Class IX

ANSWER KEY

Part 1: Robotics

Robotics & Artificial Intelligence (Ver 1.0)

1. Introduction to Robotics

Reboot (Page 24)

1. Sensors allow a robot to perceive its environment and make decisions based on that information.
2. The two types of actuators are electric actuators and pneumatic actuators.

Reboot (Page 41)

1. Space robots are used for exploring and conducting research in space.
2. The purpose of agricultural robots are to perform tasks in agriculture, such as planting, harvesting, and monitoring crops. They can improve efficiency and reduce the cost of manual labour.

Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A.

1. c	2. d	3. b	4. a	5. c
6. b	7. c	8. a	9. d	10. a

B.

1. National Robotics Association	2. Robot	3. Actuators
4. Vision	5. Controllers	6. End effectors
7. Fixed	8. Ground	9. Underwater
10. Anthropomorphic		

IMPRINT 1

SECTION B (Subjective Type Questions)

A.

1. Animal-like robots are modelled after animals, such as snakes, dogs, or birds.
2. Agricultural robots are designed to perform tasks in agriculture, such as planting, harvesting, and monitoring crops.
3. Bio-inspired robots are designed based on the anatomy, behaviour, or other characteristics of living organisms.
4. Two examples of Space Exploration robots are Sojourner and the Hubble telescope.
5. Two examples of delivery robots are Starship robots and Nuro autonomous delivery vehicles.
6. In many cases, robots can perform tasks more cost-effectively than humans, leading to reduced labour costs and increased profitability.
7. Robots can be programmed to perform a wide range of tasks, making them well-suited for changing or unpredictable environments. In this way, robots improve flexibility.

B.

1. **Bird-Inspired Robots:** These are robots that are inspired by the anatomy, behaviour, or other characteristics of birds. For example, some bird-inspired robots are designed to fly, others to move on the ground, and others to swim. Examples of bird-inspired robots include the RoboBirds developed by the University of Tokyo and the ornithopter robots developed by the University of Cambridge.
2. **Insect-Inspired Robots:** These are robots that are inspired by the anatomy, behaviour, or other characteristics of insects. Insect-inspired robots are often used for tasks such as surveillance, search and rescue, or environmental monitoring. Examples of insect-inspired robots include the RoboBees developed by Harvard University and the RoboAnt developed by the University of California, Berkeley.
3. Based on their functions, robots are classified as follows:
   - **Service robots:** These robots are designed to perform tasks for people, such as delivering food or providing companionship.
   - **Medical robots:** These robots are used in the medical field, such as for surgery or rehabilitation.
   - **Military robots:** These robots are used for military purposes, such as reconnaissance or explosive disposal.
   - **Space robots:** These robots are used for exploring and conducting research in space.
4. In the 1990s, research was driven by the need to use robots to address human safety in hazardous environments, to improve the capabilities of the human operator and reduce fatigue, or by the desire to develop products with large potential markets to improve quality of life. More recently, robots have found new applications outside factories, in areas such as cleaning, search and rescue, underwater, space and medical applications.

The field of robotics experienced a significant expansion with the development of the Internet and the increasing use of robots in various industries, such as healthcare, entertainment, and military.

5. The fourth generation of robots is currently being developed. They will feature arms, legs, jigs, and feelers that work together in synchronised movements. Their tactile senses will be vastly improved to allow the robot a sensitive touch. Another improvement will be artificial intelligence. It will allow robots the freedom to make decisions and solve many of the current problems people have to solve for robots. Artificial intelligence will allow robots to be self-programming, decision-making, problem-solving machines.
6. The three limitations of robots are as follows:
   - **Lack of creativity:** While robots can perform complex tasks with precision and speed, they cannot yet replicate human creativity, imagination, or intuition.
   - **Dependence on programming:** Robots operate based on a set of instructions provided to them through programming. As a result, they are limited by the range of tasks they have been programmed to perform, and they may struggle to adapt to new or unforeseen circumstances.
   - **Cost:** Robots can be expensive to manufacture, program, and maintain, which can limit their accessibility for many people and organisations.
7. Robots are typically characterised by several key features, including:
   - **Automation:** Robots are designed to perform tasks and functions automatically, with minimal human intervention.
   - **Repetition:** Robots are capable of performing repetitive tasks with high precision and accuracy, making them well-suited for repetitive manufacturing processes.
   - **Speed:** Robots can perform tasks much faster than humans, allowing them to increase productivity and efficiency in many industries.
   - **Strength:** Robots can be designed with high levels of strength and durability, allowing them to perform tasks that would be difficult or dangerous for humans.
   - **Adaptability:** Many robots are designed with flexible and modular components, allowing them to adapt to changing environments and tasks.
   - **Intelligence:** With advances in artificial intelligence and machine learning, robots are becoming increasingly capable of learning and making decisions, making them more flexible and autonomous.
   - **Interactivity:** Robots can be designed to interact with humans and their environment, using sensors, actuators, and control systems to respond to stimuli.

C. Competency-based/Application-based questions:

1. Himani met with underwater robot on the ship.
2. Divya has met with service robots.

Deep Thinking (Page 47)

Do yourself.

Lab Activity (Page 49)

Do yourself.

2. Robot as a System

Reboot (Page 54)

1. Swarm robot is the most common type of microbots.
2. Because of their small size, microbots can be manufactured at a lower cost than larger robots. Hence they are cost-effective.

Reboot (Page 63)

1. Two types of aerial robots are fixed-wing drones and multirotor drones.
2. UUV stands for Unmanned Underwater Vehicles.
3. Two advantages of underwater robots are:
   - the ability to operate in environments that are inhospitable to humans.
   - the ability to reach depths that are difficult or impossible for divers to reach.
4. Two advantages of mobile robots are:
   - One major advantage of mobile robots is their computer vision capabilities.
   - The onboard intelligence system and AI used by AMRs creates another advantage.
5. Humanoid robots are robots that resemble and act like humans.
6. The environmental limitations of insectbots are Insectbots may not be able to operate in all types of environments, especially those with extreme temperatures, high humidity, or rough terrain.

Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A.

1. d	2. a	3. a	4. a	5. a
6. a	7. d	8. d	9. c	10. b

B. 1. False 2. False 3. True 4. True 5. False
6. True 7. True 8. True

Section B (Subjective Type Questions)

A. 1. The controller interface's primary job is to decode information that has been delivered from one medium to another.

