

Internet of Things

Assessment Questionnaire

HSSC-1 - IOT AND DATA CODING

Conceptual Questions

QS: What is the primary purpose of IoT data analysis?

Ans: To find patterns in raw sensor noise using software.

QS: What does ML stand for in the context of IoT?

Ans: Machine Learning.

QS: Which programming language is widely considered the #1 choice for IoT data analysis?

Ans: Python.

QS: What is the function of the Pandas library in Python?

Ans: It is used for loading and organizing data, similar to a digital Excel sheet.

QS: Which Python library is specifically used to run Machine Learning algorithms?

Ans: Scikit-Learn.

QS: What is a "DataFrame" in Python?

Ans: A digital table that Python can read, usually created from a .csv file.

QS: Why is "Cleaning Data" the first step in the Machine Learning workflow?

Ans: Because real sensors are messy and might give NaN (Not a Number) errors or impossible values.

QS: What percentage of data is typically used for the "Training Set"?

Ans: 80%.

QS: What is the purpose of the "Testing Set"?

Ans: To test if the trained model can correctly predict the answers using hidden data.

QS: How is "Predictive Analytics" defined?

Ans: It is the use of historical data to predict future events.

QS: What is "Predictive Maintenance"?

Ans: Analyzing sensor data to predict when a machine will break so it can be fixed beforehand.

QS: What do sensors act as in an IoT system?

Ans: They act as the "skin," allowing the system to feel the physical world.

QS: What does a humidity sensor measure?

Ans: It measures the amount of water vapor in the air.

QS: Name a sensor module that measures both temperature and humidity simultaneously.

Ans: The DHT11 or DHT22.

QS: How does a thermistor measure temperature?

Ans: A resistor inside the sensor changes its resistance based on heat.

QS: What does the VCC pin on a sensor connect to?

Ans: It connects to 3.3V or 5V for power.

QS: What is the purpose of the GND pin?

Ans: It connects to Ground to complete the electrical circuit.

QS: What does the DHT.h library do?

Ans: It translates the sensor's complex digital signals into readable numbers.

QS: What operating system does a Raspberry Pi typically run?

Ans: Linux.

QS: What is the Thonny IDE used for on a Raspberry Pi?

Ans: It is a pre-installed program for writing Python code.

QS: Which Python library helps talk to the DHT sensor on a Raspberry Pi?

Ans: The Adafruit_DHT library.

QS: How do you tell Python to pause between sensor readings?

Ans: By using the time library.

QS: How can you store multiple temperature readings in Python to analyze them later?

Ans: By storing them in a Python List.

QS: Which Python function finds the hottest temperature in a recorded list?

Ans: The max() function.

QS: Which Python function finds the coldest temperature in a recorded list?

Ans: The min() function.

QS: Define "Real-Time Data."

Ans: Information that is delivered immediately after it is collected, without significant delay.

QS: What does "Continuous Sensing" mean?

Ans: A sensor stays awake and reads the environment constantly.

QS: What is a "Threshold" in real-time IoT processing?

Ans: A limit that the software compares incoming numbers against.

QS: What is the primary difference between monitoring and automation?

Ans: Monitoring is just watching data, while automation is the system taking action based on that data.

QS: How does real-time data improve safety?

Ans: It allows for instant reactions in emergencies, like gas leaks, where milliseconds matter.

QS: What is Home Automation?

Ans: The use of technology to control and monitor home appliances remotely or automatically.

QS: What are the three main pillars of a home automation system?

Ans: Sensors (Senses), Microcontrollers (Brain), and Actuators (Muscles).

QS: What does a PIR sensor detect?

Ans: It detects motion based on human body heat.

QS: What is an LDR used for in smart homes?

Ans: It detects light intensity, often used for automatically turning on porch lights.

QS: Why is a standard Arduino Uno limited for smart home applications?

Ans: It does not have built-in Wi-Fi, making it better for offline automation.

QS: What advantage do ESP8266 and ESP32 microcontrollers have?

Ans: They have built-in Wi-Fi, allowing connection to the internet and remote mobile app control.

QS: Why is it dangerous to connect a standard home appliance directly to a microcontroller?

Ans: Microcontrollers operate on a safe 5 Volts, while home appliances operate on a dangerous 220 Volts.

QS: What component solves the voltage difference problem in home automation?

Ans: A Relay Module.

QS: What is a Relay Module? Ans: It is an electrically operated switch that uses a small 5V signal to turn on a massive 220V circuit.

QS: In a smart lighting workflow, what happens immediately after the PIR sensor detects motion?

Ans: The PIR sends a HIGH signal, and the microcontroller reads it to trigger the relay.

Comprehensive Questions

QS: Explain the difference between writing strict rules and using Machine Learning for IoT data analysis.

Ans: Writing strict rules involves coding specific limits, such as IF temp > 30. Machine Learning, instead, feeds raw data into an algorithm so the computer learns independently what normal and abnormal patterns look like without explicit programming.

QS: Describe the two main steps involved in the Machine Learning workflow for sensor data.

Ans: The first step is Cleaning Data, which involves writing code to remove impossible values or NaN errors from messy sensor readings. The second step is Splitting Data, where 80% is used as a Training Set for the model to study patterns, and 20% is hidden as a Testing Set to verify its predictions.

QS: How does Predictive IoT differ from Reactive IoT? Provide an example.

Ans: Reactive IoT triggers an action only after an event occurs, like turning on an AC after a room gets hot. Predictive IoT uses historical data to take action before the event happens, such

as turning on the AC at 2 PM because the model knows the sun will hit the window and raise the temperature.

