

Fundamentals of AI

At its core, **Artificial Intelligence (AI)** is about building systems that can **perceive, reason, learn, and act**.

- **Perceive** → Take in information (like eyes and ears).
- **Reason** → Make sense of it (like the brain).
- **Learn** → Improve from experience (like we do when studying).
- **Act** → Do something in the world (like moving, speaking, recommending).

Analogy: Think of AI as a student

- Senses the lecture (**perceives**).
 - Understands the notes (**reasons**).
 - Studies past mistakes (**learns**).
 - Writes the exam (**acts**).
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Thinking Humanly

- **Definition:** Making machines think like humans.
 - **Example:** A program that solves math problems the way you do (showing steps, even making small mistakes).
 - **Analogy:** Teaching a robot to *daydream* like a person.
 - **Note:** Psychology and cognitive science often come in here — how do humans actually think?
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Acting Humanly

- **Definition:** Machines behaving like humans, regardless of how they think inside.
 - **Example:** The **Turing Test** → if you chat with a machine and can't tell it apart from a human, it's acting humanly.
 - **Analogy:** An actor who plays a convincing doctor on stage — they don't need real medical knowledge, just the performance.
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Thinking Rationally

- **Definition:** Perfect logic — machines reasoning using rules.
 - **Example:** A system proving theorems in mathematics.
 - **Analogy:** Think of **Spock** from *Star Trek* — cold, logical, flawless reasoning.
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Acting Rationally

- **Definition:** Doing the right thing at the right time — choosing the best action given the situation.
- **Example:** A self-driving car deciding whether to brake or swerve.
- **Analogy:** A chess player doesn't think like a human but acts to maximize their chance of winning.

👉 This is the most popular modern definition: **AI = rational agents**.

🤖 Weak AI vs Strong AI

Weak AI (Narrow AI)

- **Definition:** Focused on one specific task.
- **Example:** Google Translate → great at language conversion, useless at cooking.
- **Analogy:** Like a **Swiss Army knife tool** — sharp at specific jobs, but not a “real craftsman.”

Strong AI (General AI)

- **Definition:** Has the general intelligence of a human. Can learn any task.
- **Example:** Hypothetical future AI that could study for exams, write novels, or invent physics theories.
- **Analogy:** A student who can learn any subject with creativity and adaptability.

✅ Summary to Remember

- **Thinking/Acting Humanly** → copy humans.
- **Thinking/Acting Rationally** → follow logic & best outcomes.
- **Weak AI** → specialist.
- **Strong AI** → generalist.

📄 AI Perspectives & Types — Comparison Table

Concept	Definition	Analogy	Examples in Real Life
Thinking Humanly	Machines try to mimic how humans think (like cognitive science models).	A robot “ <i>daydreaming</i> ” like a student solving math step by step.	Cognitive modeling software, ACT-R (psychology-based AI).
Acting Humanly	Machines behave like humans, regardless of how they think inside.	An actor pretending to be a doctor — convincing, but not real.	Chatbots (e.g., ELIZA , Siri , ChatGPT in conversation mode), humanoid robots (Sophia).
Thinking Rationally	Machines use formal logic to reach correct conclusions.	Spock from <i>Star Trek</i> — perfectly logical, no emotions.	Expert systems (MYCIN for medical diagnosis), theorem provers.
Acting Rationally	Machines choose the best action to achieve goals (rational agents).	Self-driving car deciding whether to stop or go.	AlphaGo , Tesla Autopilot, Amazon’s recommender system.
Weak AI (Narrow AI)	Focused on a specific task. Excels only in its niche.	Swiss Army knife tool — sharp, but only for limited jobs.	Google Translate , Netflix recommender, spam filters, face recognition in phones.

Concept	Definition	Analogy	Examples in Real Life
Strong AI (General AI)	Hypothetical AI with human-level intelligence across all domains.	A student who can learn any subject with creativity.	Not yet achieved — often imagined in sci-fi (e.g., HAL 9000 , Jarvis from <i>Iron Man</i>).

