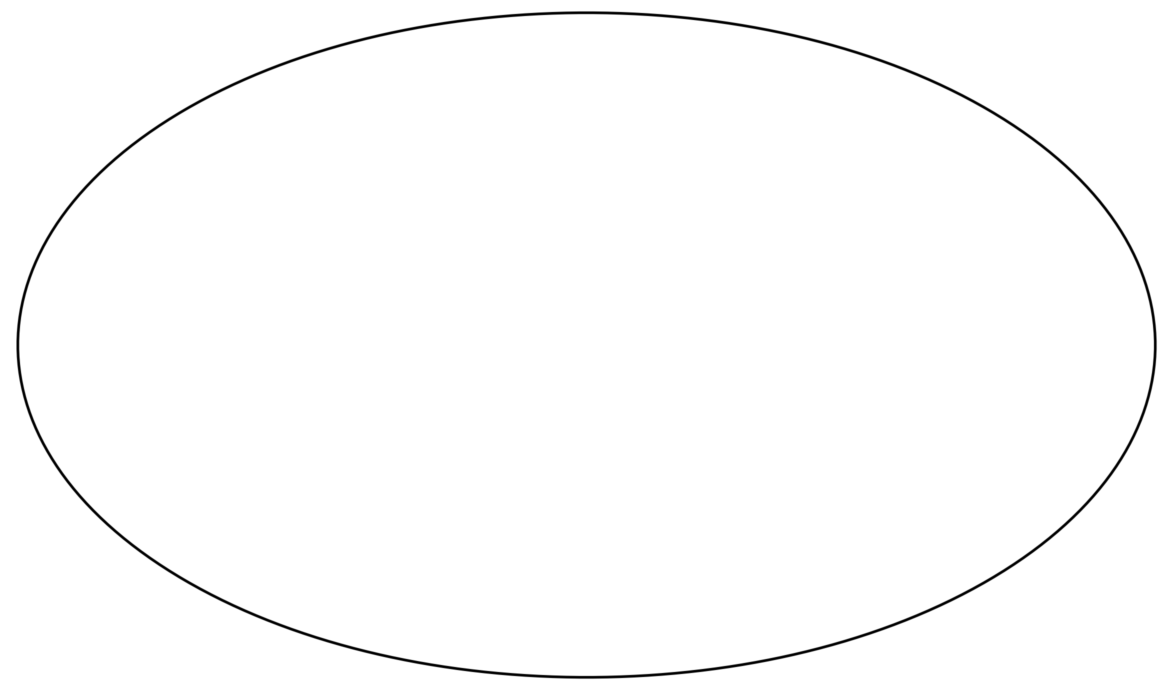

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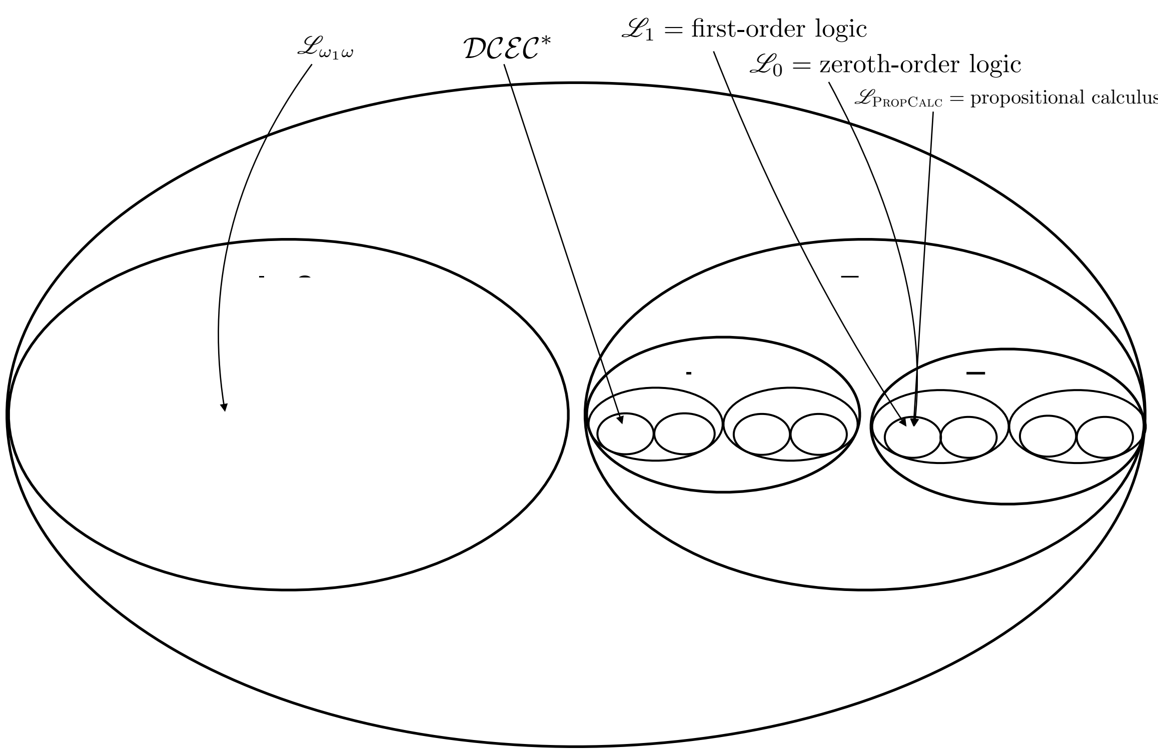

