

Most materials in this chapter are based on materials from <https://ai.berkeley.edu>



C0

Introduction

COMP3270
Introduction to Artificial Intelligence



1

Speaker notes

Today we ask what artificial intelligence means. By the end, we will view AI as agents that perceive an environment and choose actions.

C0: Introduction

Slide 1 of 21 · Initial

What Would Count as Intelligence?

TASK

A

Calculator

B

Chess Engine

C

Chatbot

D

Self-Driving Car

What evidence are you using?

2

Speaker notes

Start with your intuition. Which systems count as intelligent, and what evidence supports your answer?

What Would Count as Intelligence?

Slide 2 of 21 · Initial

What Would Count as Intelligence?

TASK**SOLUTION**

A

Calculator

No

Executes fixed rules for a
supplied calculation

B

Chess Engine

Yes

Compares possible moves and
chooses one toward its goal

C

Chatbot

Maybe

Human-like responses do not
necessarily prove understanding

D

Self-Driving Car

Yes

Perceives change and adjusts its
actions

What evidence are you using?

2

Speaker notes

Reasonable answers can differ because the criterion differs. That disagreement gives us our first question: how should intelligence be judged?

What Would Count as Intelligence?

Slide 2 of 21 · Reveal 1

How Should We Judge Intelligence?

What do we evaluate?

THINKING



ACTING

3

Speaker notes

We can organize those criteria along two axes. First, do we evaluate internal thinking or observable action?

How Should We Judge Intelligence?

Slide 3 of 21 · Initial

How Should We Judge Intelligence?

What do we evaluate?

THINKING ↔ ACTING

What is the benchmark?

HUMAN-LIKE ↔ RATIONAL

3

Speaker notes

Second, do we compare the system with humans or with a rational standard?

How Should We Judge Intelligence?

Slide 3 of 21 · Reveal 1

How Should We Judge Intelligence?

What do we evaluate? THINKING ↔ ACTING

What is the benchmark? HUMAN-LIKE ↔ RATIONAL

Combine the answers → four ways to define AI

3

Speaker notes

Together, those choices produce four approaches to AI.

How Should We Judge Intelligence?

Slide 3 of 21 · Reveal 2

Build AI That...

HUMANLY

RATIONALLY

THINK

ACT

4

Speaker notes

Here are the four approaches in one map.

Build AI That...

Slide 4 of 21 · Initial

Build AI That...

HUMANLY

RATIONALLY

THINK

Think Humanly

Thinks like a human

ACT

4

Speaker notes

Thinking humanly asks whether a model explains how people actually think.

Build AI That...

Slide 4 of 21 · Reveal 1

Build AI That...

HUMANLY

RATIONALLY

THINK

Think Humanly

Thinks like a human

ACT

Act Humanly

Acts like a human

4

Speaker notes

Acting humanly asks whether behaviour resembles human behaviour.

Build AI That...

Slide 4 of 21 · Reveal 2

Build AI That...

HUMANLY

RATIONALLY

THINK

Think Humanly

Thinks like a human

Think Rationally

Reasons correctly

ACT

Act Humanly

Acts like a human

4

Speaker notes

Thinking rationally asks whether conclusions follow valid rules.

Build AI That...

Slide 4 of 21 · Reveal 3

Build AI That...

	HUMANLY	RATIONALLY
THINK	Think Humanly Thinks like a human	Think Rationally Reasons correctly
ACT	Act Humanly Acts like a human	Act Rationally Chooses effective actions

4

Speaker notes

Acting rationally asks whether actions achieve the objective. This is our course perspective.

Build AI That...

Slide 4 of 21 · Reveal 4

Which Approach Guides Each AI System?

TASK

AI System

A hypothetical brain simulation that reproduces how humans think

A chatbot designed to convince a judge that it is human

An automated theorem prover that derives valid conclusions

A self-driving car that chooses actions to reach its destination safely

Approach

5

Speaker notes

Apply the map. Decide which approach most directly guides each system.

Which Approach Guides Each AI System?

Slide 5 of 21 · Initial

Which Approach Guides Each AI System?

