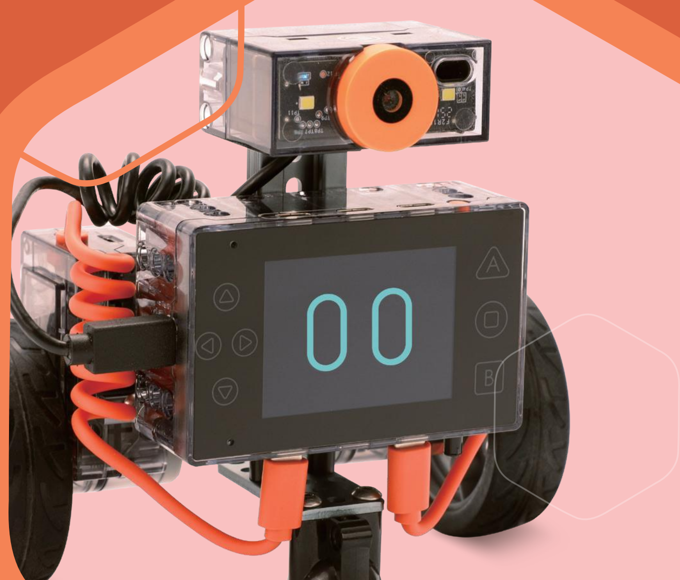
AI-Enabled Robotics

with Graphical Programming

with Nous AI Set



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Part II: Meet Nous AI Set

01

Exploring Artificial Intelligence

60 min

This lesson introduces the concept, key characteristics, core capabilities, and developmental history of artificial intelligence (AI). It helps students understand that AI is not simply automation, but a technological system designed to simulate, extend, and enhance human cognitive abilities. Through exploring real-world applications, students will gain insight into how AI impacts everyday services, agriculture, industry, and healthcare. By the end of this lesson, students will have developed a comprehensive understanding of AI, while also enhancing their technological literacy and systems thinking.

TSWBAT: the students will be able to

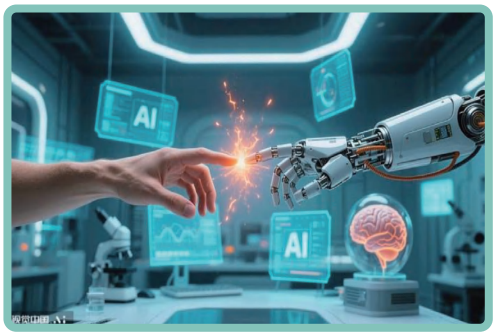
- Accurately define artificial intelligence and distinguish it from automated devices.
- Understand the four core capabilities of AI: environmental perception, information reasoning, intelligent decision-making, and action execution.
- Learn about the key milestones and events in the development of AI.
- Recognize typical AI applications in everyday services, agriculture and industrial production, and healthcare.

Core Concepts

What is Artificial Intelligence?

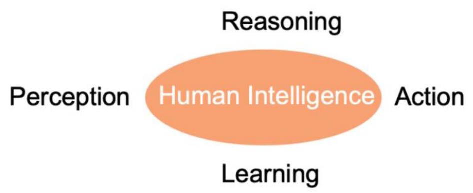
In everyday life, people often come across products marketed as "smart," such as lamps that adjust brightness automatically, motion-sensing smart locks, or appliances that follow preset programs. While convenient, these devices generally operate based on fixed rules—they do not learn, reason, or understand the world. In this sense, they are better classified as automated devices.

Artificial intelligence (AI), however, is fundamentally different. It seeks to enable machines to perceive, learn, reason, and make decisions in a manner akin to human cognition. The goal of AI is not to simply execute predefined tasks, but to equip machines with the cognitive abilities necessary to solve complex problems in dynamic environments.



Core Capabilities of Artificial Intelligence

Human intelligence can be broken down into four core capabilities: perception (understanding the world through our senses), reasoning (analyzing and drawing conclusions from information), learning (gaining improvement through experience), and action (turning thought into behavior).



AI mirrors these capabilities in the following four ways:

1. Environmental Perception

If we think of AI as a human, its perception would be akin to its "eyes, ears, and skin." Through sensors, cameras, microphones, and other data input devices, AI can "see" images, "hear" sounds, and "read" texts, enabling it to form an understanding of its environment.

2. Information Reasoning

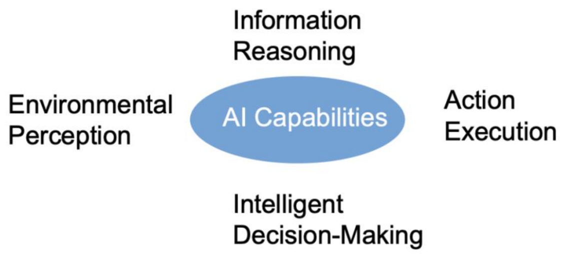
Once data is collected, AI processes and interprets it to identify patterns and make logical predictions. For example, it might infer intent from a sentence or detect common characteristics across a large set of images.

