Foundations of Artificial Intelligence
2. Introduction: AI Past and Present

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2.1 A Short History of AI

2.2 Where are we Today?

2.3 Summary

Introduction: Overview

Chapter overview: introduction

- ▶ 1. What is Artificial Intelligence?
- ▶ 2. AI Past and Present
- ▶ 3. Rational Agents
- ▶ 4. Environments and Problem Solving Methods

2.1 A Short History of AI

Origins (Until ca. 1943)

| 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | ... |

Philosophy, mathematics, psychology and linguistics
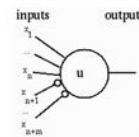asked similar questions that influence AI.

Inception (1943–1956)

| 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | ... |

Invention of electrical computers raised question:
Can computers mimic the human mind?

Inception (1943–1956)

Artificial
Neurons

| 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | ... |

W. McCulloch & W. Pitts (1943)
- ▶ first computational model of artificial neuron
- ▶ network of neurons can compute any computable function
- ▶ basis of deep learning

Inception (1943–1956)

Artificial
Neurons

| 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | ... |

Turing Test

Computing Machinery and Intelligence (A. Turing, 1950)
- ▶ famous for introducing Turing test
- ▶ (still) relevant discussion of AI potential and requirements
- ▶ suggests core AI aspects: knowledge representation, reasoning, language understanding, learning

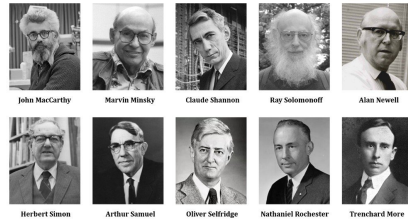## Inception (1943–1956)

Artificial Neurons

Dartmouth

1950 · 1960 · 1970 · 1980 · 1990 · 2000 · ...

Turing Test

> **Dartmouth workshop** (1956)
> - ambitious proposal: "An attempt will be made to find how to make machines use language, [...] solve kinds of problems now reserved for humans, and improve themselves."
> - no important breakthrough
> - J. McCarthy coins term artificial intelligence

Enthusiasm (1952–1969)

Artificial Neurons

Dartmouth

1950 · 1960 · 1970 · 1980 · 1990 · 2000 · ...

Turing Test

> **early enthusiasm** (H. Simon, 1957):
> "[...] there are now in the world machines that think, that learn and that create. Moreover, their ability to do these things is going to increase rapidly until – in the visible future – the range of problems they can handle will be coextensive with the range to which the human mind has been applied."

Enthusiasm (1952–1969)

Artificial Neurons

Dartmouth
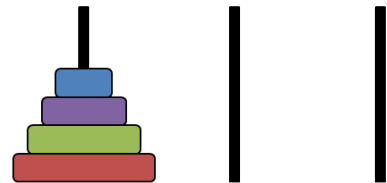
1950 · 1960 · 1970 · 1980 · 1990 · 2000 · ...

GPS

Turing Test

> **General Problem Solver** (H. Simon & A. Newell, 1957)
> - universal problem solving machine
> - imitates human problem solving strategies
> - in principle able to solve every formalized symbolic problem
> - in practice, GPS solves simple tasks like towers of Hanoi

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Enthusiasm (1952–1969)