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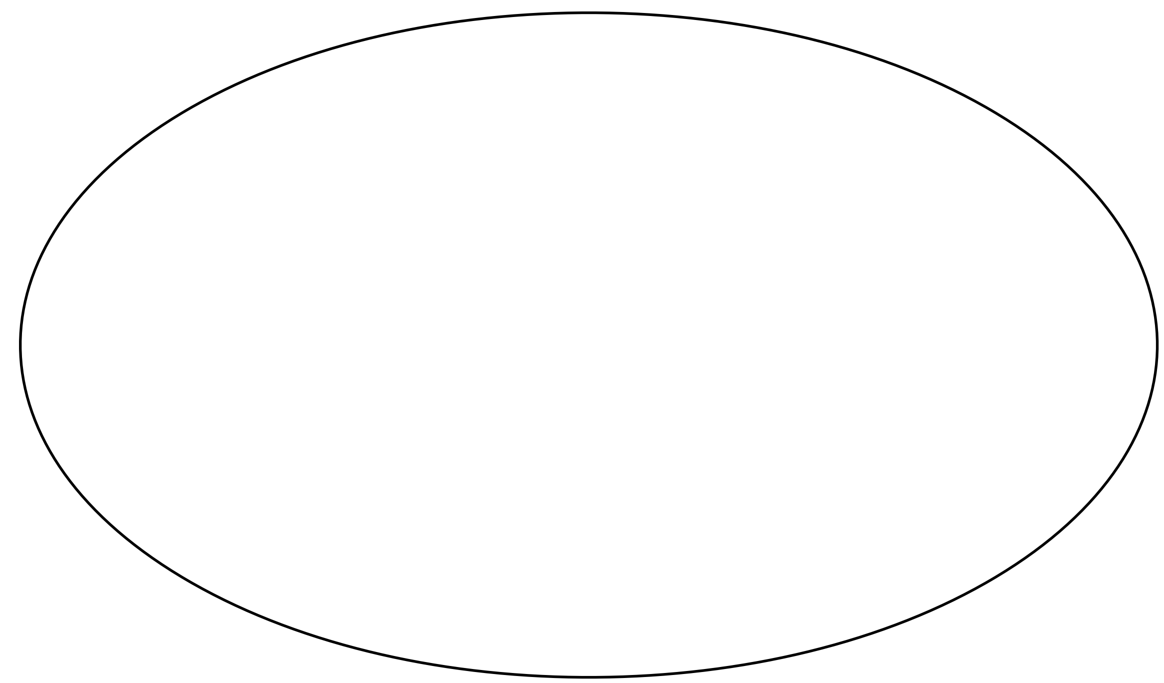

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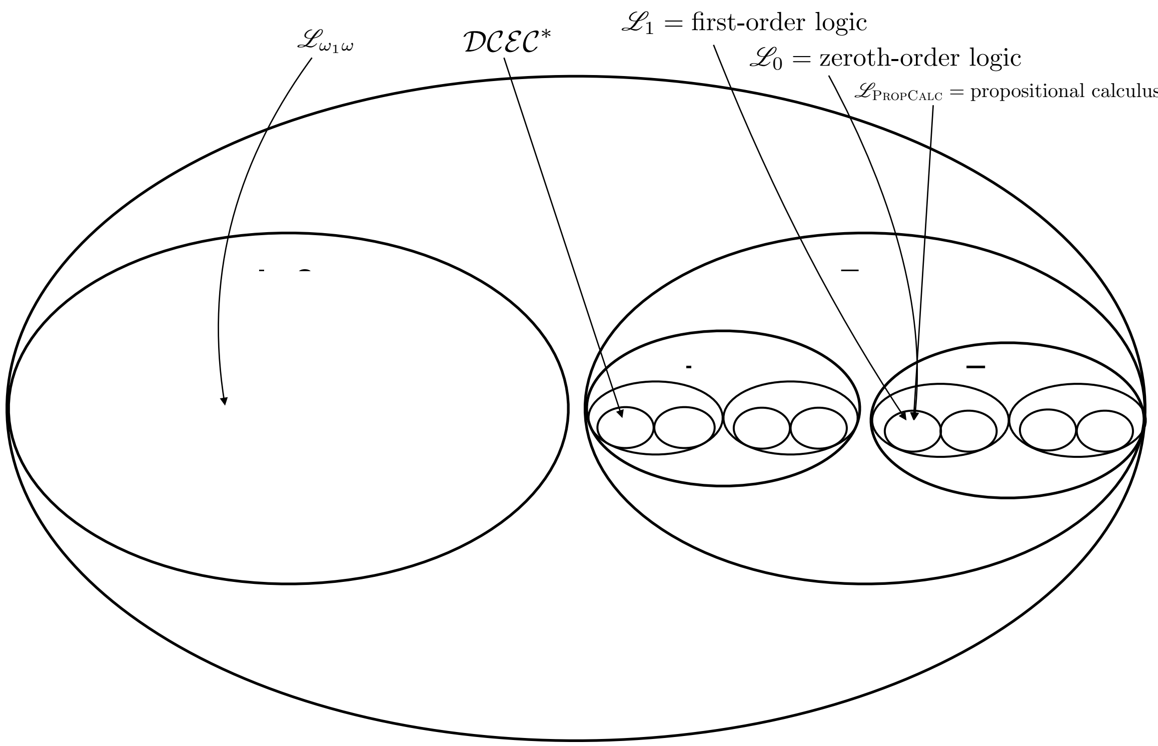