3. Intelligent Decision-Making

After perceiving and reasoning about its environment, AI evaluates different possible actions toward a given goal, ultimately selecting the optimal course of action. For instance, in a navigation system, given the goal of "going home," AI would compare multiple routes and choose the quickest option before starting the navigation.

4. Action Execution

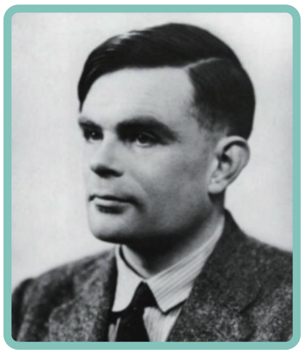
AI implements its decisions through concrete actions—whether it's a robot moving its arm, a voice assistant answering a question, or an autonomous vehicle driving itself. The outcomes of these actions are used as feedback, which helps the AI continuously refine its performance.



A system that combines perception, reasoning, decision-making, and action—and can also learn and adapt—is what defines true AI. This distinguishes AI from simple automation.

A Brief History of Artificial Intelligence

1. Foundations and Early Exploration



In 1950, British scientist Alan Turing proposed an intriguing idea: if a machine can engage in a conversation such that humans cannot distinguish it from a human, it should be considered intelligent. This concept became known as the Turing Test.

In 1956, at a pivotal conference held at Dartmouth College in the United States, the term "artificial intelligence" was formally introduced, with the goal of enabling machines to learn, reason, and solve problems in a manner similar to humans.

Dartmouth Conference (1956)

Reunion 50 Years Later (2006)

This marked the beginning of early AI research, where scientists attempted to simulate neural networks and developed early models such as ELIZA, a chatbot that mimicked a psychotherapist in basic dialogue. This represented an early exploration of natural language processing.

2. The Rise and Fall of Expert Systems

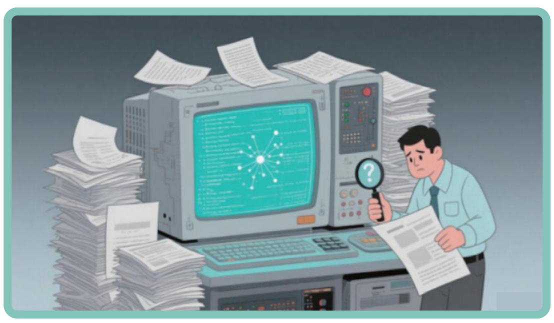
From the 1960s to the 1980s, AI research centered on knowledge-based systems. The goal was to encode expert knowledge and decision-making rules into machines so they could make decisions similar to an expert.

For example, DENDRAL, developed at Stanford University, was one of the first expert systems, which analyzed mass spectrometry data to infer the structure of organic molecules. Later systems such as MYCIN (for medical diagnosis) and XCON (for industrial configuration) extended AI into practical applications.

However, expert systems faced several significant challenges:

- Building and maintaining large knowledge bases was resource-intensive.
- The systems were inflexible and struggled with ambiguous or uncertain information.
- They lacked the ability to grasp subtle nuances in language or context.
- Updating rules was expensive and they had poor scalability.

These challenges led to a slowdown in AI research by the late 1980s, marking the beginning of what became known as the "AI winter."



3. The Breakthrough of Deep Learning

In the 21st century, AI experienced a transformative shift with the rise of deep learning, fueled by three key elements: computing power, data, and algorithms.

Computing Power acted as the engine: Graphics Processing Units (GPUs), initially used for rendering images, were repurposed around 2009–2012 for training large-scale neural networks, significantly enhancing computational efficiency.

Data served as the fuel: The massive amounts of real-world data available on the internet—ranging from text and images to audio and video—became invaluable for training deep learning models.

Algorithms acted as the navigation system: Advancements in convolutional neural networks, backpropagation, and later the Transformer architecture made it possible to train models more effectively and improve their performance over time.

Key milestones included:

- **2012**: AlexNet, developed by Alex Krizhevsky, Ilya Sutskever, and Geoffrey Hinton, won the ImageNet competition, significantly reducing error rates in image recognition.
- **2016**: DeepMind's AlphaGo defeated world champion Lee Sedol in the game of Go, demonstrating AI's ability to solve complex strategic problems.
- **2017**: The Google Brain team introduced the Transformer architecture, which revolutionized natural language processing.

3. The Era of Large Models and AI Agents

By late 2022, ChatGPT made a monumental impact, demonstrating its ability to hold natural conversations, write articles, translate languages, and even write code. Built on large language models like GPT-3.5 and later GPT-4, it showcased the power of "language intelligence."

