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Internal Assessment Test 3 – Jan 2024

Sub:	Introduction to Internet of Things (IOT)			Sub Code:	22ETC15H	Branch:	CSE,AIML,ISE, AIDS
Date:	05-1-2024	Duration:	90 Minutes	Max Marks: 50	Sec:	I A-F	OBE

	Answer any FIVE FULL Questions	MARKS	CO	RBT
1.	What is virtualization? How is it useful for end users? Explain the types of virtualizations.	[10]	CO2	L2

Virtualization is the "creation of a virtual (rather than actual) version of something, such as a server, a desktop, a storage device, an operating system or network resources". Virtualization is a technique, which allows a computer to share a single physical instance of a hardware resources or an application among multiple customers and organizations.

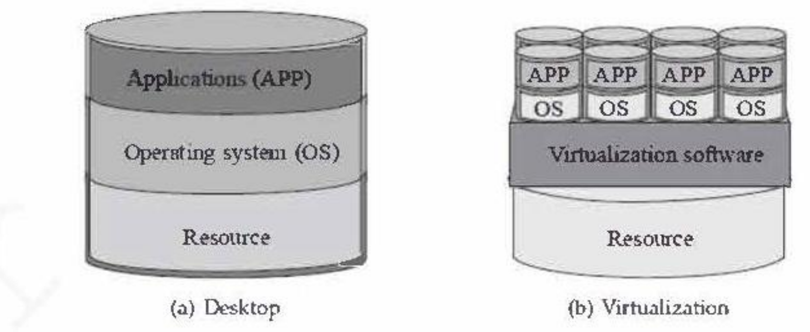

Figure 2.1 Traditional desktop versus virtualization

Figure 10.2 (a) represents a traditional desktop, where an application (App) is running on top of an OS, and resources are utilized only for that particular application. In figure 10.2(b) multiple resources are created that can be used by different end users through virtualization software (VMM- Virtual machine manager need to be installed on the system that need to be virtualized) . In virtualization a user perceives that the resource is unlimited and is dedicatedly provided to him/her.

The major advantages, from the perspective of the end user are:

Variety: The process of virtualization in cloud computing enables an end user organization to use various types of applications based on the requirements.

Availability: Virtualization creates a logical separation of the resources of multiple entities without any intervention of end users. Consequently, the concept of virtualization makes available a considerable amount of resources as per user requirements. The end users feel that there are unlimited resources present dedicatedly for him/her.

Portability: Portability signifies the availability of cloud computing services from anywhere in the world, at any instant of time. For example, a person flying from the US to the UK still has access to their documents, although they cannot physically access the devices on which the data is stored. This has been made possible by platforms such as Google Drive.

Elasticity: Through the concept of virtualization, an end user can scale-up or scale-down resource utilization as per requirements.

Types of virtualizations

Based on the requirements of the users, we categorized virtualization as shown in figure:

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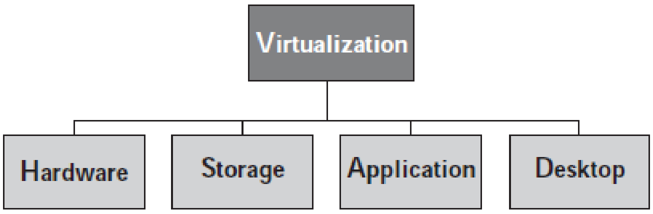

Figure 10.3 Types of virtualization

(i) Hardware Virtualization: This type of virtualization indicates the sharing of hardware resources among multiple users. For example, a single processor appears as many different processors in a cloud computing architecture. Different operating systems can be installed in these processors and each of them can work as stand-alone machines.

(ii) Storage Virtualization: In storage virtualization, the storage space from different entities are accumulated virtually, and seem like a single storage location. Through storage virtualization, a user's documents or files exist in different locations in a distributed fashion. However, the users are under the impression that they have a single dedicated storage space provided to them.

(iii) Application Virtualization: A single application is stored at the cloud end. However, as per requirement, a user can use the application in his/her local computer without ever actually installing the application. Similar to storage virtualization, in application virtualization, the users get the impression that applications are stored and executed in their local computer.

(iv) Desktop Virtualization: This type of virtualization allows a user to access and utilize the services of a desktop that resides at the cloud. The users can use the desktop from their local desktop.
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<tr><td>2.</td><td>
Explain different cloud models.