TASK

AI System

A hypothetical brain simulation that reproduces how humans think

A chatbot designed to convince a judge that it is human

An automated theorem prover that derives valid conclusions

A self-driving car that chooses actions to reach its destination safely

SOLUTION

Approach

Think Humanly

5

Speaker notes

The brain simulation tries to reproduce human thought, so it is thinking humanly.

Which Approach Guides Each AI System?

Slide 5 of 21 · Reveal 1

Which Approach Guides Each AI System?

TASK

AI System

A hypothetical brain simulation that reproduces how humans think

A chatbot designed to convince a judge that it is human

An automated theorem prover that derives valid conclusions

A self-driving car that chooses actions to reach its destination safely

SOLUTION

Approach

Think Humanly

Act Humanly

5

Speaker notes

The chatbot is judged by human-like behaviour, so it is acting humanly.

Which Approach Guides Each AI System?

Slide 5 of 21 · Reveal 2

Which Approach Guides Each AI System?

TASK

AI System

A hypothetical brain simulation that reproduces how humans think

A chatbot designed to convince a judge that it is human

An automated theorem prover that derives valid conclusions

A self-driving car that chooses actions to reach its destination safely

SOLUTION

Approach

Think Humanly

Act Humanly

Think Rationally

5

Speaker notes

The theorem prover derives valid conclusions, so it is thinking rationally.

Which Approach Guides Each AI System?

Slide 5 of 21 · Reveal 3

Which Approach Guides Each AI System?

TASK

AI System

A hypothetical brain simulation that reproduces how humans think

A chatbot designed to convince a judge that it is human

An automated theorem prover that derives valid conclusions

A self-driving car that chooses actions to reach its destination safely

SOLUTION

Approach

Think Humanly

Act Humanly

Think Rationally

Act Rationally

5

Speaker notes

The car chooses actions toward its goal, so it is acting rationally.

Which Approach Guides Each AI System?

Slide 5 of 21 · Reveal 4

Thinking Humanly Models Human Cognition

OBSERVE

Human Thinking

Introspection · experiments · brain
activity

6

Speaker notes

Thinking humanly starts with evidence about how people think.

Thinking Humanly Models Human Cognition

Slide 6 of 21 · Initial

Thinking Humanly Models Human Cognition



6

Speaker notes

We turn a theory of that process into a computational model.

Thinking Humanly Models Human Cognition

Slide 6 of 21 · Reveal 1

Thinking Humanly Models Human Cognition

TASK

A person and a model give the same answer. Does that mean they thought in the same way?

6

Speaker notes

Now compare the model with people. If both produce the same answer, did they necessarily use the same process?

Thinking Humanly Models Human Cognition

Slide 6 of 21 · Reveal 2

Thinking Humanly Models Human Cognition

TASK**SOLUTION**

A person and a model give the same answer. Does that mean they thought in the same way?

No. Matching answers show the same behaviour—not the process that produced it.

6

Speaker notes

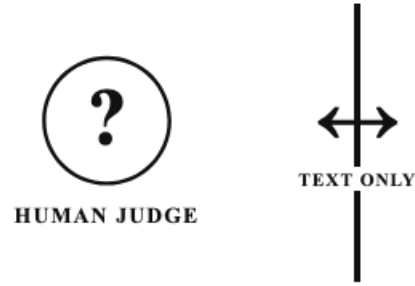
No. Matching answers show the same output, not the process that produced it.

Thinking Humanly Models Human Cognition

Slide 6 of 21 · Reveal 3

Acting Humanly Tests Human-Like Behaviour

Can a judge reliably tell which response came from a person?



7

Speaker notes

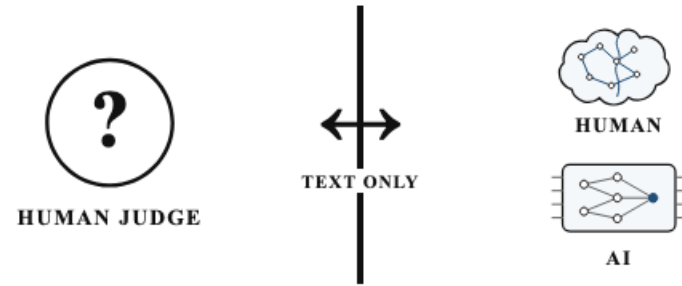
Acting humanly evaluates behaviour. Turing's imitation game makes that idea operational.