Artificial Neurons

RL for Checkers

Dartmouth

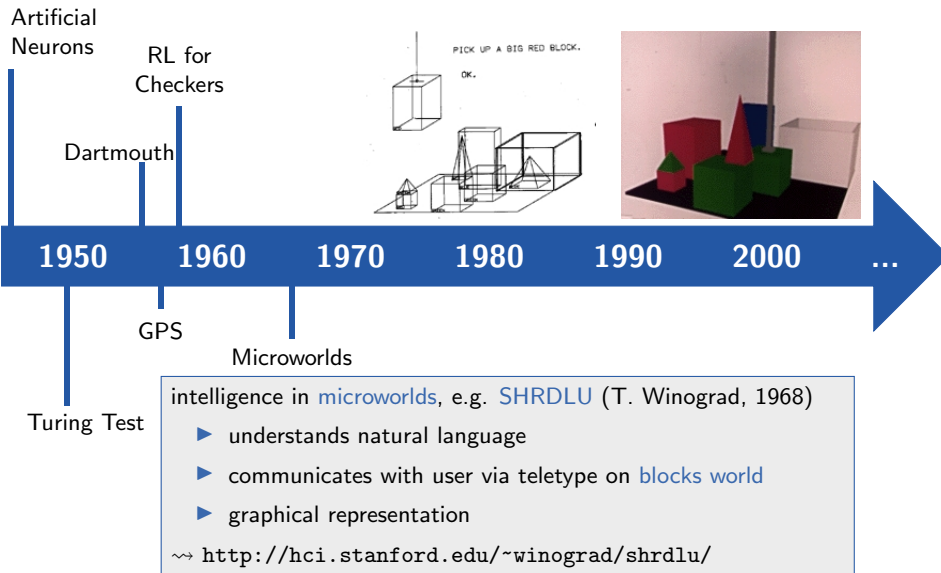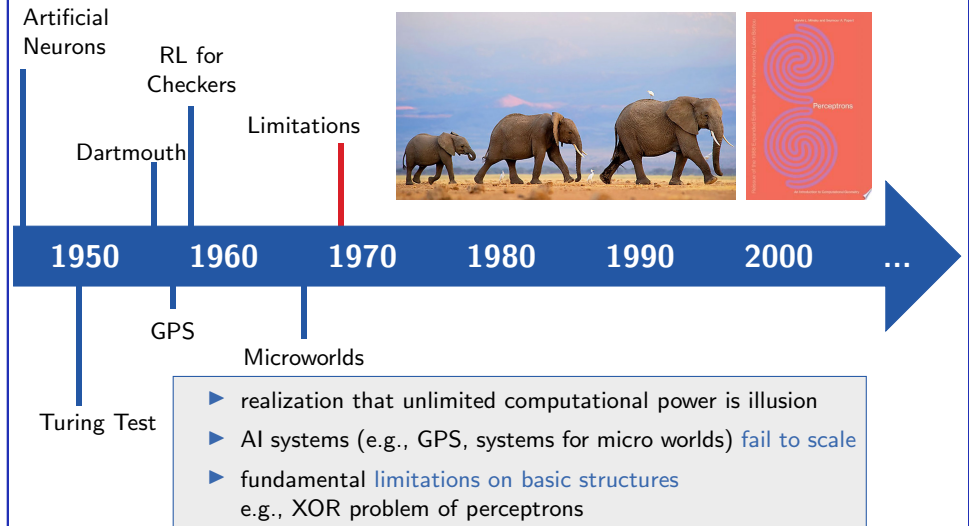1950 · 1960 · 1970 · 1980 · 1990 · 2000 · ...

