

Mobile Interaction Summer 2024

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Assignment 10

All exercises that are not explicitly declared as group tasks must be done individually and handed in individually. Identical submissions are treated as plagiarism. Plagiarism may lead to loss of exam bonus points.

You can submit the solution to this task in English or German until Wednesday, June 19, at 23:59 via <https://assignments.hci.uni-hannover.de>. Create a pdf file that contains the text and images of your solution, name it "Assignment-10-<Firstname>-<Lastname>.pdf", and save it together with the exported project (Android Studio: File → Export → Export to Zip File) in a single zip file. Your submission must consist of a single zip file containing all necessary files. The name of the .zip file, as well as the names of the contained files, **must not contain any umlauts**. Therefore, please resolve umlauts in file names.

Android Phones: Please let us know if you need an Android phone for the assignments. We can lend a limited number of simple Android phones for the duration of the semester. These must only be used for the assignments.

Exercise 1: WiFi Positioning (19 points)

In the lecture the fingerprinting method for positioning by measuring WiFi signal strengths was presented. The receiver (e.g., the mobile phone) measures the signal strength (Received Signal Strength Indicator, RSSI, in dBm) for each access point in range (Basic Service Set, BSS). Each access point is identified by its MAC address. For each location, this results in a vector ($BSS_1: RSSI_1, \dots, BSS_n: RSSI_n$). Here is an example with three base stations within range:

("bc:05:43:0f:dc:54": -70, "f8:d1:11:3a:b3:08": -84, "d4:21:22:cc:b5:93": -90)

Such a vector for a specific location is called a fingerprint. The template app allows you to perform WiFi scans and store them in a local SQLite database. In Android 9 each foreground app is allowed to scan four times in a 2-minute period. In Android 10 and higher you can disable this limitation under: Developer Options > Networking > Wi-Fi scan throttling (needs to be turned off) [1]. Please do the following subtasks:

- Explain how `WifiLocation::wifiScan` performs WiFi scans. (4 points)
- Complete the implementation of the measurement screen, which allows recording a fingerprint at a given location. The functionality should match what is shown in the center screenshot below, though the design may differ. It should be possible to select one of four locations. There should be an indication of how many fingerprints are available in

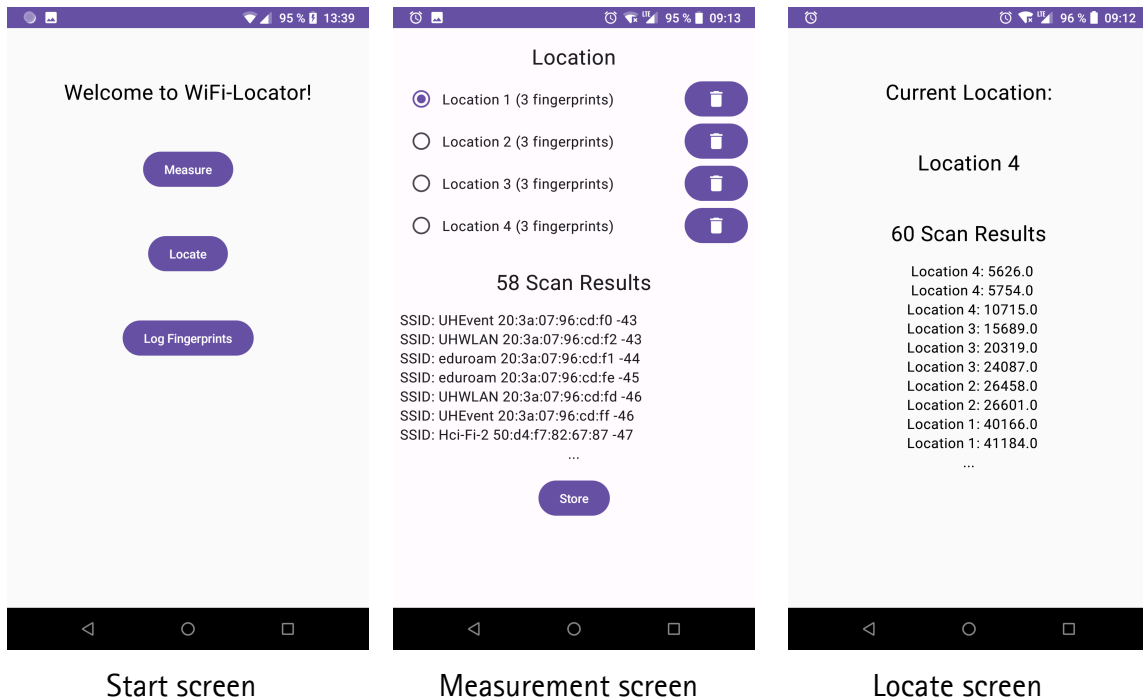
the database for each location. It should be possible to clear (i.e., delete all fingerprints of) a location. The clear button should only be shown if there are actually fingerprints for that location. Further, the screen should show the current scan results with the SSID, MAC address, and RSSI value for each measurement. If the list of scan results is empty, it should show "Scan running...". Limit the number of measurements that are shown to at most 7. Finally, there should be a button to store the current scan results as a new fingerprint for the selected location. The store button should only be shown if the list of scan results is not empty. Pressing the store button or a delete button should produce a snackbar message saying: "Fingerprint stored for Location x" or "Location x cleared", respectively. For testing, use 4 locations that are at least 5 m apart (e.g., different rooms or different areas in the cafeteria or on the street) and record 3 fingerprints for each location. Select the appropriate location with a radio button before storing. **(8 points)**

- c) Complete the implementation of the locate screen, which tries to locate the user given the current scan results. The functionality should match what is shown in the right screenshot below, though the design may differ. The current location should be shown as well as the number of current scan results and the list of known locations together with their distance measures to the current scan results. If the list of scan results is empty, it should show "Scan running...". Limit the number of locations that are shown to at most 10. **(4 points)**
- d) The `LocateViewModel::bestMatch` method tries to determine the location based on the current fingerprint and the template fingerprints stored in the database. Describe how the method works and explain the individual steps involved. **(3 points)**

Notes:

- If the list of BSSIDs returned by the `wifi.getScanResults()` method is empty, this could be, because you have selected "Phone only" / "GPS only" in the Android location / location settings. In this case, select one of the other settings (e.g. "High Accuracy").
- This exercise does not work in the emulator, but requires a real device.

[1] <https://developer.android.com/develop/connectivity/wifi/wifi-scan>



Exercise 2: Evaluation of Accuracy (14 points)

This exercise is about determining the accuracy of the location determined by your app using WiFi fingerprinting. Use 3-5 fingerprints per location. Use the same number of fingerprints for each location. Try to answer the following research questions:

1. How accurately can the location within an apartment be determined with your app?
2. How accurately can your app determine the location on a street within a residential area?
3. What factors influence the accuracy of positioning via WiFi fingerprinting?

To do this, work on the following subtasks:

- a) Design an experiment to answer the above research questions. Write down your exact procedure for the experiment and describe how you will evaluate the data. (4 points)
- b) Perform your experiment according to the guidelines you have drawn up. Include your location fingerprints in your submission by pressing the "Log Fingerprints" button on the start screen of the app and copying the relevant Logcat output to a text file. (4 points)
- c) Analyze the data you have gathered in your experiment and use the analysis to draw conclusions regarding the above research questions. (4 points)
- d) Are the research questions clarified by your experiment? If you think so, justify. If you do not think so, describe how your experiment could be improved so that the research questions can be better answered. (2 points)