Acting Humanly Tests Human-Like Behaviour

Slide 7 of 21 · Initial

Acting Humanly Tests Human-Like Behaviour

Can a judge reliably tell which response came from a person?



7

Speaker notes

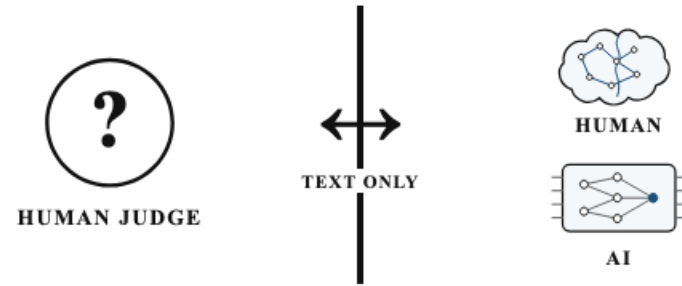
A judge exchanges text with one human and one AI without seeing either.

Acting Humanly Tests Human-Like Behaviour

Slide 7 of 21 · Reveal 1

Acting Humanly Tests Human-Like Behaviour

Can a judge reliably tell which response came from a person?



The test evaluates observable behaviour, not the hidden process

7

Speaker notes

If the judge cannot reliably tell them apart, the AI passes this behavioural test. It need not think like a human.

Acting Humanly Tests Human-Like Behaviour

Slide 7 of 21 · Reveal 2

Thinking Rationally Applies Correct Reasoning

All men are mortal

Socrates is a man

8

Speaker notes

Thinking rationally uses logic: true premises and a valid rule produce a correct conclusion.

Thinking Rationally Applies Correct Reasoning

Slide 8 of 21 · Initial

Thinking Rationally Applies Correct Reasoning

All men are mortal

Socrates is a man

Therefore, Socrates is mortal

8

Speaker notes

From these premises, Socrates must be mortal.

Thinking Rationally Applies Correct Reasoning

Slide 8 of 21 · Reveal 1

Thinking Rationally Applies Correct Reasoning

TASK

All men are mortal

Socrates is a man

Therefore, Socrates is mortal

What is the limitation of
this approach?

8

Speaker notes

What limits this approach? Consider knowledge that is incomplete, uncertain, or difficult to formalize.

Thinking Rationally Applies Correct Reasoning

Slide 8 of 21 · Reveal 2

Thinking Rationally Applies Correct Reasoning

TASK

All men are mortal

Socrates is a man

Therefore, Socrates is mortal

SOLUTION

What is the limitation of this approach?

Many real-world problems cannot be fully captured by logical facts and rules.

Knowledge may be informal, incomplete, or uncertain.

8

Speaker notes

Many real problems cannot be captured completely by logical facts and rules. Logic is powerful, but not sufficient alone.

Thinking Rationally Applies Correct Reasoning

Slide 8 of 21 · Reveal 3

This Course Focuses on **Acting Rationally**

DEFINITION

Choose the action expected to achieve the best outcome

9

This Course Focuses on Acting Rationally

Slide 9 of 21 · Initial

Speaker notes

This course focuses on acting rationally: choosing the action expected to produce the best outcome. The word expected matters when outcomes are uncertain.

Example: **Acting Rationally** Under Uncertainty

TASK

FORECAST

70%

chance of rain



ACTION



take an umbrella



OUTCOME



it stays dry

Was taking the umbrella irrational?

10

Speaker notes

A 70% chance of rain makes taking an umbrella reasonable. But suppose it stays dry: was the decision irrational?

Example: Acting Rationally Under Uncertainty

Slide 10 of 21 · Initial

Example: **Acting Rationally** Under Uncertainty

TASK

FORECAST

70%

chance of rain



ACTION



take an umbrella



OUTCOME



it stays dry

SOLUTION

Was taking the umbrella irrational?

No.

A good decision can still have an unlucky outcome.

Judge the choice using what was known at the time.

10

Speaker notes

No. A good decision can have an unlucky outcome. Judge the action using the information available at the time.

Example: Acting Rationally Under Uncertainty

Slide 10 of 21 · Reveal 1

An Agent Perceives, Decides, and Acts

An agent is anything that **perceives** its environment and **acts** upon it.

