22MBABA403

VTU 4th Semester MBA Degree Examination June/July2024

Machine Learning

Solution

<table>
<tr><td></td><td></td></tr>
<tr><td>Q1.a.</td><td>What is Machine learning? Explain with examples
Machine Learning (ML) is a branch of artificial intelligence (AI) that enables computers to learn and make decisions or predictions based on data, without being explicitly programmed.
Ex:1 Spam Detection: Email providers use ML models to classify emails as "spam" or "not spam" based on features like email content, sender address, and more.
Ex2: Predicting House Prices: Models are trained on historical data (e.g., square footage, location) to predict property prices.</td></tr>
<tr><td>b</td><td>Discuss Computer Hardware Architecture for ML
Computer hardware architecture refers to the design and organization of a computer's physical components and their interconnections. It determines how a computer processes data, stores information, and interacts with other devices. The architecture is typically divided into the following key components:</td></tr>
<tr><td>c</td><td>Discuss Programming language for machine learning
The most popular programming languages for machine learning (ML) include:
Python
Why: Python is the dominant language for ML due to its simplicity, vast libraries, and active community support.
Libraries/Frameworks:
TensorFlow
PyTorch
Scikit-learn
Keras
NumPy
Pandas
Matplotlib
Use Case: Prototyping models, production-ready ML systems, and data analysis.</td></tr>
<tr><td>2. a</td><td>Distinguish between supervised and unsupervised learning in Machine learning.
Supervised and unsupervised learning are two primary types of machine learning techniques. Here's a breakdown of their differences:<table><tr><th>Aspect</th><th>Supervised Learning</th><th>Unsupervised Learning</th></tr><tr><td>Definition</td><td>Learning from labeled data where input-output pairs are provided.</td><td>Learning from unlabeled data to discover patterns or structure.</td></tr><tr><td>Input Data</td><td>Requires labeled data (input features with corresponding labels).</td><td>Works with unlabeled data (no labels, only input features).</td></tr><tr><td>Goal</td><td>Predict outcomes or classify data into predefined categories.</td><td>Explore data to find hidden patterns or groupings.</td></tr><tr><td>Example Tasks</td><td>Classification, regression.</td><td>Clustering, dimensionality reduction.</td></tr></table></td></tr>
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Output	Predicts labels for new data.	Groups data or identifies relationships without explicit labels.
Algorithms	Linear regression, logistic regression, decision trees, etc.	K-means, hierarchical clustering, PCA, DBSCAN, etc.

In summary:

- **Supervised learning** is like a teacher guiding the model with correct answers.
- **Unsupervised learning** is more exploratory, allowing the model to find patterns on its own.

b

Discuss any two regression models used in ML with an example application for each.
Here are two commonly used regression models in machine learning, along with example applications:

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1. Linear Regression
Description:
Linear regression models the relationship between a dependent variable (target) and one or more independent variables (features) using a linear equation. The model predicts a continuous value by minimizing the sum of squared differences between predicted and actual values.
Applications:

- **House Price Prediction**: Predicting house prices based on features like square footage, location, and number of rooms.
- **Stock Market Analysis**: Predicting stock prices based on historical trends and market indicators.
- **Sales Forecasting**: Estimating future sales based on historical data.

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2. Decision Tree Regression
Description:
Decision tree regression splits the data into subsets based on feature values, creating a tree structure. Each leaf node represents a predicted value, and the splits aim to minimize error within each group.
Applications:

- **Energy Consumption Prediction**: Predicting energy usage based on time of day, weather, and occupancy.
- **Medical Cost Estimation**: Estimating healthcare costs based on patient demographics and medical history.
- **Agriculture Yield Prediction**: Predicting crop yields based on soil quality, weather conditions, and farming techniques.

Both models have their strengths and are chosen based on the nature of the problem and the data. Linear regression is ideal for simple relationships, while decision tree regression is better suited for complex, non-linear patterns.

c

Compare any two classification models used in ML
Here's a comparison of two popular classification models used in machine learning: **Logistic Regression** and **Random Forest**.

Aspect	**Logistic Regression**	**Random Forest**
Definition	A linear model that uses a sigmoid function to predict probabilities for binary or multi-class classification.	An ensemble learning method that combines multiple decision trees to improve classification accuracy.

