COMP9336 Mobile Data Networking

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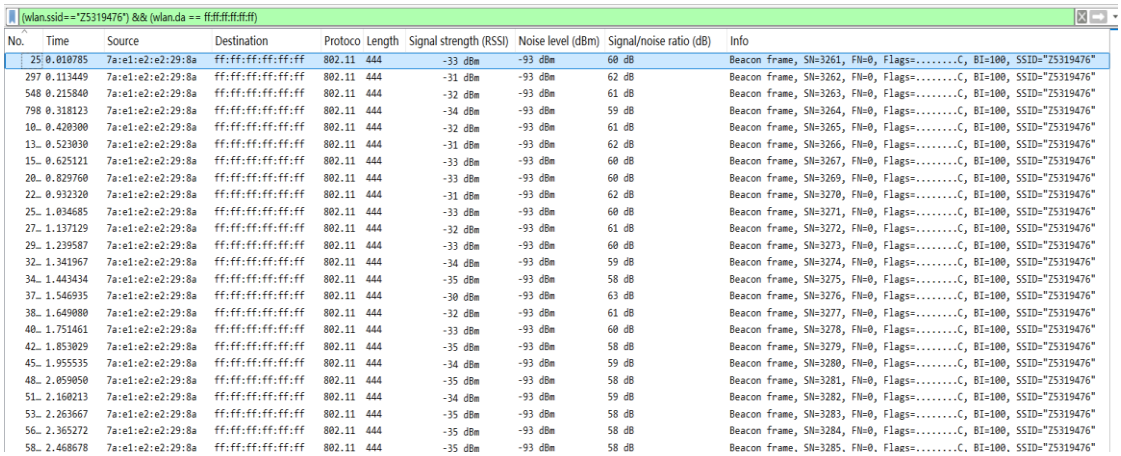
Tasks1 RSS data capture

In this experiment, I used two chairs for laptop and mobile phone to keep them at the same height and capture RSS data (indoor and outdoor) at different distances (1m to 10m).

- **Indoor RSS Data Capture**

  I captured 10 files of RSS data indoors. In each data collection session, the distance between the laptop and the phone was increased by 1 meter. Starting from 1 meter in the first dataset, I incrementally increased the distance by 1 meter for each subsequent capture, up to a total of 10 meters. This experiment was conducted in the living room.

For each trace file, I applied a filter as shown in the following image.



(wlan.ssid=="Z5319476") && (wlan.da == ff:ff:ff:ff:ff:ff)