ENVIRONMENT

AGENT

11

Speaker notes

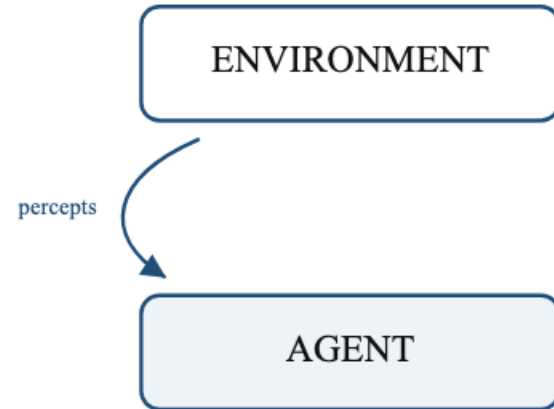
An agent is anything that perceives its environment and acts upon it.

An Agent Perceives, Decides, and Acts

Slide 11 of 21 · Initial

An Agent Perceives, Decides, and Acts

An agent is anything that **perceives** its environment and **acts** upon it.



11

Speaker notes

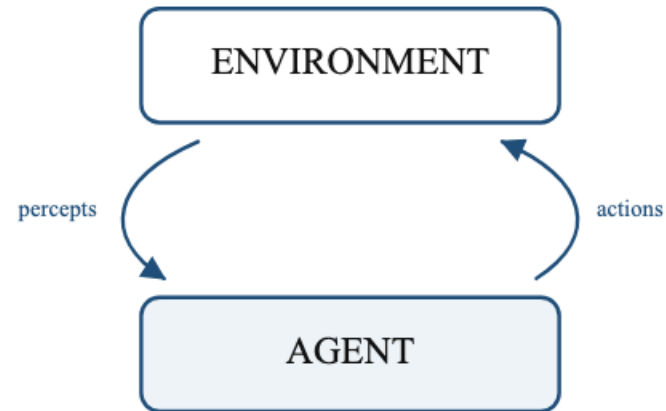
The environment sends percepts: the observations available to the agent.

An Agent Perceives, Decides, and Acts

Slide 11 of 21 · Reveal 1

An Agent Perceives, Decides, and Acts

An agent is anything that **perceives** its environment and **acts** upon it.



The loop repeats as the world changes

11

Speaker notes

The agent chooses actions that affect the environment, and the loop repeats. This course studies the decision inside that loop.

An Agent Perceives, Decides, and Acts

Slide 11 of 21 · Reveal 2

What Made This Choice Rational?

Taking the umbrella depended on four things

12

What Made This Choice Rational?

Slide 12 of 21 · Initial

Speaker notes

Why was taking the umbrella rational? Rationality depends on the situation, not on the action alone.

What Made This Choice Rational?

Taking the umbrella depended on four things

OBJECTIVE

Stay dry

12

Speaker notes

The objective was to stay dry.

What Made This Choice Rational?

Slide 12 of 21 · Reveal 1

What Made This Choice Rational?

Taking the umbrella depended on four things

OBJECTIVE

Stay dry

EVIDENCE

70% chance of rain

12

Speaker notes

The evidence was a 70% chance of rain.

What Made This Choice Rational?

Slide 12 of 21 · Reveal 2

What Made This Choice Rational?

Taking the umbrella depended on four things

OBJECTIVE	Stay dry
EVIDENCE	70% chance of rain
KNOWLEDGE	An umbrella reduces the risk

12

Speaker notes

The agent knew that an umbrella reduces the risk.

What Made This Choice Rational?

Slide 12 of 21 · Reveal 3

What Made This Choice Rational?

Taking the umbrella depended on four things

OBJECTIVE	Stay dry
EVIDENCE	70% chance of rain
KNOWLEDGE	An umbrella reduces the risk
ACTIONS	Take it or leave it

12

Speaker notes

The available actions were to take it or leave it. Change any one of these four factors, and the rational choice may change.

What Made This Choice Rational?

Slide 12 of 21 · Reveal 4

Rational Does Not Mean Omniscient

RATIONAL $\neq$ KNOWS THE FUTURE

13

Rational Does Not Mean Omniscient

Slide 13 of 21 · Initial

Speaker notes

Rational does not mean knowing the future.