2. Underwater robots require a mechanical block that is waterproof and buoyant, with actuators that allow the robot to move through water.

3. The use of computational block in humanoid robots is that humanoid robots often use sophisticated algorithms to coordinate their movements and balance, as well as algorithms that allow them to recognise and respond to human speech or gestures.

4. Underwater robots use algorithms to control their movements and detect objects in the water, as well as algorithms that allow them to navigate and perform specific tasks, such as mapping the ocean floor or monitoring underwater wildlife.

5. **Soft snakebots:** These snakebots are made from soft, flexible materials such as silicone or elastomers. This allows them to deform and bend in ways that traditional rigid robots cannot, making them ideal for navigating through tight spaces or interacting with delicate biological systems.

6. A mobile robot is another type of robot that can move around in its environment. One example of a mobile robot is the Roomba vacuum cleaner. Mobile robots can be wheeled, tracked, or legged and are used in a variety of settings, including homes, factories, and warehouses. Mobile robots are designed to navigate and explore their environment, often using sensors and algorithms to avoid obstacles and reach their destination.

7. Insectbots require less power to operate than larger robots, making them more energy-efficient. This means they can operate for longer periods of time on a single charge or battery.

8. DelFly is a small, lightweight robot that can fly like a dragonfly. It can navigate complex environments and is equipped with a camera for monitoring and surveillance.

9. The Cyborg Beetle is a hybrid robot that combines living beetles with electronic components. The robot is controlled remotely and can be used for tasks such as sensing environmental pollutants.

10. Industrial robots are often integrated with other systems, such as conveyor belts, sensors, and cameras, to improve their efficiency and effectiveness. They may also be connected to a central control system that monitors their performance and coordinates their movements with other machines or processes.

B. 1. Two advanced industrial robots are as follows:

- **ABB YuMi:** YuMi is a collaborative robot that is designed to work alongside human workers. It has dual arms that can perform tasks simultaneously and can be programmed to perform a wide range of tasks, including assembly, pick and place, and packaging.

- **Fanuc M-2000iA:** The M-2000iA is a heavy-duty industrial robot that is designed to lift and move large objects. It has a payload capacity of up to 2.3 tons and can be used for applications such as material handling, welding, and painting.

2. Aerial robots are robots that operate in the air. It can fly for an extended period of time without direct human control and can complete a specific task.

   They come in a variety of shapes and sizes, ranging from standard multicopter vehicles/ drones to autonomous helicopters and fixed-wing or hybrid devices.

   Two uses of aerial robots are aerial photography and videography and surveying and mapping.

3. **Advantages of Underwater Robots:** Underwater robots have several advantages, including the ability to operate in environments that are inhospitable to humans, the ability to reach depths that are difficult or impossible for divers to reach, and the ability to operate for long periods without human intervention.

4. Humanoid robots are robots that resemble and act like humans. Typically engineered to imitate authentic human expressions, interactions and movements, such as playing an instrument, dancing, or serving drinks. These robots are often outfitted with multiple cameras, sensors and, more recently, AI and machine learning technologies, having a complex control system, including multiple sensors, actuators, and software, that allows them to mimic human movements and behaviours.

5. An example of industrial robot is Fanuc M-2000iA.

   The M-2000iA is a heavy-duty industrial robot that is designed to lift and move large objects. It has a payload capacity of up to 2.3 tons and can be used for applications such as material handling, welding, and painting.

D. Competency-based/Application-based questions:

b

Deep Thinking (Page 70)

Do yourself.

Lab Activity (Page 71)

Do yourself.

3. Concepts in Robotics

Reboot (Page 77)

1. Locomotion can be achieved using various types of mechanisms, including wheels, legs, tracks, or aerial propellers, depending on the application and environment.
2. No, this statement is not correct. The correct statement is given below:

In helical motion, the robot moves along a linear path while simultaneously rotating around its axis.

Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A. 1. d 2. a 3. c 4. b 5. a
6. d 7. c 8. b

B. 1. True 2. True 3. False 4. True 5. False 6. True

Section B (Subjective Type Questions)

A. 1. In robotics, the degree of freedom (DOF) refers to the number of ways a robot can move or position itself in space.

2. Robotics is an interdisciplinary field that combines elements from computer science, electrical engineering, mechanical engineering, and other related fields.

3. The four types of motions in robotics are as follows:
   - Linear motion
   - Rotational motion
   - Reciprocating motion
   - Translational motion

4. In robotics, reciprocating motion is important because it can be used to move objects along a linear path, such as in conveyor belts or assembly lines.

B. 1. Oscillatory motion can be achieved in robotics using mechanisms such as harmonic drives, which convert the rotary motion of a motor into an oscillatory motion. Other mechanisms such as oscillating cams, linkages, and crankshafts can also be used to achieve oscillatory motion in a variety of applications.

2. (This question is printed incorrect in the textbook). Please correct it as:

Q. Write the advantage of locomotion.

Ans. The advantage of locomotion in robotics is its ability to provide mobility and flexibility, enabling robots to perform a wide range of tasks in different environments and conditions. Additionally, locomotion can be combined with other types of motion, such as articulated or oscillatory motion, to achieve even more complex movements and perform a wider range of tasks.

3. A rigid link is a type of mechanical component that has a fixed shape and size, and does not deform under load. Rigid links are essential for transmitting forces and torques between the joints of the robot, and they play a critical role in determining the robot's accuracy and performance. Rigid links are used to transmit motion and force between other components in a robotic system, such as between joints and actuators.
4. One advantage of revolute joints is that they can provide a relatively simple and reliable means of rotational motion, with fewer moving parts than other types of joints. However, they may be limited in the range of motion they can provide, as they only allow movement around a single axis. Additionally, they may be subject to wear and friction, which can affect their accuracy and performance over time.

D. Competency-based/Application-based questions:

1. The type of motion is rotational motion.
2. A robot's degree of freedom is determined by the number and types of joints that connect its links. Each joint provides one or more degrees of freedom, depending on the type of joint and the number of axes it can rotate or translate along.

   For example, a robot arm with three revolute joints has three degrees of freedom, as each joint can rotate around one axis. A robot with three prismatic joints has three degrees of freedom, as each joint can move along one axis.

Deep Thinking (Page 90)

Do yourself.

Lab Activity (Page 90)

Do yourself.

