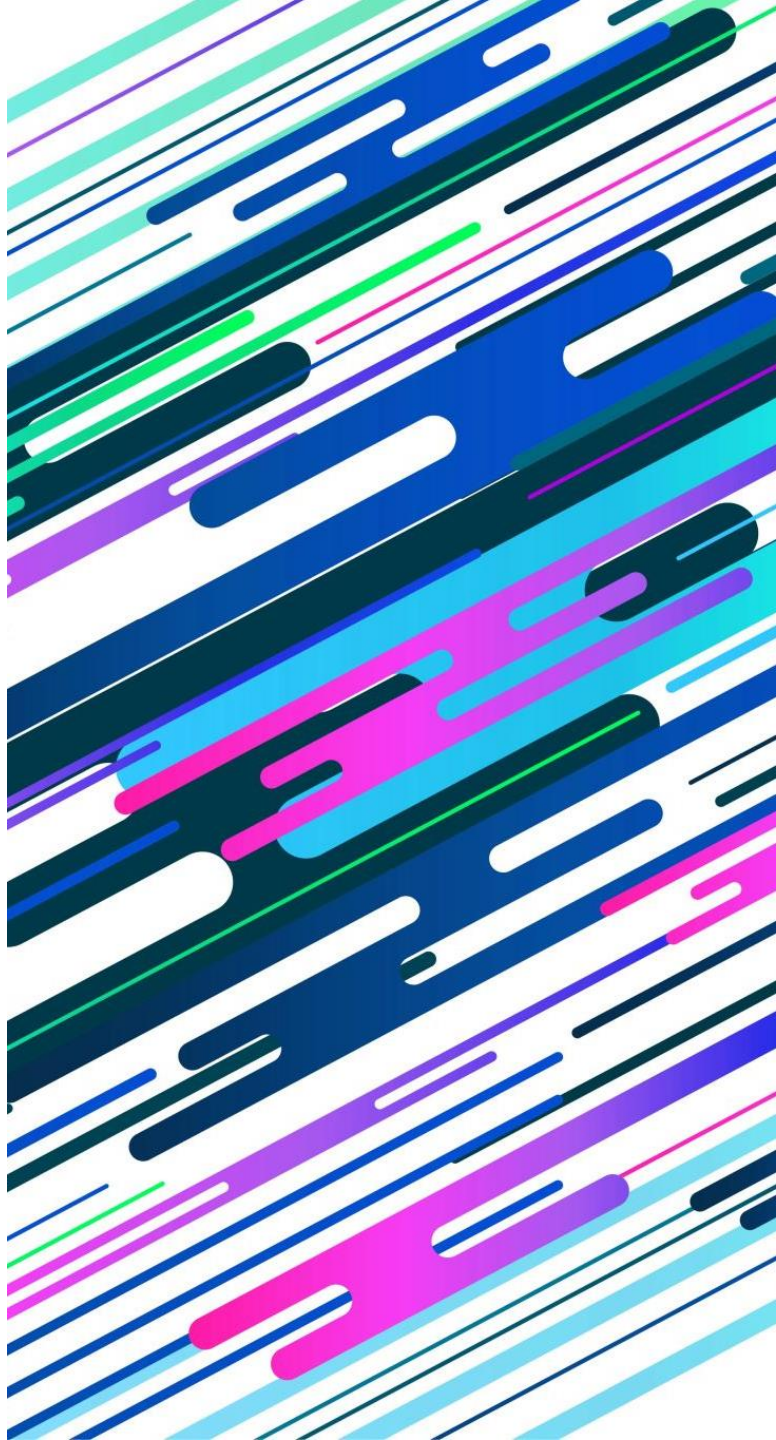
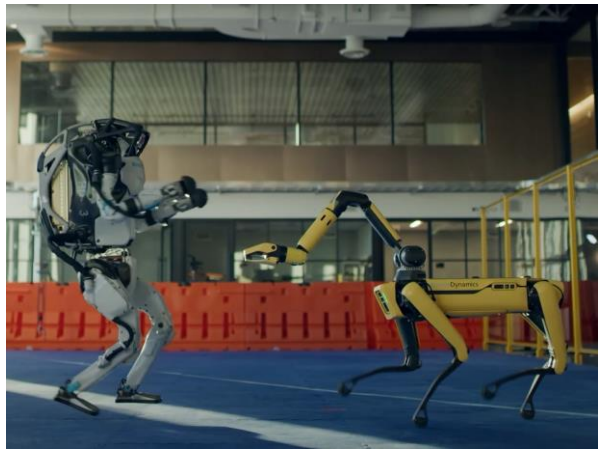
ARTIFICIAL INTELLIGENCE OVERVIEW

Thomas Tiam-Lee, PhD



Intelligent Systems

- Computational systems that perceive their environment, evaluate, and decide their actions **in ways that a human would**.



Artificial Intelligence

- The backbone of intelligent systems
- The study of **how machines can exhibit at least one aspect associated with intelligent behavior**, including but not limited to:
  - **Problem solving**: performance of non-trivial goal-directed tasks
  - **Reasoning**: drawing logical inferences from facts
  - **Learning**: improvement of performance through experience

