# TTIC 31230, Fundamentals of Deep Learning

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# AGI: Logic

## Logic Remains Central to Computer Science

Compilers remain essential to computing. Compilers have a precise (logical) notion of correctness.

The correctness of compilers underlies the correctness of the programs they compile.

I.J. Good's intelligence explosion presumably requires AI systems to be able to write (logically) correct programs.

## Logic in Common Sense

Certain facts are obvious.

A king on empty chess board can reach every square (obvious).

A knight on an empty chess board can reach every square (true but not obvious).

## Logic in Common Sense

Consider a graph with colored nodes.

If every edge is between nodes of the same color, then any path connects nodes of the same color.

Consider a swiss chocolate bar of $3 \times 5$ little squares.

How many breaks does it take to reduce this to fifteen unconnected squares?

What inference happens when one observes that each break increases the number of pieces by one?

# Logic in Lexical Semantics

Let $e$ range over "events".

$$e : \text{give}(a_1, x, a_2) \Rightarrow \text{had}(a_1, x, \text{before}(e)) \wedge \text{had}(a_2, x, \text{after}(e))$$

This is related to Davidsonian semantics for natural language (1969) and the situation calculus of McCarthy and Hayes (1968).

## Logic for Computation

Bottom-up logic programming is distinguished by its relationship to dynamic programming algorithms.

$$\text{At}(x) \Rightarrow \text{Reachable}(x)$$

$$\text{Reachable}(x) \wedge \text{CanGo}(x, y) \Rightarrow \text{Reachable}(y)$$

This defines a linear time algorithm for reachability.

# Logic for Computation

A set of inference rules (horn clauses) in which each term in the conclusion appears in some antecedent is called a local logic program.

It can be shown that local logic programs "captures the complexity class $P$" — they can express **all and only** polynomial time decidable relations.

## The MathZero Program

Is it possible to achieve super-human performance in mathematics through self-play?

# Autoformalization

Christian Szegedy (adversarial images, batch normalization, the inception network) has written a position paper taking the position that translation of natural language mathematics into formal machine-verifiable statements will provide a path to AGI.

A Promising Path Towards Autoformalization and General Artificial Intelligence, Christian Szegedy, Intelligent Computer Mathematics, 2020.

# END