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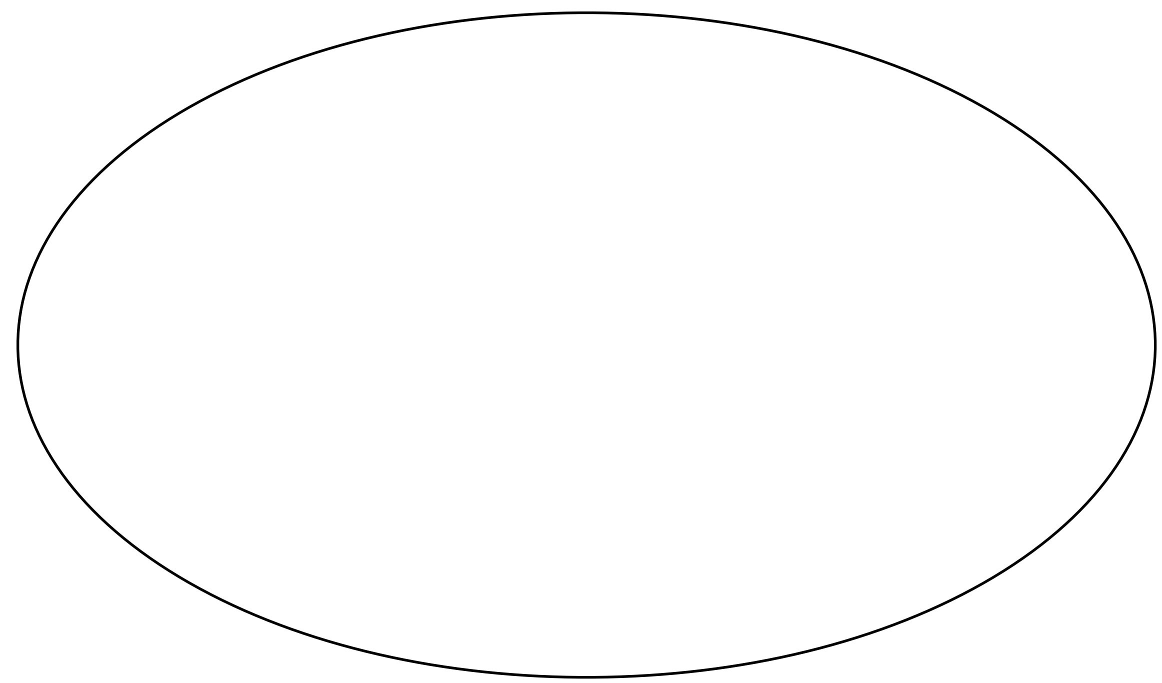

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Watch brainy zoo animals figure out a box puzzle to get at food