Type of Model	Simple, linear classification model.	Complex, non-linear ensemble model.
Interpretability	Highly interpretable; coefficients indicate the impact of features.	Less interpretable due to multiple trees; feature importance scores provide some insight.
Handling Non-linearity	Struggles with non-linear relationships unless features are transformed.	Handles non-linear relationships well.
Overfitting	Less prone to overfitting if regularization is used.	Can overfit if the number of trees is small or trees are overly deep.
Speed	Fast to train and evaluate, even with large datasets.	Slower to train due to multiple trees, but efficient for evaluation.
Feature Importance	Does not provide feature importance directly.	Provides feature importance scores based on tree splits.
Scalability	Scales well to large datasets.	Computationally intensive for very large datasets.
Robustness to Noise	Sensitive to outliers and noise in data.	More robust to noise due to averaging across trees.
Example Applications	Spam email detection, customer churn prediction.	Fraud detection, medical diagnosis, image classification.

Summary:

- **Logistic Regression** is a great choice for simpler, linearly separable problems where interpretability is key.
- **Random Forest** is better suited for complex problems involving non-linear relationships, but at the cost of interpretability and computational efficiency.

3 a

What is decision tree. Write with an example

What is a Decision Tree?

A **Decision Tree** is a supervised learning algorithm used for both **classification** and **regression** tasks. It models decisions and their possible consequences as a tree-like structure, where:

- Each **internal node** represents a decision based on a feature.
- Each **branch** represents the outcome of a decision or test.
- Each **leaf node** represents the final prediction (class label or continuous value).

The tree splits data recursively by selecting features that maximize information gain (for classification) or minimize variance (for regression).

Example:

Problem: Classify whether a customer will buy a product based on their income and age.

Dataset:

Age	Income	Buy Product?
<30	High	No
31-40	Medium	Yes
>40	Low	Yes
>40	High	No
<30	Medium	Yes

Visualization:

```
        Age
       /   \
    <30       >30
   /   \     /   \
Income   No  Yes   High
Medium       Low       \
   Yes                 No
```

b

Examine Entropy with an Example

We have a dataset with 14 samples, where the target variable is whether a person buys a product (**Yes** or **No**) based on the **Weather** feature.

Dataset:

Weather	Buys Product
Sunny	No
Sunny	No
Overcast	Yes
Rain	Yes
Rain	Yes
Rain	No
Overcast	Yes
Sunny	No
Sunny	Yes
Rain	Yes
Sunny	Yes
Overcast	Yes
Overcast	Yes
Rain	N

Step 1: Calculate Entropy for the Root Node

Counts:

- **Yes**: 9
- **No**: 5
  Total Samples: 14

Entropy Formula:

$$E(S) = -\sum p_i \log_2(p_i)$$

$$p_{\text{Yes}} = \frac{9}{14}, \quad p_{\text{No}} = \frac{5}{14}$$

Substitute values:

$$E(S) = -\left(\frac{9}{14}\log_2\frac{9}{14} + \frac{5}{14}\log_2\frac{5}{14}\right)$$

Compute logarithms:

$$\log_2\frac{9}{14} \approx -0.485 \quad \text{and} \quad \log_2\frac{5}{14} \approx -0.678$$

$$E(S) = -\left(\frac{9}{14}\cdot -0.485 + \frac{5}{14}\cdot -0.678\right)$$

Simplify:

$$E(S) = -(-0.311 + -0.242) = 0.553 + 0.242 = 0.94$$

The root node entropy is **0.94**.

Step 2: Split the Data by the Feature `Weather`

Weather Categories:

- **Sunny:** 5 samples (2 No, 3 Yes)
- **Overcast:** 4 samples (4 Yes)
- **Rain:** 5 samples (3 Yes, 2 No)

Entropy for Each Subset:

1. **Sunny:**

$$E(Sunny) = -\left(\frac{2}{5}\log_2\frac{2}{5} + \frac{3}{5}\log_2\frac{3}{5}\right)$$

$$= -\left(0.4 \cdot -1.322 + 0.6 \cdot -0.737\right) = 0.971$$

2. **Overcast:**

$$E(Overcast) = -\left(\frac{4}{4}\log_2\frac{4}{4}\right) = 0$$

3. **Rain:**

$$E(Rain) = -\left(\frac{3}{5}\log_2\frac{3}{5} + \frac{2}{5}\log_2\frac{2}{5}\right)$$

$$= -\left(0.6 \cdot -0.737 + 0.4 \cdot -1.322\right) = 0.971$$

Step 3: Calculate Weighted Average Entropy for the Split

$$E(\text{Weather}) = \frac{5}{14} \cdot E(Sunny) + \frac{4}{14} \cdot E(Overcast) + \frac{5}{14} \cdot E(Rain)$$

Substitute values:

$$E(\text{Weather}) = \frac{5}{14} \cdot 0.971 + \frac{4}{14} \cdot 0 + \frac{5}{14} \cdot 0.971$$

Simplify:

$$E(\text{Weather}) = 0.3475 + 0 + 0.3475 = 0.695$$

Step 4: Calculate Information Gain

$$\text{Information Gain} = E(S) - E(\text{Weather})$$

Substitute values:

$$\text{Information Gain} = 0.94 - 0.695 = 0.245$$

Conclusion:

The feature **Weather** splits the data with an information gain of **0.245**. Similar calculations can be repeated for other features to find the one that maximizes information gain, which will then be used for the next split.

c.

Explain ID3 Algorithm with an example

ID3 Algorithm in Decision Trees

The **ID3 (Iterative Dichotomiser 3)** algorithm is a popular method for building decision trees. It uses **information gain** as the splitting criterion, choosing the feature that maximizes the reduction in entropy at each step.

Steps in the ID3 Algorithm

1. **Calculate the Entropy** of the dataset.
2. **For each feature**, calculate the **Information Gain** after splitting on that feature.
3. Select the feature with the **highest Information Gain** for the split.
4. Repeat the process for each subset until:
   - All samples in a subset belong to the same class.
   - There are no remaining features to split on.
5. Return the final decision tree.

Example same as 3b

4 a

What is an ensemble model. Give an example

An ensemble model in machine learning combines predictions from multiple individual models to improve overall performance, accuracy, and robustness. The goal of ensemble methods is to reduce errors caused by bias, variance, or noise in individual models.

Ex: Random Forest:

Random Forest is an ensemble learning method that combines the predictions of multiple decision trees to improve accuracy and reduce overfitting. It uses bagging (Bootstrap Aggregating) to train each decision tree on a random subset of the dataset and aggregates their predictions (e.g., majority vote for classification or averaging for regression).

b

Distinguish Bagging and Boosting with an example

Feature	Bagging	Boosting
Objective	Reduces variance by training models in parallel on different subsets of data.	Reduces bias by training models sequentially, where each model corrects errors of the previous one.
Model Training	Independent training of models.	Sequential training, with each model focusing more on misclassified instances.
Data Sampling	Each model is trained on a random bootstrap (subset with replacement) of the data.	Each model is trained on the full dataset, but data points are reweighted based on errors.
Aggregation	Combines outputs using voting (classification) or averaging (regression).	Combines outputs using weighted voting or summation.
Overfitting	Reduces overfitting by decreasing variance.	Can overfit if models are too complex or boosting iterations are too high.
Examples	Random Forest (ensemble of decision trees).	AdaBoost, Gradient Boosting, XGBoost.

c

Illustrate Stacking with an example

Stacking (also known as Stacked Generalization) is an ensemble learning technique where multiple models (called base learners) are trained and then combined using a meta-model (or stacking model) to make the final prediction. Unlike methods like bagging or boosting, which combine predictions of individual models in a specific way (e.g., voting or averaging), stacking trains a meta-model to learn how to best combine the base models' predictions.

Example of Stacking: Predicting House Prices

Let's say we want to predict house prices based on features like square footage, number of bedrooms, neighborhood, etc. We use **stacking** to combine the predictions of three different models (base learners) and a meta-model.

Step 1: Train Base Models

We train three different base models:

- **Base Model 1**: Decision Tree
- **Base Model 2**: Support Vector Machine (SVM)
- **Base Model 3**: Linear Regression

Each model makes its predictions on the house price based on the input features.

