Lab 3	Laboratory Mobile Security	WED
WiSe24/25	Approximating positions of mobile base-stations	

Remark: 75 points (out of 100) are required to pass this laboratory task.
Acceptance: by December 12th at the latest by presenting your implementation and results.

1. Introduction

Develop a swarm mapping algorithm that correlates the received position data from all smartphones. The goal of your 'server' is to approximate the positions of the base stations with the cell IDs (CIs) as good as possible. The distance d (RSSI) of the smartphone to the base station should be derived linearly for the sake of simplicity. The maximum value RSSI = 60 is interpreted as d (RSSI) = 0, whereby RSSI = 1 is interpreted as d (RSSI) = r (transmission radius of the BS). RSSI = 0 means that the smartphone is not in the transmission radius r of the BS at the time of the RSSI measurement. The assumed omni-directional transmission radius r = 600 meters of the base stations is based on an urban GSM scenario.

Helpful:

1. Conversion from RSSI to meters (maxrssi is the maximum rssi of the chip, i.e. 61 or 251): **|** (rssi - maxrssi) * (radius / (maxrssi-1)) **|**
2. If a point is not assigned to a BS, this means it is outside the radius of ALL known BS. If a point has an entry only for BS x, it is outside all BS y with y != x. These points must be taken into account as they help to rule out possible BS!

2. Obtaining information

The following information is available on your server:

Sent from smartphone 1: RSSI value range [0-61]

CI	RSSI	Time	SP's x-coordinate	SP's y-coordinate
12801	10.0	100045	1450,0	1040,0
12801	53.0	100230	936,0	752,0
12801	36.0	110002	850,0	600,0

Sent from smartphone 2: RSSI value range [0-251]

CI	RSSI	Time	SP's x-coordinate	SP's y-coordinate
12801	176.0	129885	827,2	850,4
12801	201.0	134546	904,0	728,0
12802	108.0	156778	1468,0	2716,8

12804	9.0	164747	219,2	2000,0
-	0.0	169567	339,2	2614,4

Sent from smartphone 3: RSSI value range [0-61]

CI	RSSI	time	SP's x-coordinate	SP's y-coordinate
12801	10.0	004725	784,0	1262,0
12802	24.0	007321	1720,0	2050,0
12803	8.0	007321	1720,0	2050,0

Sent from smartphone 4: RSSI value range [0-251]

CI	RSSI	time	SP's x-coordinate	SP's y-coordinate
12802	87.0	094521	1984,0	2313,6
12803	17.0	136744	2216,0	2118,4
12804	70.0	156554	800.0	2434.4
-	0.0	174677	161,6	2748.8

Please take into account that different radio chipset manufacturers often use different value ranges for the RSSI.

2.1 Develop the algorithm in pseudo code *(25 points)*
Make the problem clear on a diagram and then work out a pseudocode for the problem to be solved.

2.2 Implement your algorithm *(25 points)*
Now implement the pseudocode you developed in 2.1 using python3 or another programming language. In case you choose python3 use the sympy.geometry library to calculate the circles and intersections and the distance between two points. If you want to plot you should use matplotlib.pyplot. The result should be a list of all named base stations (CIs) with the approximate position coordinates (longitude, lattitude).

2.3 Verification of the implementation *(25 points)*
Verify the accuracy of your implementation using the RSSIs and CIs listed in the tables.

2.4 Consideration of RSSI noise *(15 points)*
Research what noise different chipsets add to the measured RSSI value and the distance d (RSSI) to be derived from it to the base station. Take this noise into

account in your implementation. How do the position values calculated in 2.3 differ from the current ones?

2.5 Consideration of the time of the measurement *(5 points)*
What influence does the time of the RSSI measurement have on the falsification of the position result, especially if it can be assumed that the clocks of the individual SPs are not synchronized?

2.6 Approximation without transmission radius *(5 points)*
What should you do if the transmission radius is not specified? Write down your approach.

2.7 Optional: Detection of Fake Base-station
Please investigate how your server has to be adapted to ‘post-mortem’ detect the temporary placement of fake base-stations.

Have fun working out!