
Introduction to Logic Reasoning

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Objectives

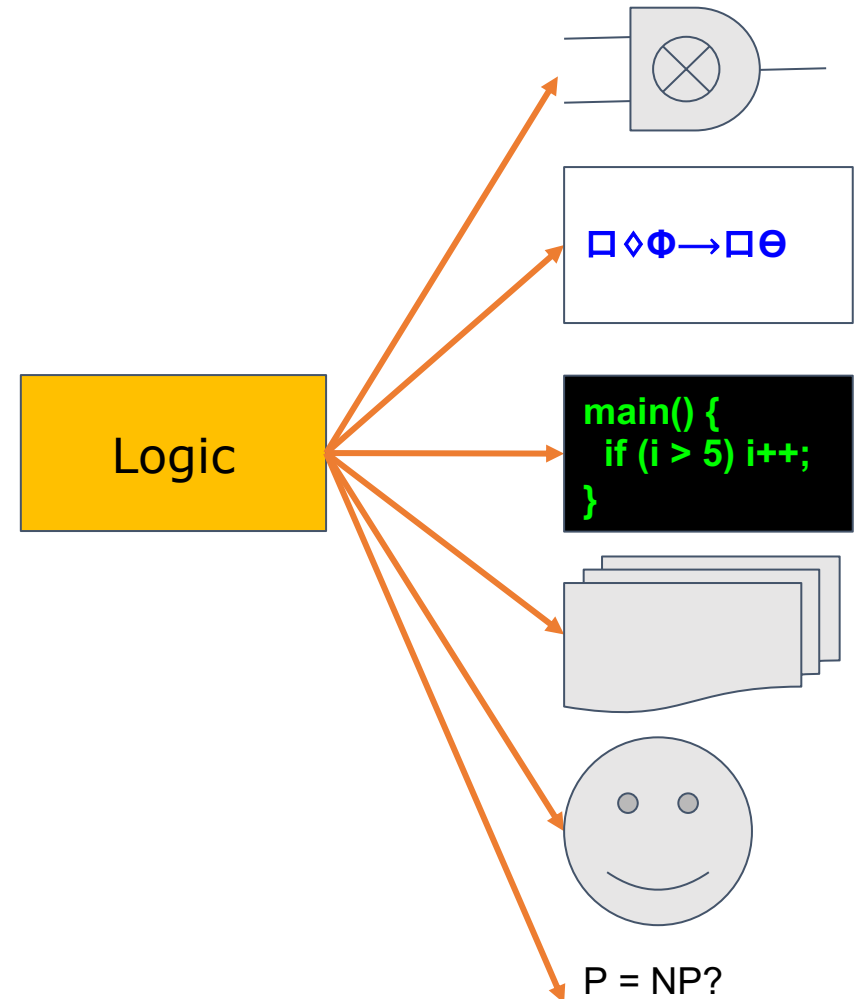


- | Know the importance of logic for computer science
- | Know what is logic
- | Know the history of logic development

“The Calculus of Computer Science”

Logic's role in Computer Science

- Computer Architecture
- Software Engineering
- Programming languages
- Databases
- Artificial Intelligence
- Computation Theory
- ...



What is logic



| “Logic is concerned with forms of reasoning ... In the process of reasoning one makes **inferences**. In an inference one uses a collection of statements, the **premises**, in order to justify another statement, the **conclusion**.”

Robert L. Causey

What is logic

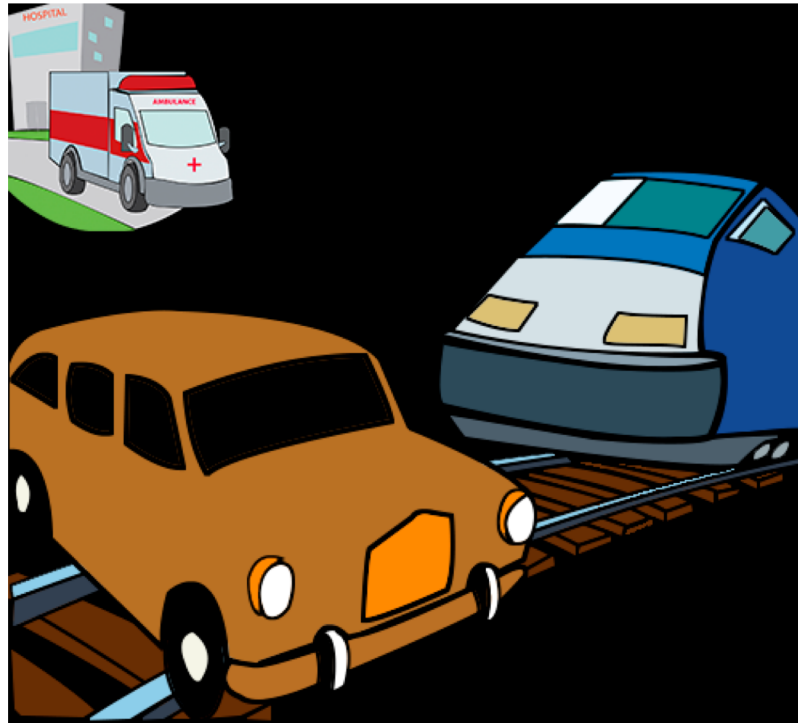
| Puzzle

- A father and his son were driving to a ball game when their car stalled on the railroad tracks. In the distance a train whistle blew a warning. Frantically, the father tried to start the engine, but in his panic, he couldn't turn the key, and the car was hit by the onrushing train. An ambulance sped to the scene and picked them up. On the way to the hospital, the father died. The son was still alive but his condition was very serious, and he needed immediate surgery. The moment they arrived at the hospital, he was wheeled into an emergency operating room, and the surgeon came in, expecting a routine case. However, on seeing the boy, the surgeon blanched and muttered, "I can't operate on this boy — he's my son."

