# Topic: Sensors, Microprocessors, and Actuators

Reading Time: 20 mins

## Note\* Highlight important/core points while reading

* Read the content and write the answers given in the document in your words, to get the solid grip on topic.

### Sensors, Microprocessors, and Actuators

**Sensors,** **microprocessors,** **and** **actuators** are key components of automated systems. They work together to collect data, process information, and trigger actions in various applications, such as smart homes, industrial automation, and medical devices.

### Sensors

A **sensor** is an **input** **device** that detects changes in its environment and sends data to a computer or microprocessor.

* + Sensors measure physical conditions such as **temperature,** **light,** **pressure,** **and** **motion**.
  + The data collected is **analogue**, meaning it needs to be converted into **digital** **form** using an **analogue-to-digital** **converter** **(ADC)** before a computer can process it.

### Common types of sensors and their uses:

|  |  |  |
| --- | --- | --- |
| **Sensor** **Type** | **Function** | **Example** **Application** |
| **Temperature** **Sensor** | Measures heat or cold | Air conditioners, thermostats |
| **Light** **Sensor** | Detects brightness levels | Streetlights, phone screens |
| **Pressure** **Sensor** | Measures force or pressure | Car airbags, water pumps |
| **Infrared** **Sensor** | Detects infrared radiation | Motion detectors, TV remotes |
| **Proximity** **Sensor** | Detects nearby objects | Automatic doors, parking sensors |
| **Gas** **Sensor** | Detects harmful gases | Smoke detectors, air quality monitors |

1. **Microprocessors**

A **microprocessor** is a small **computer** **chip** that processes sensor data and makes decisions based on programming.

* + It follows a **cycle** **of** **operations**:

1. **Receives** **input** from a sensor.
2. **Processes** **data** using predefined rules.
3. **Sends** **an** **output** **signal** to an actuator. For example, in a **smart** **thermostat**:
   * The **temperature** **sensor** detects room temperature.
   * The **microprocessor** compares the reading with the desired temperature.
   * If the room is too cold, the microprocessor **activates** **the** **heater**. **Advantages** **of** **Microprocessors**

* **Faster** **and** **more** **accurate** than humans.
* **Automates** **repetitive** **tasks** (e.g., traffic lights, factory machines).
* **Consumes** **low** **power**, making them ideal for small devices.
* Can store and analyze large amounts of data.

### Actuators

An **actuator** is an **output** **device** that performs a physical action in response to signals from a microprocessor.

* + Actuators control **motors,** **valves,** **pumps,** **and** **lights**.
  + They can **move,** **rotate,** **or** **open/close** something.

### Common types of actuators and their uses:

|  |  |  |
| --- | --- | --- |
| **Actuator** **Type** | **Function** | **Example** **Application** |
| **Motor** | Rotates or moves objects | Robot arms, drones |
| **Solenoid** | Converts electrical energy into motion | Door locks, MRI machines |
| **Relay** **Switch** | Controls circuits | Smart lighting, industrial automation |
| **Hydraulic** **Actuator** | Uses fluid pressure for movement | Car brakes, excavators |

For example, in an **automatic** **door** **system**:

* A **proximity** **sensor** detects a person.
* The **microprocessor** processes the signal.
* A **motor** **actuator** opens the door.

### How Sensors, Microprocessors, and Actuators Work Together

Let’s take an example of an **automatic** **streetlight** system:

1. **Light** **Sensor** **(Input** **Device)** detects decreasing light levels at dusk.
2. **Microprocessor** **(Processing** **Unit)** checks if the brightness is below a set threshold.
3. **Actuator** **(Output** **Device)** turns on the streetlight if needed.

This system ensures **energy** **efficiency** by automatically switching on lights **only** **when** **necessary**.

## A-Rated Questions/Answers By Examiner

### Q1: What is the function of an analogue-to-digital converter (ADC)?

**Answer:** An **ADC** **(Analogue-to-Digital** **Converter)** is used to convert **analogue** **sensor** **readings** into **digital** **data** so that a computer or microprocessor can process it.

**Q2:** **How** **does** **a** **microprocessor** **control** **an** **actuator?** **Answer:** A **microprocessor** follows these steps:

1. **Receives** **input** from a sensor.
2. **Processes** **the** **data** based on pre-programmed instructions.
3. **Sends** **a** **signal** to an actuator to perform an action.

For example, in an automatic fan system, if the temperature sensor detects high heat, the microprocessor activates the fan actuator.

### Q3: Name two sensors and their applications. Answer:

1. **Temperature** **Sensor** – Used in air conditioners to detect room temperature.
2. **Proximity** **Sensor** – Used in automatic doors to detect when someone approaches.

### Q4: What is an actuator? Give an example.

**Answer:** An **actuator** is an **output** **device** that performs a physical action in response to a microprocessor’s command.

Example: A **motor** **actuator** is used in a robot arm to pick up objects.

### Q5: How do sensors, microprocessors, and actuators work together in a car airbag system?

**Answer:**

1. **Sensor**: A **pressure** **sensor** detects a sudden impact.
2. **Microprocessor**: Processes the signal and determines if an airbag needs to be deployed.