Step 2: Create Meta-Model

We use the predictions from the three base models as input features for the meta-model. For example:

- The **meta-model** might be a **logistic regression model** that takes the predicted house prices from each base model and combines them into a final prediction.

Step 3: Make Predictions

During testing, the base models first make their individual predictions on the test data:

- **Decision Tree** predicts a house price of $350,000
- **SVM** predicts a house price of $340,000
- **Linear Regression** predicts a house price of $355,000

These predictions are then fed into the **meta-model**, which may output a final prediction of $348,000 after learning how to combine these base model predictions in the best possible way.

```
+---------------------+
|    Base Model 1     | (e.g., Decision Tree)
+---------------------+
          |
          |
+---------------------+
|    Base Model 2     | (e.g., SVM)
+---------------------+
          |
          |
+---------------------+
|    Base Model 3     | (e.g., Linear Regression)
+---------------------+
          |
          |
+---------------------+
|    Meta-Model       | (e.g., Logistic Regression)
+---------------------+
          |
Final Prediction: $348,000
```

5 a	Explain Reinforcement learning and give an example Reinforcement Learning (RL) is a type of machine learning where an agent learns to make decisions by interacting with an environment to maximize cumulative rewards. The agent takes actions in an environment, and in return, it receives feedback in the form of rewards or penalties. The goal is to learn a policy—a mapping from states of the environment to the best possible actions—so that the agent maximizes its long-term cumulative reward. Examples: ▯ **Robotics**: Robots learning how to navigate an environment, manipulate objects, or perform tasks like assembly or cleaning. ▯ **Game AI**: Training agents to play video games (e.g., AlphaGo, OpenAI Five) by learning optimal strategies. ▯ **Autonomous Vehicles**: Self-driving cars learning to navigate complex road systems while avoiding obstacles and following traffic laws.
b	Illustrate Q learning with an example **Q-Learning** is a model-free reinforcement learning algorithm used to learn the value of action-state pairs. The goal of Q-learning is to find the optimal action selection policy that will yield the highest possible cumulative reward over time.

Key Concepts of Q-Learning:

- **State (S)**: The agent's current situation or position in the environment.
- **Action (A)**: The choices the agent can make.
- **Q-Value (Q(s, a))**: The expected reward for taking action **a** in state **s** and then following the optimal policy.
- **Reward (R)**: The immediate feedback from the environment after an action is taken.
- **Learning Rate (α)**: How quickly the agent updates its knowledge (Q-value).
- **Discount Factor (γ)**: How much future rewards are considered in the current decision.

Q-Learning Example: Gridworld Problem

Let's illustrate Q-learning with a simple Gridworld environment. The agent needs to navigate from the **Start (S)** to the **Goal (G)**, avoiding obstacles, and maximizing its rewards.

Gridworld Layout:

css Copy code

```css
S - Start
G - Goal
# - Obstacle
. - Empty space

[ S | . | . | G ]
[ . | # | . | . ]
[ . | . | . | . ]
```

- **Start (S)**: Agent begins at position (0,0).
- **Goal (G)**: Agent's goal is to reach (0,3) with a reward of +10.
- **Obstacle (#)**: The agent cannot move through these cells.
- **Empty space (.)**: The agent can move here, but it will receive a penalty of -1 for each move it makes (to encourage faster learning).

The agent will learn the best path to the goal, considering future rewards, by adjusting its **Q-values**.

c

Compare and contrast reinforcement learning relation to dynamic programming and active reinforcement learning.

Reinforcement Learning (RL), Dynamic Programming (DP), and Active Reinforcement Learning (ARL) are all methods in the field of decision-making and sequential learning. They share common principles, such as seeking to maximize a long-term reward, but differ in how they approach problem-solving, especially in terms of learning mechanisms, computational requirements, and data availability.