Class IX

ANSWER KEY

Robotics & Artificial Intelligence (Ver 1.0)

Part 2:ARTIFICIAL INTELLIGENCE (AI)

1. Introduction to Robotics

Reboot (Page 99)

1. CCTV-based monitoring using AI helps reduce the crime rate by building surveillance systems to keep a check on potential criminal incidents and security of the residents.
2. The two types of actuators are electric actuators and pneumatic actuators.

Reboot (Page 107)

1. AI leads to inequality in society due to the increasing usage of AI-driven machines. These machines will generate huge amounts of wages for their owners leaving behind inequality among others.

Reboot (Page 110)

1. Yes, AI can be a threat to human dignity as its lack of genuine empathy in roles requiring care and respect may lead to feelings of isolation and devaluation among individuals.
2. AI systems can be held accountable for their actions by undergoing a training phase in which they learn from a huge data pool, followed by testing to evaluate performance. However, limitations in training may leave them unprepared for all real-world scenarios, potentially leading to misuse by malicious individuals.

Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A. . 1. b 2. a 3. a 4. a 5. b
6. a 7. b 8. d

B. 1. man-made 2. AI winter 3. CAPTCHA 4. Google
5. Natural Language Processing 6. interpretation 7. Algorithms

C. 1. True 2. False 3. False 4. True 5. True
6. True 7. False 8. False 9. True 10. True

Section B (Subjective Type Questions)

A. 1. The areas where AI has made a remarkable impact are:
   a. Security Surveillance
   b. Education
   c. Space exploration

2. Astronomers used AI to sift through years of data obtained by the Kepler telescope to identify a distant eight-planet solar system. AI is also being used for NASA's next mission to Mars, the AEGIS— a Mars-based AI robot, already on the planet is responsible to handle the autonomous targeting of cameras in order to perform investigations on Mars.

3. With rapid development of AI, the fear of unemployment is constant. Jobs in manufacturing, agriculture, food service, retail, transportation and logistics, and hospitality are some of the industries likely to be affected. The majority of the repetitive tasks would be taken over by AI.

4. Artificial Intelligence (AI) is a branch of computer science that simulates human intelligence into machines, especially in computer systems, so that they can think and perform actions similar to humans.

B. 1. The development of autonomous vehicles will revolutionaries the transportation system. Waymo, after many test drives, launched their first public riding services. Waymo's AI software crunches data from vehicles lidar, camera, GPS and cloud services to produce control signals that operate the driver-less vehicle.

2. The three important applications of AI in daily life are:
   a. **Online Shopping:** Online Shopping portals and online marketplaces use AI for recommendations when someone visits the portals. These portals recommend items based on the customer's interest, previous order history, search, age, gender, and other factors that may be of interest to the customer, thereby improving the customer experience and increasing sales opportunities.
   b. **Search Engines:** AI is used by web Search Engines to recommend correct and relevant results to customers. AI also gains revenue for the search by showing sponsored products based on Customer Preference, Search History, Gender, Age, Places Visited, etc., which increases the click ratio for the sponsored link. Search engines also allow audio and image search, which is purely AI-based, as it searches through similar audio patterns and images all over the web and gets the most relevant information for the user.

c. **Chatbots:** A chatbot is an AI application that mimics a real conversation with users through text or text-to-speech. Its key task is to answer user questions with instant messages. Interacting with customers can be time-consuming and stressful. Chatbots are taught to communicate with customers using Natural Language Processing (NLP), ensuring maximum customer satisfaction.

3. The three most important jobs at risk due to AI are:
   a. **Data entry and administrative tasks-** As AI technologies improve, automation can potentially replace manual data entry and repetitive administrative tasks.
   b. **Manufacturing and assembly line workers-** With the rise of robotics and automation, certain tasks in manufacturing and assembly processes can be performed more efficiently and accurately by machines, reducing the need for human workers.
   c. **Transportation and delivery drivers-** The development of self-driving vehicles and autonomous delivery systems has the potential to disrupt jobs in the transportation and delivery industry.
4. The two sources of AI Bias are:
   a. **Data:** AI systems are the result of the data that is fed into them. The data used to train the AI system is the first step to check for biasness. The dataset for AI systems should be realistic and need to be of sufficient size. However, the largest data collected from the real world may also reflect human subjectivity and underlying social biases. The Amazon AI recruitment system is a good example. It was found that their recruitment system was not selecting candidates in a gender-neutral way. The machine learning algorithm was based on the number of resumes submitted over a period of 10 years, and most of them were men, so it favored men over women.
   b. **People**: The last source of AI bias is people. Those who design AI models focus on achieving the desired goals. On that path at times, the biases of the developers are reflected in their models. It's important to note here that ethics and AI bias are not the problems of the machine but the humans behind the machines.

D. Competency-based/Application-based questions:

1. Metadata collected from the user's history and interactions
2. a. Disadvantages of AI are:

   The disadvantages are things like costly implementation, potential human job loss, and lack of emotion and creativity.

   b. AI has the potential to increase productivity, create new jobs, and raise living standards. However, by its very nature of performing "non-routine" tasks formerly thought to be strictly the domain of humans, AI is likely to disrupt large swaths of jobs and tasks.
   c. These could include data detectives or scientists, prompt engineers, robotics engineers, machine managers, and programmers, particularly those who can code in Python which is key for AI development.

d. Although the lives of people do not improve if they keep on being unskilled. Unskilled people have difficulties in growth and personal development.

e. No, AI should not replace laborious jobs completely as if it replaces laborious jobs completely, then there will be no source of income for the daily wage workers due to unemployment. So, industry owners can use some machines but more of manpower.

2. Role of Data and Information, Evolution of Computing

Reboot (Page 127)

1. Data is a piece of information that contains raw facts and statistics and is collected together for reference or analysis whereas, Information is processed and interpreted data placed within a meaningful context.
2. Deterministic computing refers to the traditional approach where computer programs operate based on precise rules and inputs, leading to the same outputs every time they are executed with the same initial conditions. In deterministic systems, there is a predefined structure or set of rules that govern the behavior and choices of the machine.

Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A. . 1. d 2. a 3. a

B. 1. Database 2. Data 3. information 4. Surveys

Section B (Subjective Type Questions)

A. 1. Data refers to unorganized facts and figures that have no meaning on their own. They are raw, isolated facts that describe the business but are not useful by themselves. Data can convey meaning, but they generally need to be processed and manipulated to become useful.

Information, on the other hand, is processed and interpreted data that is placed within a meaningful context. It is data that has been manipulated to be useful to someone. Information carries value and tells people something they don't already know or confirms something they suspect. It provides insights, knowledge, or answers to specific questions.

