Two Level Wi-Fi Fingerprinting based Indoor Localization using Machine Learning

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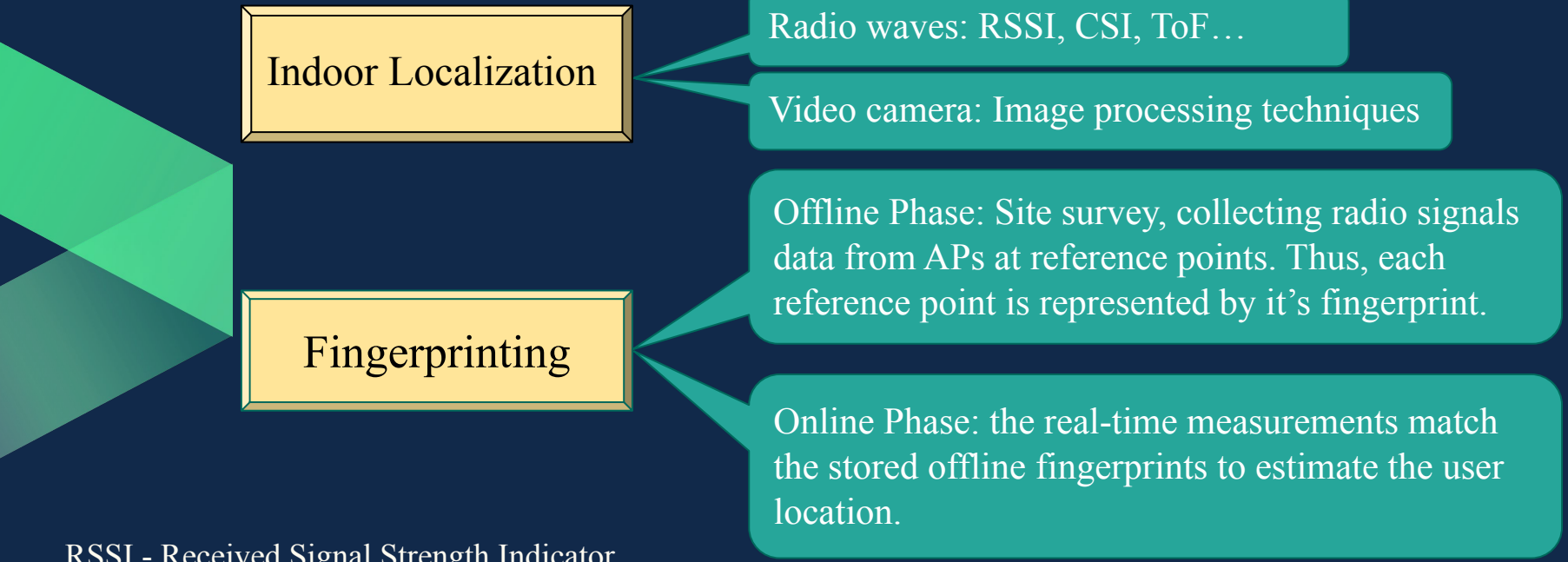
Content

Abstract

- Indoor localization is defined as the process of locating a user or device in an indoor environment.
- It can be used in a wide variety of crucial location based services, such as indoor navigation in airports, hospitals malls, tracking of goods in warehouses, or assisted living systems for elderly care.
- In this paper, we explored different machine learning algorithms on the datasets and proposed a two level localization model to effectively predict the location.

Introduction



RSSI - Received Signal Strength Indicator
CSI - Channel State Information
ToF - Time of Flight