GPS

Turing Test

> **Checkers AI** (A. Samuel, 1959)
> - popularized term machine learning
> - learned to play at strong amateur level
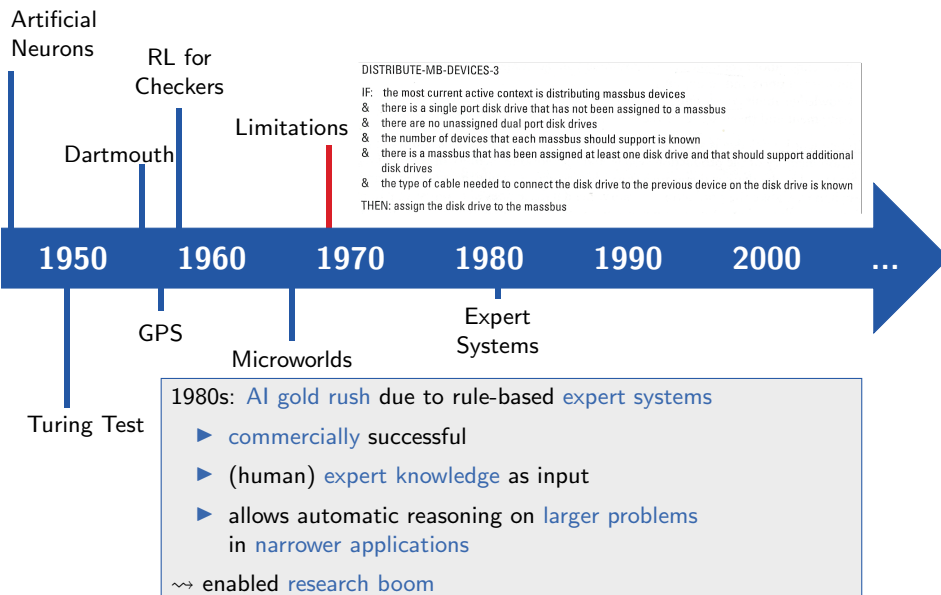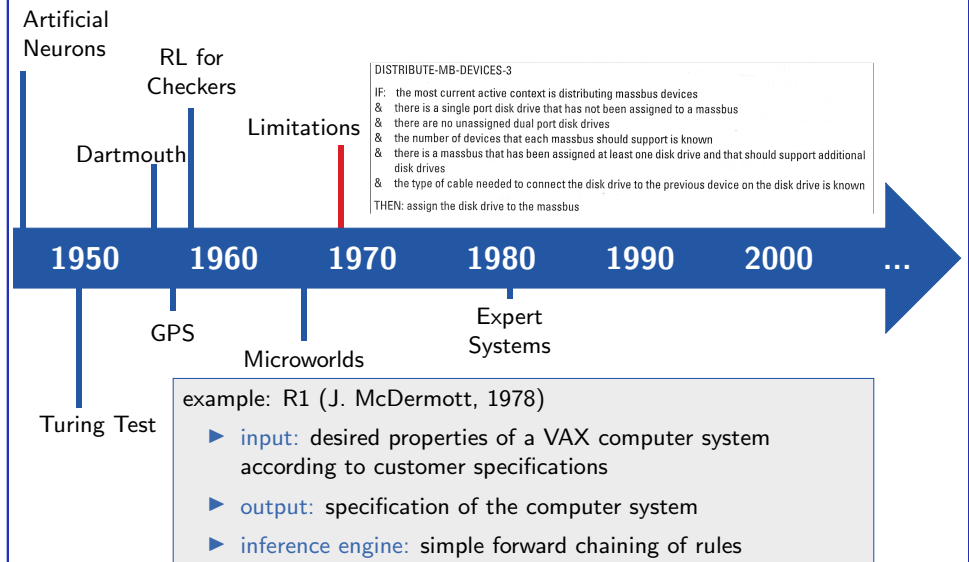> - incorporates ideas of reinforcement learning

Enthusiasm (1952–1969)