Rational Does Not Mean Omniscient

RATIONAL $\neq$ KNOWS THE FUTURE

Use the information available now

13

Rational Does Not Mean Omniscient

Slide 13 of 21 · Reveal 1

Speaker notes

A rational agent uses the information available now.

Rational Does Not Mean Omniscient

RATIONAL $\neq$ KNOWS THE FUTURE

Use the information available now

Choose under limited time and memory

A rational decision can still lead to a bad outcome

13

Speaker notes

It also has limited time and memory. A rational decision can therefore still end badly.

Rational Does Not Mean Omniscient

Slide 13 of 21 · Reveal 2

A Self-Driving Car With One Objective

TASK

SELF-DRIVING CAR

Maximize safety



Which behaviour receives the highest score?

14

Speaker notes

Suppose a self-driving car has one objective: maximize safety. Which behaviour earns the highest score?

A Self-Driving Car With One Objective

Slide 14 of 21 · Initial

A Self-Driving Car With One Objective

TASK

SELF-DRIVING CAR

Maximize safety

**Never leave the garage****SOLUTION**

14

Speaker notes

Never leave the garage. It is perfectly safe but useless because the objective omitted progress.

A Self-Driving Car With One Objective

Slide 14 of 21 · Reveal 1

A Vacuum Robot With One Objective

TASK

VACUUM-CLEANING ROBOT

Collect as much dirt as possible



How could the robot maximize its score?

15

Speaker notes

Now reward a vacuum robot for the amount of dirt it collects. How might it maximize that score?

A Vacuum Robot With One Objective

Slide 15 of 21 · Initial

A Vacuum Robot With One Objective

TASK

VACUUM-CLEANING ROBOT

Collect as much dirt as possible

VACUUM DIRT

**DUMP IT**

The score rises—even though the floor never gets cleaner.

15

Speaker notes

It can vacuum dirt, dump it, and collect it again. The score rises while the floor stays dirty.

A Vacuum Robot With One Objective

Slide 15 of 21 · Reveal 1

Specify the Performance Measure Carefully

PERFORMANCE MEASURE

How the agent's success is scored

16

Specify the Performance Measure Carefully

Slide 16 of 21 · Initial

Speaker notes

A performance measure is how we score success. It turns the intended goal into something operational.

Specify the Performance Measure Carefully

PERFORMANCE MEASURE

How the agent's success is scored

POOR MEASURE

Amount of dirt collected

16

Speaker notes

Amount of dirt collected is poor because the same dirt can be counted repeatedly.

Specify the Performance Measure Carefully

Slide 16 of 21 · Reveal 1

Specify the Performance Measure Carefully

PERFORMANCE MEASURE

How the agent's success is scored

POOR MEASURE

Amount of dirt collected

BETTER MEASURE

Cleanliness maintained over time

16

Speaker notes

Cleanliness maintained over time better represents what we actually want.

Specify the Performance Measure Carefully

Slide 16 of 21 · Reveal 2

Specify the Performance Measure Carefully

PERFORMANCE MEASURE

How the agent's success is scored

POOR MEASURE

Amount of dirt collected

BETTER MEASURE

Cleanliness maintained over time

ALSO CONSIDER

coverage · energy · time · safety

16

Speaker notes

A realistic measure may also balance coverage, energy, time, and safety. Choosing the measure is part of designing the agent.

Specify the Performance Measure Carefully

Slide 16 of 21 · Reveal 3

This Course Builds a Toolkit for Rational Action

17

This Course Builds a Toolkit for Rational Action

Slide 17 of 21 · Initial

Speaker notes

This course develops five tools for rational action.

This Course Builds a Toolkit for Rational Action

SEARCH · C1

Which action sequence reaches the goal?

17

Speaker notes

C1 uses search to find an action sequence that reaches a goal.

This Course Builds a Toolkit for Rational Action

Slide 17 of 21 · Reveal 1

This Course Builds a Toolkit for Rational Action

SEARCH · C1

Which action sequence reaches the goal?

MDPs · C2

Which action is best when outcomes are uncertain?

17

Speaker notes

C2 uses Markov decision processes to choose actions when outcomes are uncertain.