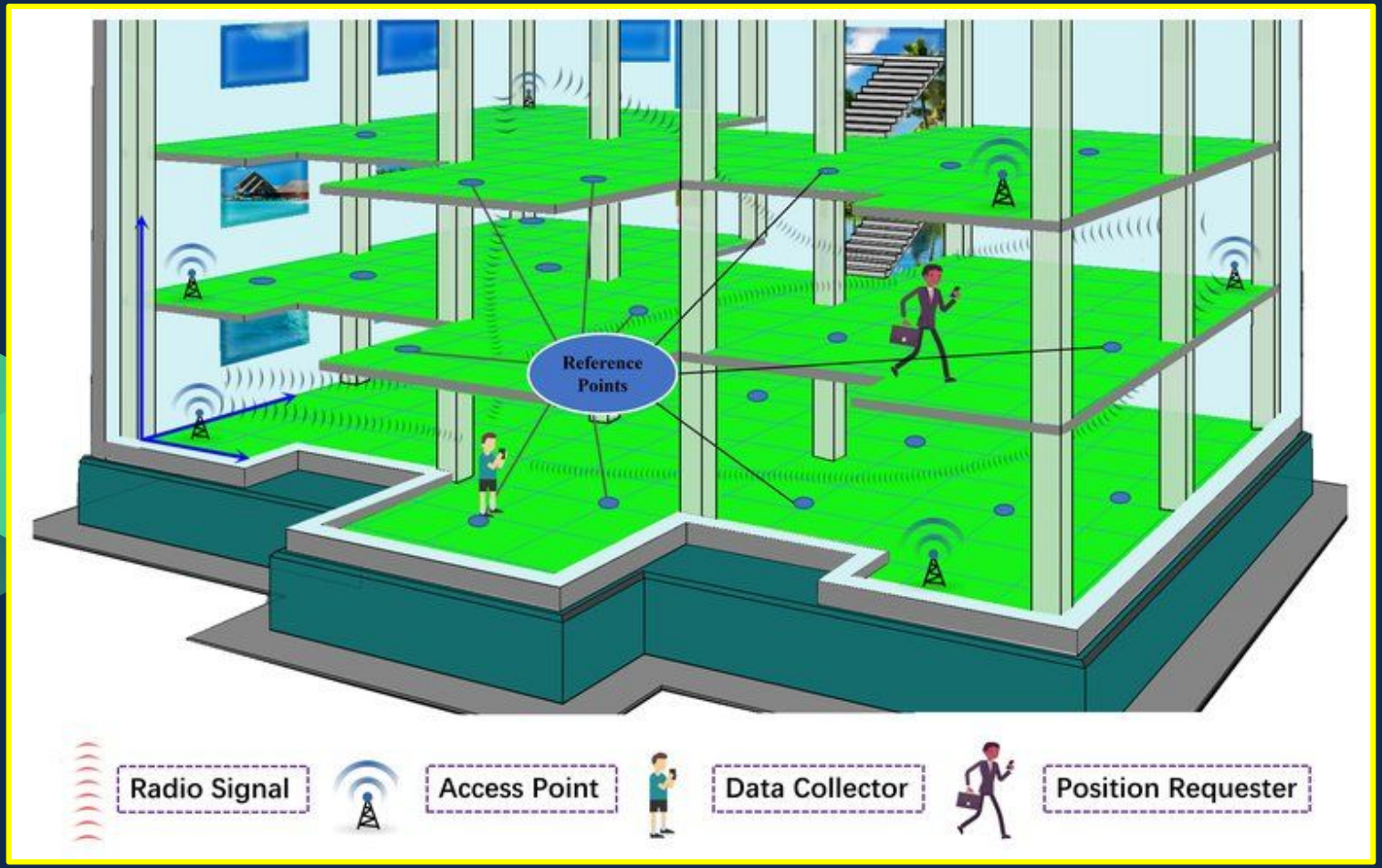


Image showing the scenario of fingerprint data collection

Literature Review

- Most of the papers published on indoor localization used radio wave signals such as CSI, RSSI,Wifi, Bluetooth, Ultra Wideband
- Various Machine Learning algorithms such as Neural Networks(NN), Support Vector Machine(SVM), K-Nearest Neighbor(KNN), Artificial Neural Networks(ANN) and Deep neural networks were proposed for indoor localization in literature.

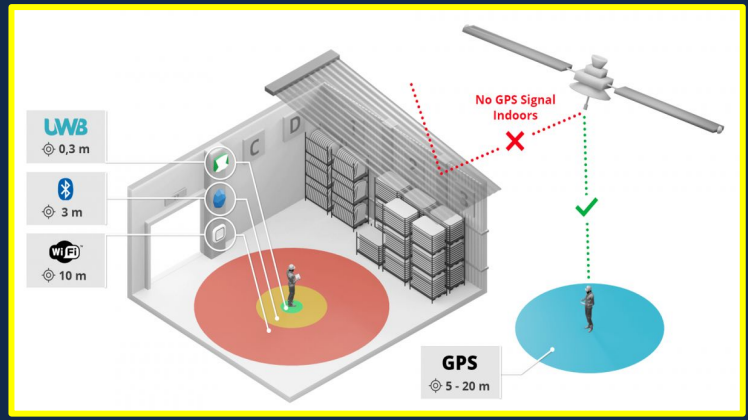


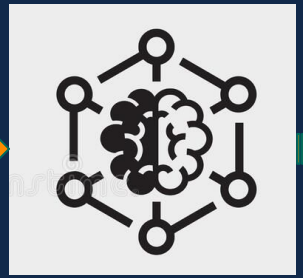
Image showing different signal's range for localization

- Recent advancements show that deep learning algorithms outperforming traditional algorithms with regard to accuracy.