Aspect	Reinforcement Learning (RL)	Dynamic Programming (DP)	Active Reinforcement Learning (ARL)
Learning Type	Model-free, learns from interaction with the environment	Model-based, requires full knowledge of the environment	Model-free, focuses on efficient exploration and learning
Environment Knowledge	No model of environment needed, learns from experience	Requires complete knowledge of the environment	Can work without full model knowledge but focuses on learning efficiency
Exploration vs Exploitation	Balances exploration and exploitation	No exploration, uses full model to find the optimal policy	Emphasizes active exploration to enhance learning efficiency
Computation	Can be computationally expensive in large state spaces	Computationally expensive, especially for large state spaces	Aims to optimize computation by selectively exploring states
Applications	Games, robotics, self-driving cars, personalized recommendations	Policy optimization in fully known environments, e.g., inventory management	Robotics, personalized learning systems, optimization problems requiring fast learning
Model Requirement	No model needed (model-free)	Full model required (transition and reward functions)	Typically no full model, focuses on learning by exploration
Real-time Learning	Yes, learns from interaction with the environment	Typically batch process, needs full information ont	Yes, but with a focus on optimizing exploration for faster learning

6 a

What is Virtual reality. Give an example

Virtual Reality (VR) is an immersive technology that creates a simulated environment, which can be similar to or completely different from the real world. It typically requires the use of special devices such as headsets, gloves, or controllers to enable users to interact with and experience the virtual world. VR aims to simulate the user's senses (mainly sight and sound) to make them feel as if they are physically present in a different environment.

One popular example of VR is the use of VR headsets for gaming. The **Oculus Rift** (now Meta Quest) is a VR headset that immerses users in a 3D world. When a player wears the headset, they see a 360-degree view of the game environment and can interact with it through motion-tracking controllers.

b

Compare the importance of flight simulation as opposed to traditional flight training methods. Where else does the flight simulator play an important role.

Flight simulation and **traditional flight training** methods (which involve actual flight experience with an instructor) both serve as vital components in the training of pilots. However, they differ in terms of cost, safety, accessibility, and the types of skills they develop.

	Applications of Flight Simulation Beyond Traditional Training Flight simulators have widespread applications beyond just pilot training: 1. **Military and Defense**: Flight simulators are extensively used in military settings to train fighter pilots, bomber pilots, and other aviation personnel. They can simulate high-speed combat situations, evasive maneuvers, and complex mission scenarios in a safe environment. 2. **Air Traffic Control (ATC) Training**: Flight simulators are also used for training air traffic controllers. They allow controllers to practice managing traffic, handling emergency situations, and ensuring safe distances between aircraft in various scenarios without actual flights taking place. 3. **Aircraft Design and Testing**: Flight simulators allow engineers to test the performance of new aircraft designs. This is useful before building prototypes and performing costly real-world tests. Simulators provide an early-stage platform for assessing new technologies and systems. 4. **Flight Crew Coordination**: Simulators are used to train entire flight crews, including pilots and cabin crew, on how to respond to emergencies, coordinate actions, and handle unusual situations during flight. 5. **Research and Development**: Flight simulators are used by research institutions and universities to explore new aviation technologies and train students. They are also employed to study human factors, such as pilot behavior and decision-making in high-stress environments. 6. **Public Safety**: Flight simulators are sometimes used in public safety applications to train personnel for rescue operations, such as those using helicopters or other aerial vehicles. This is especially useful for training in high-risk operations without endangering lives. Below is a comparison of their respective importance: □ **Flight simulation** offers significant advantages over **traditional flight training** in terms of cost-efficiency, safety, availability of diverse scenarios, and the ability to practice specific skills repetitively. □ **Traditional flight training** provides essential hands-on experience, muscle memory, and the real-world sensation of flying, which is crucial for developing a deep understanding of aircraft dynamics. □ Beyond training pilots, **flight simulators** play important roles in military training, air traffic control training, aircraft design testing, crew coordination, public safety, and research, making them a versatile and indispensable tool in aviation and beyond.
c	Examine Virtual environment requirements. Creating and running a **virtual environment (VE)**, particularly for applications like **Virtual Reality (VR)**, **Augmented Reality (AR)**, or **simulations**, involves several technical requirements in terms of hardware, software, and network capabilities. Below is a comprehensive overview of these technical requirements: **1. Hardware Requirements** **A. Processing Power (CPU and GPU):** • **Central Processing Unit (CPU)**: A fast and multi-core processor is essential to handle the computational demands of rendering, physics simulation, and AI computations in virtual environments. o **Recommended**: Intel Core i5/i7 or AMD Ryzen 5/7 or higher. o **Minimum**: Intel Core i3 or AMD Ryzen 3 for basic VR experiences. • **Graphics Processing Unit (GPU)**: VR and other immersive environments demand high-performance GPUs to render complex, high-resolution 3D scenes smoothly.