As per the National Institute of Standards and Technology (NIST) and Cloud Computing Standards Roadmap Working Group, the cloud model can be divided into two parts: (1) Service model and (2) Deployment model as shown in Figure 10.4. Further the service model is categorized as: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). On the other hand, the deployment model is further categorized as: Private cloud, Community cloud, Public cloud, and Hybrid cloud.

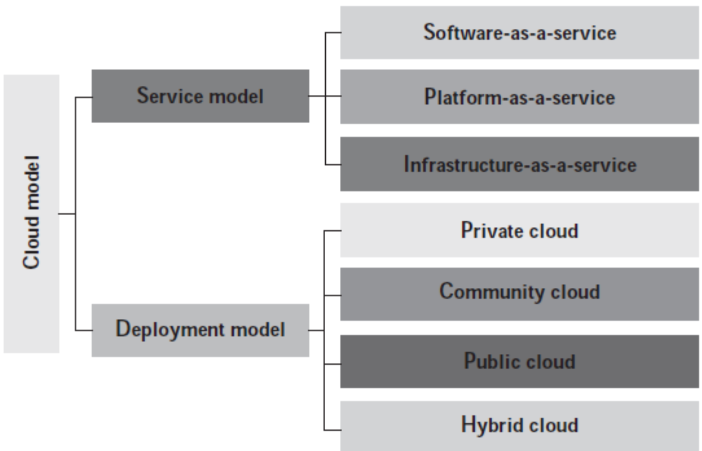

Figure 10.4 Cloud model

(i) Service Model

The service model is depicted in Figure 10.5.

(a) Software-as-a-Service (SaaS): This service provides access to different software applications to an end user through Internet connectivity. For accessing the service, a user does not need to purchase and install the software applications on his/her local desktop. The software is located in a cloud server, from where the services are provided to multiple end users. SaaS offers scalability, by which users have the provision to use multiple software applications as per their requirements. Additionally, a user does not need to worry about the update of the software applications. These software are accessible from any location. One example of SaaS is Microsoft Office 365.
</td><td>[10]</td><td>CO2</td><td>L2</td></tr>
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(b) Platform-as-a-Service (PaaS): PaaS provides a computing platform, by which a user can develop and run different applications. The cloud user need not go through the burden of installing and managing the infrastructure such as operating system, storage, and networks. However, the users can develop and manage the applications that are running on top of it. An example of PaaS is Google App Engine.

(c) Infrastructure-as-a-Service (IaaS): IaaS provides infrastructure such as storage, networks, and computing resources. A user uses the infrastructure without purchasing the software and other network components. In the infrastructure provided by a CSP, a user can use any composition of the operating system and software. An example of IaaS is Google Compute Engine.

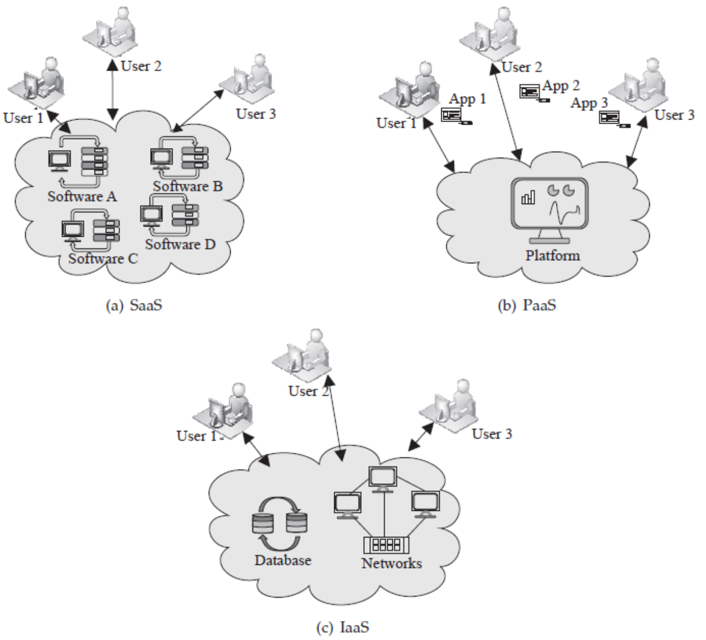

Figure 10.5 Service models

(ii) Deployment Model

(a) Private Cloud: This type of cloud is owned explicitly by an end user organization. The internal resources of the organization maintain the private cloud.