Modeling Inference Learning Paradigm

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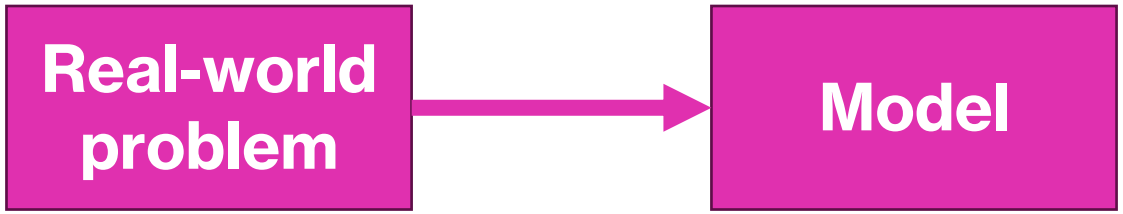
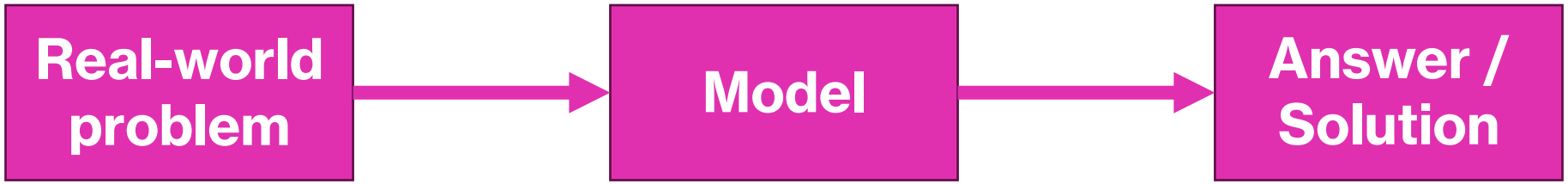


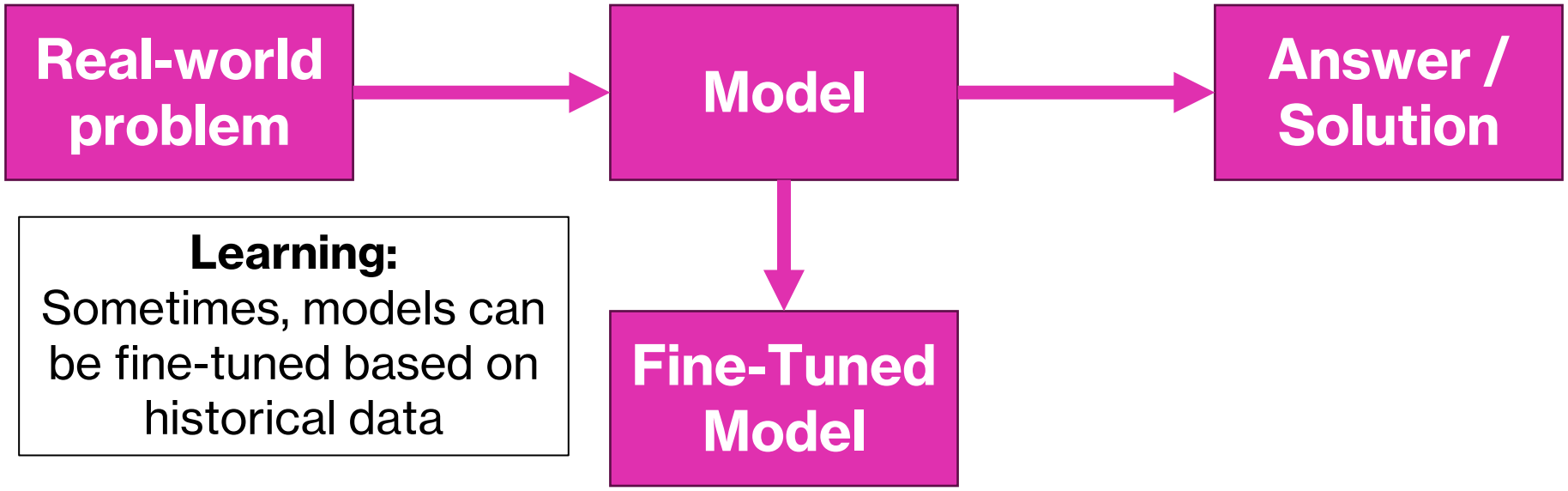
Modelling:
represent a real-world task into an abstract model

Modeling Inference Learning Paradigm

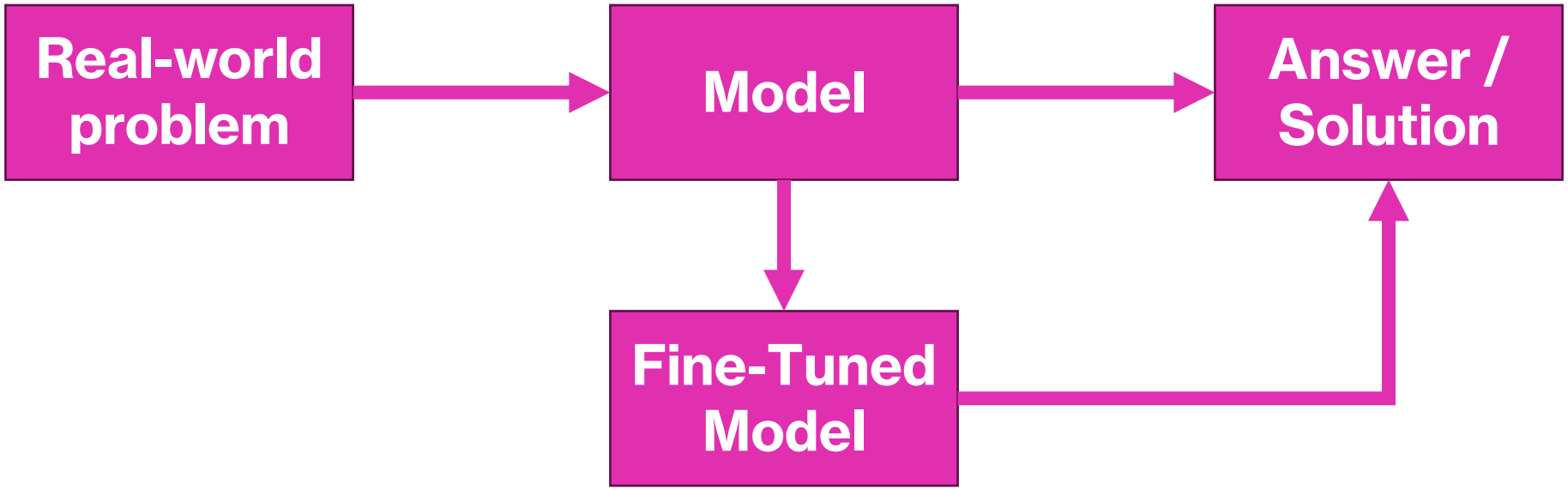


Inference:
answer questions / find solutions to the problem through systematic algorithms run on the model