**Actuator**: A **gas** **release** **actuator** inflates the airbag instantly.

## Write your Answers on your Notebook and Verify it on Next Screen

**Q6.** **Why** **do** **most** **sensors** **produce** **analogue** **data,** **and** **how** **is** **it** **processed** **by** **a** **microprocessor?**

**Q7.** **Describe** **how** **a** **microprocessor** **is** **used** **in** **an** **automatic** **washing** **machine.**

**Q8.** **What** **are** **two** **advantages** **of** **using** **microprocessors** **in** **automated** **systems?**

**Q9.** **How** **does** **an** **automatic** **braking** **system** **(ABS)** **in** **a** **car** **use** **sensors,** **microprocessors,** **and** **actuators?**

**Q10.** **Explain** **the** **role** **of** **a** **solenoid** **actuator** **in** **an** **electronic** **door** **lock** **system.**

1. **Answer:** Most sensors produce analogue data because they measure continuous physical conditions (e.g., temperature, pressure, or light levels). However, microprocessors can only process digital data. To convert analogue signals into digital form, an **Analogue-to-Digital** **Converter** **(ADC)** is used before the data is processed by the microprocessor.
2. **Answer:** In an automatic washing machine:
   1. **Sensor** **(Input)** – A water level sensor detects the amount of water in the drum.
   2. **Microprocessor** **(Processing)** – The microprocessor checks if the water level matches the required level.
   3. **Actuator** **(Output)** – If the water level is low, the microprocessor activates a water valve actuator to fill the drum.

### Answer:

* 1. **Improved** **efficiency** – Microprocessors work faster and more accurately than humans, reducing errors in automated tasks.
  2. **Automation** **of** **repetitive** **tasks** – Microprocessors can handle continuous tasks without human intervention, such as controlling traffic lights or factory production lines.

### Answer:

* 1. **Sensor** **(Input)** – A speed sensor detects sudden deceleration or wheel lock-up.
  2. **Microprocessor** **(Processing)** – The microprocessor analyzes the data and determines if braking force needs adjustment.
  3. **Actuator** **(Output)** – A hydraulic actuator adjusts the brake pressure to prevent skidding.

1. **Answer:** A **solenoid** **actuator** is used to control the locking and unlocking mechanism in an electronic door lock. When the microprocessor receives an access signal (e.g., from a keypad or keycard reader), it sends a signal to the solenoid actuator. The actuator then moves a metal pin to unlock or lock the door.

# Topic: Robotics

Reading Time: 20 mins

## Note\* Highlight important/core points while reading

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### What is Robotics?

Robotics is the field of **engineering** **and** **computer** **science** that focuses on **designing,** **building,** **and** **programming** **robots** to perform various tasks. Robots are **automated** **machines** that can be controlled manually or work autonomously using **sensors,** **microprocessors,** **and** **actuators**. They are widely used in **factories,** **homes,** **warehouses,** **military** **applications,** **and** **entertainment**.

### Three Laws of Robotics

The **Three** **Laws** **of** **Robotics**, created by science fiction writer **Isaac** **Asimov**, are basic ethical principles for robotic behavior:

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

These laws ensure that robots remain **safe,** **controlled,** **and** **beneficial** to humans.

### Applications of Robotics

1. **Robotics** **in** **Factories**

Robots are used in **manufacturing** **and** **assembly** **lines** to improve efficiency and accuracy. Examples include:

* + **Welding** **parts** **together** – Robots use **high** **precision** **welding** to join metal parts in car production.
  + **Spray-painting** **panels** – Used in **automobile** **factories** to paint car exteriors evenly.
  + **Fitting** **windscreens** – Robots ensure **proper** **alignment** **and** **sealing** of car windshields.
  + **Cutting** **out** **metal** **parts** – CNC (Computer Numerical Control) robots cut metal with **high** **accuracy**.
  + **Bottling** **and** **labeling** **plants** – Robots **fill,** **cap,** **and** **label** **bottles** in food and pharmaceutical industries.
  + **Warehouse** **automation** – Robots **scan,** **pick,** **and** **transport** items efficiently.

**Example:** Amazon warehouses use robots to **find** **and** **move** **packages** automatically.

### Robotics in the Home

Robots are becoming common in households for **automation** **and** **convenience**. Examples include:

* + **Autonomous** **floor** **sweepers** – Robot vacuums like **Roomba** clean floors automatically.
  + **Autonomous** **lawn** **mowers** – Robots cut grass **without** **human** **supervision**.
  + **Ironing** **robots** – Devices like **Dressman** press and **iron** **clothes** automatically.
  + **Pool** **cleaning** **robots** – Clean pools by removing **debris** **and** **algae**.
  + **Automatic** **window** **cleaners** – Use suction and sensors to **clean** **glass** **surfaces**.
  + **Entertainment** **robots** – **AI-powered** **companion** **robots** interact with humans for fun or emotional support.

**Example:** Sony’s **Aibo** is a robotic dog that interacts with owners using **AI** **technology**.

### Robotics in Drones

Drones, also called **Unmanned** **Aerial** **Vehicles** **(UAVs)**, are used for various purposes:

* + **Reconnaissance** – Drones **capture** **aerial** **images** for military surveillance and disaster assessment.
  + **Parcel** **delivery** – Companies like **Amazon** use drones for **fast** **delivery** **of** **packages**.
  + **Agriculture** – Drones **spray** **pesticides** **and** **monitor** **crops**.
  + **Search** **and** **rescue** – UAVs help locate **missing** **persons** in remote areas.
  + **Disaster** **response** – Drones assess damage after earthquakes, floods, and fires.

**Example:** **DJI** **drones** are widely used for **photography,** **filmmaking,** **and** **mapping**.

## A-Rated Questions/Answers By Examiner

### Q1: What is a robot?

**Answer:** A robot is a **programmable** **machine** that can **perform** **tasks** **automatically** using **sensors,** **microprocessors,** **and** **actuators**. Robots can be controlled manually or work autonomously.

### Q2: State the Three Laws of Robotics. Answer:

1. A robot may not **harm** **a** **human** or allow harm to occur through inaction.
2. A robot must **follow** **human** **orders**, unless it conflicts with the First Law.
3. A robot must **protect** **itself**, unless this conflicts with the First or Second Law.