(b) Community Cloud: This cloud forms with the collaboration of a set of organizations for a specific community. For a community cloud, each organization has some shared interests.

(c) Public Cloud: The public cloud is owned by a third party organization, which provides services to the common public. The service of this cloud is available for any user, on a payment basis.

(d) Hybrid Cloud: This type of cloud comprises two or more clouds (private, public, or community).

3.	With a neat diagram explain the architecture of a sensor cloud platform.	[10]	CO2	L2

In a traditional cloud computing architecture, two actors, cloud service provider (CSP) and end users (customer) play the key role. Unlike cloud computing, in sensor-cloud architecture, the sensor owners play an important role along with the service provider and end users. However, a service provider in sensor-cloud architecture is known as a sensor-cloud service provider (SCSP). The detailed architecture of a sensor-cloud is depicted in Figure 10.7.

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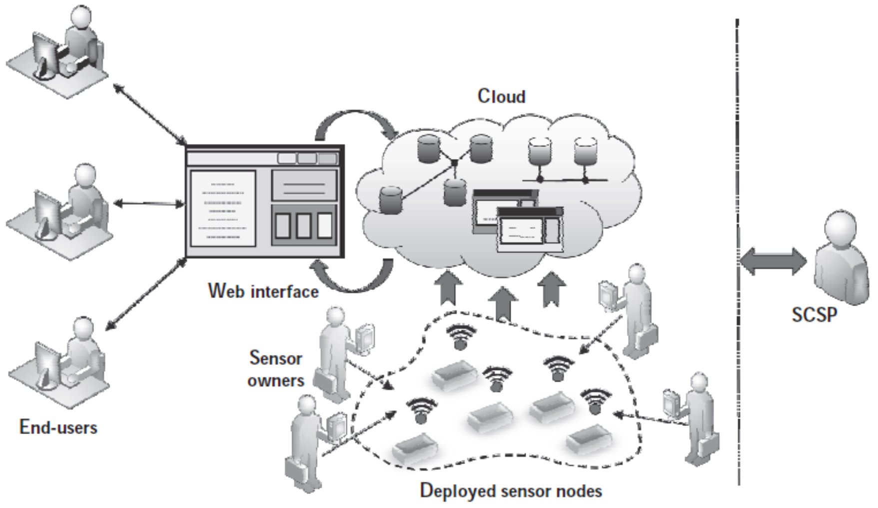
<tr><td></td><td>

Figure 10.7 Architecture of a sensor-cloud platform
Typically, in a sensor-cloud architecture, three actors are present. We briefly describe the role of each actor.
(i) End User: This actor is also known as a customer of the sensor-cloud services. Typically, an end user registers him/herself with the infrastructure through a Web portal. Thereafter, he/she chooses the template of the services that are available in the sensor-cloud architecture to which he/she is registered. Finally, through the Web portal, the end user receives the services, as shown in Figure 10.7. Based on the type and usage duration of service, the end user pays the charges to the SCSP.
(ii) Sensor Owner: We have already discussed that the sensor-cloud architecture is based on the concept of Se-aaS. Therefore, the deployment of the sensors is essential in order to provide services to the end users. These sensors in a sensorcloud architecture are owned and deployed by the sensor owners, as depicted in Figure 10.7. A particular sensor owner can own multiple homogeneous or heterogeneous sensor nodes. Based on the requirements of the users, these
sensor nodes are virtualized and assigned to serving multiple applications at the same time. On the other hand, a sensor owner receives rent depending upon the duration and usage of his/her sensor node(s).
(iii) Sensor-Cloud Service Provider (SCSP): An SCSP is responsible for managing the entire sensor-cloud infrastructure (including management of sensor owners and end users handling, resource handling, database management, cloud handling etc.), centrally. The SCSP receives rent from end users with the help of a pre-defined pricing model. The pricing scheme may include the infrastructure cost, sensor owners' rent, and the revenue of the SCSP. Typically, different algorithms are used for managing the entire infrastructure. The SCSP receives the rent from the end users and shares a partial amount with the sensor owners. The remaining amount is used for maintaining the infrastructure. In the process, the SCSP earns a certain amount of revenue from the payment of the end users.</td><td></td><td></td><td></td></tr>
<tr><td>4.</td><td>What are the different components of an Agricultural IoT?
The development of an agricultural IoT has helped farmers enhance crop productivity and reduce the overhead of manual operations of the agricultural equipment in the fields. Different components such as analytics, drone, cloud computing, sensors, hand-held devices, and wireless connectivity enable agricultural IoT as depicted in Figure 12.2.</td><td>[10]</td><td>CO2</td><td>L2</td></tr>
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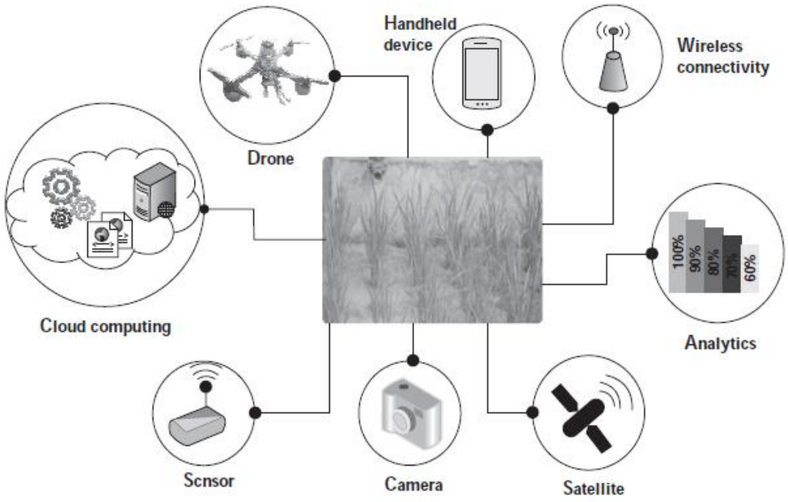