Artificial Neurons

RL for Checkers
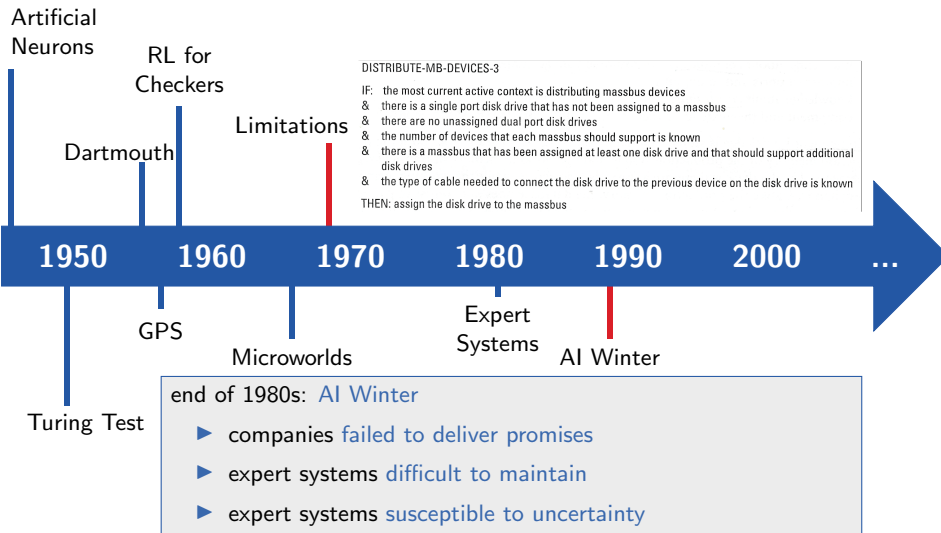
Dartmouth

PICK UP A BIG RED BLOCK.

OK.

1950   **1960**   **1970**   **1980**   **1990**   **2000**   ...

GPS

Microworlds

Turing Test

intelligence in microworlds, e.g. SHRDLU (T. Winograd, 1968)
- ▶ understands natural language
- ▶ communicates with user via teletype on blocks world
- ▶ graphical representation
- ⤳ http://hci.stanford.edu/~winograd/shrdlu/

A Dose of Reality (1966–1973)

Artificial Neurons

RL for Checkers

Dartmouth

Limitations

Perceptrons

1950   **1960**   **1970**   **1980**   **1990**   **2000**   ...

GPS

Microworlds

Turing Test

- ▶ realization that unlimited computational power is illusion
- ▶ AI systems (e.g., GPS, systems for micro worlds) fail to scale
- ▶ fundamental limitations on basic structures e.g., XOR problem of perceptrons

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Expert Systems (1969–1986)

Artificial Neurons

RL for Checkers

Dartmouth

Limitations

DISTRIBUTE-MB-DEVICES-3

IF: the most current active context is distributing massbus devices
& there is a single port disk drive that has not been assigned to a massbus
& there are no unassigned dual port disk drives
& the number of devices that each massbus should support is known
& there is a massbus that has been assigned at least one disk drive and that should support additional disk drives
& the type of cable needed to connect the disk drive to the previous device on the disk drive is known

THEN: assign the disk drive to the massbus

1950   **1960**   **1970**   **1980**   **1990**   **2000**   ...

GPS

Microworlds

Expert Systems

Turing Test

1980s: AI gold rush due to rule-based expert systems
- ▶ commercially successful
- ▶ (human) expert knowledge as input
- ▶ allows automatic reasoning on larger problems in narrower applications
- ⤳ enabled research boom

Expert Systems (1969–1986)

Artificial Neurons

RL for Checkers

Dartmouth

Limitations

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1950   **1960**   **1970**   **1980**   **1990**   **2000**   ...

GPS

Microworlds

Expert Systems

Turing Test

example: R1 (J. McDermott, 1978)
- ▶ input: desired properties of a VAX computer system according to customer specifications
- ▶ output: specification of the computer system
- ▶ inference engine: simple forward chaining of rules

Expert Systems (1969–1986)

DISTRIBUTE-MB-DEVICES-3

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Timeline: Artificial Neurons, Dartmouth, RL for Checkers, Limitations, Turing Test, GPS, Microworlds, Expert Systems, AI Winter — 1950, 1960, 1970, 1980, 1990, 2000, ...

end of 1980s: AI Winter
- companies failed to deliver promises
- expert systems difficult to maintain
- expert systems susceptible to uncertainty

Coming of Age (1990s and 2000s)

Timeline: Artificial Neurons, Dartmouth, RL for Checkers, Limitations, Turing Test, GPS, Microworlds, Expert Systems, AI Winter — 1950, 1960, 1970, 1980, 1990, 2000, ...