Plenty of Tests Out There for Nonhuman Animals

E.g. search in your browser for …

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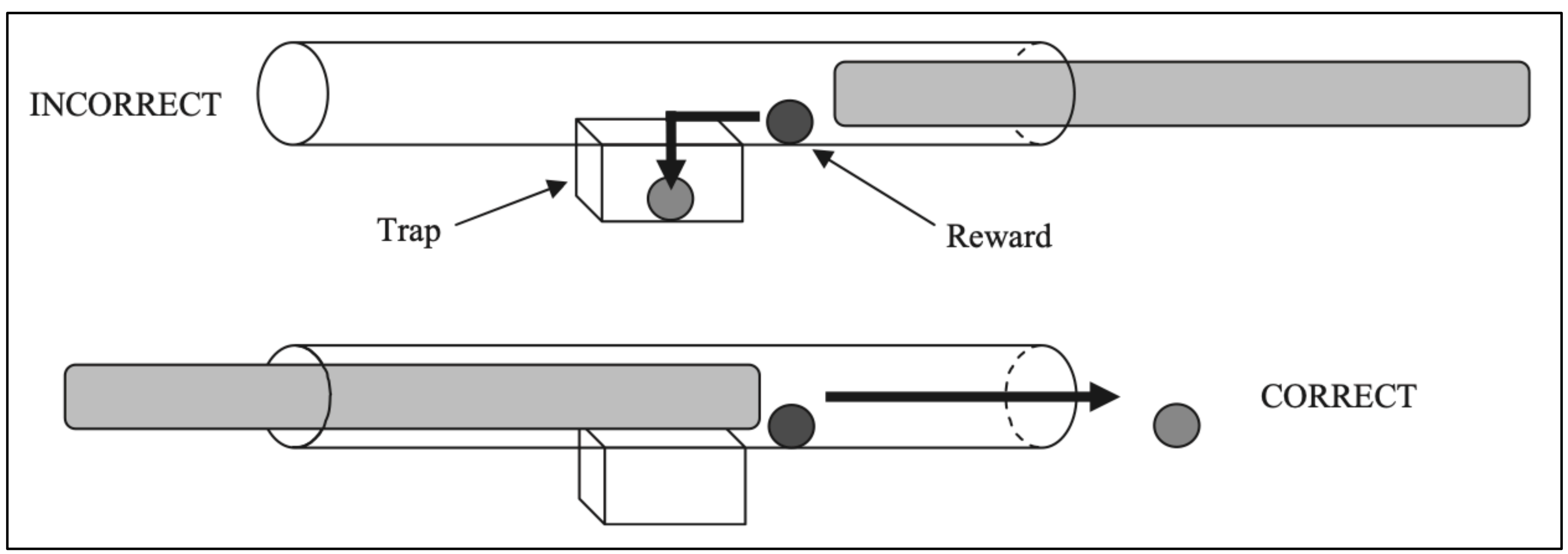

Horner, V. & Whiten, A. (2007) "Learning from Others' Mistakes? Limits on Understanding a Trap-Tube Task by Young Chimpanzees (*Pan troglodytes*) and Children (*Homo sapiens*)" *Journal of Comparative Psychology* **121.1**: 12–21.

Background Claim

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recursion

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$\mathcal{R}$ Humans, at least neurobiologically normal ones, are fundamentally rational, where rationality is constituted by certain logico-mathematically based reasoning and decision-making in response to real-world stimuli, including stimuli given in the form of focused tests; but mere animals are not fundamentally rational, since, *contra* Darwin, their minds are fundamentally qualitatively inferior to the human mind. As to whether computing machines/robots are fundamentally rational, the answer is "No." For starters, if [illegible]te, x can't be rational; computing machines/robots can neither read nor write nor create; ergo, they aren't fundamentally rational.

intensional reasoning

recursion

self-reference

To infinity and beyond! — routinely

quantification

intensional reasoning

recursion

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abstract-and-valid inference schemata

quantification

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To infinity and beyond! — routinely

What *is* Logic?

