



BLUETOOTH LOCALIZATION

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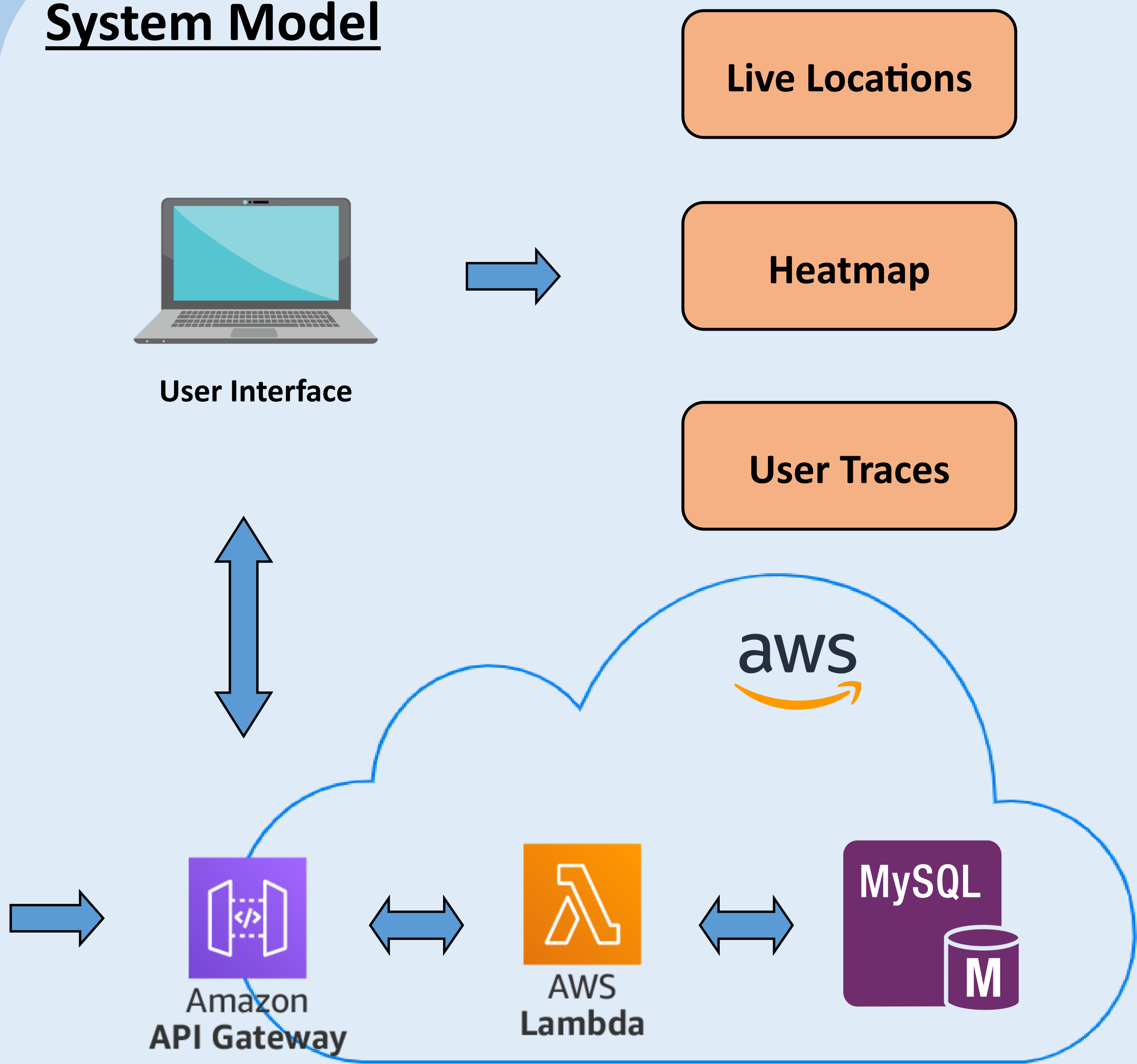


Introduction

Problem:
Due to the increase in the number of large and complex buildings such as malls, companies, museums security is starting to become a problem. For example in an event, a company should make sure that visitors are not entering unauthorized areas.