AI is now advancing toward multimodal systems, capable of processing not only text but also images, audio, and video. Moreover, AI is transitioning from simply responding to queries to actively planning and executing tasks based on user goals.

Applications of Artificial Intelligence in Everyday Life

1. AI in Daily Services

AI is significantly improving convenience and efficiency through natural human–machine interactions:

- **Voice assistants** (e.g., Siri, Xiao Ai) help users with tasks such as making calls, searching the web, or controlling devices.
- **Recommendation systems** (e.g., YouTube, Taobao) suggest personalized content based on users' preferences.
- **Facial recognition** systems are used for phone unlocking and secure access control.

2. AI in Agriculture and Industry

In agriculture, drones equipped with sensors collect data on crops, which AI analyzes to optimize irrigation, fertilization, and pest control. In manufacturing, AI systems equipped with computer vision inspect products on assembly lines, performing quality checks at high speed.

3. AI in Healthcare

AI is playing an increasingly vital role in healthcare:

- **Health monitoring** devices (e.g., smartwatches) track vital signs like heart rate and sleep patterns.
- **Medical imaging** systems assist healthcare professionals by analyzing X-rays, CT scans, and MRIs to detect conditions such as lung cancer or neurological diseases.

It is important to emphasize that, due to legal, ethical, and safety considerations, AI can only serve as an assistive tool in clinical settings, and the final diagnosis must be made by a qualified doctor.

Summary

In this lesson, you will explore the world of AI, starting from an understanding of what AI truly is and how it differs from automation. You will delve into AI's four core capabilities—perception, reasoning, decision-making, and action—and track its evolution from early theoretical concepts to the cutting-edge applications we see today. By the end of this lesson, you'll not only have a well-rounded understanding of AI but also be equipped to recognize and critically analyze AI technologies in your own life.

02

Understanding Robots

60 min

This lesson begins with a look at science fiction works to trace the origins of the concept of robots. It introduces the three laws of robotics and differentiates between automated devices, robots, and humanoid robots, clarifying the distinctions between the three. The lesson then explores the roles and collaborative logic of the three core systems of robots: perception, control, and execution. Finally, the lesson focuses on the Nous AI robotic kit, helping students understand its perception, control, and execution systems to enhance their understanding of robot design.

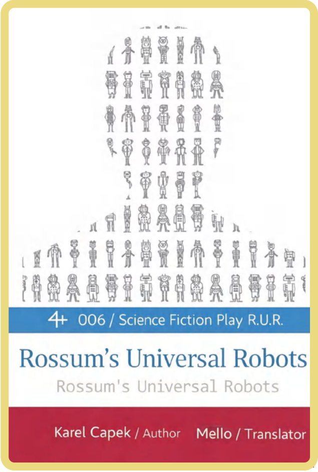
TSWBAT: the students will be able to

- Understand the origin of the concept of "robot" and grasp the core content of Isaac Asimov's three laws of robotics.
- Distinguish between automated devices, robots, and humanoid robots.
- Understand the functions of the three core components of a robot: perception, control, and execution.
- Understand the perception, control, and execution systems in Nous AI robots to enhance the understanding of robot core systems.

Core Concepts

Robots in Science Fiction Novels and Movies

The term "robot" was first introduced by Czech writer Karel Čapek in his 1920 play R.U.R. (Rossum's Universal Robots). The word "robot" comes from the Czech word robota, meaning "labor" or "forced labor," referring to machines that were artificially created to work like humans.



In early science fiction films, the German film Metropolis (1927) first presented a humanoid robot in a striking visual form. The robot Maria, with its metallic look and human-like shape, shocked audiences and became the inspiration for many future robot portrayals.

As literature and art evolved, robot characters became more complex. American science fiction author Isaac Asimov introduced robots with the ability to think and exhibit emotional traits, sparking serious debates about **how robots should coexist with humans if they could think**. In the 2008 animated film WALL-E, the cleaning robot WALL-E broke the stereotype of "cold machines" with a character full of tenderness, loneliness, and curiosity, demonstrating the emotional potential of robots.

The Three Laws of Robotics

Isaac Asimov proposed the famous "Three Laws of Robotics" in his collection of short stories I, Robot:

- A robot may not harm a human being, or, through inaction, allow a human being to come to harm.
- A robot must obey the orders given it by human beings, except where such orders would conflict with the First Law.
- A robot must protect its own existence, as long as such protection does not conflict with the First or Second Laws.

These three laws form the ethical framework for robots in science fiction, and many stories on "human-robot relationships" and "AI ethics" are based on these principles.

Automated Devices, Robots, and Humanoid Robots

In daily life, we often hear the term "robot." But what exactly is a robot? Does a robot always need to have a human-like appearance? Is a microwave oven a robot? How about a robot vacuum? To clarify these questions, we need to differentiate between "automated devices," "robots," and "humanoid robots."