System Model

Fingerprinting database

Preprocessing of Data



Applying Machine Learning Algorithms on Data

Prediction of location

Dataset-1

Table 1: Main characteristics of the dataset 1

#Buildings	1
#Floors	3
#Training Samples	7175
#Testing Samples	390

- Energy-efficient indoor localization wifi-fingerprint dataset[*]
- Over fitting
- Very less change in attributes for different data samples
- Repetitive data, same reference point, multiple samples

stands for “number of”, [*]-https://ieee-dataport.org/open-access/energy-efficient-indoor-localization-wifi-fingerprint-dataset

Dataset-2

Table 2: Main characteristics of the dataset 2

	Building 1	Building 2
# Samples	1478	583
#Floors	4	3
#attributes	312	357

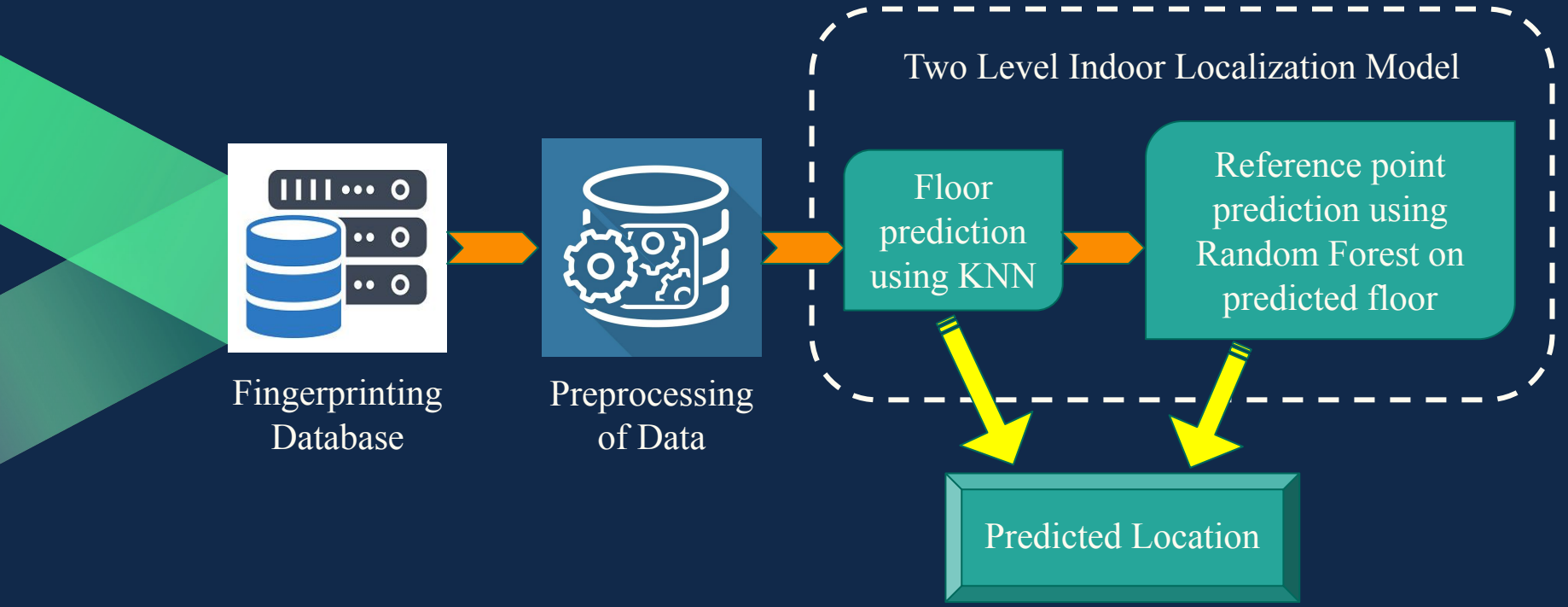
- This dataset is taken from Tampere University of Technology
- The data from these two buildings are separate, without any implicit relation
- Two models were used to predict location, for floor and location coordinates (latitude, longitude)