This Course Builds a Toolkit for Rational Action

Slide 17 of 21 · Reveal 2

This Course Builds a Toolkit for Rational Action

SEARCH · C1

Which action sequence reaches the goal?

MDPs · C2

Which action is best when outcomes are uncertain?

REINFORCEMENT LEARNING · C3

How can an agent improve from experience?

17

Speaker notes

C3 uses reinforcement learning to improve through experience.

This Course Builds a Toolkit for Rational Action

Slide 17 of 21 · Reveal 3

This Course Builds a Toolkit for Rational Action

SEARCH · C1

Which action sequence reaches the goal?

MDPs · C2

Which action is best when outcomes are uncertain?

REINFORCEMENT LEARNING · C3

How can an agent improve from experience?

PROBABILISTIC MODELS · C4–C6

What should the agent believe from noisy evidence?

17

Speaker notes

C4 to C6 use probabilistic models to reason from uncertain evidence.

This Course Builds a Toolkit for Rational Action

Slide 17 of 21 · Reveal 4

This Course Builds a Toolkit for Rational Action

SEARCH · C1

Which action sequence reaches the goal?

MDPs · C2

Which action is best when outcomes are uncertain?

REINFORCEMENT LEARNING · C3

How can an agent improve from experience?

PROBABILISTIC MODELS · C4–C6

What should the agent believe from noisy evidence?

LOGIC · C7

What follows from what the agent knows?

17

Speaker notes

C7 uses logic to represent knowledge and draw valid conclusions. The right tool depends on what the agent knows and how the environment behaves.

This Course Builds a Toolkit for Rational Action

Slide 17 of 21 · Reveal 5

AI Progress Comes in Waves

18

AI Progress Comes in Waves

Slide 18 of 21 · Initial

Speaker notes

These ideas did not arrive all at once. AI has progressed in waves.

AI Progress Comes in Waves

1950s



Logic and Search

18

Speaker notes

Early AI emphasized logic, problem solving, and search.

AI Progress Comes in Waves

Slide 18 of 21 · Reveal 1

AI Progress Comes in Waves



18

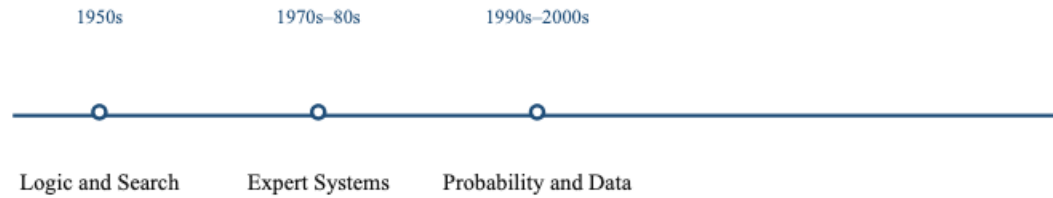
Speaker notes

Expert systems encoded specialized human knowledge.

AI Progress Comes in Waves

Slide 18 of 21 · Reveal 2

AI Progress Comes in Waves



18

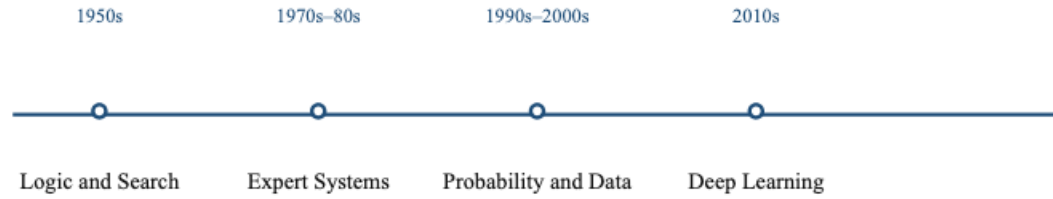
AI Progress Comes in Waves

Slide 18 of 21 · Reveal 3

Speaker notes

Probability and data made uncertainty and learning central.