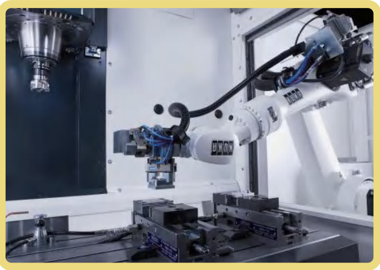
1. Automated Devices

An automated device is a machine that can perform simple, repetitive tasks based on preset programs. Examples include automatic doors and conveyor belts. These devices cannot perceive their environment or adjust to changes, making them less intelligent and limited to fixed tasks.

2. Robots

Robots are more complex and intelligent than automated devices. They can perceive their surroundings through sensors and make autonomous decisions based on programmed instructions, enabling them to perform more complicated tasks.

- **Perception** (e.g., cameras, microphones, distance sensors)
- **Control** (analyzing data and making decisions)
- **Execution** (motors, robotic arms performing actions)



For instance, a restaurant delivery robot can "see" the path using a camera, avoid obstacles like customers and tables, and deliver food accurately to a designated table. An industrial robotic arm can precisely position itself in 3D space to perform tasks. These are typical examples of robots.

3. Humanoid Robots

Humanoid robots are a special type of robot that mimic the structure and behavior of humans. They possess features like a torso, arms, and legs, and can perform tasks such as walking and object manipulation just like humans. More importantly, humanoid robots often have human-like interaction abilities, such as simple conversations using speech recognition or displaying emotions like "happiness" or "confusion" through facial expression modules. Some service humanoid robots can provide assistance such as guidance or companionship. Humanoid robots are the closest in form to human beings.

Humanoid robots typically have:

- Speech recognition and conversational abilities
- Emotion simulation or facial expression capabilities
- Interaction functions like providing service or companion ship

The Three Core Systems of Robots

Robots can complete complex tasks through the coordination of three core systems: perception, control, and execution. These systems function like the human sensory system, brain, and limbs, enabling robots to simulate human processes from perceiving the environment to analyzing decisions and performing actions.

1. Perception System

The perception system functions as the robot's "senses," composed of various sensors responsible for collecting physical information from the environment. Common sensors include distance sensors, light sensors, and gyroscopes, which measure basic data like spatial distance, light intensity, and orientation. Additionally, visual and auditory sensors collect more complex data: the visual sensor captures images for recognition and tracking algorithms, while the auditory sensor captures sound for speech recognition. These sensors convert external physical signals (light, sound, distance) into processable digital data, providing the foundation for the robot's analysis and decision-making.

2. Control System

The control system acts as the "brain" of the robot, responsible for processing information and making decisions. Typically, it consists of a microprocessor or control board that receives data from the perception system and analyzes it using program logic or trained models. The control system then generates corresponding instructions and sends them to the execution system to carry out the task. Without this system, the robot cannot effectively process environmental information or respond accurately.

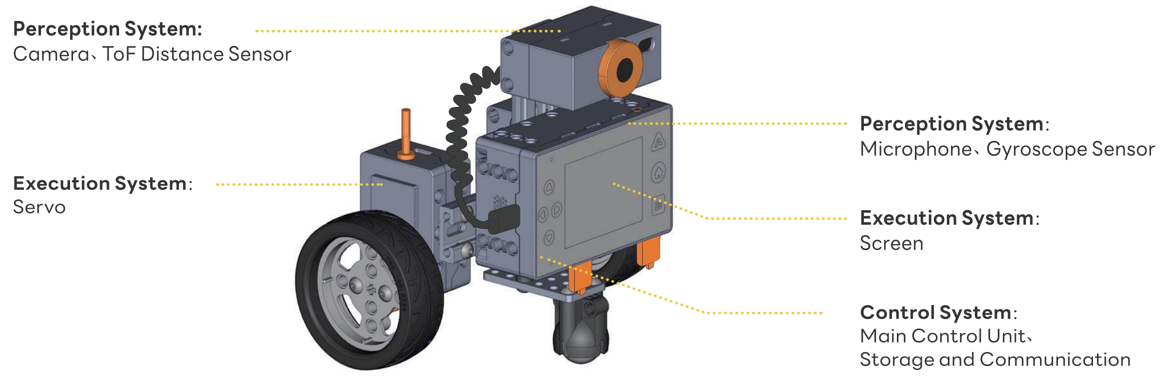
3. Execution System

The execution system serves as the robot's "body and motor system," converting the decisions made by the control system into actual motion and output. It typically includes motors, servos, hydraulic or pneumatic actuators, mechanical structures, and parts like wheels or joints. Motors and actuators provide power, enabling the robot to move its wheels or operate robotic arms to perform tasks like grasping and transporting objects.

