Assignment 10

Task 1

a)

The wifiScan method in WifiLocation class is responsible for initiating and managing WiFi scans.

1. WiFi Manager Initialization: The method initializes the WiFi manager which is an Android system service used to manage WiFi connectivity.
2. BroadcastReceiver Registration: It registers a BroadcastReceiver to listen for WiFi scan results. This receiver is triggered when a WiFi scan is completed.
3. Start WiFi Scan: The method calls the startScan method on the WiFi manager to begin the WiFi scanning process. This triggers the WiFi hardware to start scanning for available WiFi networks.
4. Handle Scan Results: Once the scan is completed, the BroadcastReceiver retrieves the scan results from the WiFi manager. These results contain information about the available WiFi networks, including SSID, BSSID (MAC address), and RSSI (signal strength).
5. Process and Store Results: The scan results are processed and stored as fingerprints in the local SQLite database. Each fingerprint includes the BSSID and RSSI for each access point detected during the scan.

d) The bestMatch method aims to determine the user's current location by comparing the current WiFi scan results with previously stored fingerprints. Here are the steps involved in the method:

1. Compute Distances:
    - For each stored fingerprint, compute the distance to the current fingerprint (the one obtained from the latest WiFi scan). This distance is typically calculated using a distance metric like Euclidean distance, which quantifies how similar or different the fingerprints are.
2. Sort by Distance:
    - Sort the list of fingerprints based on the computed distances in ascending order. The closer (or smaller the distance), the more similar the fingerprints are.
3. K-Nearest Neighbors (K-NN):
    - Use the K-Nearest Neighbors algorithm to find the most probable location. In this case, k is set to 3, meaning the algorithm looks at the 3 closest fingerprints.

- Each of the 3 nearest fingerprints casts a vote for its location.

4. Vote Counting:
    - Count the votes for each location from the 3 nearest neighbors.
    - The location with the highest score (most votes) is selected as the best match.
5. Update Current Location:
    - Update the currentLocation variable with the best-matched location.

Task 2

a)

Objective: Determine the accuracy of the app's location determination using WiFi fingerprinting in two different environments: an apartment and a residential street.

Procedure:

1. **Preparation:**
    - Select 4 distinct locations within the apartment and 4 locations on the residential street.
    - Ensure locations are at least 5 meters apart to avoid overlapping WiFi signals.
2. **Data Collection:**
    - For each selected location, collect 3-5 WiFi fingerprints using the app. Each fingerprint consists of the BSSID and RSSI values for detected access points.
    - Repeat the scanning process at different times of the day to capture variations in WiFi signal strengths.
3. **Implementation:**
    - Use the app's measurement screen to record fingerprints. Select the appropriate location using the provided radio buttons.
    - Store each fingerprint by pressing the "Store Fingerprint" button. Ensure at least 3 fingerprints are stored for each location.
    - Log the collected fingerprints using the "Log Fingerprints" button and save the Logcat output to a text file.
4. **Data Evaluation:**

- Use the locate screen to determine the current location based on real-time scans.
- Perform multiple location determination tests.
- Calculate the accuracy.

Evaluation Metrics:

- **Accuracy:** Percentage of correctly identified locations.
- **Error Distance:** Average distance between the predicted location and the actual location if the prediction is incorrect.

b)

Sample Data:

- We have fingerprints from 4 different locations.
- Each location has multiple fingerprints with BSSID (MAC address) and RSSI (signal strength) values.

Example Data (excerpts):

Location 1:

00:2a:10:26:b5:80 : -82, 00:2a:10:26:b5:81 : -80, 00:2a:10:26:b5:8d : -79, ...

Location 2:

00:2a:10:26:b5:81 : -79, 00:2a:10:26:b5:8d : -83, 00:2a:10:26:b5:8e : -84, ...

Location 3:

00:2a:10:26:b5:81 : -79, 00:2a:10:26:b5:8d : -83, 00:2a:10:26:b5:8e : -84, ...

Location 4:

10:a8:29:5b:a6:41 : -84, 10:a8:29:5b:a6:42 : -84, 34:5d:a8:43:44:80 : -62, ...

Steps for Analysis:

1. **Compare Fingerprints for Similarity:**
   - We Identify unique BSSIDs (MAC addresses) common to multiple locations.
   - Then, we compare RSSI values for common BSSIDs across different fingerprints.
2. **Distance Calculation:**
   - We use Euclidean distance or another metric to calculate the difference between the current scan and stored fingerprints.

- The location with the smallest distance is the predicted location.

Example Calculation:

We take an example with simplified fingerprints for two locations.

Location 1:

00:2a:10:26:b5:80 : -82, 00:2a:10:26:b5:81 : -80, 00:2a:10:26:b5:8d : -79

Location 2:

00:2a:10:26:b5:81 : -79, 00:2a:10:26:b5:8d : -83, 00:2a:10:26:b5:8e : -84

Current Scan:

00:2a:10:26:b5:80 : -83, 00:2a:10:26:b5:81 : -78, 00:2a:10:26:b5:8d : -80

c)

1. **How accurately can the location within an apartment be determined with your app?**
    - The accuracy within the apartment can be relatively high. The Euclidean distance calculations for different locations show that distinct RSSI patterns can help identify the correct location. For example, if the average distance for correct predictions is significantly lower than incorrect ones, the accuracy can be considered good.
2. **How accurately can your app determine the location on a street within a residential area?**
    - Accuracy on a residential street might be lower compared to within an apartment. This is due to more variable signal strengths, potential interference, and fewer distinct WiFi signals. The log data would need to show a clear pattern of lower accuracy or higher error distances for street locations compared to apartment locations.
3. **What factors influence the accuracy of positioning via WiFi fingerprinting?**
    - **Signal Strength Variations:** Differences in RSSI values due to obstacles, signal reflections, and interference.
    - **Number of Access Points:** More access points generally improve accuracy.
    - **Time of Day:** Signal strength can vary at different times, affecting accuracy.
    - **Environmental Changes:** Movement of objects or people can affect signal strength.

d)

Justification:

- **Yes, the experiment clarifies the research questions to an extent.** The analysis of the fingerprint data provides insights into how accurately the app can determine locations in different environments. By comparing the distances between the current scan and stored fingerprints, we can infer the accuracy.

Improvements:

- **Increase the Number of Fingerprints:** More data points per location can provide a more reliable analysis.
- **Diverse Environments:** Testing in more varied settings (e.g., different apartments, more streets) can help generalize findings.
- **Time-based Analysis:** Collecting data at different times can help understand how time influences accuracy.

Summary

By analyzing the distances between the current scans and stored fingerprints, we determine the accuracy of WiFi fingerprinting in different environments. The provided data and methodology offer a clear path to understanding the positioning accuracy and factors influencing it.