✔ Quick Memory Hack

- **Humanly** → copy people (appearance or thought).
- **Rationally** → use logic and optimality.
- **Weak AI** → today’s reality.
- **Strong AI** → tomorrow’s dream.

🧠 What are Cognitive Science Models?

Cognitive science models are attempts to simulate the way humans **think, learn, and solve problems**.

Instead of just building a machine that gives the right answer, we ask:

👉 “Can the machine go through the same mental steps a human does?”

It’s about **understanding and imitating the mind**, not just the outcome.

🔍 Example: Solving a Math Problem

- **Human**: You don’t immediately know the answer. You recall formulas, try one, maybe erase mistakes, then finally solve it.
- **AI with Cognitive Model**: Simulates these steps: recall → attempt → revise → answer.

💡 The **focus** is on the **process of thought**, not just the final result.

👤 Analogy

Imagine two art students asked to paint like **Van Gogh**:

- **Without Cognitive Model** → One just prints a Van Gogh painting. It looks right, but no learning happened.
- **With Cognitive Model** → The other studies Van Gogh’s brushstrokes, experiments with them, and paints in that style.

👉 The second approach shows *how the artist thought*, not just the finished product.

📊 Comparison Table: Cognitive Models vs Other AI Approaches

Approach	What it Focuses On	Analogy	Example
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Approach	What it Focuses On	Analogy	Example
Cognitive Science Models	Replicate how humans think.	Student solving step by step, with mistakes & retries.	ACT-R, Soar architecture
Thinking Rationally	Only the correct reasoning path (ideal logic).	Calculator always giving exact answers, never guessing.	Prolog systems, theorem provers
Acting Rationally	Just the best action, doesn't care how humans do it.	GPS choosing fastest route (may not be the way you'd drive).	AlphaGo, self-driving cars
Acting Humanly	Mimic behavior, even if internal process differs.	Actor pretending to be	

Cognitive Science Models in University Contexts

1. How Students Study for Exams

- **Human:** Reads lecture notes → recalls related examples → attempts practice questions → makes mistakes → corrects → improves.
- **Cognitive Model AI:** A system that simulates those same mental steps.
- **Example:** A tutoring AI that doesn't just give you the correct answer, but also "*shows its work*" like a struggling student might.

👉 **Contrast:** A **calculator** (rational model) skips all steps and instantly spits out the right answer.

2. Language Learning in Class

- **Human:** When learning a new language, you try rules, sometimes confuse grammar, and refine over time.
- **Cognitive Model AI:** An AI language tutor that imitates these mistakes and learns grammar step by step.
- **Example: Duolingo** partially models human memory — it predicts when you'll forget a word and reminds you.

👉 **Contrast: Google Translate** (weak AI) doesn't "learn like you do," it just outputs the translation.

3. Problem-Solving in Group Projects

- **Human Teams:** Break problems into smaller parts, argue over solutions, backtrack when wrong.
- **Cognitive Model AI:** A simulation of a "*team of agents*" that works through the same stages.
- **Example: Soar architecture** has been used in simulations of group decision-making, similar to student project meetings.

👉 **Contrast:** An **optimization algorithm** (acting rationally) would just jump straight to the mathematically optimal solution.

4. Tutoring Systems at University

- Some universities use **Intelligent Tutoring Systems (ITS)** powered by cognitive models.
- They simulate how a student learns and forgets, so they know **when to quiz you** or **which concept you're struggling with**.
- **Example: Carnegie Mellon's Cognitive Tutor** (based on **ACT-R**) used in algebra courses.

👉 Students notice it feels like a **patient TA** who "knows" their thought process.

5. Memory Recall in Exams

- **Human:** During an exam, you sometimes recall in stages: first a vague idea → then a detail → then the full formula.
 - **Cognitive Model AI:** Models this "*layered recall*" process.
 - **Example:** In cognitive psychology experiments, AI systems predict the **Ebbinghaus forgetting curve** (how memory fades over time).
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✓ Summary with Analogy

Cognitive science models are like the **professor's brain twin** — they don't just grade the final answer, they're trying to **understand how you solved it**.