In the robot's workflow, the perception system collects environmental data, the control system analyzes and generates instructions, and the execution system carries out the physical actions. These three systems collaborate, allowing the robot to interact effectively with its surroundings.

The Three Core Systems of the Nous AI Robot

The Nous AI robot (referred to as "Nous") is a modular educational robot that supports various AI technologies and applications, including machine learning, neural networks, machine vision, speech recognition, ChatGPT interaction, AIGC content generation, and autonomous driving simulations. It is compatible with both graphical programming and Python coding, making it suitable for learners at different stages. Additionally, its expansion ports allow for flexibility in adding various electronic modules.



1. Nous' Perception System

The perception system in Nous is responsible for collecting environmental data. The main electronic modules in the perception system include:

- **Nous Camera Module:** Core component for visual perception, responsible for image capture and target recognition.
- **ToF Distance Sensor on the Camera:** Used for detecting obstacles and measuring distances, providing depth and spatial information.
- **Microphone on the Main Control Board:** Captures environmental sounds and human speech, used for speech recognition and sound detection.
- **Gyroscope Sensor (IMU) on the Main Control Board:** Detects robot posture in real-time, including angular velocity, tilt, and acceleration, helping the system maintain stability and navigate smoothly.

2. Nous' Control System

The control system handles data analysis and decision-making. The main electronic components of the control system in Nous include:

- **Main Control Unit** (Microprocessor + Control Board): Executes programs, processes perception data, makes decisions, and sends action commands to the execution system. It is the true "brain" of the robot.
- **Storage and Communication Units on the Main Control Board:** Store programs, models, and parameters, and manage data transfer and communication between modules.

The control system determines how the robot understands the environment, makes judgments, and takes action. It is the core source of Nous' intelligent capabilities.

3. Nous' Execution System

The execution system converts the control system's instructions into real-world motion or output. In Nous, the execution system includes:

- **Nous Servo Module:** Drives joints or structural parts to perform movements such as rotation or swinging, essential for mechanical execution.
- **Display Screen on the Main Control Board:** Displays emotions, status indicators, and feedback, functioning as part of the robot's output system. It represents the robot's "non-mechanical" actions.

These execution modules allow Nous to move, express itself, and interact with users and the environment.

Summary

In this lesson, students explored the origin of the term "robot" and its evolution in science fiction. They learned about Isaac Asimov's Three Laws of Robotics and were able to distinguish between automated devices, robots, and humanoid robots. Through the analysis of the core systems—perception, control, and execution—students gained an understanding of how robots complete complex tasks. Finally, through the example of the Nous AI robot, students have developed an intuitive understanding of the functions and applications of each core module, laying a solid foundation for future programming and practical activities.

03

AI and Robotics Integration

60 min

This lesson introduces the significance of AI empowering robotics, helping students understand the three core characteristics of AI robots: environmental adaptability, autonomous decision-making, and learning evolution. The course also presents real-world cases of AI robots in industrial, service, and specialized scenarios to demonstrate their practical value. Finally, through demonstrations of four computer vision functions of the Nous AI Robot, students will gain a comprehensive understanding—both theoretical and practical—of the logic and value behind AI–robot integration.

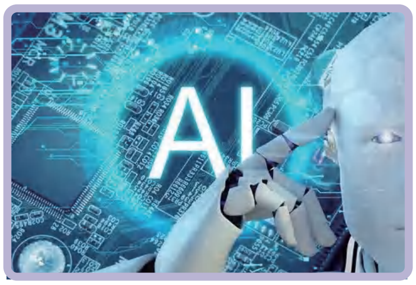
TSWBAT: the students will be able to

- Distinguish between traditional robots and AI-powered robots, and master the three core features of AI robots: environmental adaptability, autonomous decision-making, and learning evolution.
- Understand the applications and value of AI robots in industrial, service, and special environments, as well as their intelligent evolution.
- Experience the basic AI vision functions of the Nous AI Robot.
- Explore the MatataChat (AI Agent version) feature (optional).

Core Concepts

Why Does AI Empower Robotics?

In today's rapidly advancing world, the deep integration of artificial intelligence and robotics gives new meaning to "intelligence." Traditional robots typically rely on sensor inputs and pre-programmed instructions—for example, a vacuum robot avoids obstacles based on preset rules, or a delivery robot moves along a planned route.



When AI technology is integrated into robotics, however, robots can analyze environmental data, plan, and optimize their behavior—achieving a leap from fixed-program execution to autonomous perception and intelligent decision-making.

Unlike robots that depend solely on fixed programs, AI robots are enhanced through artificial intelligence technologies and feature three major capabilities:

• **Environmental Adaptability:** AI robots analyze sensor data in real time through intelligent algorithms, dynamically adjusting their behavior in complex environments. For instance, an AI-powered vacuum robot continuously refines its cleaning route based on environmental data, reducing collisions and repetitive paths, and improving efficiency over time.