### Q3: Give two examples of how robots are used in factories. Answer:

1. **Welding** **metal** **parts** together in car manufacturing.
2. **Spray-painting** **panels** on vehicles to ensure even coverage.

**Q4:** **How** **are** **robots** **used** **in** **homes?** **Answer:** In homes, robots are used for:

* + **Vacuuming** **floors** (robot vacuum cleaners).
  + **Cutting** **grass** (autonomous lawn mowers).
  + **Cleaning** **windows** (automatic window cleaners).

**Q5:** **What** **is** **a** **drone,** **and** **how** **is** **it** **used?**

**Answer:** A **drone** **(UAV)** is an **unmanned** **aerial** **vehicle** that can be **remotely** **controlled** **or** **fully** **autonomous**. Drones are used for:

* + **Military** **surveillance** (taking aerial photos).
  + **Parcel** **deliveries** (Amazon drone delivery).
  + **Search** **and** **rescue** (finding missing people).

## Write your Answers on your Notebook and Verify it on Next Screen

**Q6.** **What** **are** **the** **main** **components** **of** **a** **robot,** **and** **what** **are** **their** **functions?**

**Q7.** **Explain** **how** **robots** **improve** **efficiency** **in** **warehouse** **automation.**

**Q8.** **What** **is** **an** **autonomous** **robot?** **Give** **an** **example.**

**Q9.** **Describe** **two** **ways** **drones** **are** **used** **in** **agriculture.**

**Q10.** **Identify** **one** **advantage** **and** **one** **disadvantage** **of** **using** **robots** **in** **manufacturing.**

1. **Answer:** A robot consists of the following key components:
   1. **Sensors** – Detect environmental changes (e.g., cameras for vision, proximity sensors for obstacle detection).
   2. **Microprocessor** – Acts as the robot’s "brain," processing data and making decisions.
   3. **Actuators** – Convert electrical signals into physical movement (e.g., motors to move robotic arms).
2. **Answer:** Robots improve warehouse automation by:

* **Scanning** **and** **identifying** **packages** using barcode scanners and AI-powered vision systems.
* **Picking** **and** **transporting** **items** with robotic arms and conveyor systems.
* **Reducing** **human** **errors** in sorting, packaging, and inventory management. Example: **Amazon’s** **warehouse** **robots** sort and transport parcels efficiently, reducing delivery times.

1. **Answer:** An **autonomous** **robot** is a machine that can perform tasks without human intervention by using AI, sensors, and microprocessors.

Example: **A** **self-driving** **car** uses cameras, radar, and AI to navigate roads safely without a driver.

### Answer:

* 1. **Crop** **Monitoring** – Drones take aerial images to analyze crop health and detect diseases.
  2. **Pesticide** **Spraying** – Drones distribute pesticides evenly over large farmlands, reducing manual labor.

### Answer:

**Advantage:**

* Robots work **faster** **and** **more** **accurately** than humans, increasing productivity in factories.

### Disadvantage:

* **High** **initial** **cost** – Purchasing and maintaining robots can be expensive for businesses.

# Topic: Characteristics of a Robot

## Note\* Highlight important/core points while reading

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### Characteristics of a Robot

A **robot** is a **programmable** **machine** that can perform tasks **automatically** or under **human** **control**. Robots are used in **manufacturing,** **medicine,** **military,** **homes,** **and** **various** **industries**.

### Ability to Sense Their Surroundings

* + Robots use **sensors** (light, pressure, temperature, acoustic, infrared) to detect their environment.
  + **Sensor** **data** **is** **sent** **to** **a** **microprocessor** for decision-making. Sensors allow robots to:
  + Recognize **size,** **shape,** **or** **weight** of objects.
  + Detect **temperature** (hot or cold objects).
  + Identify **obstacles** to avoid collisions.

**Example:** Self-driving cars use **cameras** **and** **LiDAR** **sensors** to detect pedestrians and obstacles.

### Have a Degree of Movement

* + Robots move using **wheels,** **cogs,** **pistons,** **gears,** **and** **motors**.
  + They can **turn,** **twist,** **grip,** **lift,** **or** **move** objects.
  + They use **mechanical** **structures** like **actuators** **and** **circuit** **boards**. **End** **effectors** (special attachments) allow robots to:
  + **Weld** (used in car manufacturing).
  + **Spray** (painting in industries).
  + **Cut** (precision cutting in factories).
  + **Lift** (used in warehouses and construction).

**Example:** Robotic arms in car assembly **weld,** **paint,** **and** **fit** parts with accuracy.

### Programmable

* + Robots have a **controller** **(brain)** that processes **sensor** **data** and determines actions.
  + Controllers are **programmable**, meaning robots can perform **specific** **tasks** automatically.

**Example:** Industrial robots are **pre-programmed** to assemble **products** **efficiently**. **Robotics** **vs.** **Artificial** **Intelligence** **(AI)**

Many robots **do** **not** **have** **AI** because they perform **repetitive** **tasks** without needing **human-like** **intelligence**.

AI allows robots to **learn** **and** **adapt**, making them **more** **flexible** in performing different tasks.

* + **Example** **of** **non-AI** **robots:** Factory robots that **weld** **and** **paint** without learning new tasks.