Observations

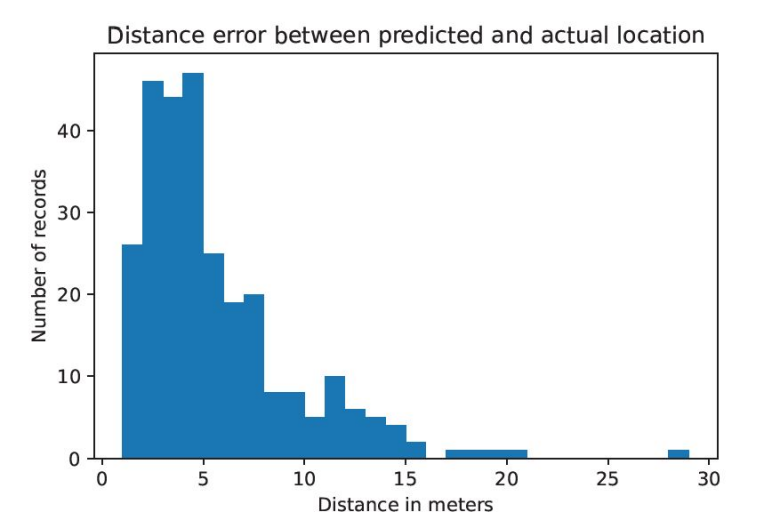
Table 3: Scores of models on dataset using different Regressors

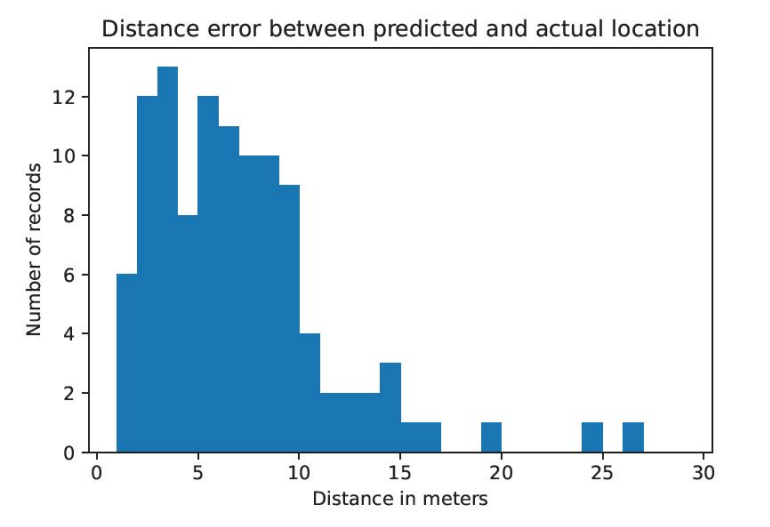
Regressor	Dataset	r2_score
K Nearest Neighbors (KNN)	Tempere1	0.918
	Tempere2	0.951
RandomForest	Tempere1	0.926
	Tempere2	0.961
Decision Trees	Tempere1	0.823
	Tempere2	0.939
Support Vector Machines (SVM)	Tempere1	0.852
	Tempere2	0.761

