GEO1003 – 23Q2 – Assignment 2: Wi-Fi Fingerprinting (06-12-2023)
(note: the description of this assignment has been 'improved' by ChatGPT 😊)

The primary objective of this assignment is to delve into the realm of Wi-Fi fingerprinting, exploring both its potentials and constraints, particularly in terms of performance metrics such as accuracy and availability.

Conducted by eight distinct groups, each comprised of three to four students, the assignment unfolds with the initial task of engaging in negotiations with other groups. This collaborative aspect aims to foster a deeper understanding of the subject matter.

To encapsulate and share the insights gained, the culmination takes the form of concise yet comprehensive presentations. Each group is tasked with distilling their findings into a succinct narrative, encapsulated within a maximum of 12 slides or presented over a succinct 5-minute duration.

This strategic blend of exploration, collaboration, and presentation ensures a holistic comprehension of Wi-Fi fingerprinting, establishing a platform for informed discussions and reflections.

Ensure your assignment reaches Brightspace no later than 11:59 PM on Thursday, December 21, 2023. Remember to submit individually, providing both your name and study number. A heads up: individual submissions confirm your active contribution to the group work, guarding against any 'piggybacking' attempts, a form of academic dishonesty. Check: https://www.tudelft.nl/en/student/legal-position/fraud-plagiarism.

Before you start, study the reader:

Xia, S.; Liu, Y.; Yuan, G.; Zhu, M.; Wang, Z. Indoor Fingerprint Positioning Based on Wi-Fi: An Overview. ISPRS Int. J. Geo-Inf. 2017, 6, 135. https://doi.org/10.3390/ijgi6050135

A. Radio Mapping Phase

Measure with all 8 groups the Wi-Fi fingerprints for 32 uniquely identifiable places (lecture rooms, library, entrances, etc.) at the Faculty of Architecture and the Built Environment.

- Divide the workload (so each group of students measures 4 locations).

- Use this Wi-Fi performance / scanner tool:

Homedale: https://www.the-sz.com/products/homedale/

- Hint: use right mouse button to create logfile. Both Windows and MacOS versions are available.

You can define the 'identifiable places' at the BK-City floor plan, available at:

https://www.tudelft.nl/bk/over-faculteit/het-gebouw/plattegrond/
https://filelist.tudelft.nl/BK/Over_de_faculteit/Het_gebouw/BKCity_plattegrond_2-20_01.pdf

- Hint: report only the RSS for MAC addresses used by the Eduroam wireless network.

State, alike the first assignment the GPS (GNSS) precision. Measure for at least 15 minutes. Utilize your smartphone's built-in GPS receiver along with a suitable NMEA app to log essential measurements, including latitude, longitude, time, PDOP, HDOP, and VDOP. for instance: https://play.google.com/store/apps/details?id=com.peterhohsy.nmeatools

- Hint: check NMEA-$GPGSA message on http://aprs.gids.nl/nmea/

Measure the Wi-Fi RSS (Received Signal Strength) over time, **at least 15 minutes**. Take notice of the presence of people, and the device used. **Make these measurements available to all other groups!**

A1. Illuminate the estimated GNSS accuracy of this indoor location through a visual representation in a scatterplot. Don't forget to include key metrics like standard deviation, HDOP, and VDOP.

A2. Dive into the comparison of Wi-Fi fingerprints from two proximate (geographically) locations. Gauge the degree of similarity between these fingerprints. Alternatively, on a broader scale, assess the 'distance' between the 32 identifiable places in RSS-space. In essence, explore how distinguishable these places are from each other.

B. Localisation Phase

Extend your Wi-Fi fingerprint exploration by measuring at four locations distinct from your radio mapping data—specifically, locations measured by other groups (request their measurements). **Employ a 30-second snapshot**, akin to phase A (15 minutes at least).

Now, leverage a pattern recognition matching algorithm, such as minimizing the sum of squares, to identify the best fit among the 32 fingerprints corresponding to recognizable places.

B1. Were you able to successfully pinpoint these four locations?

B2. How confident are you in your findings?

C. Building Rhythms

Imagine the Faculty of Architecture's management is keen on gauging the attendance and locations of students during lectures, precisely pinpointing their presence within specific classrooms for a designated 45-minute time frame. The canvas is yours to enhance the campus card with any requisite sensor, tag, or short-distance radio-transmission technology. Additionally, you have the liberty to install the necessary hardware in the building to detect these upgraded campus cards.

a. System Design Proposal for a Near Real-time Indoor 'Building Rhythms' System Using Wi-Fi Fingerprinting:

1. Visualization of Students in Identifiable Spaces:

Design an intricate system leveraging Wi-Fi fingerprinting for near real-time tracking of students within identifiable places such as lecture rooms, libraries, etc., during specific time slots (lecture 'hours'). The upgraded campus card or Wi-Fi scanning devices (smartphones with dedicated apps) will continuously transmit readings to a central server for seamless processing.

2. Dynamic Movement Tracking within the Building:

Develop a comprehensive system that captures and visualizes the movement of students throughout the building. This encompasses transitions from one location to another—be it from the entrance to a lecture room, between lecture rooms, or even exiting the building. By harnessing the data transmitted by the Wi-Fi scanning devices, create a dynamic map that reflects the ebb and flow of student movement within the designated time frame.

Assumptions:

- Every student possesses a Wi-Fi scanning device, either in the form of a smartphone with a dedicated app or an upgraded campus card.

- The data from these devices are transmitted in real-time to a centralized server for efficient processing.

This proposed system not only provides granular insights into students' presence within specific areas during lectures but also offers a real-time visualization of their movement patterns within the building, contributing to a comprehensive understanding of building rhythms.

Hint: please check both the report and the video of one of the previous Geomatics Synthesis Projects: “Building Rhythms: Reopening the workspace with indoor localisation”:

https://repository.tudelft.nl/islandora/object/uuid%3A060d104f-bce9-4608-9aa9-a73132317254?collection=education

“This project’s main objective is to analyse how ArcGIS Indoors can be used with location awareness methods to elaborate and develop space management tools for COVID--19 restrictions in order to reopen the workspace for TU Delft Campus. This was accomplished by using six Arduino micro controllers, which were programmed in C++ to scan all available Wi-Fi fingerprints in the east wing of the Faculty of Architecture and the Built Environment of TU Delft and send over the data to an ArcGIS Indoor Information Model (AIIM).“