### Example of AI-powered robots: Self-driving cars that learn road conditions and improve driving decisions.

* + **Software** **Robots** **vs.** **Physical** **Robots**

**Software** **robots** **are** **not** **physical** **robots** but programs that perform **automated** **tasks**.

Examples of software robots:

* + **Web** **crawlers** **(search** **engine** **bots)** – scan and categorize websites.
  + **Chatbots** – interact with users (e.g., customer support AI).
  + **Physical** **robots** **are** **real-world** **machines** that perform **physical** **tasks**.
  + **Independent** **vs.** **Dependent** **Robots**

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| **Type** | **Description** | **Example** |
| **Independent** | Work without human control | Self-driving cars, Mars Rover, robot |
| **Robots** | (autonomous). | vacuum cleaners. |
| **Dependent** **Robots** | Work with human interaction. | Robotic arms in car factories, remote- controlled drones. |

## A-Rated Questions/Answers By Examiner

### Q1: How do robots sense their environment?

**Answer:** Robots use **sensors** (light, pressure, temperature, acoustic, infrared) to detect objects, measure temperature, and avoid obstacles.

### Q2: What is the function of end effectors in robots?

**Answer:** End effectors are **attachments** that allow robots to **weld,** **spray,** **cut,** **and** **lift** objects.

### Q3: How do independent robots differ from dependent robots? Answer:

* + **Independent** **robots** work **autonomously** (e.g., self-driving cars).
  + **Dependent** **robots** require **human** **control** (e.g., robotic arms in factories).

### Q4: Give two examples of software robots. Answer:

1. **Web** **Crawlers** – scan and categorize websites for search engines.
2. **Chatbots** – respond to users in online customer support.

### Q5: Why don’t all robots use AI?

**Answer:** Many robots perform **repetitive** **tasks** that don’t require **learning** **or** **adaptation**, so they **do** **not** **need** **AI** (e.g., welding robots in car factories).

## Write your Answers on your Notebook and Verify it on Next Screen

**Q6.** **Why** **do** **robots** **need** **sensors,** **and** **how** **do** **they** **help** **in** **decision-making?**

**Q7.** **What** **is** **the** **difference** **between** **physical** **robots** **and** **software** **robots?**

**Q8.** **How** **do** **actuators** **help** **robots** **move?**

**Q9.** **Explain** **the** **role** **of** **controllers** **in** **programmable** **robots.**

**Q10.** **What** **is** **the** **main** **difference** **between** **AI-powered** **robots** **and** **non-AI** **robots?**

1. **Answer:** Robots need sensors to **detect** **their** **environment** and make decisions based on the data collected.
   * Sensors help robots **identify** **obstacles**, **measure** **temperature**, **recognize** **objects**, and **detect** **movement**.
   * The sensor data is sent to a **microprocessor**, which processes it and determines the appropriate action.

**Example:** A self-driving car uses LiDAR sensors to detect pedestrians and avoid collisions.

### Answer:

* + **Physical** **robots** are **machines** that perform tasks in the real world (e.g., robotic arms in factories, self-driving cars).
  + **Software** **robots** are **programs** that automate digital tasks (e.g., chatbots, web crawlers).

1. **Answer:** Actuators **convert** **electrical** **signals** **into** **physical** **movement** by controlling parts like wheels, gears, and motors.
   * They allow robots to **lift,** **turn,** **grip,** **and** **push** **objects**.
   * Actuators work with sensors and microprocessors to perform tasks.

**Example:** A robotic arm in a factory uses actuators to **assemble** **car** **parts**.

1. **Answer:** A **controller** acts as the **robot’s** **brain** by processing sensor data and determining actions.
   * It is **programmable**, meaning instructions can be changed to perform specific tasks.

Some robots have **AI-powered** **controllers** that allow them to **learn** **and** **adapt**. **Example:** A robotic vacuum cleaner follows programmed cleaning paths based on sensor input.

### Answer:

* + **AI-powered** **robots** can **learn** **and** **adapt** to new situations (e.g., self-driving cars improve driving decisions over time).
  + **Non-AI** **robots** perform **repetitive,** **pre-programmed** **tasks** without learning (e.g., industrial robots that weld or paint).

# Topic: The role of robots and their advantages and disadvantages

Reading Time: 20 mins

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### The Role of Robots and Their Advantages & Disadvantages

Robots are machines programmed to perform tasks with high precision and efficiency. They play a crucial role in various sectors, helping to automate processes, increase productivity, and reduce human effort in repetitive or hazardous jobs.

### Industry

Robots are widely used in manufacturing industries for assembling, welding, painting, and quality control.

### Working

* + **Automated** **Assembly** **Lines:** Robots perform tasks like assembling car parts, circuit boards, and appliances with speed and accuracy.
  + **Welding** **&** **Painting:** Industrial robots are used in car manufacturing plants to perform welding and spray painting.
  + **Quality** **Inspection:** Robots use cameras and sensors to detect product defects.

### Advantages

* + Faster production and efficiency
  + Reduces human errors and improves quality
  + Can work in hazardous environments

### Disadvantages

* + High initial cost
  + Job losses for human workers
  + Requires maintenance and skilled workers for operation

### Transport

Autonomous robots and AI-driven vehicles are transforming the transport industry.

### Working

* + **Autonomous** **Vehicles:** Self-driving cars use sensors, cameras, and AI to navigate roads.
  + **Drones:** Used for delivery services and monitoring traffic.
  + **Robotic** **Traffic** **Control:** AI-powered robots help manage traffic in busy cities.

### Advantages

* + Reduces human driving errors
  + Improves efficiency in goods transport
  + Can operate in dangerous environments

### Disadvantages

* + Expensive technology
  + Cybersecurity risks (hacking)
  + Ethical concerns about AI decision-making

### Agriculture

Robots in agriculture help automate tasks like planting, harvesting, and irrigation.

### Working

* + **Autonomous** **Tractors** **&** **Harvesters:** Robots plow fields and harvest crops.
  + **Drones** **for** **Monitoring:** Drones scan large farms to check crop health.
  + **Automated** **Irrigation:** AI-powered systems optimize water usage.