Modeling Inference Learning Paradigm

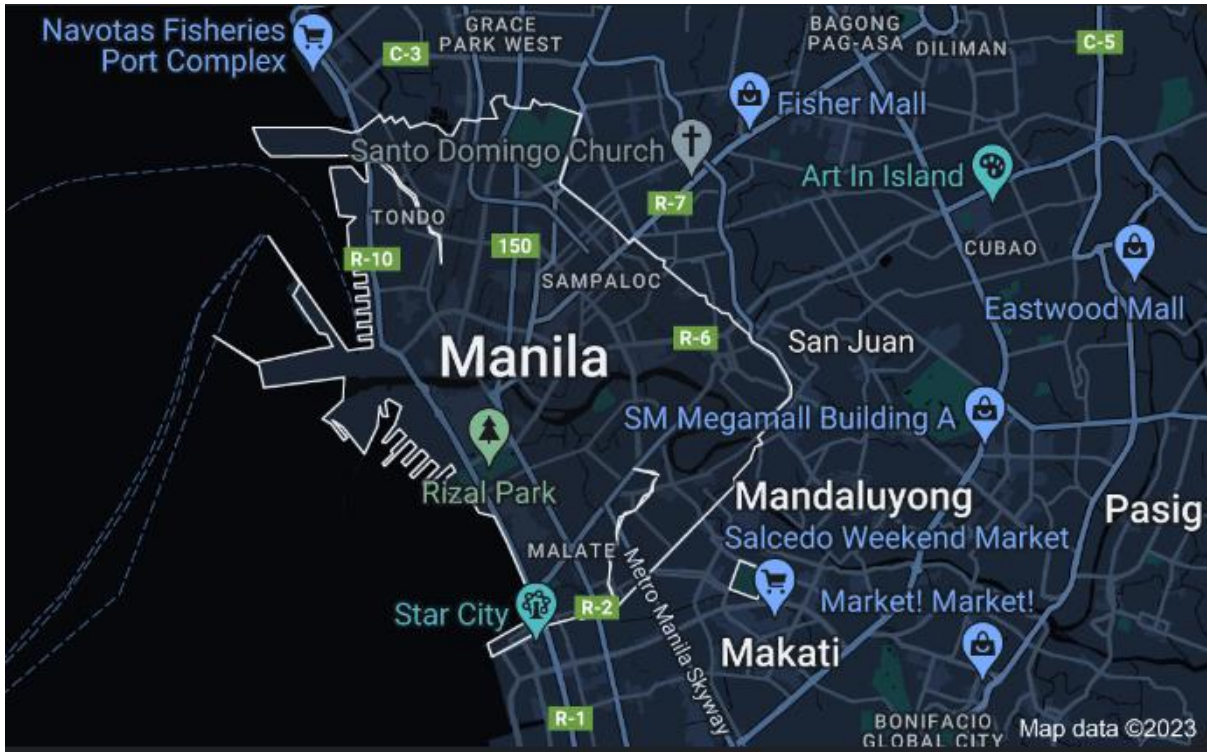


Modeling Inference Learning Paradigm



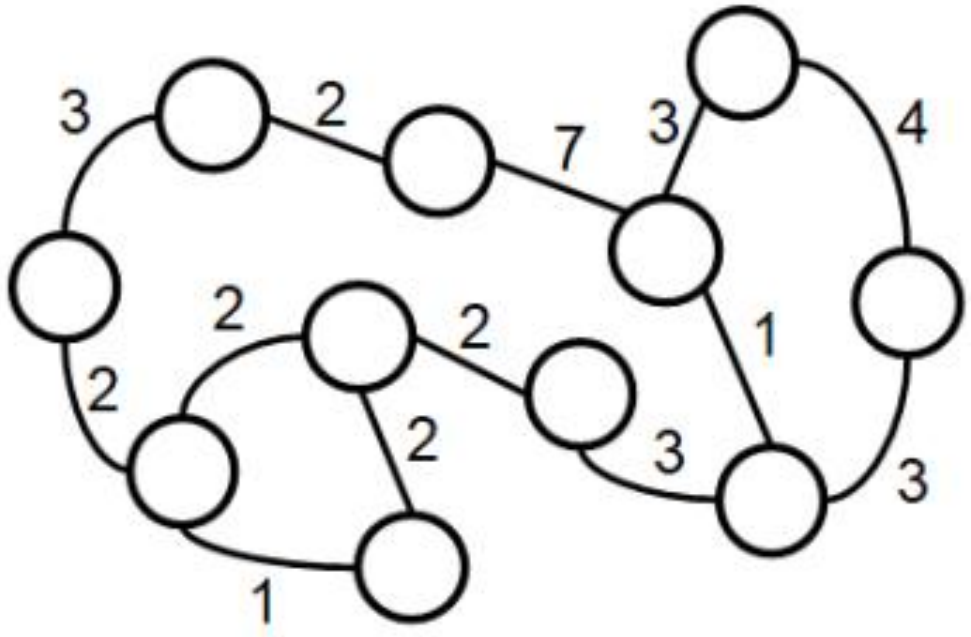
Example:

- **Real-world problem**: find a route from one place to another in Manila, considering the traffic.