2. The given examples represent raw facts or figures that describe specific aspects of a retail transaction, but on their own, they lack contextual meaning and are considered data.

a. A file listing all of the orders placed through an online service

b. Data is created when we buy a product from a retailer. This includes the transaction's time and date, transaction amount, etc.

c. Information about what was bought like a hairdryer, cosmetics pack, shaving foam and what quantity of items were bought, payment method used and the employee record are all examples of data.

3. Sensors are helpful in collecting data through their ability to collect environmental data. They are connected through gateways, which allow them to gather live data. This data can then be stored in data storage solutions.

B. 1. The term data acquisition means collecting raw data for the purpose of reference or analysis for the project. The data can be in the form of text, numbers, images, videos, or audio.

There are various ways to collect relevant data for our project. Here are a few examples:

- **Surveys:** Data can be collected through online surveys, telephonic surveys, or in-person surveys. Surveys are a way of collecting data from a group of people in order to gain information and insights into various topics of interest. The process involves asking people for information through questionnaires, which can be online or offline. It can be considered a data source.
- **Sensors:** Data can also be collected and stored in some data storage solutions from various sensors that collect environmental data. Sensors are connected through gateways which enable them to collect live data.

2. Prior to the development of AI/ML binary logic systems and conditional gates, problems were solved using deterministic approaches with defined steps to follow. The emergence of probabilistic computing and advancements in artificial intelligence and machine learning allowed for solving non-deterministic problems that lack well-defined solutions. These technologies handle uncertainty, reason about it, and make decisions based on probabilistic predictions. AI/ML systems with binary logic and conditional gates enable us to address complex and subjective scenarios by providing tools to analyze and solve problems that involve subjective concepts like "high" or "small."

3. Deterministic computing refers to the traditional approach where computer programs operate based on precise rules and inputs, leading to the same outputs every time they are executed with the same initial conditions. In deterministic systems, there is a predefined structure or set of rules that govern the behavior and choices of the machine. Whereas, Probabilistic computing is a branch of computer science and artificial intelligence that emphasizes on the study and application of probabilistic algorithms, models, and methods for computation. It tries to create systems capable of handling uncertainty, reasoning about it, and making decisions based on probabilistic world predictions.

C. **Competency-based/Application-based questions:**

Sonu is performing Data Exploration of the AI project.

3. Introduction to Data and Programming with Python

Reboot (Page 144)

1. This operator is used to calculate exponents.
2. Relational operators or comparison operators compare the values given on both sides of the operators and returns the Boolean value either True or False.
3. X = 2

   Y = 5

   X**= Y

   Output: 32

Task (Page 146)

- 10 + 20 / 5 – 3 * 2

  = 10 + 4 – 6

  = 14 – 6

  = 8
- 5 * (10 + 5) + 10 – 5

  = 5 * (15) + 10 – 5

  = 75 + 10 – 5

  = 85 – 5

  = 80

Task (Page 146)

1. When we run this code in a Python interpreter or Python IDLE, it will display the "Zen of Python" poem, which provides guiding principles and philosophies for writing Python code.
2.
```
import math
r = int(input("Enter the radius of the circle: "))
area = math.pi * r * r
perimeter = 2 * math.pi * r
print("The area of the circle is:", area)
print("The perimeter of the circle is:", perimeter)
```

Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A. . 1. d 2. c 3. a 4. d 5. c 6 a

B. 1. Algorithm 2. Flowchart 3. Guido van Rossum
4. ==, += 5. ASCII 6. None 7. Python 8. condition
9. else 10. Traversing 11. return 12. variable-length

C. 1. True 2. True 3. False 4. True 5. False
6. False 7. False 8. True 9. True 10. True

D. 1.
```
x=y=10
a=int(input("enter number"))
print("number entered is",a)
a+=5
b=10
a=a+10
print(a)
```

2.
```
y=int(input("Enter y:"))
if y<10:
print("smaller")
else:
print(y)
```

3.
```
M=int(input("Enter M: "))
while M<10:
if M==5:
print("Middle Value")
else:
print(M)
M=+1
```

4.
```
str="book"
i=0
while i<=1:
print(str, sep="%")
i+=1
```

E. 1.
```
Program:
i = 1
while i < 5:
print(i)
i += 2
print("Python")
```

2.
```
Program:
sum = 0
i = 20
for j in range(9,0,-2):
   sum += i
print(sum)
```

F. 1. 1022*1024*1026*1028*

2. 50

3. 0*2*4*

4. a has occurred 2 times

Section B (Subjective Type Questions)

A. 1. We will need to enclose it with a pair of Triple quotes, one at the start and the second in the end. Anything inside the enclosing Triple quotes will become part of one multiline string.

2. The print() function prints the specified message to the screen or other standard output device.

3. Variables are used to store information to be referenced and manipulated in a computer program. They also provide a way of labeling data with a descriptive name, so our programs can be understood more clearly by the reader and ourselves.

4. Floor division divides the first number with the second number and returns the whole number adjusted left to the number line. For example: 11//2=5

   Whereas normal division just divides the two values. For example: 11//2=5.5

5. You must follow the given rules while creating and naming the variables and constants?

   • Names should be descriptive and meaningful. Avoid using short names or single letters, unless the meaning is obvious. For example, "age" is a better name than "a".

• Variable names should be in lowercase, with words separated by underscores. For example, "first_name" is a better name than "firstName".

• Constant names should be in uppercase, with words separated by underscores. For example, "PI" is a better name than "pi".

• Avoid using reserved keywords as variable or constant names. Reserved keywords are words that have special meaning in Python, such as "if", "else", "for", "while", "class", etc.

• Use camel case for class names, with the first letter of each word capitalized. For example, "MyClass" is a better name than "myclass".

• Use descriptive names that reflect the purpose of the variable or constant. For example, "total_cost" is a better name than "x".

6. A nested if statement is an if statement placed inside another if statement. Nested if statements are often used when you must test a combination of conditions before deciding on the proper action.
7. Step value is the value by which the counter variable is incremented or decremented every time the loop body is executed. It can be a positive or a negative value, but it cannot be zero. The step value is optional. In case it is omitted, the counter variable is increased by one every time the loop is executed.
8. This loop is also called an entry-controlled loop as it checks for the condition in the beginning only. If the condition is true then the body of the loop will be executed. If the condition is false then it will not be allowed to enter within the loop and it stops.
9. **Features of Python:** Some features of Python are given the following:

   High-Level Language: Python is a high-level and general-purpose programming language which simplifies the process of developing a program. .