What is logic

Puzzle

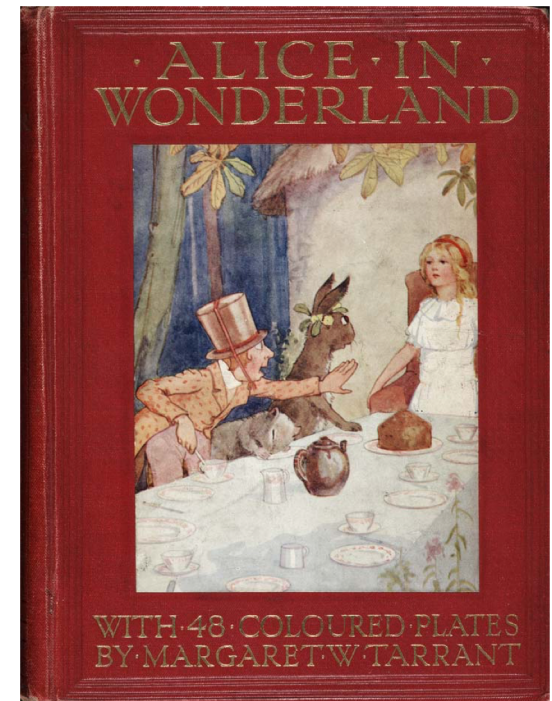
- How is this possible? (The surgeon was not lying or mistaken, no adoption, etc.)



What is logic

| Lewis Carroll Puzzle (I)

- Derive an inescapable conclusion using all of these:
 - a. All babies are illogical
 - b. Nobody is despised who can manage a crocodile
 - c. Illogical persons are despised



Beginning of Logic

| “A deduction is speech (logos) in which, certain things having been supposed, something different from those supposed results of necessity because of their being so. (Prior Analytics I.2, 24b18–20)”

– Each of the “things supposed” is a **premise (protasis)** of the argument, and what “results of necessity” is the **conclusion (sumperasma)**.

- **From**

All men are mortal

Socrates is a man

- **Deduce**

Socrates is mortal

Aristotle (384 BC-322 BC)

Beginning of Logic



| “The only way to rectify our reasonings is to make them as tangible as those of the Mathematicians, so that we can find our error at a glance, and when there are disputes among persons, we can simply say: Let us calculate [calculemus], without further ado, to see who is right.”

- I saw someone on the hill with a telescope.

Gottfried Wilhelm Leibniz (1646-1716)

Beginning of Logic



- | **George Boole (1815-1864) is the one who made logic mathematical (“The Mathematical Analysis of Logic”, 1847)**
 - Boolean algebra
- | **German philosopher Gottlob Frege (1848--1925) with the long title “Ideography, a Formula Language, Modeled upon that of Arithmetic, for Pure Thought” (1879), introduced notation that is somewhat similar to what is now called first-order formulas.**

Lewis Carroll Puzzle (I)

| Derive an inescapable conclusion using all of these:

- All babies are illogical
- Nobody is despised who can manage a crocodile
- Illogical persons are despised
 - B: it is a baby
 - L: it is logical
 - M: it can manage a crocodile
 - D: it is despised

$$B \rightarrow \neg L$$

$$M \rightarrow \neg D$$

$$\neg L \rightarrow D$$

Lewis Carroll Puzzle (II)

Derive an inescapable conclusion using all of these:

- None of the unnoticed things, met with at sea, are mermaids.
- Things entered in the log, as met with at sea, are sure to be worth remembering.
- I have never met with anything worth remembering, when on a voyage.
- Things met with at sea, that are noticed, are sure to be recorded in the log.

- N: it is noticed, while at sea

$$\neg N \rightarrow \neg M$$

- M: it is a mermaid

$$L \rightarrow R$$

- L: it is entered in the log, while at sea

$$I \rightarrow \neg R$$

- R: it is worth remembering

- I: I have met with it on a voyage

$$N \rightarrow L$$

Importance of Logic



| “I think the best hope for human-level AI is logical AI, based on the formalizing of commonsense knowledge and reasoning in mathematical logic”

John McCarthy (1927-2011)

| “In the long run I expect computing science to transcend its parent disciplines, mathematics and logic, by effectively realizing a significant part of Leibniz's Dream of providing symbolic calculation as an alternative to human reasoning.”

Edsger Dijkstra (1930-2002)

Summary

Introduction to Logic

- “The calculus of computer science”
- Logic is about the reasoning process
- Logic in computer science requires a mathematical language