Two Level Indoor Localization Model



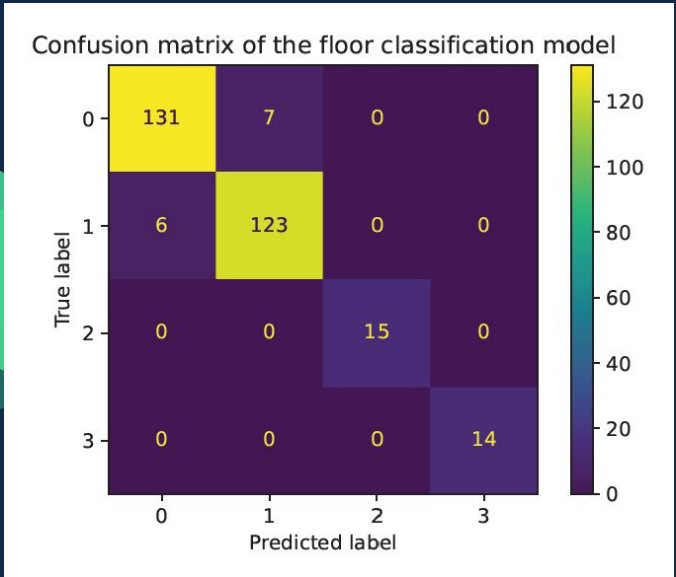
Plots

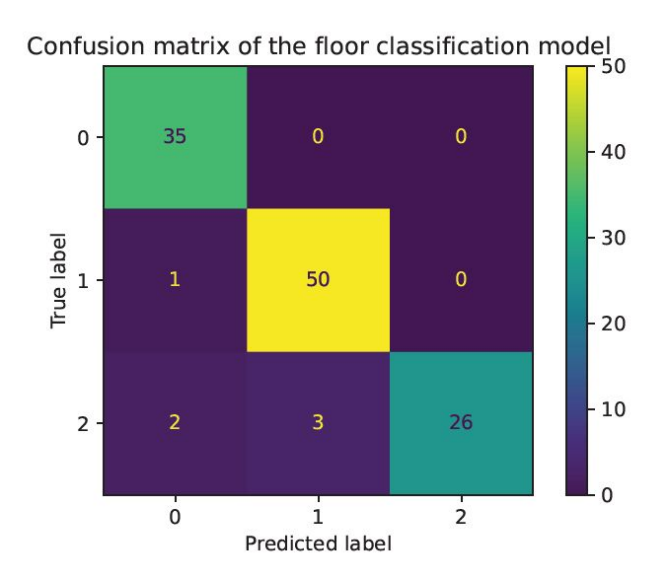




Histogram plots showing the distance between predicted and actual location of final model for Tampere1 and Tampere2 respectively

Confusion Matrix





Confusion Matrix of the final model for floor prediction using KNN Classifier for Tampere1 and Tampere2 respectively

Conclusions

- To address the indoor localization problem, a two-level localization model is proposed which improves both the accuracy and the response time
- This localization phase has two steps i) floor prediction, and ii) reference point prediction using predicted floor
- Various machine learning approaches were explored and tested
- Finding a proper standardized dataset is a tough nut to crack
- A lot of research need to be done considering it's dynamicity in practical scenarios
- Future communication technologies like 5G and wave fingerprints may be explored to take it further