Figure 12.2 Components of agricultural IoT

The different components of an agricultural IoT are discussed as follows:

• Cloud computing: Sensors such as the camera, devices to measure soil moisture, soil humidity, and soil pH-level are used for serving different agricultural applications. These sensors produce a huge amount of agricultural data that need to be analyzed. Sometimes, based on the data analysis, action needs to be taken, such as switching on the water pump for irrigation. Further, the data from the deployed sensors are required to be stored on a long-term basis since it may be useful for serving future applications. Thus, for agricultural data analysis and storage, the cloud plays a crucial role.

• Sensors: In previous chapters, we already explored different types of sensors and their respective requirements in IoT applications. We have seen that the sensors are the major backbone of any IoT application. Similarly, for agricultural IoT applications, the sensors are an indispensable component. A few of the common sensors used in agriculture are sensors for soil moisture, humidity, water level, and temperature.

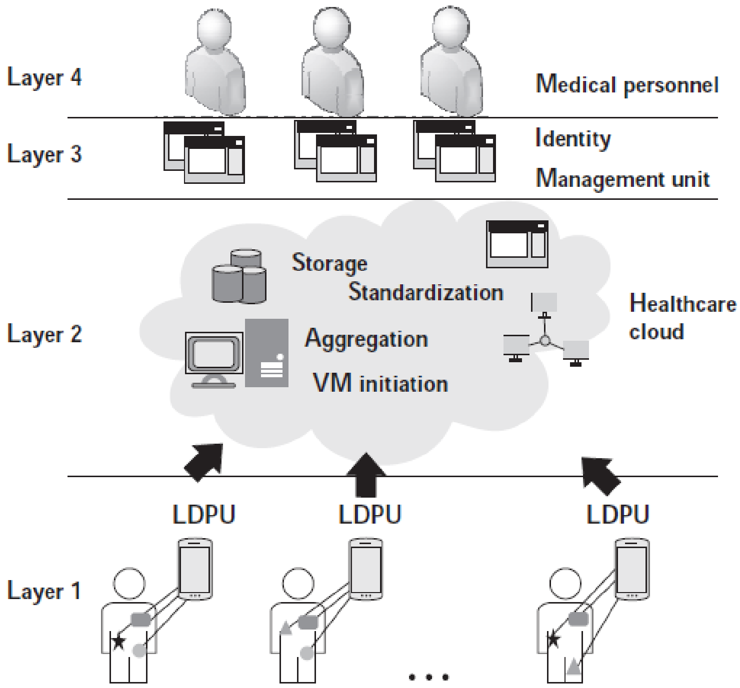
• Cameras: Imaging is one of the main components of agriculture. Therefore, multispectral, thermal, and RGB cameras are commonly used for scientific agricultural IoT. These cameras are used for estimating the nitrogen status, thermal stress, water stress, and crop damage due to inundation, as well as infestation. Video cameras are used for crop security. • Satellites: In modern precision agriculture, satellites are extensively used to extract information from field imagery. The satellite images are used in agricultural applications to monitor different aspects of the crops such as crop health monitoring and dry zone assessing over a large area.