   Easy to Learn and Use: Python has simple English-like statements which are easy to learn and use. Anybody can easily get used to its syntax and can expertise in it.

   Expressive Language: Python supports simple code that expresses itself in a few lines to do big and complicated tasks.

   Free and Open Source: Python code is developed under OSI-approved open-source license which allows it to be downloaded free of cost from its official website https://www.python.org.

   Cross Platform Language: Python supports multiple platforms like Windows, Linux, Mac, Raspberry, Pi, etc.

   Applications of Python: Some applications of Python are given the following:

   - Web Development
   - Scientific Computing
   - Data Science
   - Artificial Intelligence

- Game Development. • Desktop Applications
- Automation

B. 1.

Name	Symbol	Purpose	Example	Output
Addition	+	Adds two values.	2 + 4 2.0 + 4 "hi" + "all"	6 6.0 "hiall"
Subtraction	–	Subtracts second value form the first value.	6 – 2 6.0 – 2	3 4.0
Multiplication	*	Multiplies two values.	2 * 3 1.5 * 2 "Hi" * 3	6 3.0 HiHiHi
Division	/	Divides two values.	4 / 2 6.0 / 2 6 / 2.0 11 / 2	2.0 3.0 3.0 5.5
Remainder	%	Returns the remainder of a division.	5 % 2 16 % 11	1 5
Exponential	**	Second number raised to the power of first number.	5 ** 2 1.5 ** 2	25 2.25
Floor division	//	Divides the first number with the second number and returns the whole number adjusted left to the number line.	11 // 2 –11 // 2 13 // 4 –13 // 4	5 –6 3 –4

2. Comments are used to increase the readability of the code. We use them to give proper understanding of the code in simple English statements. They are completely ignored by the Python interpreter.

   There are two different ways of writing comments in Python.

   - Single Line Comment
   - Multiple Line Comments

3. Following are some number types:
   - **Integer:** Integers are whole numbers (+ve, -ve or 0) with no fractions or decimal value. Its length is dependent on the available memory. For example, 10, 124, 4567, 7812568751.
   - **Float:** It is a real number with floating point representation. For example, 15.5 and 12.0. It can also be represented using the exponent notation E. For example, 1E5 is 100000.

- **Complex:** It is made up of a real number and an imaginary number. For example, 3+2i where 3 is a real number and 2i is an imaginary number.

4. There are three kind of errors which a programmer encounters in Python— syntax error, logical error and runtime error.

   Syntax Error

   Syntax means writing the code following the rules of Python language. Syntax error is occurred when we violating the rules of Python language.

   This is the most common type of an error made by a programmer. If there is typing error, incorrect indentation, or incorrect arguments given in a function then Python will not be able to interpret the instruction and will raise a syntax error.

   Logical Error

   This kind of error is difficult to find since the program will run correctly but the desired output is not achieved. This happens if we give a wrong formula for the calculation to be done, write wrong logic for the problem to be solved through the code.

   Runtime Error

   Runtime error occurs during the execution of a program like wrong input or output errors, undefined object errors, division by zero errors. This type of error will halt the program execution unexpectedly.

5. **Data Type Conversion:** Data of one type can be converted into another type by using type conversion built-in functions like int(), float(), str(), etc. The process of converting value of one data type to another is called type conversion or type casting. For example,

```
>>> float(12)
12.0
>>> int(15.5)
15
>>> str(12)
'12'
>>> int(True)
1
>>> bool(0)
False
```

6. **The for Loop**

   The for loop is used to repeat a set of instructions for a fixed number of times. It means the number of iterations are known/definite before we start with the execution of a loop. Therefore, the for loop is also known as definite loop. Indentation of statements is must to specify the block of statements to be repeated using the for loop.

The while loop

The while loop is used to repeat a set of instructions as long as the condition is true. It means when the number of iterations are not fixed/indefinite before we start with the execution of a loop. It is therefore known as indefinite loop. Indentation of statements is must to specify the block of statements to be repeated using while loop.

7. Using the range() Function: The range( ) function is an inbuilt function that is used to generate a set of values between the specified range.

```
for <Var> in range(<Start>, <End+1>, <Step>):
Statements
```

Where,

`for`, in and `range` are keywords.

`Start, End and Step` are parameters of `range()` function and will always be integers.

`Start` is the starting value of loop and End is an ending value+1 of `loop, Step` is the number of `steps` taken to reach the end value.

If only **two** parameters are used then Step value becomes 1 by default.

If only **one** parameter is used the Start becomes **0** and Step becomes **1** by default.

If `Start` > `End` then `Step` is a -ve integer should be given.

If `Start` < `End` then `Step` is a +ve integer.

If Start >= `End` and `Step` value is not specified then it assumes as +ve which is an invalid condition to run a loop so the loop will not execute at all.

8. In Python, the process of repeating a set of instructions based on a condition is called loop. There are two types of loops in Python— `for` loop and `while` loop.

The for Loop

The `for` loop is used to repeat a set of instructions for a fixed number of times. It means the number of iterations are known/definite before we start with the execution of a loop. Therefore, the `for` loop is also known as definite loop. Indentation of statements is must to specify the block of statements to be repeated using the `for` loop.

The while loop

The `while` loop is used to repeat a set of instructions as long as the condition is true. It means when the number of iterations are not fixed/indefinite before we start with the execution of a loop. It is therefore known as indefinite loop. Indentation of statements is must to specify the block of statements to be repeated using while loop.