No.	Time	Source	Destination	Protoco	Length	Signal strength (RSSI)	Noise level (dBm)	Signal/noise ratio (dB)	Info
25	0.010785	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-33 dBm	-93 dBm	60 dB	Beacon frame, SN=3261, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
297	0.113449	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-31 dBm	-93 dBm	62 dB	Beacon frame, SN=3262, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
548	0.215840	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-32 dBm	-93 dBm	61 dB	Beacon frame, SN=3263, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
798	0.318123	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-34 dBm	-93 dBm	59 dB	Beacon frame, SN=3264, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
10…	0.420300	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-32 dBm	-93 dBm	61 dB	Beacon frame, SN=3265, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
13…	0.523030	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-31 dBm	-93 dBm	62 dB	Beacon frame, SN=3266, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
15…	0.625121	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-33 dBm	-93 dBm	60 dB	Beacon frame, SN=3267, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
20…	0.829760	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-33 dBm	-93 dBm	60 dB	Beacon frame, SN=3269, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
22…	0.932320	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-31 dBm	-93 dBm	62 dB	Beacon frame, SN=3270, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
25…	1.034685	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-33 dBm	-93 dBm	60 dB	Beacon frame, SN=3271, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
27…	1.137129	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-32 dBm	-93 dBm	61 dB	Beacon frame, SN=3272, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
29…	1.239587	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-33 dBm	-93 dBm	60 dB	Beacon frame, SN=3273, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
32…	1.341967	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-34 dBm	-93 dBm	59 dB	Beacon frame, SN=3274, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
34…	1.443434	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-35 dBm	-93 dBm	58 dB	Beacon frame, SN=3275, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
37…	1.546935	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-30 dBm	-93 dBm	63 dB	Beacon frame, SN=3276, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
38…	1.649080	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-32 dBm	-93 dBm	61 dB	Beacon frame, SN=3277, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
40…	1.751461	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-33 dBm	-93 dBm	60 dB	Beacon frame, SN=3278, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
42…	1.853029	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-35 dBm	-93 dBm	58 dB	Beacon frame, SN=3279, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
45…	1.955535	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-34 dBm	-93 dBm	59 dB	Beacon frame, SN=3280, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
48…	2.059050	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-35 dBm	-93 dBm	58 dB	Beacon frame, SN=3281, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
51…	2.160213	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-34 dBm	-93 dBm	59 dB	Beacon frame, SN=3282, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
53…	2.263667	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-35 dBm	-93 dBm	58 dB	Beacon frame, SN=3283, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
56…	2.365272	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-35 dBm	-93 dBm	58 dB	Beacon frame, SN=3284, FN=0, Flags=.....C, BI=100, SSID="Z5319476"
58…	2.468678	7a:e1:e2:e2:29:8a	ff:ff:ff:ff:ff:ff	802.11	444	-35 dBm	-93 dBm	58 dB	Beacon frame, SN=3285, FN=0, Flags=.....C, BI=100, SSID="Z5319476"

RSS data Capture Count

Distance	Signal strength (RSSI)
1	322
2	263
3	290
4	246
5	391
6	304
7	343
8	230
9	314
10	247

RSS data average Signal Strength(log_Distance)

Distance	Signal strength (RSSI)	log_Distance
1	-31.220497	0.000000
2	-45.809886	0.301030
3	-46.341379	0.477121
4	-54.394309	0.602060
5	-55.337596	0.698970
6	-53.118421	0.778151
7	-51.965015	0.845098
8	-57.191304	0.903090
9	-59.076433	0.954243
10	-56.125506	1.000000

- **Outdoor RSS Data Capture**

  Using the same method as the indoor experiment, I conducted the same task in an outdoor park.

RSS data Capture Count

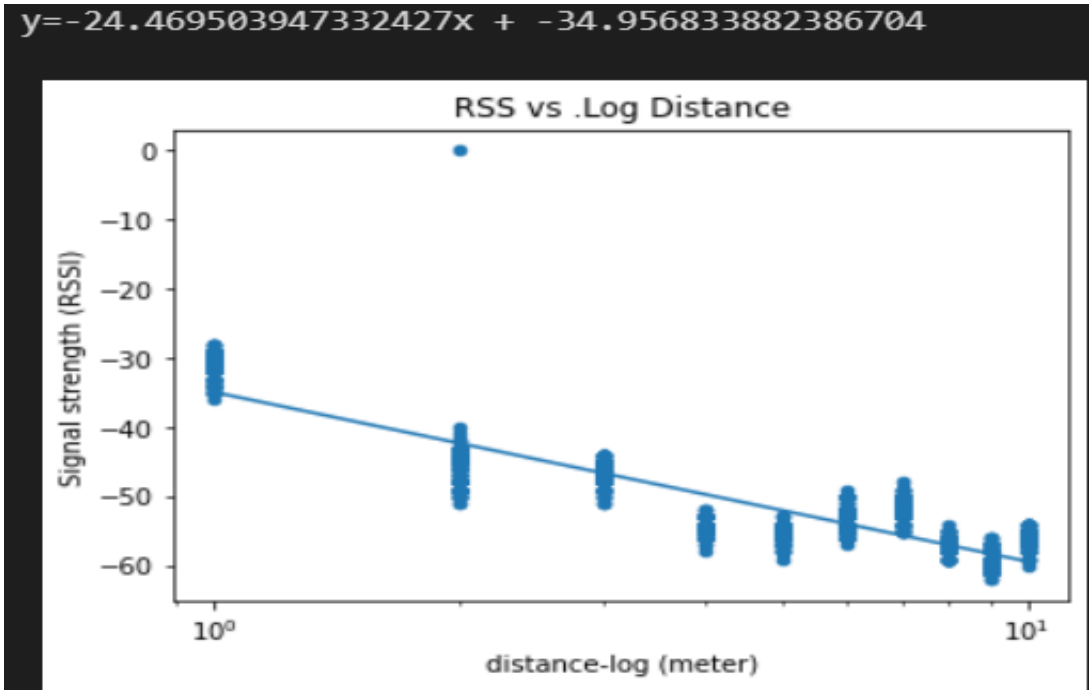
Distance	Signal strength (RSSI)
1	281
2	257
3	302
4	214
5	270
6	219
7	395
8	218
9	300
10	309