• **Autonomous Decision-Making:** AI robots are no longer restricted by fixed workflows. Using machine learning models, they build dynamic decision systems that allow them to plan actions independently. For example, when a vacuum robot detects low battery power, it autonomously plans the shortest route back to its charging station, recharges, and resumes unfinished work—all without human intervention.

• **Learning and Evolution:** AI robots continuously accumulate user habits and environmental data to refine their behavioral strategies, becoming "smarter with use." They can learn patterns, such as cleaning on weekend mornings when users are typically out, or prioritizing certain areas based on weather or activity, optimizing performance intelligently.

In short, if a robot is viewed as a "body capable of action," then AI acts as its "central brain," giving it intelligence and decision-making power. Robots thus become the real-world embodiment of AI, transforming abstract algorithms into tangible actions and evolving from passive executors into adaptive, intelligent systems.

Connections Between AI Robots and Daily Life

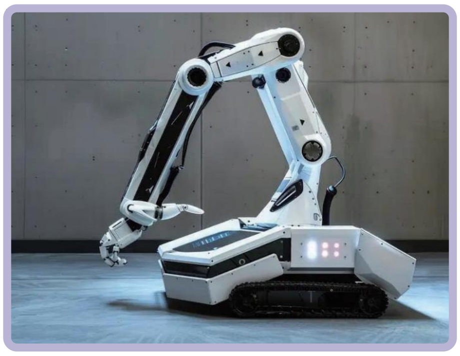
1. AI Robots in Industrial Scenarios: From Automation to Intelligence

In industrial production, AI robots are driving the transformation from traditional automation to intelligent manufacturing.

Smart Welding Robots: Equipped with AI vision systems, these robots use cameras to identify deviations in part positioning and dynamically adjust their motion angles and force, improving adaptability across different specifications.

Smart Welding Robot

Autonomous Mobile Robots (AMR): Unlike Automated Guided Vehicles (AGV) that follow fixed routes, AI-driven AMRs use LiDAR and sensors to scan surroundings, build dynamic maps, and plan optimal obstacle-avoidance routes. They can also optimize delivery order based on weight, priority, and distance, significantly improving warehouse efficiency.



Autonomous Mobile Robot

2. AI Robots in Service Scenarios: From Basic Tasks to Personalized Services

In the service industry, AI robots are evolving from performing simple tasks to providing customized, adaptive services.

Smart Cleaning Robots: With AI-based learning, they memorize home layouts and surface types, automatically adjust cleaning modes, and even learn user routines to clean when users are away.

Intelligent Surgical Assistant Robots: These robots analyze 3D surgical images and patient data in real time to identify risks and assist surgeons in optimizing force and angle—enhancing both safety and precision.

Intelligent Surgical Assistant Robot

3. AI Robots in Special Scenarios: Pushing Boundaries in Extreme Environments

AI robots play a vital role in performing tasks in hazardous or inaccessible environments.

Deep-Sea Exploration Robots: These robots use AI-driven environmental modeling to navigate dark, high-pressure environments, identifying terrain, species, and water composition autonomously.

Mars Rovers (e.g., "Zhurong"): On Mars, AI systems enable autonomous navigation, obstacle detection, soil analysis, and mission planning under time-delay communication conditions.

Bomb Disposal Robots: With AI-based image recognition, these robots can assess explosive devices, determine type and risk level, and assist operators in safely conducting remote defusal operations.

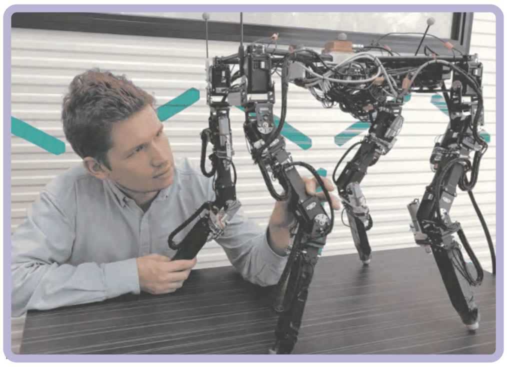
Mars Rover

4. AI Robots and Intelligent Evolution: From Program Execution to Self-Learning

As AI technology advances, high-end robots are beginning to demonstrate self-learning capabilities, transitioning from passive operation to active optimization.

Adaptive Tactical Robots: These robots record and analyze combat patterns using AI algorithms to refine defensive strategies and respond faster in similar future situations.

Personalized Educational Robots: By analyzing learners' performance and behavior data, AI models identify weak areas and dynamically adjust content and difficulty for customized learning paths.