C. 1. Program:

```
A=int(input("Enter the 1st angle= "))
B=int(input("Enter the 2nd angle= "))
C=int(input("Enter the 3rd angle= "))
```

```
S=A+B+C
if S==180:
print("The angles form a triangle")
else:
print("The angles do not form a triangle")
```

2. Program:

```
F = int(input("Enter the temperature in fahrenheit: "))
C = ((F / 5) * 5) - 32
print(F, "degree fahrenheit is equal to ", C, "celcius")
```

3. Program:

```
s=float(input("Enter the time in seconds: "))
m=s/60
print("The time in minutes is: ", m)
```

4. Program:

```
Radius = 5
area_of_the_circle = 22/7 * Radius * Radius
print ("Area: ", area_of_the_circle)
```

5. Program:

```
x = int(input("Enter the length: "))
y = int(input("Enter the breadth: "))
if(x==y):
print("It's a square")
else:
print("It's not a square")
```

6. Program:

```
weekday = int(input("Enter weekday day number (1-7) : "))
if weekday == 1 :
print("\nMonday");
elif weekday == 2 :
print("\nTuesday")
elif(weekday == 3) :
print("\nWednesday")
elif(weekday == 4) :
print("\nThursday")
```

```
elif(weekday == 5) :
print("\nFriday")
elif(weekday == 6) :
print("\nSaturday")
elif (weekday == 7) :
print("\nSunday")
else :
print("\nPlease enter weekday number between 1-7.")
```

7. Program:

```
bool_value = False
float_value = 15.6
result = bool_value and float_value
print(result)
```

8. Program:

```
Salary = int(input("Enter the salary of the employee: "))
Years_of_Service = int(input("Enter the number of service years: "))
Bonus = (Salary * 0.15)
Net_Salary = 0
if Years_of_Service > 5:
Net_Salary = Salary + Bonus
print(Net_Salary)
```

9. Program:

```
string_value = "Zero"
bool_value = True
result = bool(string_value) + bool_value
print(result)
```

10. Program:

```
Bill_Amount = int(input("Enter the billing amount: "))
Discount = Bill_Amount * 0.1
if Bill_Amount > 5000:
Net_Amount = Bill_Amount - Discount
print("The net billing amount is: ", Net_Amount)
else:
print("The net billing amount is: ", Bill_Amount)
```

11. Program:

```
Y = int(input("Enter the year: "))
if (Y % 4) ==0:
if(Y % 400) == 0:
print("The year entered is a leap year")
else:
print("The year entered is not a leap year")
```

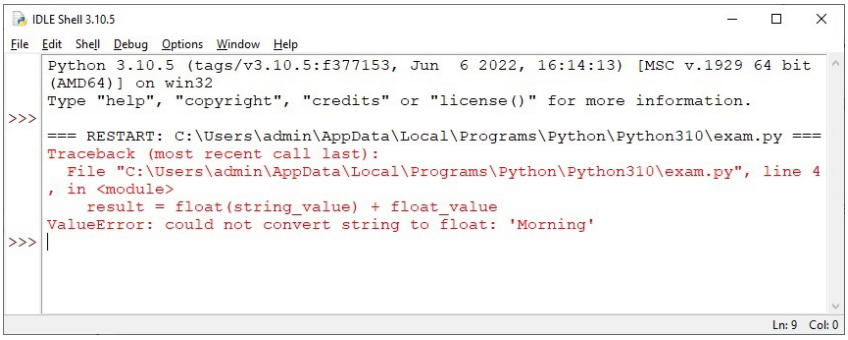
12. Program:

```
bool_value = True
string_value = "Hello"
result = str(bool_value) + string_value
print(result)
```

13. Program:

```
string_value = "Morning"
float_value = 90.4
result = float(string_value) + float_value
print(result)
```

Error: could not convert string to float: 'Morning'



D. Competency-based/Application-based questions:

1. Aahana can use a while loop to repeat a block of statements for a given number of times, until the control condition is false. The syntax for a while loop is:

```
while condition:
    statements
```

2. Atharv can use the continue statement to skip the rest of the statement of the current block and to move to the next iteration of the loop. The syntax for the continue statement continues.

The continue statement is typically used when a certain condition is met, and you want to skip the rest of the statements in the current block and move on to the next iteration of the loop.

For example:

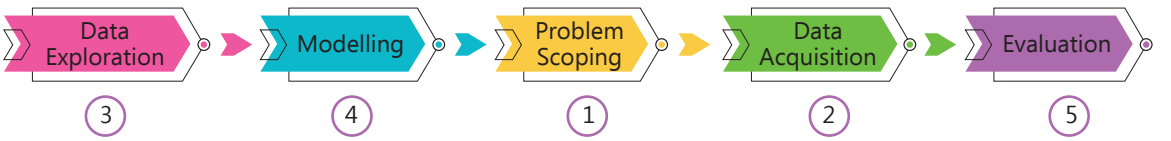
```
i = 0
while i < 10:
    if i == 5:
        continue
    print(i)
    i += 1
```

4. AI Concepts and AI Project Framework

Reboot (Page 191)

1. Ex Machina, Her, Blade Runner, A.I. Artificial Intelligence, Robot
2. By 2030, AI will replace most of the number jobs that are done by Human like for example most of the cleaning jobs will be done by Robots. There will be Bots, AI enabled that will be dealing with people with stress – CBT.
3. Computers can do tasks that are repetitive like large statistical calculations.

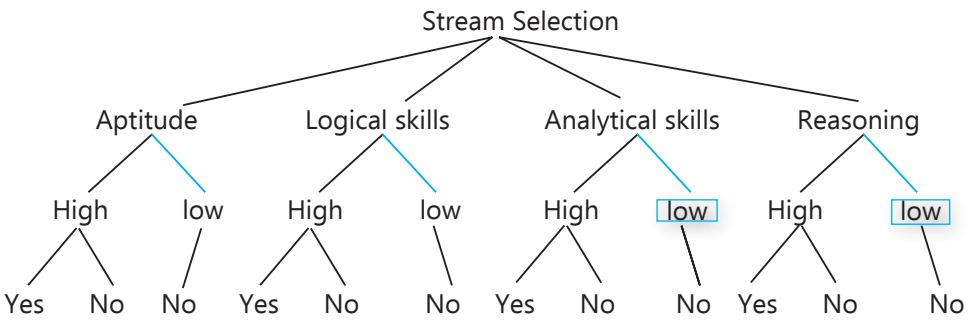
Reboot (Page 206)