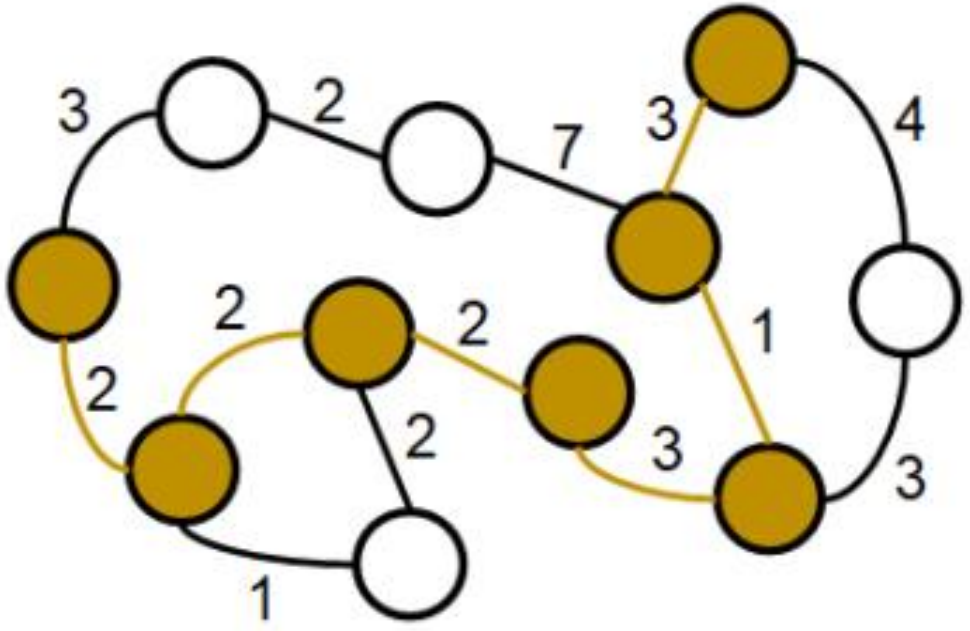
Example:

- **Modelling**: use a weighted graph to model the problem.
  - **Nodes**: places / junctions
  - **Edges**: roads
  - **Weights**: amount of traffic on that road



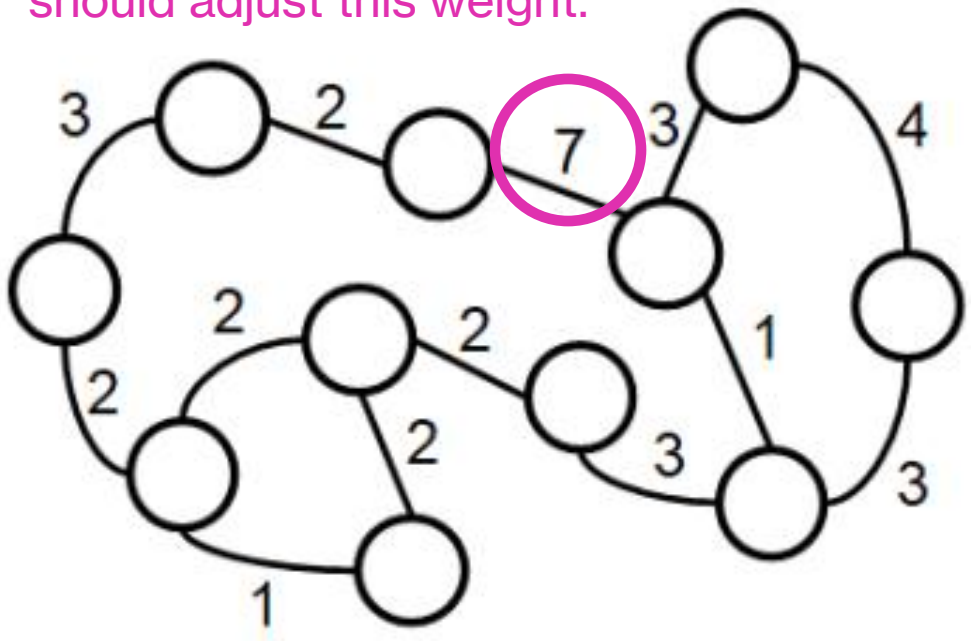
Example:

- **Inference**: use a **search algorithm** that can find the minimum-cost path from one node to another.



Example:

- **Learning**: Improve the weights assigned to each edge based on historical data observed in the real-world.