### Advantages

* + Increases food production
  + Reduces labor costs
  + Efficient use of water and fertilizers

### Disadvantages

* + High cost of robots and maintenance
  + Not affordable for small-scale farmers
  + Requires training to operate

### Medicine

Robots assist in surgeries, rehabilitation, and patient care.

### Working

* + **Surgical** **Robots:** Perform precise operations like heart or brain surgery.
  + **Rehabilitation** **Robots:** Help disabled patients regain movement.
  + **Hospital** **Assistance:** Robots deliver medicine and assist nurses.

### Advantages

* + More accurate surgeries
  + Reduces workload on doctors and nurses
  + Can operate in remote areas using telemedicine

### Disadvantages

* + Expensive technology
  + Technical failures can be dangerous
  + Lacks human empathy in patient care

### Domestic (Home) Use

Robots are used for cleaning, security, and personal assistance.

### Working

* + **Cleaning** **Robots:** Vacuum cleaners like Roomba clean floors autonomously.
  + **Smart** **Assistants:** AI devices like Alexa control smart homes.
  + **Security** **Robots:** AI-powered cameras detect intruders.

### Advantages

* + Saves time and effort
  + Improves home security
  + Assists elderly or disabled individuals

### Disadvantages

* + Expensive for some households
  + Privacy concerns (AI devices recording data)
  + May not fully replace human effort

### Entertainment

Robots are used in movies, gaming, and theme parks.

### Working

* + **AI** **Game** **Characters:** Smart robots in video games create realistic experiences.
  + **Animatronics:** Robots in theme parks entertain visitors.
  + **Social** **Robots:** Humanoid robots interact with people in exhibitions.

### Advantages

* + Creates new entertainment experiences
  + Enhances video game AI
  + Reduces costs in film production (robotic CGI)

### Disadvantages

* + Can replace human performers
  + Ethical concerns about AI-generated media Expensive technology

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| --- | --- | --- |
| **Type** | **Description** | **Example** |
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| **Dependent** **Robots** | Work with human interaction. | Robotic arms in car factories, remote- controlled drones. |

## A-Rated Questions/Answers By Examiner

### Q1. What are two advantages of using robots in industry? Answer:

1. Robots improve production speed and efficiency by performing tasks without fatigue.
2. They reduce human errors, ensuring better quality control.

### Q2. How do robots contribute to the medical field?

**Answer:** Robots assist in surgeries by increasing precision, help in patient rehabilitation, and automate hospital tasks like delivering medicine.

### Q3. What is a disadvantage of using robots in agriculture?

**Answer:** One disadvantage is that robots are expensive to buy and maintain, making them less accessible to small-scale farmers.

### Q4. Name one way robots are used in transport and explain how it works.

**Answer:** Self-driving cars use sensors, cameras, and AI algorithms to navigate roads and avoid obstacles without human intervention.

### Q5. How can domestic robots improve everyday life?

**Answer:** Domestic robots, such as robotic vacuum cleaners and smart assistants, save time by performing household chores and providing security.

## Write your Answers on your Notebook and Verify it on Next Screen

**Q6.** **Why** **are** **robots** **widely** **used** **in** **industry?**

**Q7.** **What** **is** **one** **major** **disadvantage** **of** **using** **robots** **in** **medicine?**

**Q8.** **Explain** **how** **robots** **help** **in** **agriculture.**

**Q9.** **How** **do** **robots** **enhance** **home** **security?**

**Q10.** **What** **is** **one** **ethical** **concern** **related** **to** **AI** **in** **entertainment?**

1. **Answer:** Robots are used in industry because they **increase** **efficiency,** **reduce** **human** **error,** **and** **perform** **repetitive** **tasks** **with** **high** **precision**.
   * They are used in **automated** **assembly** **lines**, **welding**, **painting**, and **quality** **inspection**.
   * They **work** **faster** and **can** **operate** **in** **hazardous** **environments** where humans cannot.
2. **Answer:** One major disadvantage is that **medical** **robots** **are** **expensive**, making them difficult for smaller hospitals to afford.
   * Additionally, **technical** **failures** in surgical robots **can** **be** **dangerous** to patients.
3. **Answer:** Robots improve farming by **automating** **tasks** such as:
   * **Autonomous** **tractors** **&** **harvesters** – Plow fields and collect crops efficiently.
   * **Drones** – Scan fields to monitor crop health.
   * **Automated** **irrigation** – Uses AI to control water and fertilizer use. This helps **increase** **food** **production** and **reduce** **labor** **costs**.

### Answer:

* + **AI-powered** **cameras** detect intruders and send alerts.
  + **Smart** **assistants** control smart locks and monitor security systems.
  + **Security** **robots** patrol homes and recognize suspicious activity.

This improves **safety** **and** **peace** **of** **mind** for homeowners.

1. **Answer:** One ethical concern is that **AI-generated** **media** and **robotic** **performers** may **replace** **human** **actors** **and** **artists**, leading to job losses.
   * AI can **create** **realistic** **digital** **characters**, which may reduce opportunities for real performers in movies and games.

# Topic: What is Artificial Intelligence (AI)?

Reading Time: 20 mins

## Note\* Highlight important/core points while reading

* Read the content and write the answers given in the document in your words, to get the solid grip on topic.

### What is Artificial Intelligence (AI)?

Artificial Intelligence (AI) is a branch of computer science that enables machines to mimic human intelligence. AI allows computers to learn from data, recognize patterns, and make decisions without explicit programming for every task. AI is used in various applications such as virtual assistants, self-driving cars, medical diagnosis, and more.