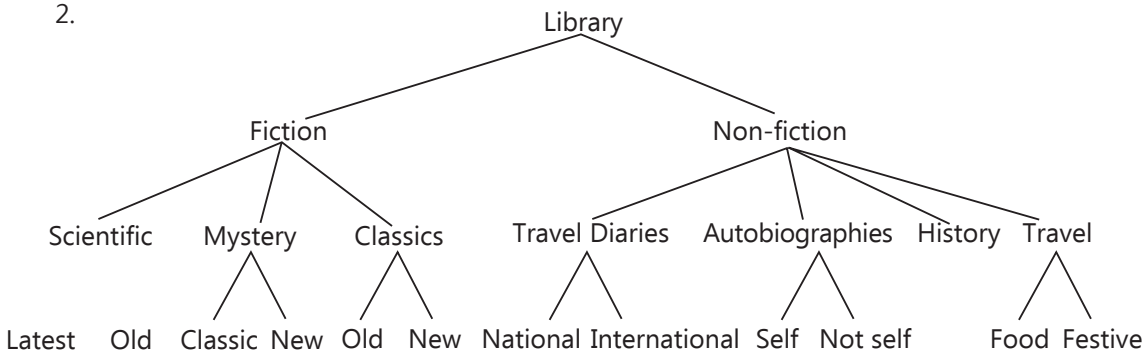
1. List of people who have access to the flight, that is passenger maintenance and engineering staff associated with the flight, crew members of the flight, and flight officials having access to the flight.
2. Criminals who have explicitly shown interest in his escape on any media.
3. Background of the criminal, and who have been his associates in crime and have still not been captured.
4. Background of the security team accompanying the criminal.
5. Flight stop-overs, and who all can have access to the flight at the time of stop-over and the duration of the flight

Task (Page 221)

1.



2.



Task (Page 221)

Accept all relevant answers.

Exercise

Unsolved Questions

SECTION A (Objective Type Questions)

Quiz

A. 1. b 2. c 3. a 4. d 5. a 6. c
7. b 8. d 9. d 10. d 11. b 12. c
13. d 14. b 15. d 16. a

B. 1. AI project cycle 2. Evaluation 3. Data visualization
4. Solution 5. Testing data 6. System maps
7. Data visualization 8. Unstructured data 9. Pie
10. Decision tree 11. Rule-based 12. Accuracy

C. 1. False 2. True 3. False 4. False
5. False 6. True 7. False 8. False

Section B (Subjective Type Questions)

A. 1. AI project cycle is the life cycle of an AI project defining each and every step that every organization should follow to derive the business value from Artificial Intelligence.

2. Modelling or data modeling is defined as the process of designing decision-making algorithms that has to be trained on a set of data (which was acquired at the data acquisition stage for the problem you scoped in the problem scoping stage) and apply that learning to recognize certain types of patterns.

3. AI Project Cycle has 5 stages:
   a. Problem Scoping b. Data Acquisition
   c. Data Exploration d. Modelling e. Evaluation

4. There are two types of data:

   Training Data: It is data on which we train our AI project model. It is basically to fit the parameters of the project for the model. In training data, the output is available to the model.

   Testing Data: It is used to check the performance of an AI model. In testing data, the data is not seen for which the predictions have to be made.

5. (This question was printed incorrectly in the book, please correct it in your textbook.)

   Question: What is the root node in a decision tree?

   Ans. A root node is the first node of a decision tree and it represents the entire set of data.

6. Data is the base for any AI project to be built. When the data is acquired, it's important to check if it's from a reliable and authentic source for the accuracy of the project.

7. (This question was printed incorrectly in the book, please correct it in your textbook.)

   Questions: What is a child node?

   Ans. A sub-node that falls under another node.

8. Pixel It is an example of a machine learning approach which is used in computer vision applications. The graphics or images created on computers are pixel-based images. It shows how the computer classifies the images and reads them.

9. Learning based approach refers to the model where the relationship or patterns in the data are not defined by the developer. Random data is fed into the machine and the machine develops its own pattern or trends based on data outputs.

10. (This question was printed incorrectly in the book, please correct it in your textbook.)

    Questions: What is web scrapping?

    Ans. Web scraping or Data scraping is the method of downloading information from the World Wide Web (WWW) and storing it onto your computer for later reference.

B. 1. The concept of the AI project cycle involves several stages that are followed to develop an AI solution. The AI project cycle using the example of developing a recommendation system for an e-commerce website:

a. **Identification of the goal:** The first step is to clearly define the goal of the project. In this case, the goal is to develop a recommendation system that suggests relevant products to users based on their browsing and purchase history.

b. **Designing an algorithm to solve the problem:** Once the goal is defined, the next step is to design an algorithm or a model that can effectively recommend products to users. This involves selecting appropriate machine learning techniques, such as collaborative filtering or content-based filtering, to create the recommendation algorithm.

c. **Collection of data in large quantities:** Data acquisition is a crucial step in the AI project cycle. In this stage, large quantities of data related to user behavior, product information, and historical transactions are collected from the e-commerce website. This data will be used to train and fine-tune the recommendation algorithm.

2. Who?

- Stakeholders:
- MIIT Academy
- Working professionals applying for the entrance test
- Exam center staff
- What do you know about them?
- MIIT Academy: Provides computer training to senior professionals, limited seats, high demand
- Working professionals: Seeking admission to the academy, need a fair admission selection process
- Exam center staff: Responsible for managing the entrance test process and ensuring security

What?

- Problem:
- Unauthorized people entering the exam centers during the entrance test
- How do you know it is a problem? (Is there any evidence?)
- MIIT Academy's need for a fair admission selection process
- Ensuring the security and integrity of the entrance test

Where?

- Context/situation the stakeholders experience the problem:
- Exam centers where the entrance test is conducted
- Where is the problem located?

- At the entrance of the exam centers where unauthorized individuals may attempt to enter

Why?

- Who will benefit from the solution?
- **MIIT Academy:** Ensuring a fair admission selection process and maintaining the reputation of the institute
- **Working professionals:** Ensuring fair competition and selection process for admission
- Base of "Why" you want to solve this problem:
- Ensuring a secure and fair entrance test process
- Maintaining the integrity and reputation of MIIT Academy

3. The 4W Project Canvas provides a high-level overview of the project's stakeholders, problem, location, and purpose. Further details such as the specific classification system approach, implementation plan, and evaluation criteria would be required for a comprehensive project plan.

   a. Who?
      - IT company
      - Operations team
      - Support ticket users/customers

   b. What?
      - Problem: Inability to properly classify support tickets, leading to delays in response

   c. Where?
      - Support ticket management system/software
      - Communication channels between IT company and support ticket users/customers

   d. Why?
      - IT company and Operations team will benefit from the solution:
      - Efficient and accurate classification of support tickets
      - Improved prioritization and allocation of resources
      - Timely response to urgent and important tickets
      - Streamlined workflow and reduced delays
      - Support ticket users/customers will benefit from:
      - Prompt and appropriate response to their inquiries or issues
      - Enhanced customer satisfaction and experience

4. Data exploration means finding the patterns and trends in the data. It is the third stage in the AI project cycle and the initial step in data analysis. It is used to understand what is in a dataset and the characteristics of the data. It is an important step in AI Project as it cleans the big data to provide input to an AI project. Terabytes of data sitting in the data center unused is a burden, if correctly processed it can become digital gold.