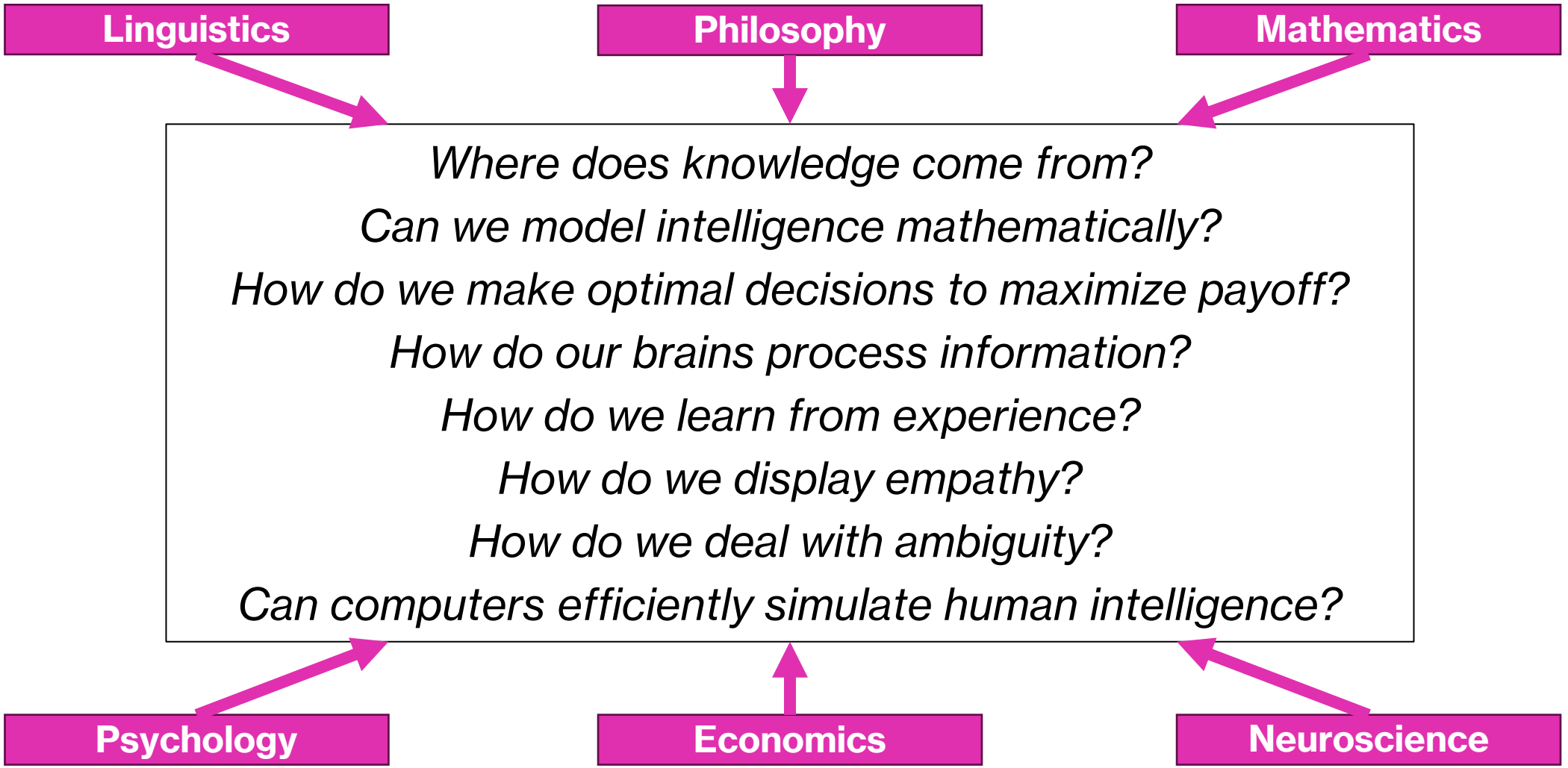
Intellectual Traditions in AI

- **Symbolic AI:** top-down approach
  - Identify the “rules” of the problem and model it
  - Find a solution based on those rules
- **Neural AI**: bottom-up approach
  - Start with examples (data), and feed it to the model
  - Adjust the “rules” of the model based on the data
- **Statistical AI**: view of mathematicians
  - provides mathematical rigor to AI approaches

Types of AI Models

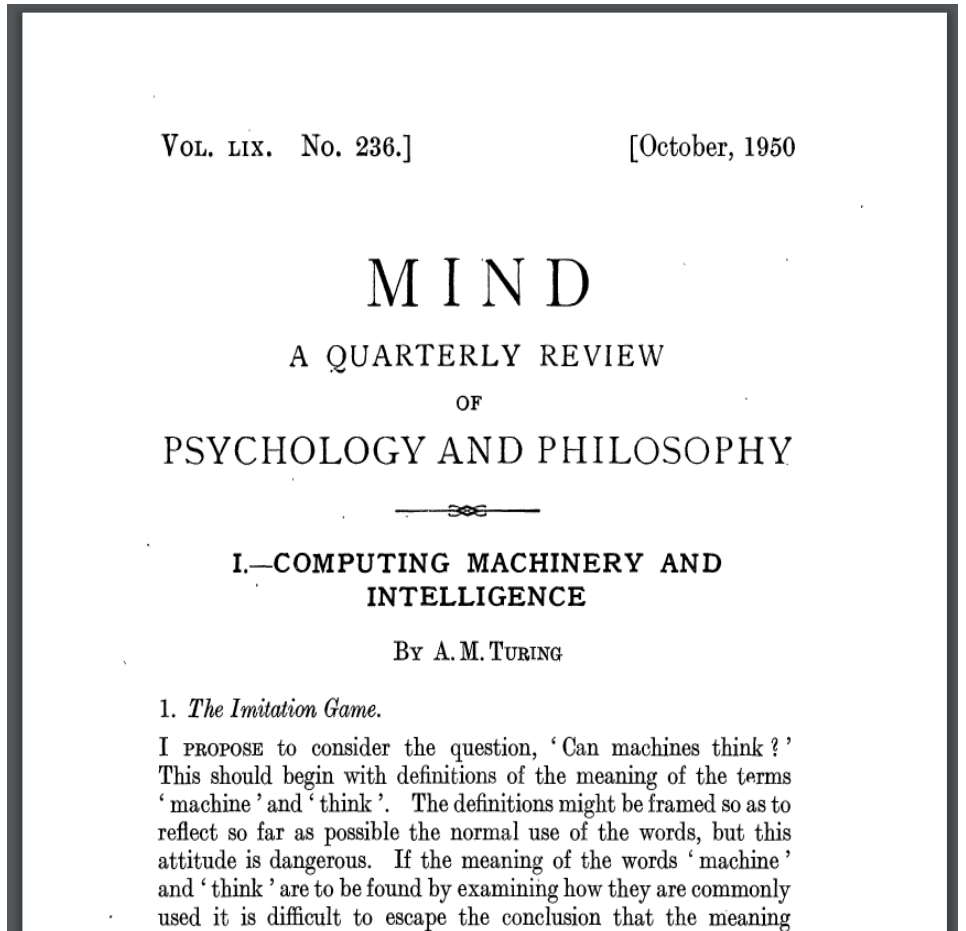
- **Reflex-Based Models:** single-pass processing of input features to map it to an output.
- **State-Based Models:** represent the problem as a set of states to search through.
- **Variable-Based Models:** represent the problem as a set of constraints to satisfy.
- **Logic-Based Models:** automatic deduction and reasoning based on known facts.

Foundations of AI



The Turing Test

- **1950: Alan Turing** publishes a landmark paper, proposing the **Turing Test** as a philosophical framework for artificial intelligence.