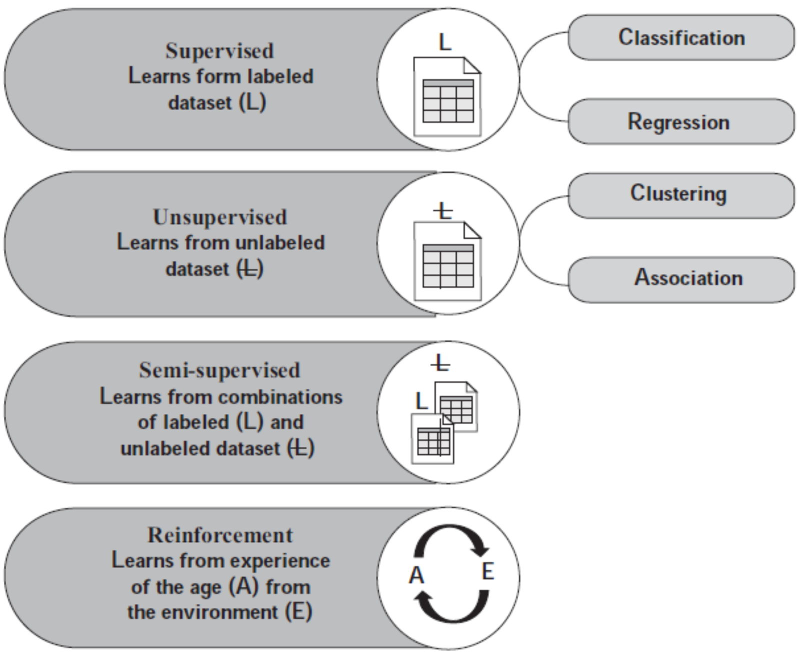
• Analytics: Analytics contribute to modern agriculture massively. Currently, with the help of analytics, farmers can take different agricultural decisions, such as estimating the required amount of fertilizer and water in an agricultural field and estimating the type of crops that need to be cultivated during the upcoming season. Moreover, analytics is not only responsible for making decisions locally; it is used to analyze data for the entire agricultural supply chain. Data analytics can also be used for estimating the crop demand in the market.

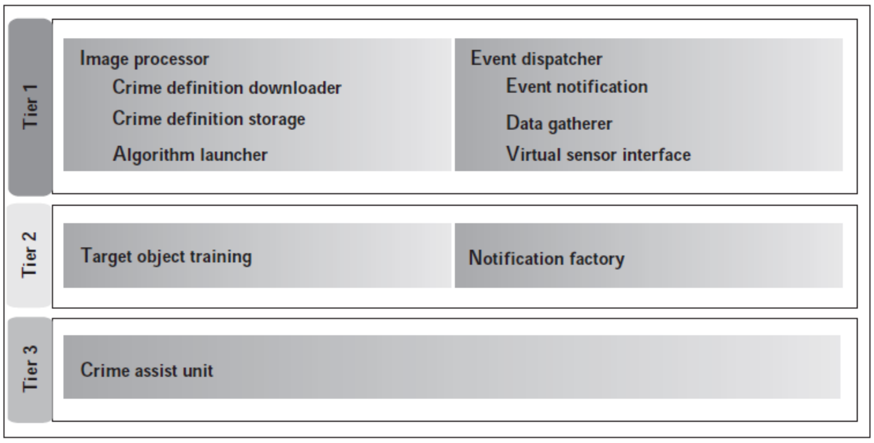
• Wireless connectivity: One of the main components of agricultural IoT is wireless connectivity. Wireless connectivity enables the transmission of the agricultural sensor data from the field to the cloud/server. It also enables farmers to access various application services over handheld devices, which rely on wireless connectivity for communicating with the cloud/server.

• Handheld devices: Over the last few years, e-agriculture has become very popular. One of the fundamental components of e-agriculture is a handheld device such as a smartphone. Farmers can access different agricultural information, such as soil and crop conditions of their fields and market tendency, over their smartphones. Additionally, farmers can also control different field equipment, such as pumps, from their phones.