	◦ **Recommended**: NVIDIA RTX 30 series, AMD Radeon RX 6000 series, or equivalent. ◦ **Minimum**: NVIDIA GTX 1060 or AMD equivalent for entry-level VR experiences. **B. Memory (RAM):** • **Recommended**: 16 GB or more to ensure smooth operation of both the environment and any background applications (e.g., software tools, databases). • **Minimum**: 8 GB for entry-level VR or simpler virtual environments. **C. Storage:** • **Solid-State Drive (SSD)**: For faster data read/write speeds, particularly when loading large files or real-time content in VR environments. ◦ **Recommended**: At least 500 GB of SSD space (or more depending on the complexity of the VR content). ◦ **Minimum**: 256 GB SSD or 1 TB HDD (though SSDs provide better performance). **D. Headsets and Controllers (For VR):** • **VR Headset**: Essential for full immersion in VR. These headsets typically include built-in motion tracking and may require specific hardware for connectivity. ◦ **Popular Models**: Oculus Rift, HTC Vive, Meta Quest, PlayStation VR. • **Motion Controllers**: Used to track the user's hand movements and enable interaction with the virtual environment. ◦ **Recommended**: VR controllers compatible with the chosen VR system (e.g., Oculus Touch controllers, HTC Vive controllers). **E. Input Devices:** • For applications beyond VR, a combination of input devices such as **keyboards**, **mice**, **trackpads**, **joysticks**, or **motion capture systems** may be required for interacting with virtual environments. **F. Sensors:** • **Motion Tracking**: Sensors such as **infrared cameras**, **accelerometers**, **gyroscopes**, or **motion capture systems** are used to track user movement and map it into the virtual world. ◦ **Example**: Cameras and sensors used in the **Oculus Rift** or **HTC Vive** to track head and hand movements. **2. Software Requirements** **A. Operating System (OS):** • A stable and modern operating system capable of handling high-performance applications. ◦ **Recommended**: Windows 10/11 or Linux for development, macOS for Apple-specific applications. ◦ **Minimum**: Windows 7 (for basic applications or simulations). **B. Virtual Reality Software Development Kit (SDK):** • **SDKs** are essential for building and managing VR or AR environments, as they provide the necessary libraries, tools, and APIs. ◦ **Examples**: ▪ **Unity3D** or **Unreal Engine**: These are the most common game engines used to create virtual environments. ▪ **Oculus SDK**, **HTC Vive SDK**, or **OpenVR** for device-specific development. ▪ **ARCore** (for Android) or **ARKit** (for iOS) for augmented reality development.

C. 3D Modeling and Animation Software:

- To create content such as characters, environments, and objects within virtual environments.
  - **Examples**: Blender, Autodesk Maya, 3ds Max, Cinema 4D.

D. Simulation Software:

- For specialized virtual environments like **flight simulators**, **driving simulators**, or **medical training**.
  - **Examples**: X-Plane, Microsoft Flight Simulator, Simulink for engineering simulations.

E. Middleware (Optional):

- Middleware for managing multiple users or multi-user environments, as well as integrating with external systems.
  - **Examples**: Unity's Photon, Unreal's Multiplayer Networking, or other server solutions.

3. Network Requirements

A. Bandwidth and Latency:

- High-speed, low-latency internet is essential for streaming data (especially in multiplayer or online VR environments).
  - **Recommended**: 25 Mbps or higher for smooth data transmission in multiplayer environments.
  - **Minimum**: 10 Mbps, but latency should be kept under 50 ms for a good experience.

B. Local Network:

- If running on a local network (e.g., in a corporate setting or a VR gaming center), ensuring a fast and stable **Wi-Fi** or **Ethernet** connection is important for reducing lag or disconnections.
  - **Recommended**: Gigabit Ethernet or Wi-Fi 5/6 (802.11ac or 802.11ax).
  - **Minimum**: 100 Mbps Ethernet or 802.11n (Wi-Fi 4) for small applications.