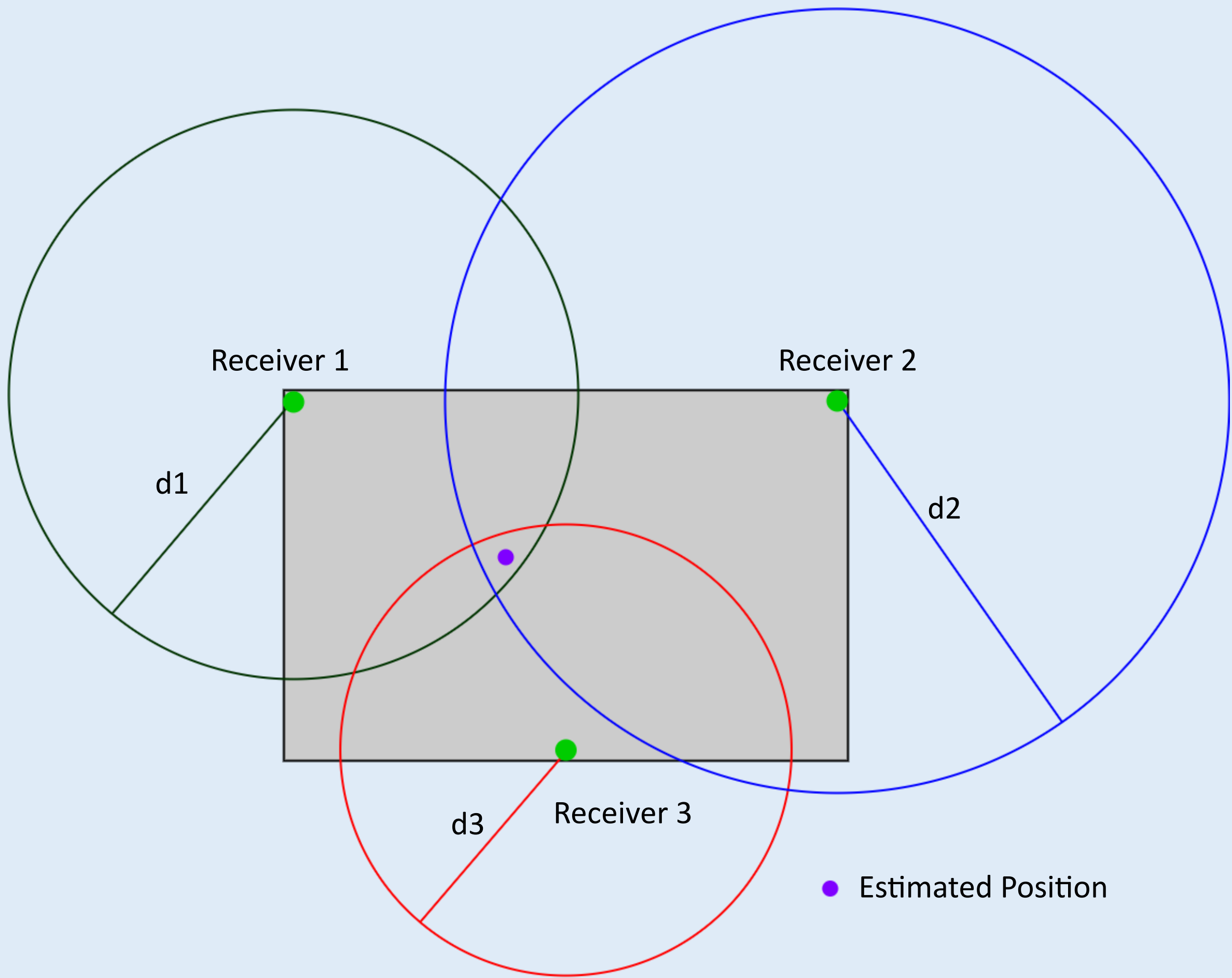
Solution:
Main goal of our project is to locate people in a building, store these locations to a database and then analyze them to obtain valuable information. We provide live locations and user traces to increase security in a building. Also we provide heatmap in order to analyze most crowded areas and detect bottlenecks in the system.

System Model



Trilateration [1]

$$RSSI_d = (-10 * n) * \log_{10}(d/d_0) + RSSI_{d_0} \quad [2]$$



Fingerprinting [3]