- The key to becoming rational.
- "The science and engineering of reasoning." — so the not-unreasonable slogan goes.
- The only invincible subject there is.
- The basis for the formal sciences (from mathematics to game theory to decision theory to probability calculi to axiomatic physics ….) — and hence the basis for disciplines based on the formal sciences (e.g., engineering, computer science).
  - Computer Science!
- The way of escape from shallow content and context to pure, immaterial, and immortal form and structure (which is why the exotic, imaginary, and seemingly non-sensical is so pedagogically useful).
- The most challenging subject there is.
- One of the chief differentiators between dogs and monkeys versus you (let alone bears and you); and mindless machines (like Deep Blue & Watson) versus you.
- A key to riches.
- The key to divining the meaning of life (and other such big questions).
- The better way to program computers; and fundamentally the *only* way to *reliably* program computers.
- One of two fundamental approaches to studying minds, and replicating/simulating minds in machines…
- The thing many creatures of fiction have mastered — have you (as a New Yorker)?…
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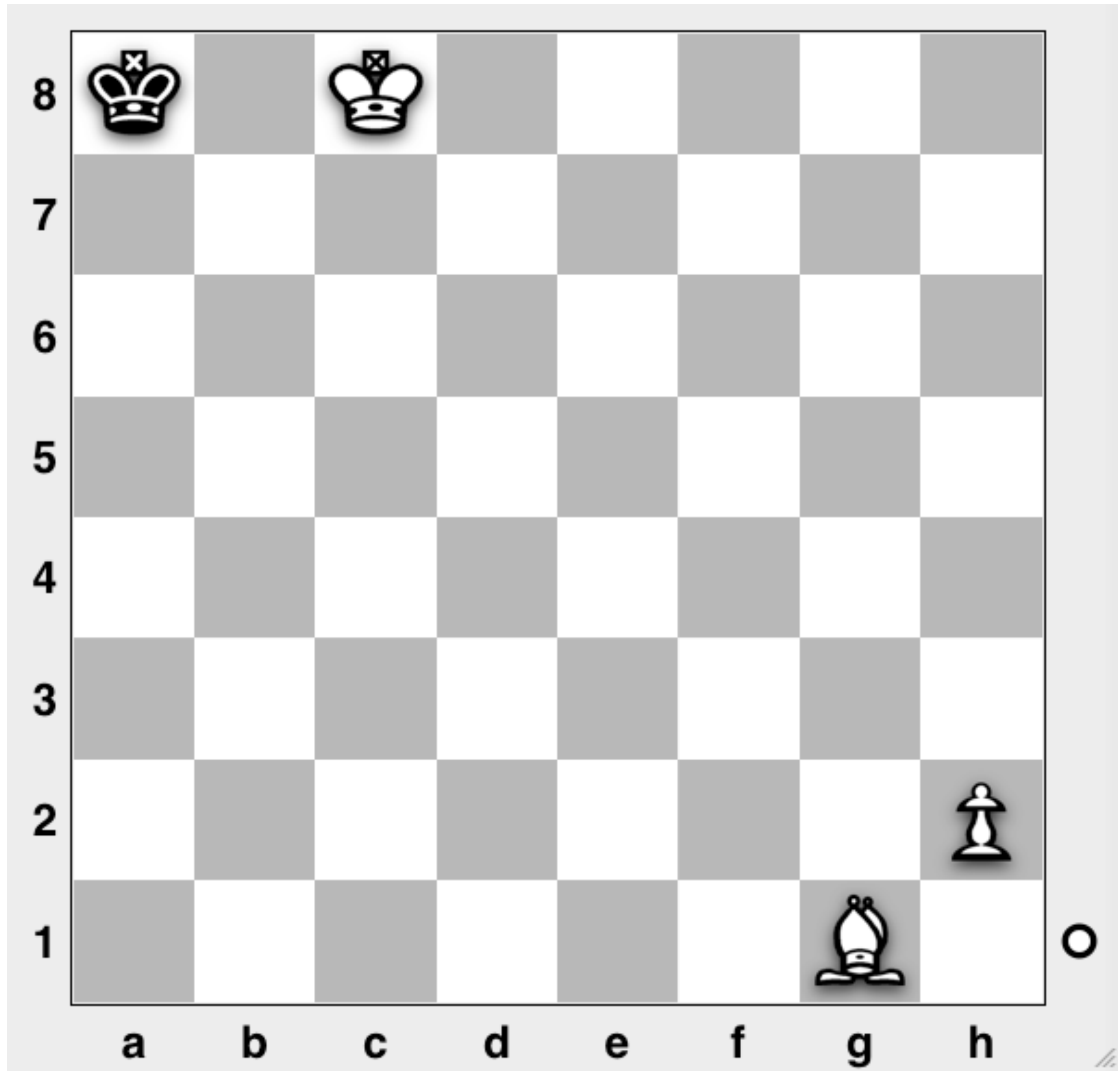
It’s White’s turn. What move did Black just make?



Aha! (Beyond Deep Blue?)

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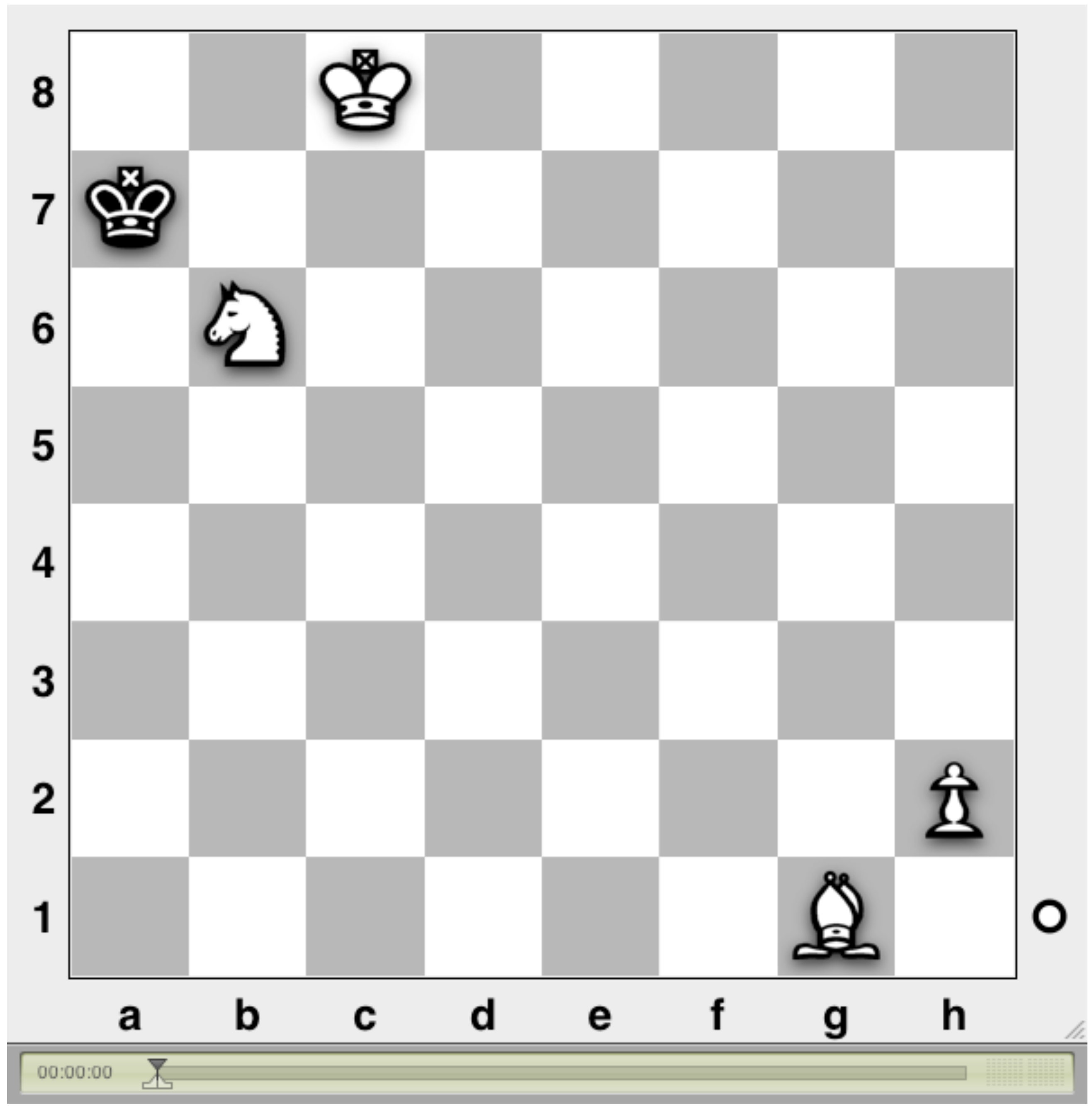