VOL. LIX. No. 236.] [October, 1950

MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

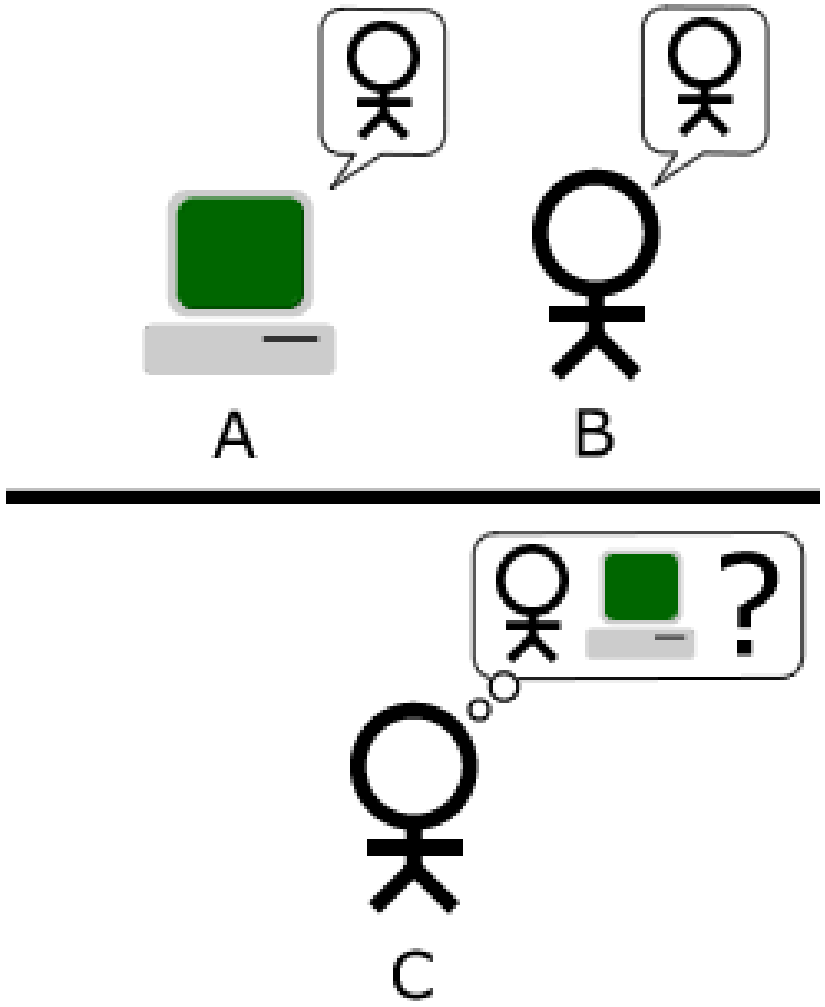
BY A. M. TURING

1. *The Imitation Game.*

I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning

The Turing Test

- **Human evaluator** (C) talks with a **machine** (A) and a **human** (B).
- C cannot see A or B and they must communicate by typewritten messages.
- C will try to guess who is the machine.
- A must convince C that A is not the machine.



Birth of AI as a Field

- **1956: John McCarthy** organizes a workshop at Dartmouth College with an ambitious goal: *“precisely describe every aspect of learning and intelligence so that a machine can be made to simulate it”*

Early Successes

- **1952:** Samuel's Checkers
- **1955:** Newell and Simon's Logic Theorist
- **1950s to 1960s:** Machine translation
- Prominent paradigm was **symbolic AI**.

Challenges:

- **Limited computation**
- **Limited information**

Early Era of AI

- **A lot of optimism**
  - *“Machines will be capable, within twenty years, of doing any work a man can do”*
  - *“Within a generation, the problem of creating 'artificial intelligence' will substantially be solved”*

Machine Translation

- **1950s to 1960s:** a lot of hype around machine translation

Fig. 2: Hurd, Dostert and Watson at the demonstration

Georgetown-IBM Experiment, the first public demonstration of machine translation intended to attract funding from the government

Despite the Hype...

- Rule-based machine translation faced a lot of problems.
- Cannot handle semantic ambiguity and other linguistic nuances!

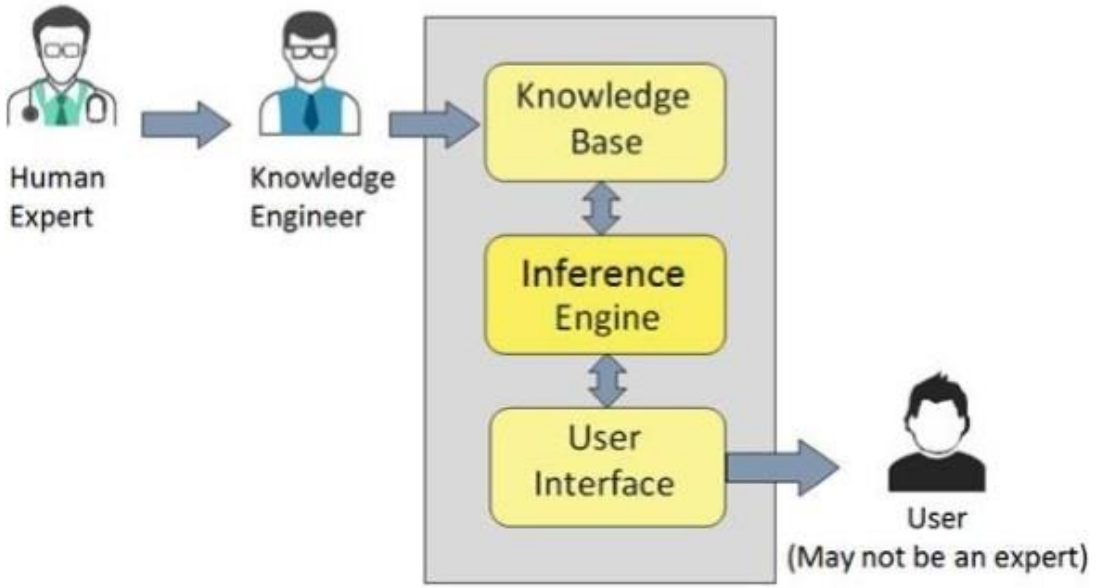
- 1966: the government published a report concluding that machine translation was **slower**, **less accurate**, and **twice as expensive** as hiring human translators.
- This resulted in significant cuts in government funding, leading to the **first AI winter**.