5. The important points to consider for data visualization are:
   a. **Understand trends:** Visual representation of data grabs our interest and keeps our concentration. If we see data in the form of numbers, understanding it will take some time. But when we see the same data in the form of a chart, we quickly see trends and outliers.
   b. **Deciding which model:** Understanding visuals by humans is better than any tabular data format or reports. Data visualisation tools accelerate decision-making based on the data insights, accelerating business growth.
   c. **Easier to comprehend:** Visualisation is a key tool to make sense of huge data in the form of rows. A good visualisation tool helps to clean big data and highlight useful information. It enables decision-makers to interrelate the data to find better insights and be easy to comprehend.
   d. **Easier to communicate:** Visualisation lets you communicate large amounts of data to the audience with ease. Interactive data visualisation tools help to communicate data findings and critical information effectively.
6. **Artificial Intelligenc**e refers to any technique that enables computers to mimic or imitate, develop and demonstrate human intelligence. They are machines that can perform tasks that they are programmed for. AI enables machines to think without any human intervention. Whereas, In **Machine Learning**, machines need to learn the ways of humans by learning the techniques and processes. So machine learning is a subset of artificial intelligence that uses statistical methods that enable machines to improve with experiences. So machines learn from their mistakes and take them into consideration in the next iteration, this way they keep improving with experience. For example, Snapchat filters and Netflix recommendations.
7. The important points to consider while designing a decision tree are:
   a. There can be a possibility of multiple decision trees which lead to correct prediction for a single dataset. The simplest one should be chosen.
   b. The dataset might contain redundant data at times, which does not have any reference while creating a decision tree. Therefore, it is necessary that only those parameters that affect the output directly should be included.
   c. While making Decision Trees, one should take a look at the dataset given to them and try to figure out what pattern the output leaf follows. Try selecting any one output and on its basis, find out the common links which all the similar outputs have.
8. Decision trees are a kind of flow chart, where the flow starts at the root node and ends with a decision made at the leaves. It is used to depict conditions and their outcomes. It is one of the most widely used and practical methods for supervised learning.

   Decision trees are tools that follow a rule-based approach that uses a tree-like model of decisions and their possible consequences. The decision tree starts from the **root node** just like the structure of a tree with two different ways or conditions: Yes or No. The forks or

diversions are known as **Branches** of the tree. The branches either lead to another **decision/ question** node or they lead to another condition for decision, which is known as **leaf node.** If you look closely at the image, it looks like an inverted tree with roots above and leaves below. That's why it's called the decision tree.

9. In Machine Learning, machines need to learn the ways of humans by learning the techniques and processes. So machine learning is a subset of artificial intelligence that uses statistical methods that enable machines to improve with experiences. So machines learn from their mistakes and take them into consideration in the next iteration, this way they keep improving with experience.

   The two applications of machine learning in our daily lives are Snapchat filters and Netflix recommendations.

C. Competency-based/Application-based questions:

1. Who?
   - Stakeholders: Institute management, current students, prospective students, parents/ guardians, faculty members.
   - What do we know about them? The institute management wants to maintain a balanced gender ratio, current and prospective students may face challenges due to inadequate facilities, parents/guardians have concerns about the living arrangements, faculty members need to adapt to the changing demographics.

   What?
   - Problem: The sudden change in the gender ratio to 70% girls and 30% boys has caused accommodation issues in the girls' hostel.
   - Evidence: Observation of the gender ratio change and the lack of space in the girls' hostel.

   Where?
   - Context/Situation: The Institute's campus, specifically the girls' hostel.
   - Location: The Institute where the imbalance in gender ratio is affecting the accommodation facilities.

   Why?
   - Value to stakeholders:
   - Institute Management: Maintain a balanced gender ratio and provide equal opportunities to both boys and girls.
   - Current and Prospective Students: Ensure adequate accommodation facilities for all students, creating a conducive learning environment.
   - Parents/Guardians: Ensure the safety and well-being of their children in the hostel.
   - Faculty Members: Adapt teaching and support systems to cater to the changing demographics.

- How it improves their situation:
- Institute Management: Promotes diversity and inclusivity, enhances the reputation of the institute.
- Students: Provides comfortable living arrangements, reduces gender imbalance-related issues.
- Parents/Guardians: Ensures the safety and satisfaction of their children.
- Faculty Members: Facilitates a balanced learning environment and helps in creating an inclusive academic experience.

2. Who?
   - Stakeholders: People with visual impairments, restaurant owners/staff, other customers.
   - What do we know about them? People with visual impairments require assistance to order meals from the menu, restaurant owners/staff may lack the necessary resources to cater to their needs, other customers may have limited awareness of inclusivity and accessibility.

   What?
   - Problem: People with visual impairments face difficulties in independently ordering meals from the menu.
   - Evidence: Observations of individuals with visual impairments struggling to access and understand menu options.

   Where?
   - Context/Situation: Restaurants or food establishments.
   - Location: The specific restaurants where accessibility for people with visual impairments is lacking.

   Why?
   - Value to stakeholders:
   - People with visual impairments: Enables them to independently order meals of their choice, promoting inclusivity and enhancing their dining experience.
   - Restaurant Owners/Staff: Enhances customer satisfaction and inclusivity, attracts a broader customer base, and demonstrates a commitment to accessibility.
   - Other Customers: Increases awareness and fosters a more inclusive environment in restaurants.
   - How it improves their situation:
   - People with visual impairments: Enables them to make choices based on their preferences and dietary restrictions without relying on assistance, promoting independence and dignity.
   - Restaurant Owners/Staff: Enhances the customer experience, improves efficiency in serving

customers with visual impairments, and demonstrates commitment to accessibility.

- Other Customers: Fosters a more inclusive and empathetic dining environment, creating a positive social impact.

3. The scenario of redesigning the water closet/flush to reduce water consumption relates to the Sustainable Development Goal (SDG) is Clean water and sanitation.
4. The ideal problem statement template for the given scenario would be option "C" i.e. Our people have a problem that air pollution has damaging effects on human health when harmful gases like SO_2, NO_2, and CO are emitted directly into the air. An ideal solution would be to develop an air quality index monitor so that one can know the local air quality and take action to protect their health.
5. The stage of the AI project cycle we are talking about in this scenario is Data Acquisition.