Simple Selection Task

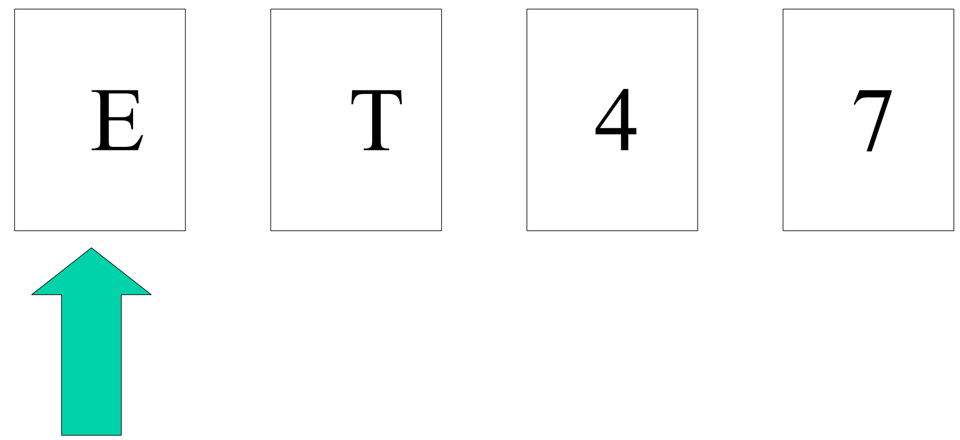
E	T	4	7

Suppose I claim that the following rule is true.

> If a card has a vowel on one side, it has an even number on the other side.

Which card or cards, if any, should you turn over in order to try to efficiently decide whether the rule is true or false?

Simple Selection Task



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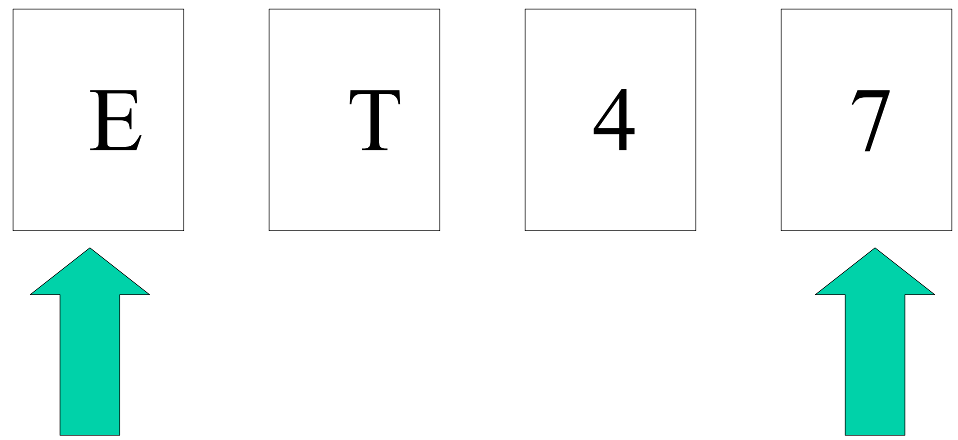