4. Environmental Requirements

A. Space for Physical Movement (For VR):

- In some VR applications, the user needs sufficient physical space to move around. For room-scale VR (e.g., HTC Vive, Oculus Rift S), an area of at least **6.5 x 5 feet (2 x 1.5 meters)** is recommended for safe movement.
- **Clearance**: Ensuring there are no obstacles or hazards (e.g., furniture, cords) is essential for safety.

B. Lighting:

- The lighting conditions in the physical environment should be well-lit but not too bright or reflective, as this can interfere with the tracking systems of the VR headsets.
- **Optimal Lighting**: Even lighting, avoiding direct sunlight or excessive shadows, helps in motion and position tracking.

5. User Experience Considerations

A. Comfort and Accessibility:

- VR headsets and immersive systems should be adjustable and comfortable to wear for extended periods, with proper ergonomic design to prevent discomfort or fatigue.
- **Adjustable Headsets**: Should accommodate users with different head sizes and provide proper support for long sessions.

	B. Audio: • High-quality spatial or 3D audio is often a critical aspect of a fully immersive virtual environment. This requires either integrated speakers in the headset or external headphones to simulate sounds coming from specific directions within the virtual space. **6. Performance Optimization** • **Frame Rate**: VR environments typically require a frame rate of at least **90 frames per second (FPS)** to avoid motion sickness and ensure a smooth experience. o High-end systems might push beyond 120 FPS, depending on the complexity of the environment. • **Resolution**: High resolution (typically **1080p per eye or higher**) is essential to prevent pixelation and enhance immersion. • **Rendering Optimization**: Techniques like **foveated rendering**, where the focus area is rendered in higher detail than the peripheral areas, can help improve performance and reduce load on the GPU.
7 a	What is Augmented Reality? Give an example. **Augmented Reality (AR)** is a technology that overlays digital content—such as images, sounds, or other sensory enhancements—onto the physical world in real-time. Unlike **Virtual Reality (VR)**, which creates a completely immersive virtual environment, AR enhances the user's perception of the real world by adding interactive digital elements on top of it. AR typically requires a device such as a smartphone, tablet, or AR glasses to enable the overlay of virtual objects onto the physical world. Ex: Surgeons can use AR to overlay important information, such as 3D models of organs, during surgeries. Apps like **Microsoft HoloLens** can project visual guides onto the patient, assisting with precise operations and improving outcomes.
b	Elaborate on motivation and sampling theory in reinforcement learning
c	List and elaborate the various visualization techniques used in augmented reality
8	Case Study A local supermarket chain, “Fresh mart” is facing declining sales in the past three quarters. Fresh Mart focuses on produce (fresh fruits and vegetables), dairy products and bakery. Their high margin section is bakery as they bake bread, cakes and pastries in house. However, with the mushrooming of individual bakers, who operate from home, the sales of bakery goods have been declining. The management of Fresh Mart has hired you to help them resolve their challenges. The management has set the following objectives: - i) Predict whether a customer is likely to purchase a baked product (bread, cake, pastry) ii) Increase the customer purchases by interactions with the products iii) Use advanced technology to enhance customer experience of shopping at Fresh Mart Present the concept and application of the following algorithm to the management of Fresh Mart. a. Decision Tree Algorithm b. Reinforcement Learning c. Augmented Reality Provide adequate justifications to defend your presentation. a. Decision Tree Algorithm: Predict whether a customer is likely to purchase a baked product (such as bread, cake, or pastry) using a decision tree algorithm, you can follow these steps: **1. Collect Data**

	- Gather historical data on customer behavior, such as: - Customer demographics (age, gender, location, etc.) - Shopping habits (frequency of visits, spending patterns) - Previous purchase history (purchased items, frequency of purchase, etc.) - External factors (seasonality, holidays, promotions) - Customer preferences (preferences for specific baked goods) **2. Prepare the Data** - Clean the data by handling missing values, outliers, and duplicates. - Convert categorical data (like product type, season, etc.) into numerical values using techniques like one-hot encoding or label encoding. - Normalize numerical data (if necessary) to ensure consistency. b. Reinforcement Learning This can be done by giving different promotional offers & checking whether sales are happening or not. Depending on the positive sales, those promotions to be retained. c. Augmented Reality Whenever customers browse for products on the company app, enabling the AR tools so as to see the images of the store items on a dining table or serving area improves customer experience.