First AI Winter (1974 – 1980)

- **AI winter**: a period of reduced funding and interest in artificial intelligence research
- The AI field is notorious for having hype cycles, followed by disappointment and criticism, and eventually funding cuts.

Knowledge-Based Systems

- **1970s - 1980s:** AI research heavily shifted to **expert systems**
  - Allows domain experts to encode their knowledge into the system
  - Narrower focus (domain-specific)



Source: tutorialspoint.com

Notable Expert Systems

Name	Description
CADUCEUS	Medical diagnosis based on symptoms
MYCIN	Identifying bacteria that caused infections and recommending antibiotics
DENDRAL	Analyzing and identifying chemical compounds
R1 / XCON	Assists users on selecting computer system components based on their specifications

Expert systems were able to have commercial and industrial impact!

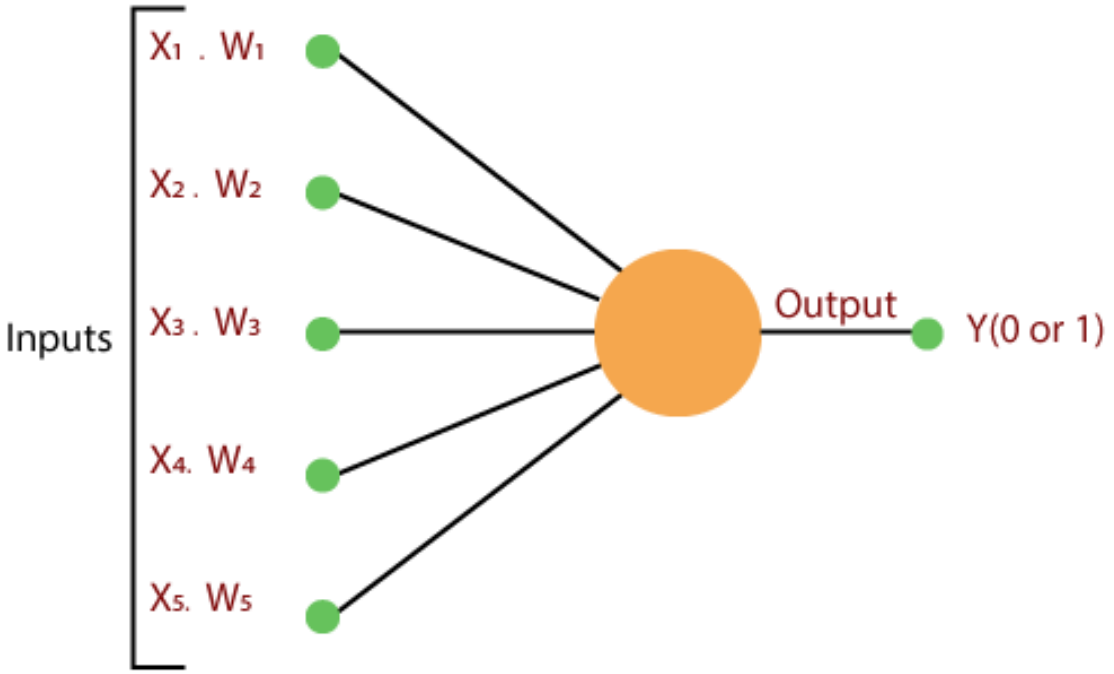
Second AI Winter (1987 – 2000)

- Problems with Expert Systems:
  - Cannot handle uncertainty in the real-world.
  - Difficult to maintain the rules in the knowledge base.

- **1987:** the LISP market crashes because there were not enough killer apps and the **second AI winter** starts.

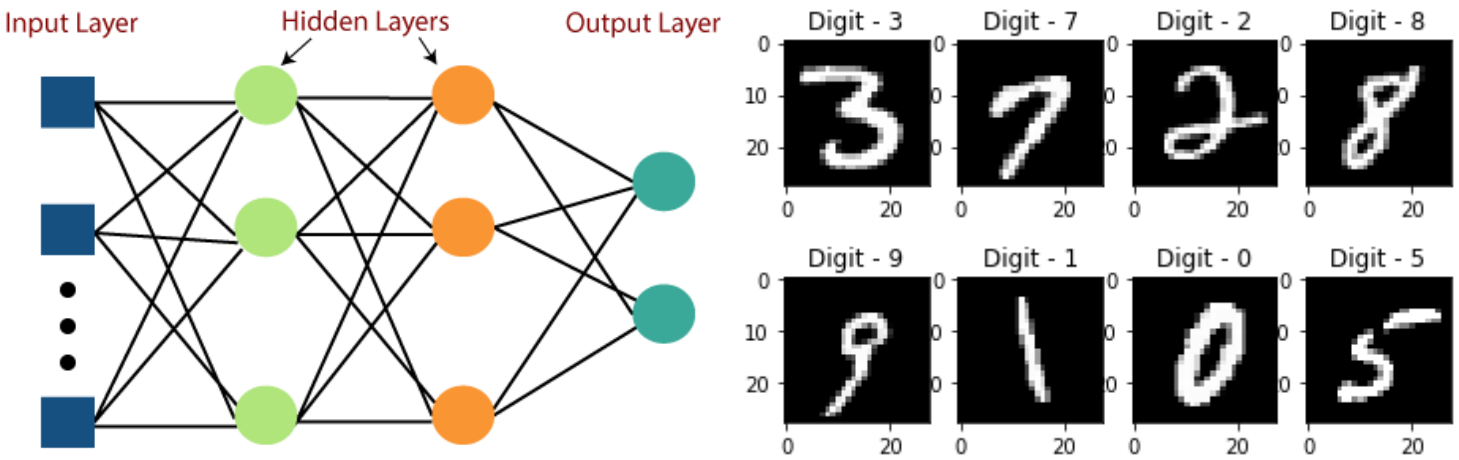
The Roots of Neural AI

- **1943:** McCulloch and Pitts publishes the first mathematical model for an **artificial neural network**.
- **1958:** Rosenblatt publishes the **Perceptron learning algorithm**.