RSS data average Signal Strength(log_Distance)

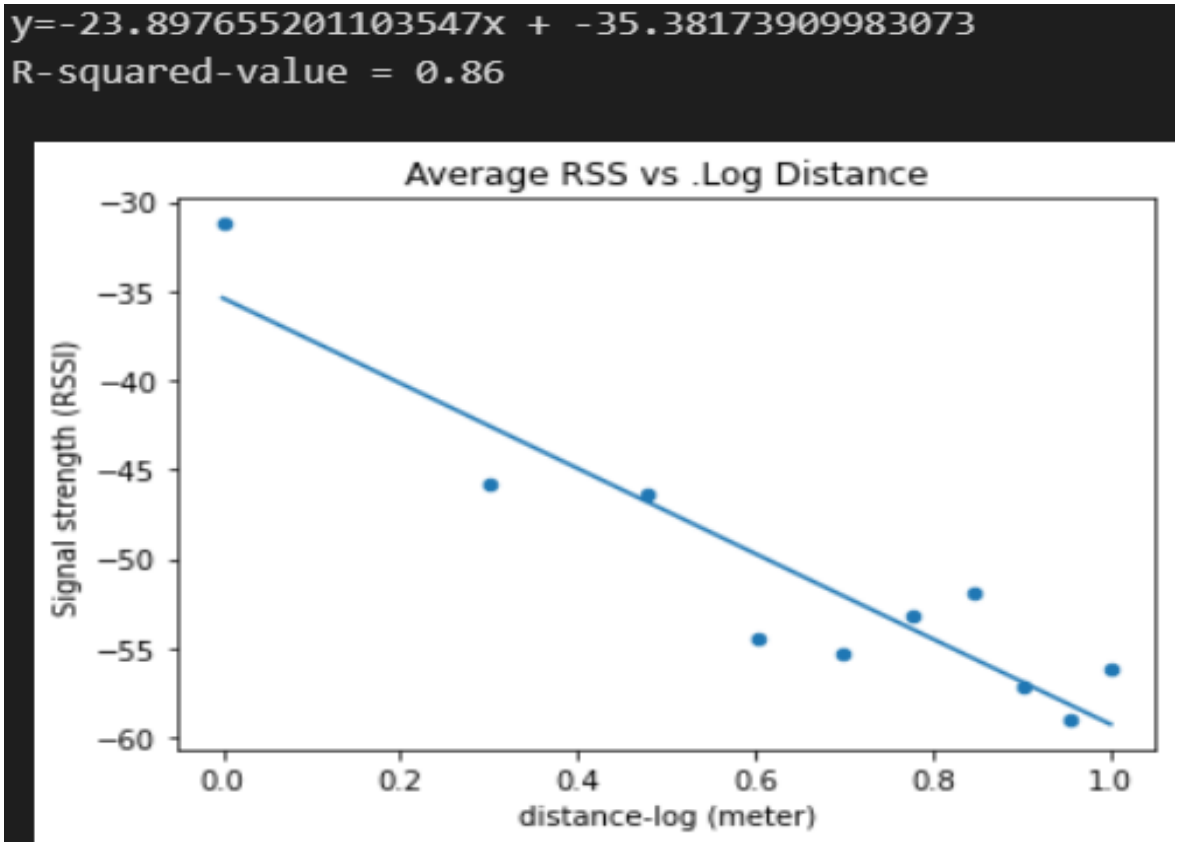
Distance	Signal strength (RSSI)	log_Distance
1	-24.857651	0.000000
2	-33.342412	0.301030
3	-33.605960	0.477121
4	-40.640187	0.602060
5	-43.144444	0.698970
6	-47.607306	0.778151
7	-44.865823	0.845098
8	-42.862385	0.903090
9	-44.016667	0.954243
10	-49.873786	1.000000