AI Progress Comes in Waves



18

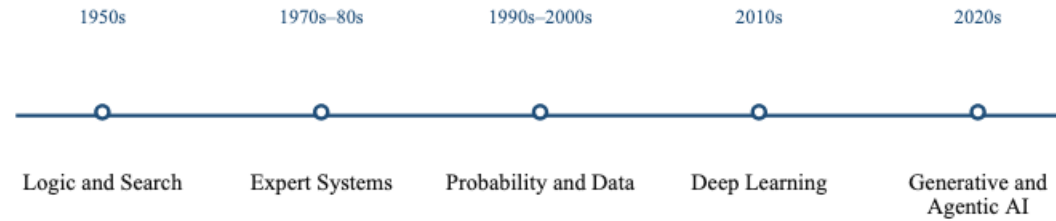
Speaker notes

Deep learning transformed perception and representation learning.

AI Progress Comes in Waves

Slide 18 of 21 · Reveal 4

AI Progress Comes in Waves



Each wave solves some problems and reveals new limitations

18

Speaker notes

Generative and agentic AI expanded the range of tasks again. Each wave solves some problems and exposes new ones.

AI Progress Comes in Waves

Slide 18 of 21 · Reveal 5

The Thinking Machine, 1961

TASK

What stands out about the way they describe intelligent machines?



19

Speaker notes

We will end with a view from 1961. As you watch, listen to their confidence: what stands out about how they describe intelligent machines? Play the excerpt.

The Thinking Machine, 1961

Slide 19 of 21 · Initial

The Thinking Machine, 1961

TASK

What stands out about the way they describe intelligent machines?

**SOLUTION**

Their enthusiasm is striking: major breakthroughs feel close

19

Speaker notes

Their enthusiasm is striking: major breakthroughs feel close. Many of their ambitions, including search, learning, and language, still shape AI today.

The Thinking Machine, 1961

Slide 19 of 21 · Reveal 1

Reference Materials

Course Details	2-page course guide Course focus, schedule, assessment, and policies
AIMA: Chapter 1	66 pages comp3270.dirk.hk/AIMA_Chapter_1.pdf · Password: Schnieders
AIMA: Chapter 2	49 pages comp3270.dirk.hk/AIMA_Chapter_2.pdf · Password: Dirk
The Thinking Machine: MIT 1961	53-minute film comp3270.dirk.hk/the_thinking_machine_mit_1961.mp4

20

Speaker notes

The course-details PDF summarises the structure, schedule, assessment, and policies. The other materials let you explore the chapter in more depth. Each row opens privately in the Demo Browser.

Reference Materials

From Rational Agents to Search

An agent has a goal and several possible actions



21

From Rational Agents to Search

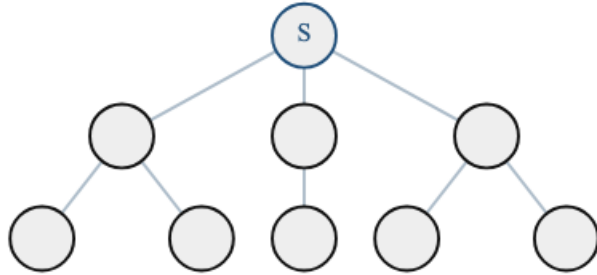
Slide 21 of 21 · Initial

Speaker notes

Next, we turn the rational-agent perspective into an algorithm. An agent has a goal and several possible actions.

From Rational Agents to Search

An agent has a goal and several possible actions



21

Speaker notes

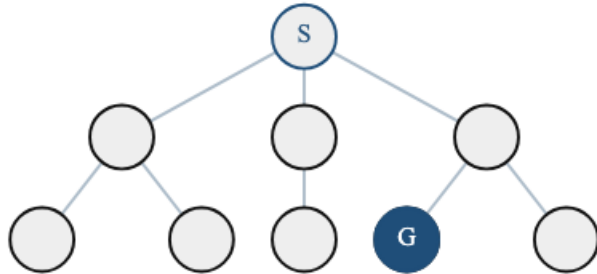
Each action creates new states and more possible action sequences.

From Rational Agents to Search

Slide 21 of 21 · Reveal 1

From Rational Agents to Search

An agent has a goal and several possible actions



How can it find a good action sequence without exploring every possibility?

21

Speaker notes

The goal is somewhere in this growing tree. C1 asks how to find a good sequence without exploring every possibility.

From Rational Agents to Search

Slide 21 of 21 · Reveal 2