Source: javatpoint.com

Resurgence of Neural Networks

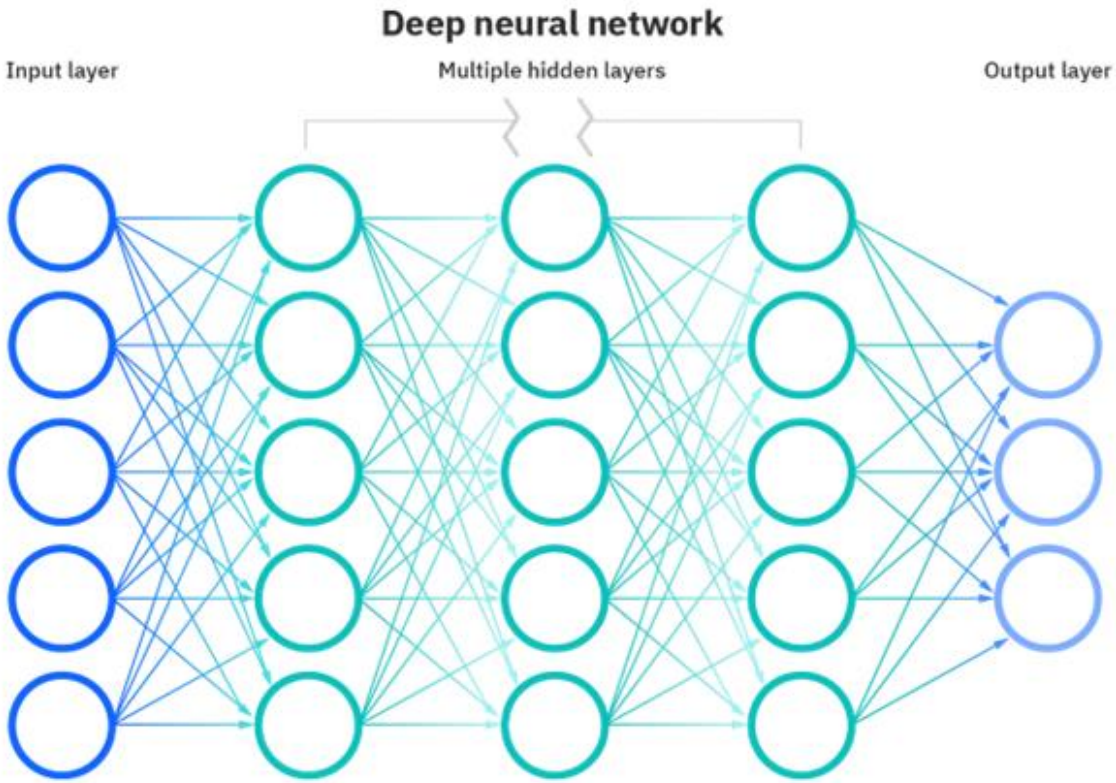


Source: javatpoint.com, MNIST dataset

- **1960:** Multi-layer perceptrons were introduced
- **1986:** Popularization of the backpropagation learning algorithm
- **1989:** Application of convolutional neural networks to recognize handwritten digits (Yann LeCun)

Deep Learning

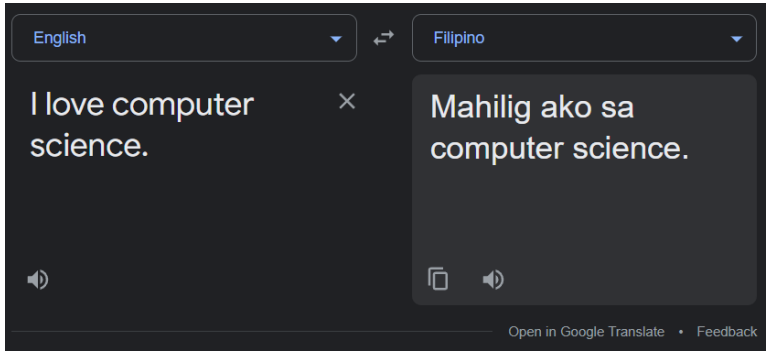
- Simple definition: neural network with **many hidden layers**.



Deep Learning

- **2012: AlexNet** makes big progress in object recognition with deep learning.
- **2016: AlphaGo** defeats world Go champion Lee Sedol with deep reinforcement learning.

AI Today



TJ What do you think about AI?

I don't have personal thoughts or feelings, but I can certainly provide information and insights about AI!

Artificial Intelligence (AI) is a rapidly advancing field of technology that focuses on creating systems that can perform tasks that typically require human intelligence, such as understanding natural language, recognizing patterns, making decisions, and learning from data. AI has the potential to revolutionize various industries and aspects of our lives, from healthcare and finance to transportation and entertainment.

AI Today

- Ubiquitous in our daily lives
- Used to be a purely academic endeavor, now very integrated into the mainstream

In 2021, the Philippines launched the national artificial intelligence (AI) roadmap which made the Philippines one of the first 50 countries in the world to have a national strategy and policy on AI.

More info: https://innovate.dti.gov.ph/wp-content/uploads/2020/07/AI-Roadmap-Usec-Aldaba.pdf

Summary

- Intelligent systems, made possible by AI, are computational systems that behave intelligently like humans in some aspects.
- AI follows the model-inference-learning paradigm.
- There are many types of models.
- AI has a long and rich history, leading to its ubiquitous status today.

Acknowledgments

- Stanford University CS221 Autumn 2021 course. Available online at: https://stanford-cs221.github.io/autumn2021
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