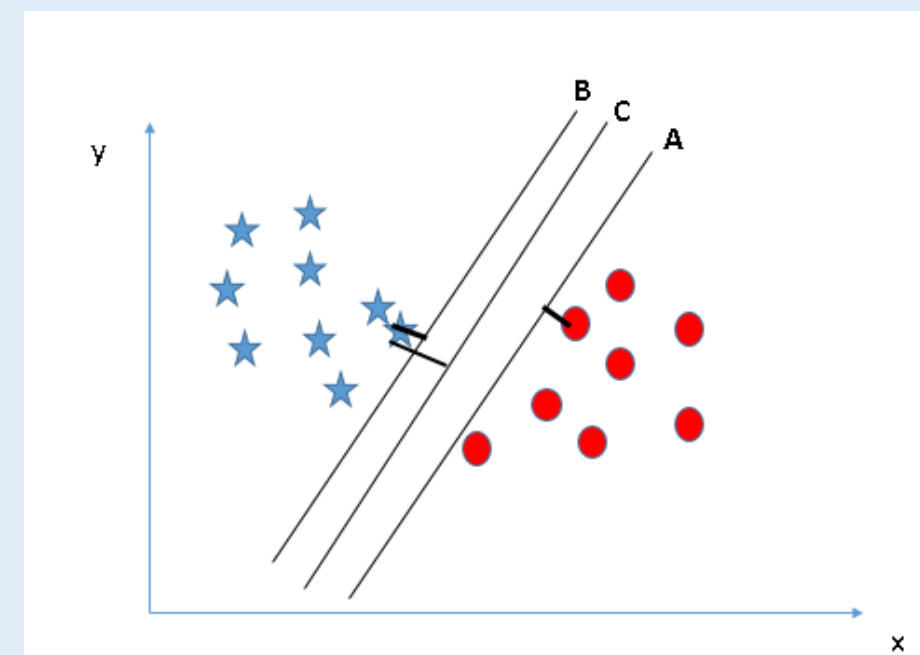
1) Select locations



3) Classification Results

	precision	recall	f1-score
1_1	0.84	0.81	0.83
4.25_2.45	0.96	0.97	0.97
accuracy			0.94
macro avg	0.90	0.89	0.90
weighted avg	0.94	0.94	0.94
Training set score for SVM	0.942308		
Testing set score for SVM	0.943878		