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D	U	9	4

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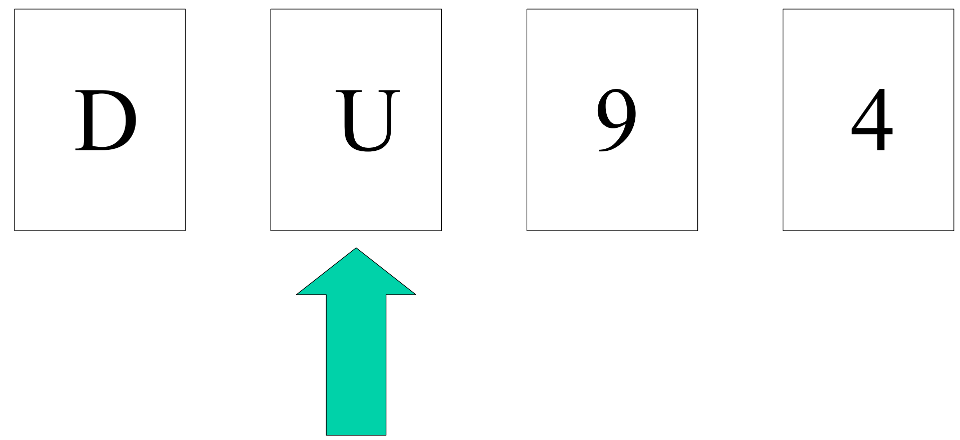

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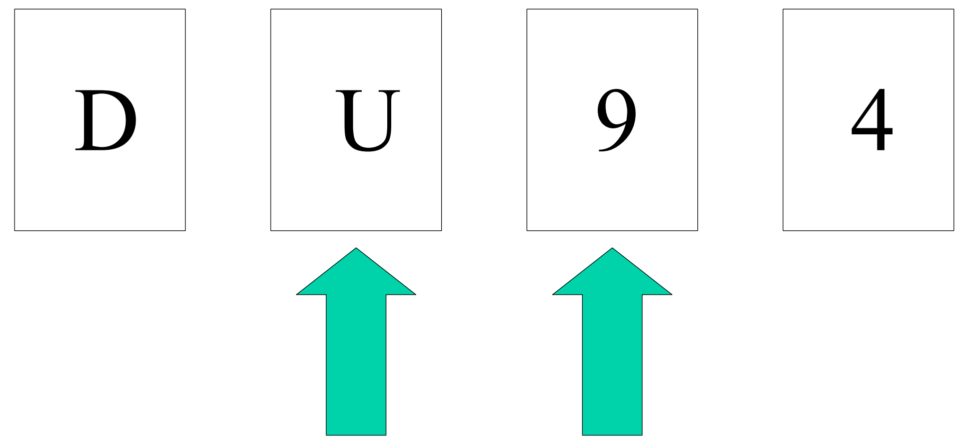

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"NYS 1"

Given the statements

$\neg a \vee \neg b$

b

$c \rightarrow a$

which one of the following statements must also be true?

c

$\neg b$

$\neg c$

h

a

none of the above

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Which one of the following statements is logically equivalent to the following statement: “If you are not part of the solution, then you are part of the problem.”

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“NYS 3”

Given the statements

$\neg\neg c$

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$b \rightarrow d$

$\neg(d \vee e)$

which one of the following statements must also be true?

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Solved by an Oracle in Slate