Tasks2 Path loss exponent estimation

- **Indoor** Raw RSS data against distance in Log Scale

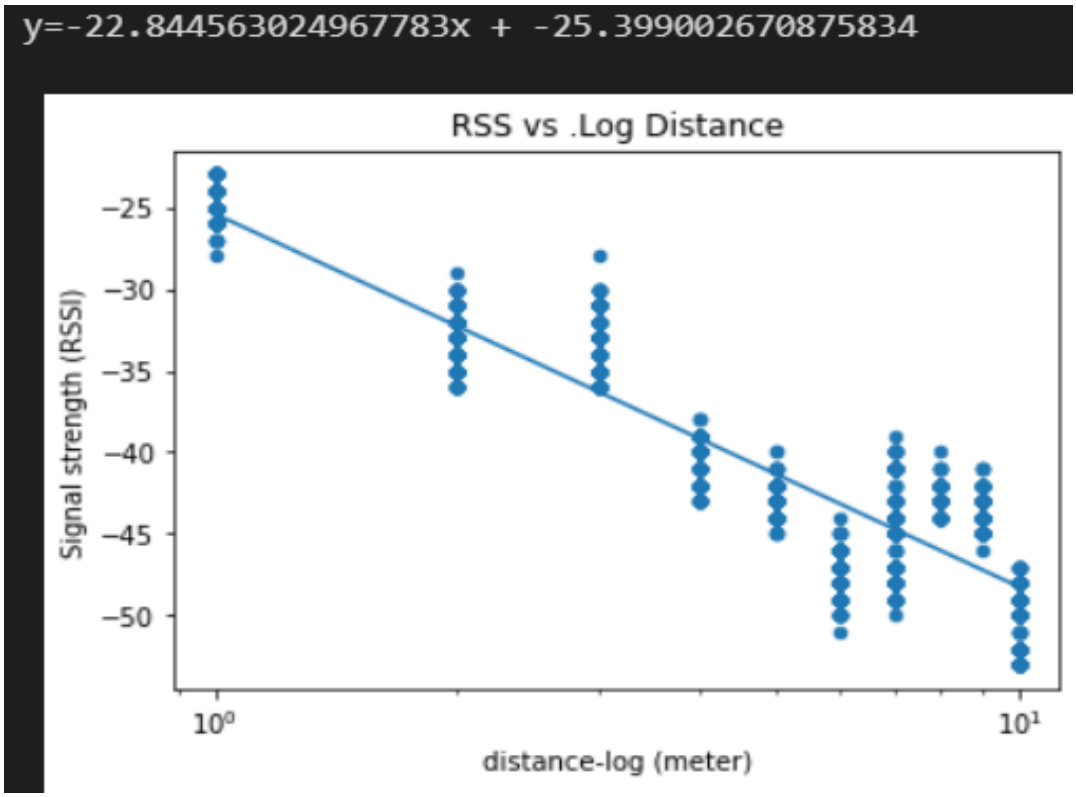


- **Indoor** average RSS values against distance in Log Scale

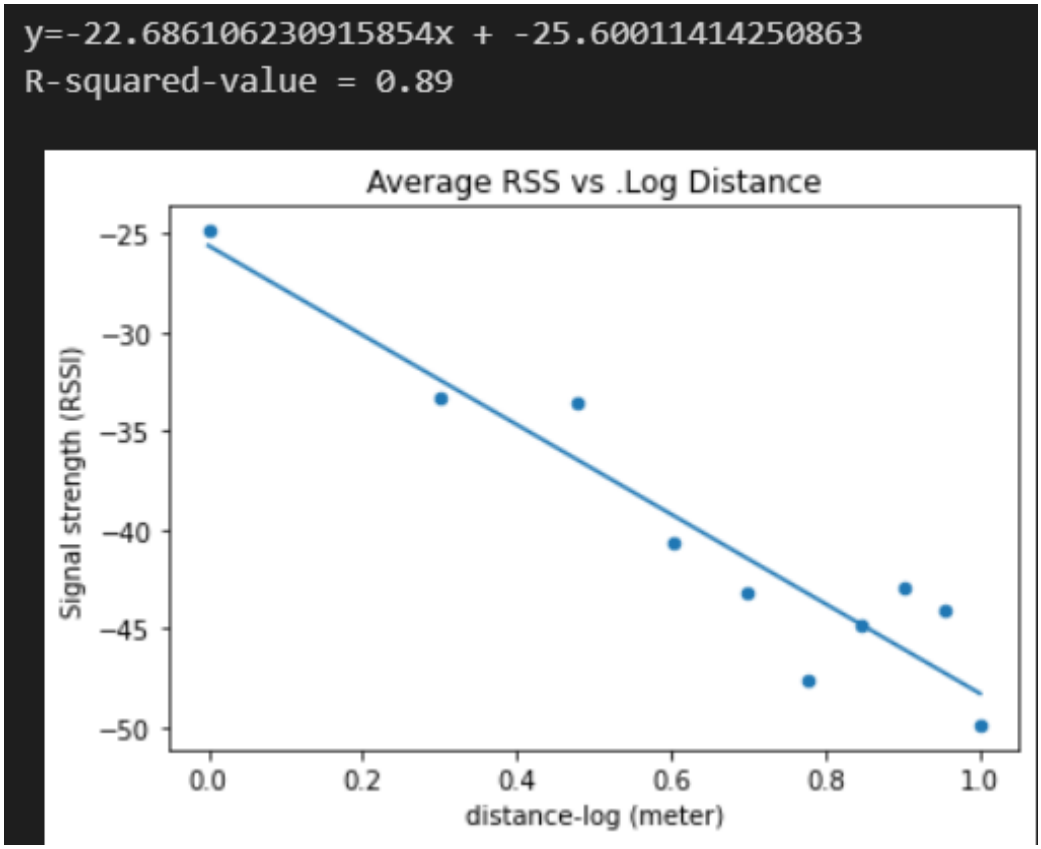


Based on my RSS measurements in the living room, the signal strength data points are scattered rather than concentrated in a specific region. Two factors likely contributed to this variation. First, I used my phone as a hotspot while there were 2-3 other Wi-Fi networks in the vicinity, along with a microwave oven operating at 2.4GHz. These factors may have caused interference, affecting the consistency of the signal strength readings. Second, I unintentionally blocked the laptop's antennas during the experiment, which likely influenced the detection of the signals. Despite these challenges, I ensured consistency in the experiment by maintaining the same height for both devices using chairs and measuring incremental distances before taking readings. Overall, the results indicate the expected trend as the distance between the receiver and the access point increases, the average signal strength decreases due to attenuation over distance. The calculated R-squared value of 0.86 suggests a strong correlation between the distance and the signal strength, indicating that the model fits the data well.