### How AI Works

AI systems work by processing vast amounts of data and using algorithms to recognize patterns and make decisions. The key working principles of AI include:

### Machine Learning (ML)

* + Machine Learning is a subset of AI where computers are trained using large datasets.
  + AI models analyze past data to predict future outcomes.
  + Example: Spam email detection—AI learns from past spam messages to filter new ones.

### Neural Networks

* + AI mimics the human brain using artificial neural networks (ANNs).
  + These networks consist of layers of interconnected nodes that process data in steps.
  + Example: Facial recognition systems analyze facial features step by step to identify a person.

### Natural Language Processing (NLP)

* + AI enables computers to understand, interpret, and generate human language.
  + NLP is used in virtual assistants like Siri, Google Assistant, and chatbots.
  + Example: AI chatbots understand customer queries and provide relevant responses.

### Computer Vision

* + AI enables computers to analyze and interpret visual information from images and videos.
  + Used in self-driving cars, medical image analysis, and facial recognition.
  + Example: AI in hospitals can detect diseases from X-ray images.

### Robotics & AI Integration

* + AI-powered robots can perform complex tasks without human intervention.
  + Used in manufacturing, space exploration, and healthcare.
  + Example: AI-assisted robots in surgery improve precision.

### Advantages of AI

* + AI can process large amounts of data faster than humans.
  + Reduces human errors in decision-making.
  + Automates repetitive tasks, increasing efficiency.
  + AI systems work continuously without fatigue.
  + Helps in medical diagnosis, saving lives.

### Disadvantages of AI

* + AI can be expensive to develop and maintain.
  + Lacks human creativity and emotions.
  + AI can replace human jobs, leading to unemployment.
  + AI decisions can be biased if trained on incorrect or incomplete data.
  + Security risks like hacking or misuse of AI systems.

## A-Rated Questions/Answers By Examiner

### Q1. What is Artificial Intelligence (AI)?

**Answer:** Artificial Intelligence (AI) is the simulation of human intelligence in computers, allowing them to learn from data, recognize patterns, and make decisions without explicit programming.

### Q2. How does machine learning improve AI systems?

**Answer:** Machine Learning enables AI systems to learn from past data and improve their performance without being explicitly programmed for every scenario.

### Q3. Give one advantage and one disadvantage of AI in decision-making. Answer:

* + **Advantage:** AI reduces human errors and makes faster decisions based on data analysis.
  + **Disadvantage:** AI decisions can be biased if trained on incorrect or incomplete data.

### Q4. What is the role of neural networks in AI?

**Answer:** Neural networks are AI models designed to mimic the human brain, allowing machines to process data in layers and recognize patterns for tasks like image recognition and speech processing.

### Q5. How is AI used in Natural Language Processing (NLP)?

**Answer:** AI in NLP enables computers to understand, interpret, and generate human language, used in applications like virtual assistants and chatbots.

## Write your Answers on your Notebook and Verify it on Next Screen

**Q6.** **What** **are** **some** **real-world** **applications** **of** **AI** **in** **healthcare?**

**Q7.** **How** **does** **AI** **contribute** **to** **self-driving** **cars?**

**Q8.** **What** **is** **the** **difference** **between** **weak** **AI** **and** **strong** **AI?**

**Q9.** **Why** **is** **data** **important** **for** **AI** **models?**

**Q10.** **What** **are** **ethical** **concerns** **related** **to** **AI?**

1. **Answer:** AI is used in healthcare for medical diagnosis, drug discovery, robotic surgeries, and personalized treatment plans. For example, AI can detect diseases from medical images like X-rays and MRIs.
2. **Answer:** AI helps self-driving cars by processing sensor data, recognizing objects, predicting movements, and making real-time driving decisions to ensure safety.
3. **Answer:** Weak AI, or narrow AI, is designed for specific tasks like voice assistants, whereas strong AI aims to perform any intellectual task that a human can do, with general intelligence.
4. **Answer:** AI models rely on large datasets to learn patterns, improve accuracy, and make informed decisions. Poor-quality data can lead to biased or inaccurate AI outcomes.
5. **Answer:** Ethical concerns include job displacement, data privacy, AI biases, misuse of AI in surveillance, and decision-making without human oversight.

# Topic: Characteristics of AI

Reading Time: 20 mins

## Note\* Highlight important/core points while reading

* Read the content and write the answers given in the document in your words, to get the solid grip on topic.

### Characteristics of Artificial Intelligence (AI)

Artificial Intelligence (AI) refers to the ability of machines to perform tasks that typically require human intelligence, such as decision-making, problem-solving, and learning. AI has different characteristics that define its functionality and capabilities.

### Characteristics of AI

1. **Learning** **and** **Adaptation**

AI systems learn from past experiences and improve their performance over time. Machine Learning (ML) models use data to enhance accuracy in tasks like speech recognition and recommendation systems.

### Problem-Solving Ability

AI can analyze complex problems and find solutions efficiently. For example, AI in navigation apps calculates the best route based on traffic data.

### Pattern Recognition

AI recognizes patterns in data, which is useful in fraud detection, facial recognition, and medical diagnosis.

### Automation of Tasks

AI automates repetitive tasks, improving efficiency and reducing human effort. Chatbots in customer service are an example of AI-driven automation.

### Decision-Making

AI uses algorithms to make logical decisions based on data, such as self-driving cars deciding when to stop or accelerate.

### Human Interaction (Natural Language Processing - NLP)

AI-powered virtual assistants like Siri and Google Assistant understand and respond to human speech using NLP.

### Perception and Sensing

AI can perceive the environment through cameras and sensors. Computer vision technology is used in autonomous robots and security systems.