• Drones: Currently, the use of drones has become very attractive in different applications such as surveillance, healthcare, product delivery, photography, and agriculture. Drone imaging is an alternative to satellite imaging in

	agriculture. In continuation to providing better resolution land mapping visuals, drones are used in agriculture for crop monitoring, pesticide spraying, and irrigation.			
5.	Explain the hardware components of front-end design features of AmbuSense system. The AmbuSens system is equipped with different physiological sensors along with a local hub. These sensors sense the physiological parameters from the patient's body and transmit those to a local data processing unit (LDPU). The physiological sensors and LDPU form a wireless body area network (WBAN). Further, this local hub forwards the physiological data to the cloud for storing and analyzing the health parameters. Finally, the data are accessed by different users. The detailed layered architecture of the AmbuSens system is depicted in Figure 14.4.  **Figure 14.4** Layered architecture of AmbuSens In the AmbuSens system, a variety of hardware components are used such as sensors, communication units, and other computing devices. • Sensors: The sensors used in the AmbuSens system are non-invasive. The description of the sensors used for forming the WBAN in the AmbuSens system are as follows: (i) Optical Pulse Sensing Probe: It senses the photoplethysmogram (PPG) signal and transmits it to a GSR expansion module. Typically, PPG signals are sensed from the ear lobe, fingers, or other location of the human body. Further, the GSR expansion module transfers the sensed data to a device in real-time. (ii) Electrocardiogram (ECG) unit and sensor: The ECG module used in ambuSens is in the form of a kit, which contains ECG electrodes, biophysical 9" leads, biophysical 18" leads, alcohol swabs, and wrist strap. Typically, the ECG sensor measures the pathway of electrical impulses through the heart to sense the heart's responses to physical exertion and other factors affecting cardiac health. (iii) Electromyogram (EMG) sensor: This sensor is used to analyze and measure the biomechanics of the human body. Particularly, the EMG sensor is used to measure different electrical activity related to muscle contractions; it also assesses nerve conduction, and muscle response in injured tissue. (iv) Temperature sensor: The body temperature of patients changes with the condition of the body. Therefore, a temperature sensor is included in the AmbuSens system, which can easily be placed on the body of the patient. (v) Galvanic Skin Response (GSR) sensor: The GSR sensor is used for measuring the change in electrical characteristics of the skin. In the AmbuSens system, three actors—doctor, paramedic/nurse, and patient—are able to participate and use the services. The web interface is designed as per the requirements of the actors of the system. Each of the actors	[10]	CO3	L2

	has an option to log in and access the system. The confidentiality of a patient and their physiological data is important in a healthcare system. Therefore, the system provides different scopes for data accessibility based on the category of an actor. For example, the detailed health data of a patient is accessible only to the assigned doctor. These data may not be required for the nurse; therefore, a nurse is unable to access the same set of data a doctor can access. The system provides the flexibility to a patient to log in to his/her account and download the details of his/her previous medical/treatment details. Therefore, in AmbuSens, the database is designed in an efficient way such that it can deliver the customized data to the respective actor. Each of the users must register with the system to avail of the service of the AmbuSens. Therefore, in this system, the registration process is also designed in a customized fashion, that is, the details of a user to be entered into the registration form is different for different actors. For example, a doctor must enter his/her registration number in the registration form.			
6.	Explain the four categories of Machine Learnings. Typically, ML algorithms consist of four categories: (i) Supervised (ii) Unsupervised(iii) Semi-supervised (iv) Reinforcement Learning **Supervised Learning:** This type of learning supervises or directs a machine to learn certain activities using labeled datasets. The labeled data are used as a supervisor to make the machine understand the relation of the labels with the properties of the corresponding input data.  **Figure 17.2** Types of ML **Unsupervised Learning:** Unsupervised learning algorithms use unlabeled datasets to find scientific trends. ML algorithms in this category try to identify the nature and properties of the input equation and the nature of the formulae responsible for solving it. Unsupervised learning algorithms try to create different clusters based on the features of the formulae and relate it with the input equations. Unsupervised learning is usually applied to solve two types of problems: clustering and association. Clustering divides the data into multiple groups. In contrast, association discovers the relationship or association among the data in a dataset. **Semi-Supervised Learning:** Semi-supervised learning belongs to a category between supervised and unsupervised learning. Algorithms under this category use a combination of both labeled and unlabeled datasets for training. Labeled data are typically expensive and are relatively difficult to label correctly. Unlabeled data is less expensive than labeled data. Therefore, semi-supervised learning includes both labeled and unlabeled dataset to design the learning model. Traditionally, semi-supervised learning uses mostly unlabeled data,	[10]	CO3	L2