2) Classification with SVM



4) Output of the algorithm

Class	Probability
[1, 1]	0.91
[4.25, 2.45]	0.09

Note: Probability threshold = 0.70

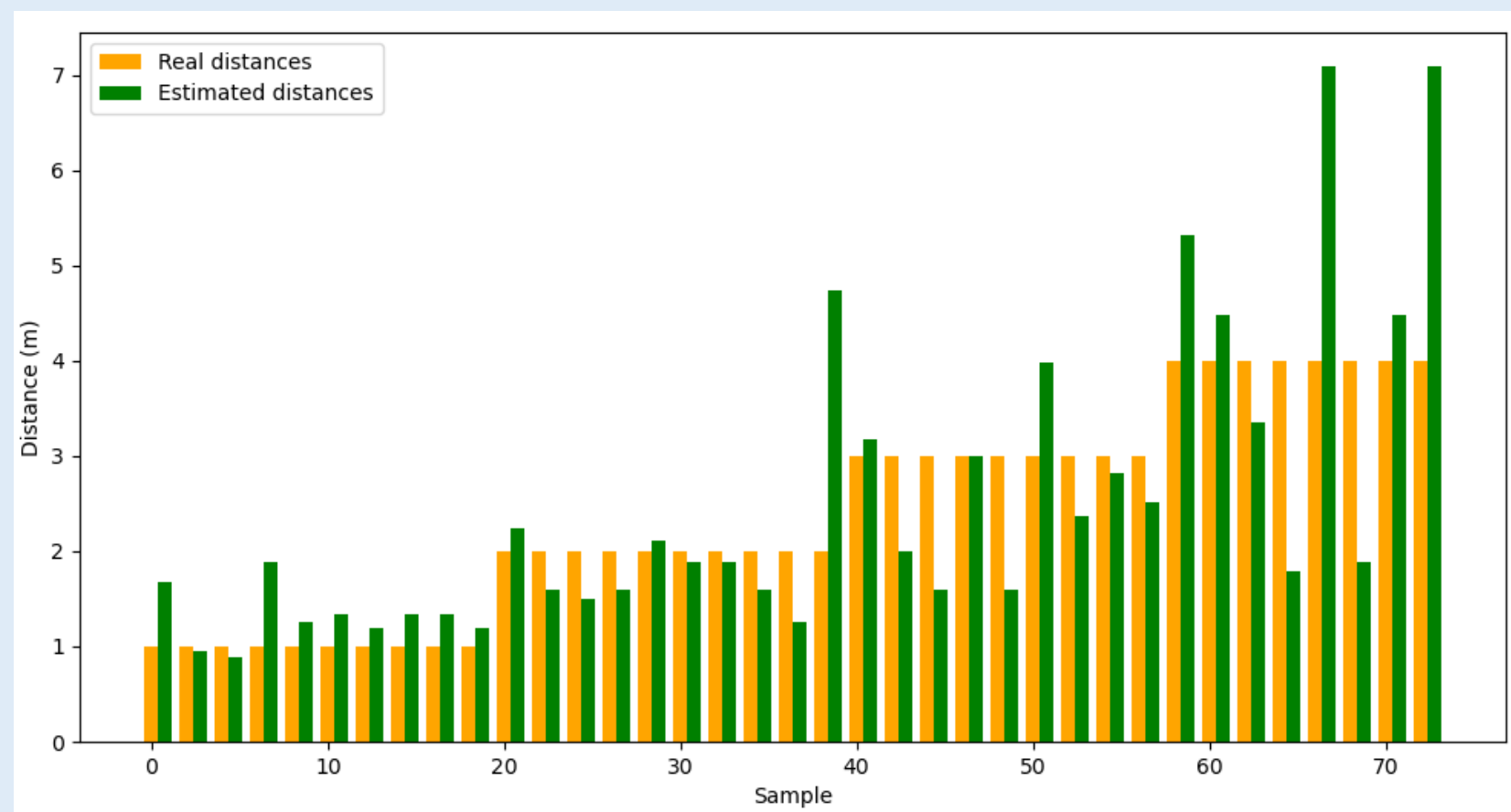
Combined Algorithm

Final estimation = (Class prob x class location) + ((1-Class prob) x trilateration estimation)

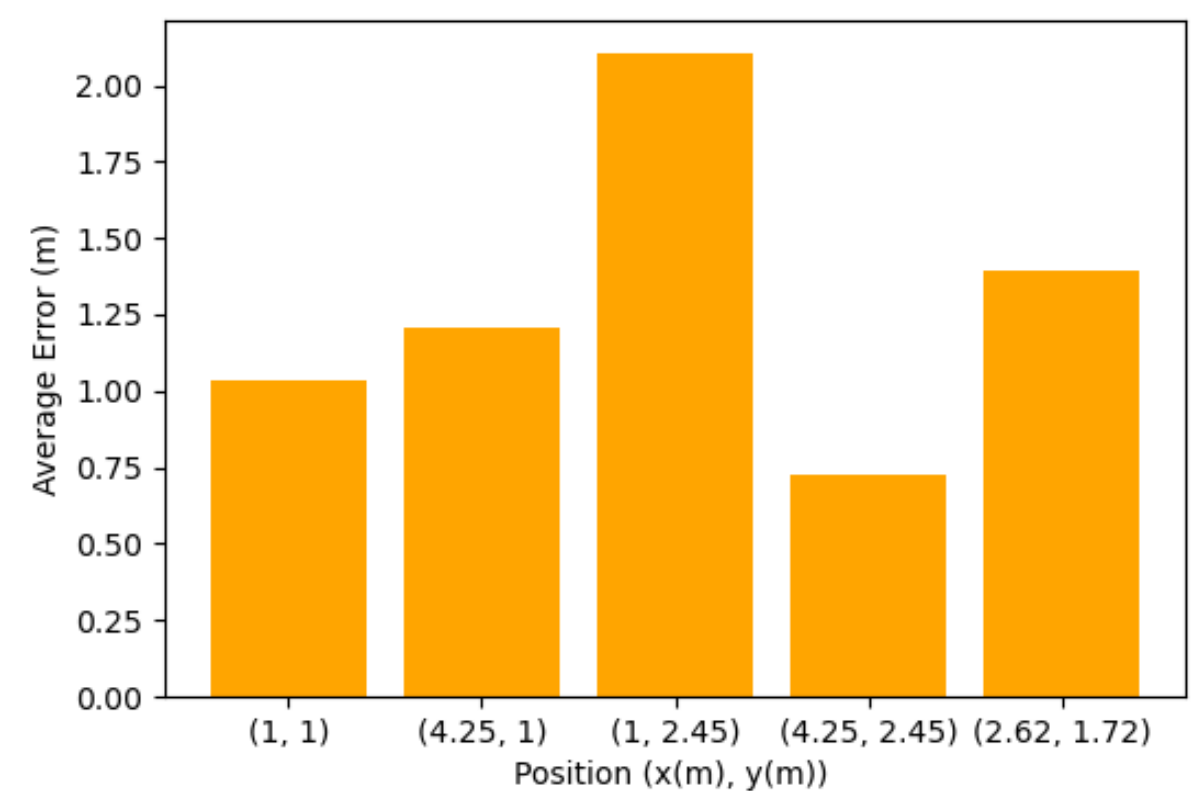
References

- [1] X. Yan, Q. Luo, Y. Yang, S. Liu, H. Li and C. Hu, "ITL-MEPOSA: Improved Trilateration Localization With Minimum Uncertainty Propagation and Optimized Selection of Anchor Nodes for Wireless Sensor Networks," in *IEEE Access*, vol. 7, pp. 53136-53146, 2019.
- [2] C. Yang and H. Shao, "WiFi-based indoor positioning," in *IEEE Communications Magazine*, vol. 53, no. 3, pp. 150-157, March 2015.
- [3] BEKKELIEN, Anja. Bluetooth Indoor Positioning. Université de Genève. Maîtrise, 2012, pages 12-14.

Results



Real distances and estimated distances calculated by the formula in [2]



Average locating error in some positions

Used Technologies