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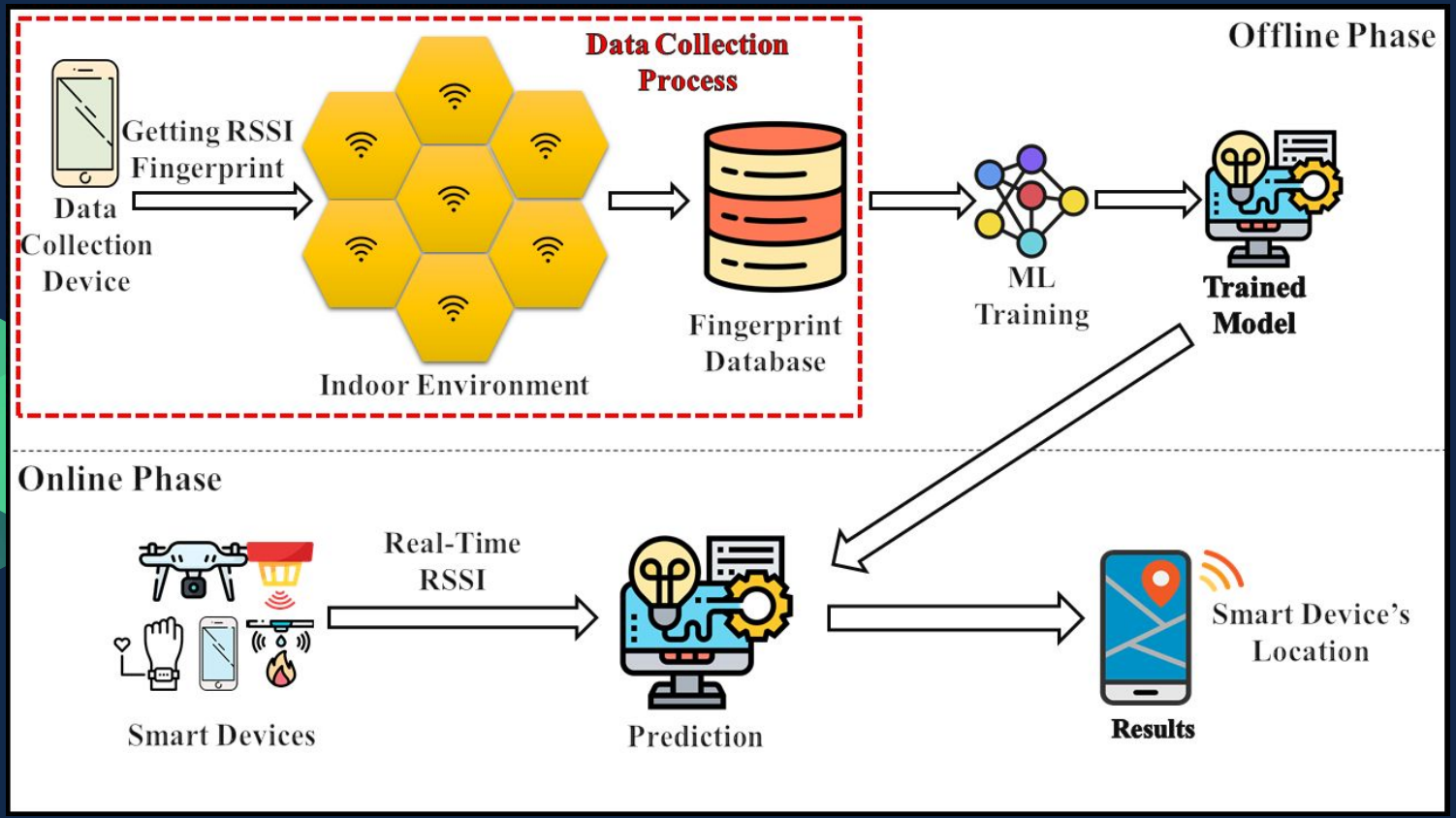
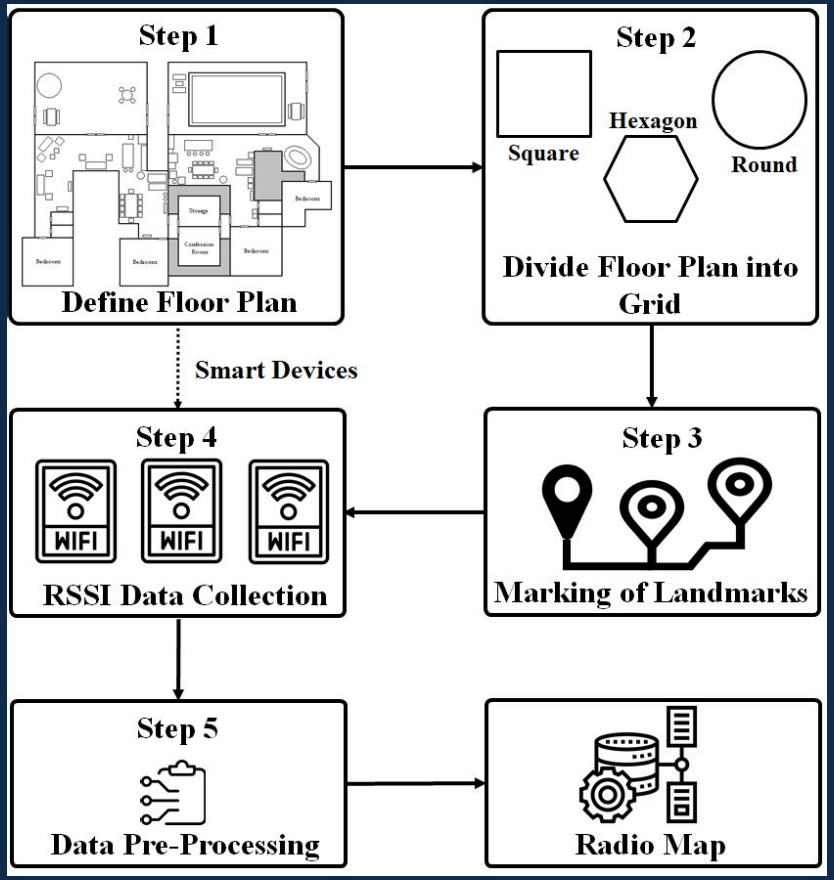
Thank You



Basic workflow of ML-based indoor localization using Wifi RSSI fingerprints



Overview of fingerprint data collection process