### Types of AI and Their Working

1. **Narrow** **AI** **(Weak** **AI)**

Narrow AI is designed to perform a specific task better than humans but cannot perform other tasks outside its programming.

### Working

* + Uses machine learning models to analyze and process large amounts of data.
  + Limited to one domain and cannot transfer its intelligence to other tasks.
  + Example:
    - **Voice** **Assistants** **(Alexa,** **Siri)** – Recognize and respond to voice commands.
    - **Chess** **AI** – Can defeat human chess champions but cannot do other tasks.

### Characteristics:

* + Excels in a single task
  + Uses predefined data and rules
  + Cannot learn outside its programmed task

### General AI

General AI is when a machine performs tasks at the same level as a human in multiple domains but does not surpass human intelligence.

### Working

* + Capable of reasoning, understanding, and learning new tasks.
  + Uses deep learning and cognitive computing to analyze data and solve problems.
  + Example:
    - **A** **robot** **that** **can** **drive** **a** **car,** **cook** **food,** **and** **play** **a** **game** **like** **a** **human.**

### Characteristics:

* + Can perform multiple tasks
  + Learns and adapts to new problems
  + Limited to human-level intelligence

### Strong AI (Super AI)

Strong AI is when machines surpass human intelligence in multiple tasks and can make independent decisions.

### Working

* + Uses advanced neural networks, deep learning, and artificial consciousness.
  + Capable of understanding emotions, reasoning, and making decisions autonomously.
  + Example:

### A super-intelligent AI that can outperform humans in every field, including science, business, and creativity.

**Characteristics:**

* + Thinks and reasons like a human
  + Performs multiple tasks better than humans
  + Can learn and evolve without human input

## A-Rated Questions/Answers By Examiner

### Q1. What is the main difference between Narrow AI and General AI?

**Answer:** Narrow AI is designed to perform one specific task better than humans, while General AI can perform multiple tasks at a human-like level.

### Q2. Give an example of a system that uses Narrow AI.

**Answer:** A chess-playing AI, which is programmed to play chess better than humans but cannot perform any other task.

### Q3. What is Strong AI?

**Answer:** Strong AI is a type of artificial intelligence that has superior performance to humans in many tasks and can make independent decisions.

### Q4. How does AI recognize patterns in data?

**Answer:** AI uses machine learning algorithms and neural networks to analyze large datasets and identify trends, which are used in applications like facial recognition and fraud detection.

### Q5. What role does Natural Language Processing (NLP) play in AI?

**Answer:** NLP allows AI to understand, interpret, and respond to human language, as seen in virtual assistants like Siri and Google Assistant.

## Write your Answers on your Notebook and Verify it on Next Screen

**Q6.** **How** **does** **AI** **automate** **repetitive** **tasks** **in** **industries?**

**Q7.** **What** **is** **the** **significance** **of** **perception** **and** **sensing** **in** **AI?**

**Q8.** **Why** **is** **General** **AI** **considered** **more** **advanced** **than** **Narrow** **AI?**

**Q9.** **How** **does** **AI** **improve** **decision-making** **in** **real-world** **applications?**

**Q10.** **What** **are** **the** **potential** **risks** **of** **Strong** **AI?**

1. **Answer:** AI automates repetitive tasks by using algorithms and robotics, improving efficiency in sectors like customer service (chatbots), manufacturing (robotic assembly lines), and data entry (AI-powered automation tools).
2. **Answer:** Perception and sensing allow AI to gather information from its surroundings using cameras, sensors, and computer vision, enabling applications like self-driving cars and security surveillance systems.
3. **Answer:** General AI is more advanced because it can learn, reason, and adapt to multiple tasks like a human, whereas Narrow AI is limited to performing a single specific task.
4. **Answer:** AI enhances decision-making by analyzing large amounts of data, recognizing patterns, and making data-driven choices, such as predicting stock market trends or diagnosing diseases.
5. **Answer:** The risks of Strong AI include loss of human control, ethical concerns, job displacement, and potential misuse in areas like surveillance, warfare, or decision- making without human oversight.

# Topic: AI systems

Reading Time: 20 mins

## Note\* Highlight important/core points while reading

* + Read the content and write the answers given in the document in your words, to get the solid grip on topic.

### AI Systems

Artificial Intelligence (AI) systems are computer programs designed to perform tasks that typically require human intelligence. These systems can analyze data, make decisions, and learn from experience. There are two main types of AI systems: **Expert** **Systems** and **Machine** **Learning**.

### Expert Systems

**What** **is** **an** **Expert** **System?**

An expert system is a computer program that mimics human decision-making using AI. It is designed to solve complex problems in a specific field by using expert knowledge and inference rules.

### How Expert Systems Work

Expert systems have three main components:

### User Interface

* + This allows users to interact with the expert system.
  + Users input information via dialogue boxes, command prompts, or other methods.
  + The system asks questions with Yes/No answers based on previous responses.

### Inference Engine

* + Acts like a search engine, examining the **knowledge** **base** to find relevant information.
  + Gathers information by asking questions.
  + Uses inference rules to draw conclusions and solve problems.

### Knowledge Base

* + A collection of expert knowledge stored in the system.
  + Contains facts, rules, and information gathered from experts or research sources.

### Rules Base

* + A set of logical "IF-THEN" statements used by the inference engine to make decisions.
  + Example Rule:

**IF** a bird has feathers AND can fly **THEN** it is likely a sparrow.

### Applications of Expert Systems

Expert systems are widely used in various fields:

* + **Oil** **and** **Mineral** **Prospecting** – Helps locate oil or minerals underground.
  + **Medical** **Diagnosis** – Assists doctors in diagnosing diseases.
  + **Fault** **Diagnostics** – Detects problems in machines and electronic devices.
  + **Tax** **and** **Financial** **Calculations** – Used in financial decision-making and tax assessments.
  + **Strategy** **Games** **(Chess,** **Go,** **etc.)** – Helps AI opponents make strategic moves.
  + **Logistics** – Optimizes routes for parcel delivery.
  + **Identification** **Systems** – Identifies plants, animals, and chemicals.