	which makes it efficient to use, and capable of overcoming samples with missing labels. **Reinforcement Learning:** Reinforcement learning establishes a pattern with the help of its experiences by interacting with the environment. Consequently, the agent performs a crucial role in reinforcement learning models. It aims to achieve a particular goal in an uncertain environment. Typically, the model starts with an initial state of a problem, for which different solutions are available. Based on the output, the model receives either a reward or a penalty from the environment. The output and reward act as inputs for proceeding to the next state. Thus, reinforcement learning models continue learning iteratively from their experiences while inducing correctness to the output.			
7.	Explain fog framework for intelligent public safety in vehicular environment FISVER with block diagram. The architecture of the fog-FISVER consists of different IoT components. Moreover, the developers utilized the advantages of the low-latency fog computing architecture for designing their system. Fog-FISVER is based on a three-tiered architecture, as shown in Figure 13.4. We will discuss each of the tiers as follows:  **Figure 13.4** Architecture of Fog-FISVER (i) Tier1—In-vehicle FISVER STS Fog: In this system component, a fog node is placed for detecting criminal activities. This tier accumulates the real sensed data from within the vehicle and processes it to detect possible criminal activities inside the vehicle. Further, this tier is responsible for creating crime-level metadata and transferring the required information to the next tier. For performing all the activities, Tier 1 consists of two subsystems: Image processor and event dispatcher • Image Processor: The image processor inside Tier 1 is a potent component, which has a capability similar to the human eye for detecting criminal activities. Developers of the system used a deep-learning-based approach for enabling image processing techniques in the processor. To implement the fog computing architecture in the vehicle, a Raspberry-Pi-3 processor board is used, which is equipped with a high-quality camera. Further, this architecture uses template matching and correlation to detect the presence of dangerous articles (such as a pistol or a knife) in the sub-image of a video frame. Typically, the image processor stores a set of crime object templates in the fog-FISVER STS fog infrastructure, which is present in Tier 2 of the system. The image processor is divided into the following three parts: (a) Crime definition downloader: This component periodically checks for the presence of new crime object template definitions in fog-FISVER STS fog infrastructure. If a new crime object template is available, it is stored locally. (b) Crime definition storage: In order to use template matching, the crime object template definition is required to be stored in the system. The crime definition storage is used to store all the possible crime object template definitions. (c) Algorithm launcher: This component initiates the instances of the registered algorithm in order to match the template with the video captured by the camera attached in the vehicles. If a crime object is matched with the video, criminal activity is confirmed.	[3+7]	CO3	L2

	• Event dispatcher: This is another key component of Tier 1. The event dispatcher is responsible for accumulating the data sensed from vehicles and the image processor. After the successful detection of criminal activity, the information is sent to the fog-FISVER STS fog infrastructure. The components of the event dispatcher are as follows: (a) Event notifier: It transfers the data to the fog-FISVER STS fog infrastructure, after receiving it from the attached sensor nodes in the vehicle. (b) Data gatherer: This is an intermediate component between the event notifier and the physical sensor; it helps to gather sensed data. (c) Virtual sensor interface: Multiple sensors that sense data from different locations of the vehicle are present in the system. The virtual sensor interface helps to maintain a particular procedure to gather data. This component also cooperates to register the sensors in the system. (ii) Tier 2—FISVER STS Fog Infrastructure: Tier 2 works on top of the fog architecture. Primarily, this tier has three responsibilities—keep updating the new object template definitions, classifying events, and finding the most suitable police vehicle to notify the event. FISVER STS fog infrastructure is divided into two sub-components: • Target Object Training: Practically, there are different types of crime objects. The system needs to be up-to-dated regarding all crime objects. This subcomponent of Tier 2 is responsible for creating, updating, and storing the crime object definition. The algorithm launcher uses these definitions in Tier 1 for the template matching process. The template definition includes different features of the crime object such as color gradient and shape format. A new object definition is stored in the definition database. The database requires to be updated based on the availability of new template definitions. • Notification Factory: This sub-component receives notification about the events in a different vehicle with the installed system. Further, this component receives and validates the events. In order to handle multiple events, it maintains a queue. (iii) Tier 3 consists of mobile applications that are executed on the users' devices. The application helps a user, who witnesses a crime, to notify the police.			

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