- advent of probabilistic methods
- formalization of AI techniques
- better understanding of theoretical complexity
- increased use of mathematical methods
- exploitation of large data sets (big data)

Broad Visibility in Society (Since 2010s)

Timeline: Artificial Neurons, Dartmouth, RL for Checkers, Limitations, Turing Test, GPS, Microworlds, Expert Systems, AI Winter — 1950, 1960, 1970, 1980, 1990, 2000, ...

well known systems and famous breakthroughs, e.g.,
- broadly used systems (e.g., virtual assistants)
- AI systems act in real-world (e.g., self-driving cars)
- systems outperform humans in hard tasks (e.g., AlphaGo)
- AI- and human-written text hard to distinguish (ChatGPT)

2.2 Where are we Today?

## Where are we Today?

- ▶ many coexisting paradigms
    - ▶ reactive vs. deliberative
    - ▶ data-driven vs. model-driven
    - ▶ often hybrid approaches
- ▶ many methods, often borrowing from other research areas
    - ▶ logic, decision theory, statistics, . . .
- ▶ different approaches
    - ▶ theoretical
    - ▶ algorithmic/experimental
    - ▶ application-oriented

Focus on Algorithms and Experiments

Many AI problems are inherently difficult (NP-hard),
but strong search techniques and heuristics often solve
large problem instances regardless:

- ▶ satisfiability in propositional logic
    - ▶ 10,000 propositional variables or more
      via conflict-directed clause learning
- ▶ constraint solvers
    - ▶ good scalability via constraint propagation
      and automatic exploitation of problem structure
- ▶ action planning
    - ▶ 10^{100} search states and more by search
      using automatically inferred heuristics

What can AI do Today?

url: https://kahoot.it/
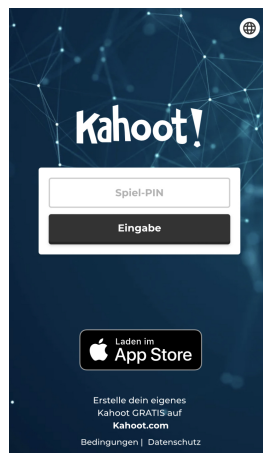
What can AI do Today? – Videos, Articles and AIs
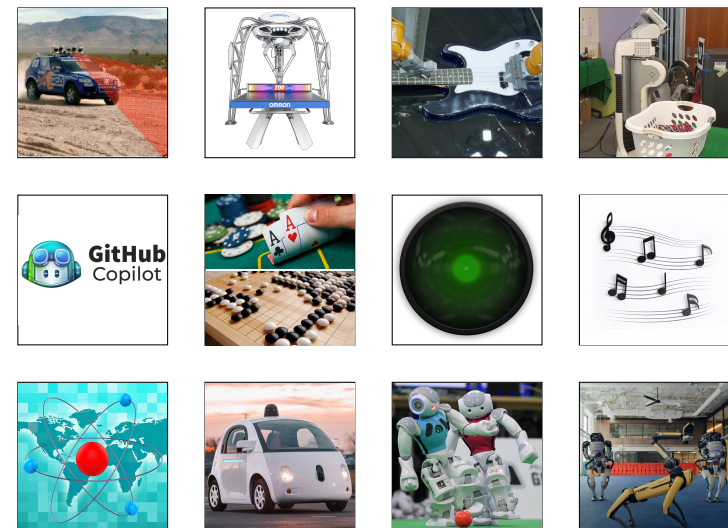
What can AI do Today?

✓ successfully complete an off-road race
✗ beat a world champion table tennis player
✓ play guitar in a robot band
✓ do and fold the laundry
? write code on the level of a CS student
✓ beat a world champion Chess, Go or Poker player
? create inspiring quotes
✓ compose music
✗ engage in a scientific conversation
? drive safely in downtown Zürich
✗ win a football match against a human team
✓ dance synchronously in a group of robots

2.3 Summary

Summary

▶ 1950s/1960s: beginnings of AI; early enthusiasm
▶ 1970s: micro worlds and knowledge-based systems
▶ 1980s: gold rush of expert systems followed by "AI winter"
▶ 1990s/2000s: AI comes of age; research becomes more rigorous and mathematical; mature methods
▶ 2010s: AI systems enter mainstream