QS: Explain the working principle of a capacitive humidity sensor.

Ans: A capacitive humidity sensor relies on a moisture-holding component. As the humidity in the air rises or falls, this component changes its electrical capacity. An internal chip then converts these analog changes into digital data that a microcontroller can read.

QS: Detail the hardware connection paths required to wire a DHT11 sensor to an Arduino.

Ans: The sensor requires three main connections. The VCC pin must be connected to a 3.3V or 5V power source. The GND pin must be connected to the Ground on the Arduino. Finally, the DATA or OUT pin must be connected to a digital GPIO pin to transmit the signal.

QS: What are the three key reasons a Raspberry Pi is beneficial for data collection compared to a standard microcontroller?

Ans: First, it operates as a full computer running a Linux operating system. Second, it can run powerful Python scripts directly on the device. Third, it has the capability to store collected data locally into files for later analysis.

QS: Describe how you would write a Python script on a Raspberry Pi to continuously monitor temperature.

Ans: You first import the Adafruit_DHT library to talk to the sensor and the time library to pause between readings. You then write a repeating loop using sensor.read() to fetch the temperature and humidity. Finally, you use the print() command to output the results to the screen continuously.

QS: Why is basic analysis, like calculating the average of a temperature list, important in IoT?

Ans: Raw numbers on their own are just noise. By storing readings in a list and analyzing them—such as calculating the average to see the general temperature—you turn raw numbers into useful information. This information helps the system make intelligent decisions, like turning on a fan if the average becomes too high.

QS: Outline the four-step step-by-step process of developing a real-time IoT application.

Ans: The process starts with Continuous Sensing, where the sensor constantly reads the environment. Next is Instant Transmission, sending the data immediately to a processor without storing it. Third is Threshold Checking, comparing the incoming number to a preset limit. Finally, Immediate Action occurs, triggering an automatic response if the limit is crossed.

QS: How does real-time data serve as the "fuel" for system automation?

Ans: Automation means a machine works by itself without human intervention. Without real-time data, a human must monitor a gauge and manually press a button. Real-time data acts as fuel because it allows the system to instantly "see" environmental changes and "press the button" automatically based on current reality.

QS: Explain the real-world example of a Smart Irrigation System.

Ans: In a smart irrigation system, a soil moisture sensor continuously checks the ground and sends the moisture level (e.g., 20%) to a controller. The code checks this data against a threshold (e.g., is it less than 40%). If true, the system automatically triggers the water pump, ensuring plants get water exactly when needed.

QS: Describe the "Anatomy of a Smart Home System" using the human body analogy.

Ans: The system has three pillars. Sensors act as the "Senses" (input devices) to gather environmental data. The Microcontroller acts as the "Brain" (processing unit) to read data and make decisions based on code. Actuators act as the "Muscles" (output devices) to perform physical actions like locking doors or switching lights.

QS: What is the main difference between an Arduino Uno and an ESP8266 in smart home architecture?

Ans: An Arduino Uno is great for learning basic logic but lacks built-in Wi-Fi, restricting it to offline automation. An ESP8266 or ESP32 is a specialized microcontroller with built-in Wi-Fi, allowing the system to connect to the internet so you can control your home from a mobile app anywhere.

QS: Provide three examples of sensors used in home automation and explain their specific use cases.

Ans: A PIR sensor detects human body heat and is used for security alarms or triggering lights when someone enters a room. An LDR detects light intensity and is used to automatically turn on porch lights at night. A DHT11 detects temperature and is used to automatically turn on a fan when the room exceeds a certain heat level.

QS: Explain the safety mechanism of a Relay Module in home automation.

Ans: Microcontrollers run on a low-power 5V signal, which is insufficient and dangerous to connect directly to 220V home appliances. A Relay Module solves this by using the safe 5V signal from the microcontroller to magnetically "click" a switch. This physically isolates the low-power brain from the high-power appliance while allowing it to turn the 220V circuit on.

QS: Detail the complete logic workflow of a smart light triggered by a PIR sensor.

Ans: The workflow begins when the PIR sensor detects motion and sends a HIGH signal (Input). The ESP8266 microcontroller reads this signal, and the programmed code checks if motion is detected (Processing). If true, the microcontroller sends a 5V signal from a specific pin to the Relay Module (Output). The Relay then switches on the 220V circuit, causing the light bulb to glow.

QS: How is a trained Machine Learning model evaluated for accuracy?

Ans: After the algorithm studies the training data, it is asked to predict outcomes for the hidden "Test Set" using the command `predictions = model.predict(X_test)`. These generated predictions are then compared directly against the actual, real values (`Y_test`) to evaluate how close and accurate the model's logic was.

QS: What is the purpose of importing libraries in Python, specifically for IoT applications?

Ans: Python libraries are packages of pre-written code. They do the hard math and translate complex raw electrical signals from sensors into readable numbers. This saves developers from having to write complex, low-level instructions from scratch just to communicate with the hardware.

QS: How does real-time data transmission differ from data logging?

Ans: In real-time data transmission, the microcontroller sends the sensor reading immediately to the cloud or processor for instant analysis. It intentionally does not store the data for later, ensuring there is zero delay in checking thresholds and triggering emergency actions. Data logging, conversely, records and stores data into files to be looked at and analyzed later.

QS: What is the ultimate goal of combining IoT sensors with Machine Learning?

Ans: The goal is to move systems from simple monitoring to intelligent prediction. By giving systems "eyes" through sensors and a "brain" through Machine Learning, environments can become proactive, anticipating needs and fixing problems before they occur, rather than just reacting after the fact.