### Advantages of Expert Systems

* + Provide a high level of expertise in a specific area.
  + Offer high accuracy and consistent results.
  + Can store and analyze vast amounts of data.
  + Provide traceable and logical solutions.
  + Can handle multiple expertise areas in one system.
  + Have fast response times, much quicker than human experts.
  + Offer unbiased reporting based purely on facts.
  + Can indicate the probability of a suggested solution being correct.

### Disadvantages of Expert Systems

* + Users need training to properly use the system.
  + High setup and maintenance costs.
  + Responses can feel "cold" and lack human empathy (especially in medical cases).
  + The system is only as good as the information entered into it.
  + Users may wrongly assume that expert systems are always correct.

### Machine Learning

**What** **is** **Machine** **Learning?**

Machine Learning (ML) is a branch of AI that enables computers to learn from data and make predictions without being explicitly programmed. Instead of following fixed rules, ML models improve their accuracy over time by analyzing data.

### How Machine Learning Works

1. **Training** **Data** – The system is fed large amounts of data related to a specific task.
2. **Learning** **Process** – The system detects patterns and learns from past experiences.
3. **Prediction/Decision** **Making** – Once trained, the system can make predictions on new data.
4. **Continuous** **Improvement** – The more data the system processes, the better its predictions become.

### Types of Machine Learning

1. **Supervised** **Learning** – The model is trained on labeled data (i.e., data with known outputs). Example: Email spam detection.
2. **Unsupervised** **Learning** – The model finds patterns in unlabeled data. Example: Customer behavior analysis.
3. **Reinforcement** **Learning** – The system learns by trial and error, receiving rewards for good decisions. Example: AI in self-driving cars.

### Examples of Machine Learning Applications

* + **Spam** **Filters** – Identifies spam emails based on previous data.
  + **Speech** **Recognition** – Converts spoken words into text (Siri, Google Assistant).
  + **Face** **Recognition** – Detects and verifies faces in images.
  + **Autonomous** **Vehicles** – Helps self-driving cars understand their surroundings.
  + **Fraud** **Detection** – Identifies suspicious financial transactions.

### Advantages of Machine Learning

* + Can analyze vast amounts of data quickly.
  + Learns from experience and improves accuracy over time.
  + Reduces human effort in repetitive tasks.
  + Can identify patterns and make decisions faster than humans.
  + Useful in many industries, including healthcare, finance, and security.

### Disadvantages of Machine Learning

* + Requires a large amount of high-quality data to work well.
  + Training AI models can be time-consuming and expensive.
  + Can make mistakes if trained on biased or incorrect data.
  + Lack of transparency in decision-making (often called the "black box" problem). Needs continuous monitoring and updating.

## A-Rated Questions/Answers By Examiner

### Q1. What is the main function of an expert system?

**Answer:** An expert system mimics human decision-making by using a knowledge base, inference engine, and rules base to analyze data and provide expert-level solutions in a specific domain.

### Q2. What are the three main components of an expert system? Answer:

1. **User** **Interface** – Allows users to interact with the system.
2. **Inference** **Engine** – Processes queries and applies rules to reach conclusions.
3. **Knowledge** **Base** – Stores expert knowledge and facts.

### Q3. How does machine learning differ from expert systems? Answer:

* + **Expert** **systems** follow fixed rules and rely on pre-programmed knowledge to make decisions.
  + **Machine** **learning** improves over time by analyzing new data and learning patterns without explicit programming.

### Q4. What is the role of the inference engine in an expert system?

**Answer:** The inference engine processes user inputs, searches the knowledge base, applies inference rules, and provides a solution or decision. It acts as the problem- solving part of the system.

### Q5. Give one example each of an application for expert systems and machine learning.

**Answer:**

* + **Expert** **System:** Medical diagnosis system that helps doctors identify diseases.
  + **Machine** **Learning:** Spam detection system that filters unwanted emails based on past data.

## Write your Answers on your Notebook and Verify it on Next Screen

**Q6.** **What** **are** **some** **limitations** **of** **expert** **systems** **compared** **to** **human** **experts?**

**Q7.** **How** **does** **reinforcement** **learning** **differ** **from** **supervised** **and** **unsupervised** **learning?**

**Q8.** **Why** **is** **high-quality** **data** **important** **for** **machine** **learning** **models?**

**Q9.** **How** **do** **expert** **systems** **assist** **in** **medical** **diagnosis?**

**Q10.** **What** **are** **some** **ethical** **concerns** **related** **to** **machine** **learning?**

1. **Answer:** Expert systems lack common sense, human intuition, and adaptability to new or unforeseen situations. They also require accurate data input and maintenance to remain effective.
2. **Answer:** Reinforcement learning involves trial-and-error learning with rewards and penalties, whereas supervised learning uses labeled data for training, and unsupervised learning identifies patterns in unlabeled data.
3. **Answer:** High-quality data ensures accurate predictions, reduces bias, and prevents errors in AI decision-making. Poor data quality can lead to incorrect outcomes and unreliable AI performance.
4. **Answer:** Expert systems analyze patient symptoms and medical history using a knowledge base and inference engine to provide possible diagnoses and treatment recommendations.
5. **Answer:** Ethical concerns include bias in AI models, data privacy violations, potential job displacement, and the lack of transparency in AI decision-making (the "black box" problem).