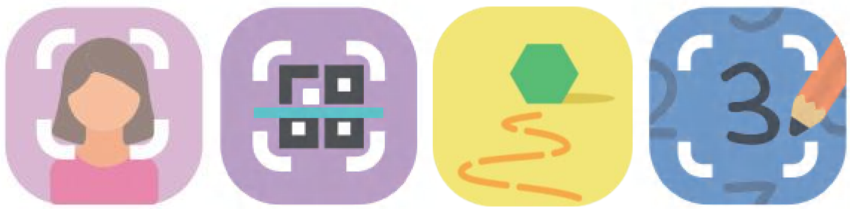


Autonomous Mobile Robot

From factory floors to homes, from the deep sea to outer space, the integration of AI and robotics is constantly expanding its boundaries—enhancing efficiency, improving service quality, and enabling exploration beyond human reach.

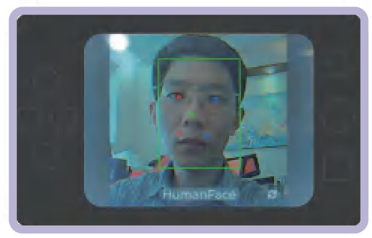
Experiencing the AI Vision Features of the Nous AI Robot

Students will explore the four basic AI vision features: **Face Recognition, AprilTag Recognition, Color Recognition, and MNIST Handwritten Digit Recognition.**



Human Tag Color MINST

1. Face Recognition



In Nous Hub, click **"Human"** to activate face detection. The camera captures facial features in real time and displays them on the screen. When a face is detected, a green box appears with five key points marking facial landmarks. The robot greets:

"Hello! My name is Nous Robot!"

2. AprilTag Recognition

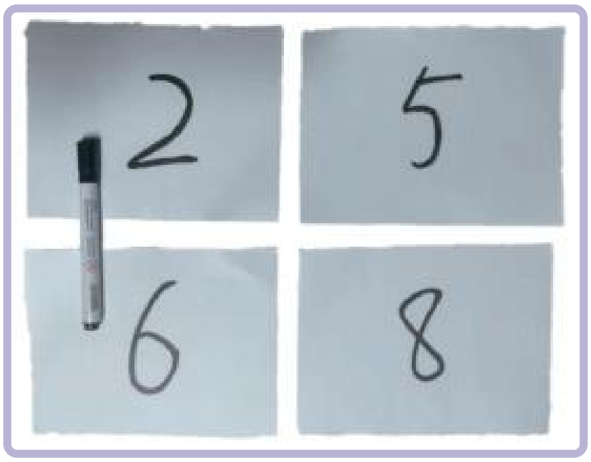
In Nous Hub, click **"Tag."** Point an AprilTag toward the camera. When detected, a red box and Tag ID will appear on the screen, and the robot will read the ID number aloud.

3. Color Recognition

Before starting, prepare colored cards (yellow, green, red). In Nous Hub, click "Color." When the camera detects the color, a box of the same color will appear, and the robot will announce: **"Yellow!"**

4. MNIST Handwritten Digit Recognition

Prepare handwritten digit cards using a black marker on A4 paper.

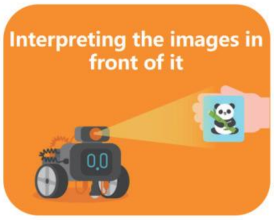


In Nous Hub, click **"MNIST."** When the number is detected, it is highlighted with a red frame, displayed on the screen, and read aloud by Nous.

Exploring MatataChat (AI Agent Version)

Thanks to advances in AI models and intelligent agents, robots have become an ideal interface for human–AI interaction. The new MatataChat (AI Agent Version) replaces the previous OpenAI Version, offering smoother dialogue and additional features such as natural voice control, volume adjustment, and image interpretation.