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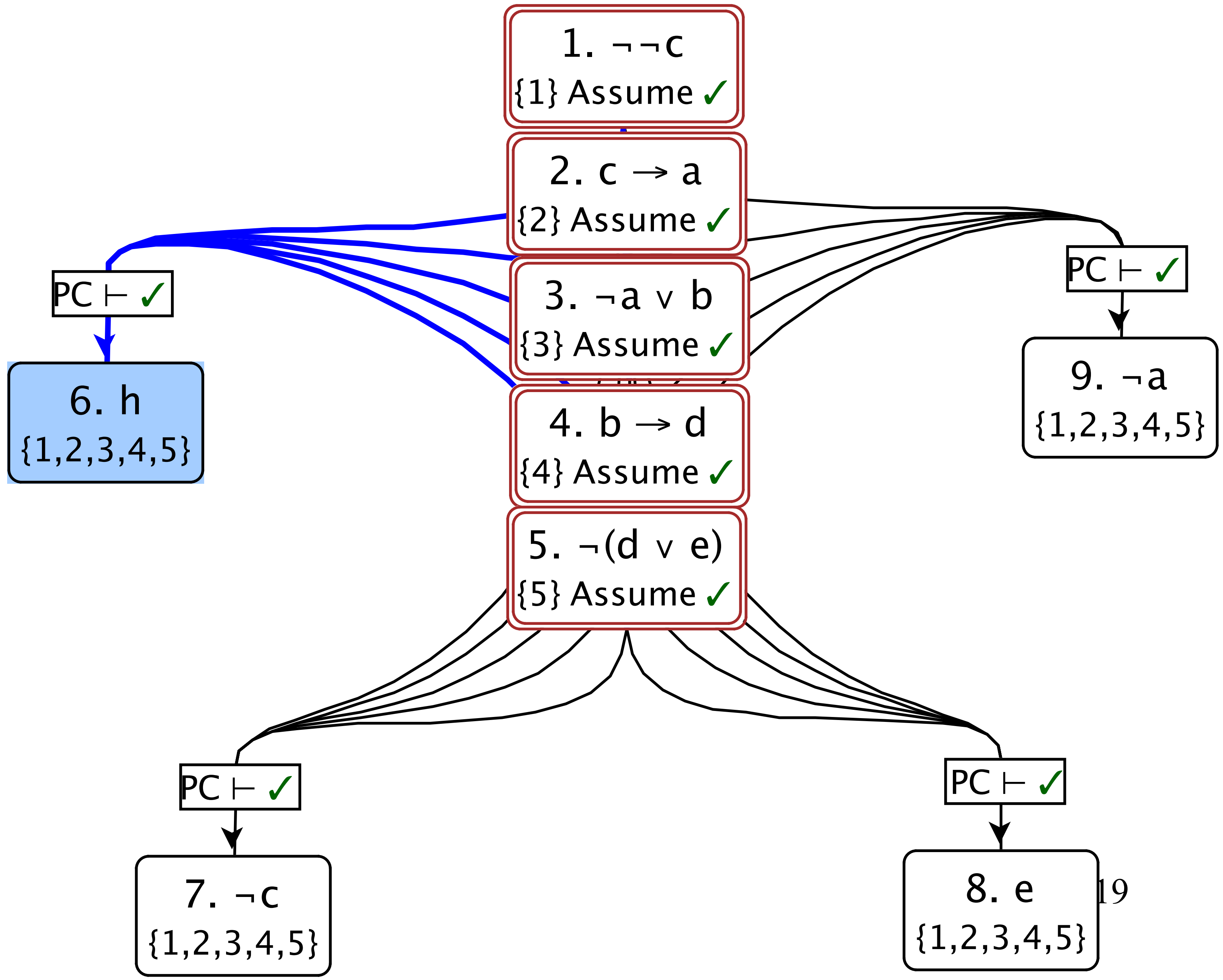

The Original King-Ace

Suppose that the following premise is true:

> If there is a king in the hand, then there is an ace in the hand, or else if there isn’t a king in the hand, then there is an ace.

What can you infer from this premise?

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NO! ~~There is an ace in the hand.~~ NO!

In fact, what you *can* infer is that there *isn't* an ace in the hand!

King-Ace 2

Suppose that the following premise is true:

If there is a king in the hand, then there is an ace in the hand; or if there isn't a king in the hand, then there is an ace; but not both of these if-then statements are true.

What can you infer from this premise?

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There is an ace in the hand.

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King-Ace Solved

(informal proof)

Proposition: There is *not* an ace in the hand.

Proof: We know that at least one of the if-thens (i.e., at least one of the **conditionals**) is false. So we have two cases to consider, viz., that *K* => *A* is false, and that ¬*K* => *A* is false. Take first the first case; accordingly, suppose that *K* => *A* is false. Then it follows that *K* is true (since when a conditional is false, its antecedent holds but its consequent doesn't), and *A* is false. Now consider the second case, which consists in ¬*K* => *A* being false. Here, in a direct parallel, we know ¬*K* and, once again, ¬*A*. In both of our two cases, which are exhaustive, there is no ace in the hand. The proposition is established. **QED**

Train-to-Princeton Problem

Everyone loves anyone who loves someone.

Larry loves Lucy.

Can you infer that everyone loves Lucy?

ANSWER:

PROOF:

Train-to-Princeton Problem

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Larry loves Lucy.

Can you infer that everyone loves Lucy?

ANSWER: Yup.

PROOF: ??

Bringsjord 1

(1) The following three assertions are either all true or all false:

If Billy helped, Doreen helped.
If Doreen helped, Frank did as well.
If Frank helped, so did Emma.

(2) The following assertion is definitely true: Billy helped.

Can it be inferred from (1) and (2) that Emma helped?

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YUP! — & now prove it!

Bringsjord 1: Proof

Proof: We have two cases to work from: when the conditionals in (1) are all true, and when they are all false. (In both cases, (2) remains true, and available.) So assume Case 1 first. In this case, we can simply chain through the conditionals by repeated application of *modus ponens* to arrive at the conclusion that Emma helped. Now assume Case 2 holds. This immediately implies that the first two conditionals are false; i.e., we have ~(B =>D) and ~(D => F). Recalling that a conditional fails to hold exactly when its antecedent if true while its consequent is false, we have, in turn: B & ~D, and D & ~F. But then we have a contradiction, viz. ~D & D. Since everything follows ("explosively"!) from a contradiction, we are done. **QED**