- **Outdoor** Raw RSS data against distance in Log Scale

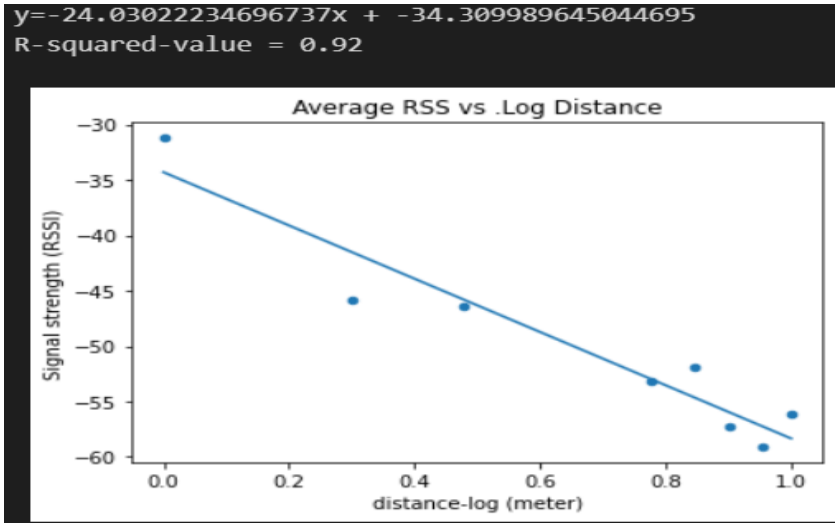


- **Outdoor** average RSS values against distance in Log Scale



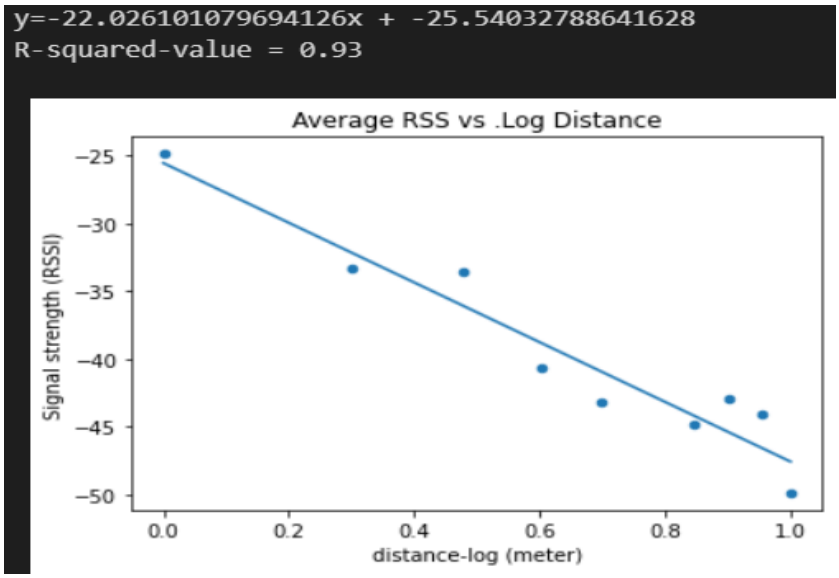
In outdoor environments, signal strength measurements tend to be more dispersed across various locations compared to indoor settings. This dispersion can be attributed to several factors, including the presence of open spaces, which allow for greater signal variation influenced by environmental elements. The average slope of the signal strength in outdoor measurements is typically lower, indicating a more gradual decrease in signal strength with increasing distance. Notably, the R-squared value for outdoor measurements is higher at 0.89, reflecting a strong correlation between distance and signal strength.
This may be because outdoor environments usually have fewer physical obstacles, such as walls and furniture, resulting in less multipath interference and a clearer relationship between distance and signal strength. Additionally, the open nature of outdoor spaces leads to greater signal variation due to interactions with environmental factors.

- **Indoor** average RSS values against distance in Log Scale after removing outliers



I removed the data in distance 4 and 5 (outlier) and then R squared value increased to 0.92.

- **Outdoor** average RSS values against distance in Log Scale after removing outliers



I removed the data in distance 6 (outlier) and then R squared value increased to 0.93.