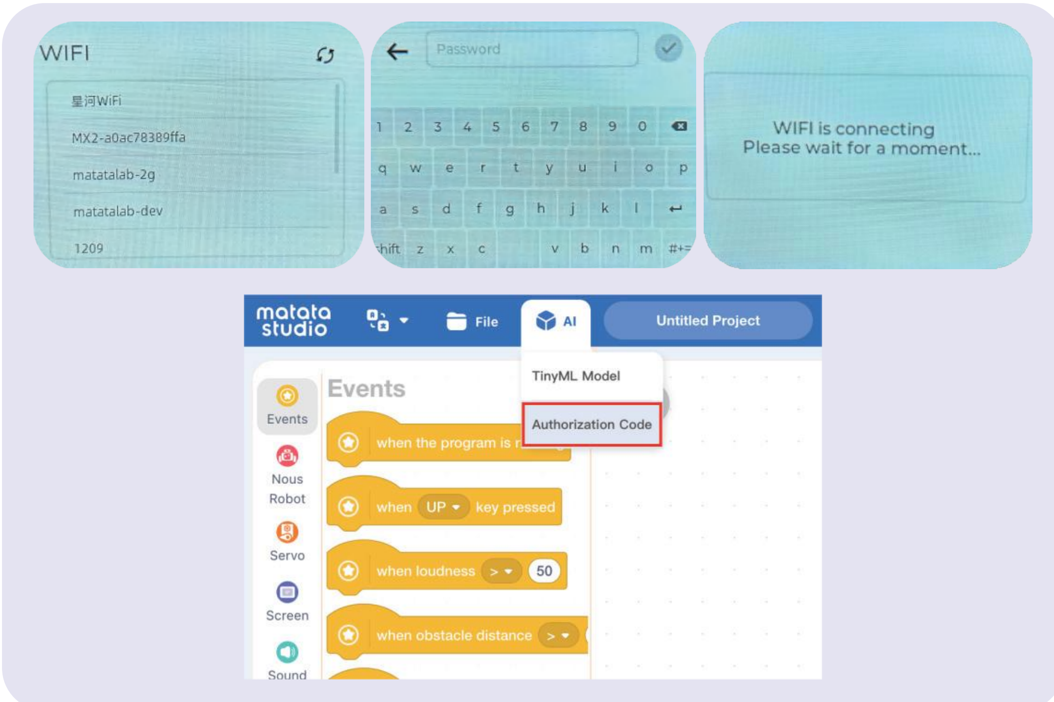
MatataChat



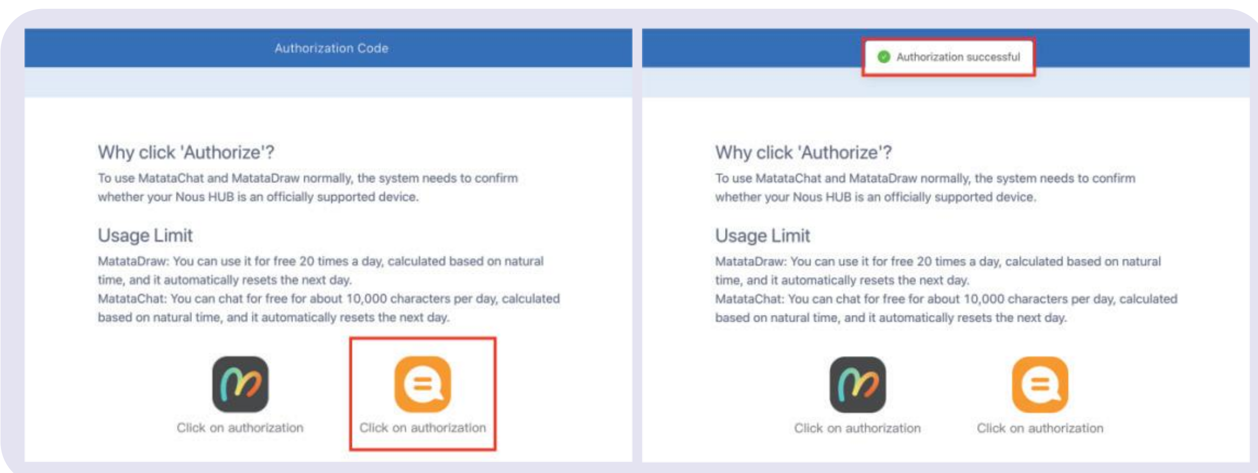
1. Setup Before Using MatataChat (AI Agent Version)

• Check the Nous Hub firmware version (lower right corner of the screen). If it's **3.0.0 or below**, upgrade via USB to version **V3.1.0**.
https://www.yuque.com/matatalab/nou_help/qfarmxish7f7bpue

• Connect to a Wi-Fi network and obtain an authorization code through MatataCode under **AI** → **Authorization Code**.



When "Authorization Successful" appears, setup is complete.



2. Interacting with the Official AI Agent "Matata"

In Nous Hub, click "**MatataChat**." Say the wake word: "**Hey, Matata!**"
When "listening…" appears on screen, you can say: "**Can you introduce yourself?**"

Matata will respond, and the screen will display “**Speaking...**” along with the reply. Matata currently supports **Chinese and English** communication. If you wish to communicate in other languages, you need to create a custom agent (we will explain how to define an agent in a later lesson).

You can also use voice commands to

- Make Nous Robot move, for example, “Move forward.” , “Step back two steps.”, “Turn left.”, “Do a dance!”
- Adjust Nous’s volume, such as “Your voice is too loud. Please lower the volume.”
- Ask Nous to describe what it sees, like “What can you see?”

Summary

This lesson guides students through the fascinating integration of AI and robotics—from understanding how AI makes robots truly intelligent to recognizing how they evolve from mechanical executors into active thinkers. Students will master the three core capabilities of AI robots and explore their impact across industries, services, and special operations. Finally, through hands-on experiences with Nous AI Robot vision features and MatataChat, students will appreciate the power of computer vision and AI agents.