PHYSICS - BASED MACHINE LEARNING MODELS FOR INDOOR WIRELESS LOCALIZATION

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Background and Motivation

Indoor localization systems help locate a person or an object within an enclosed space. Its application range from helping firefighters conduct search and to allowing indoor robot assistants map their surroundings.

WiFi Based localisation involves using Received Signal Strength Indicator (RSSI) measured from an access point at a specific point in the space. A machine learning model is trained on raytracer generated WiFi signal strengths in dB vs its {x,y location}. But raytracers are computationally expensive and take a long time to generate very accurate results.

Project Goal

Use machine learning and low-fidelity RSSI to predict the location of a person/object within a fixed indoor environment.

Project Requirements

Functional Requirements:

1. Location in x-y coordinates of a static target given a WiFi (RSSI) signal
2. Create RSSI WiFi fingerprint map using ray tracer simulations
3. Map of Bahen 8th floor

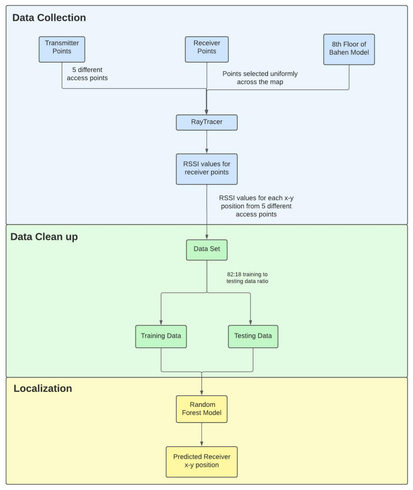
Constraints:

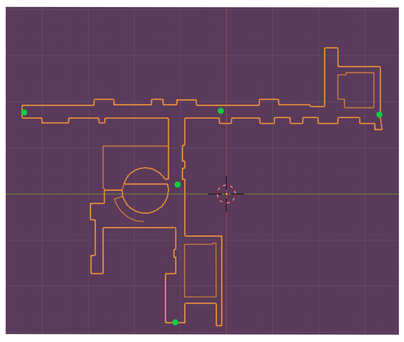
Raspberry Pi access points (APs) configured separately from existing APs in Bahen

Objectives:

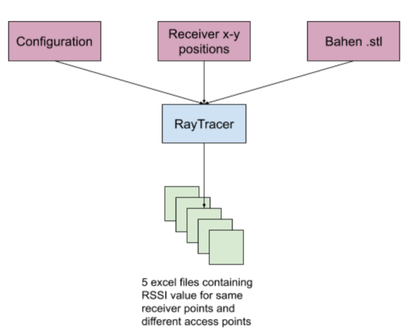
1. Augment training data
2. Prediction error < 4 metres

Methodology





Schematic of Bahen 8th floor highlighting the 5 access points in green

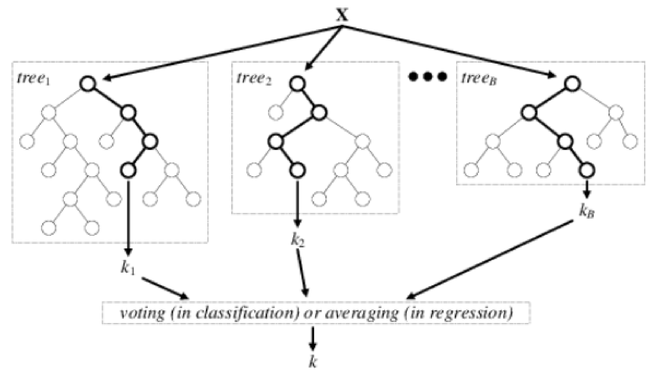


RayTracer simulator inputs and outputs when run 5 times

Design Challenges

- Data required cleaning and engineering to enhance results. **Techniques used:** convergence analysis, normalization and adding additional receiver points
- Data points gathered from real transmitter/receiver points did not match simulated datapoints. Our final design used only the simulated dataset.
- Multiple possible models to generate predictions. Had to compare results across an ANN, KNN, and Random Forest Regressor and picked the model with the lowest mean absolute error

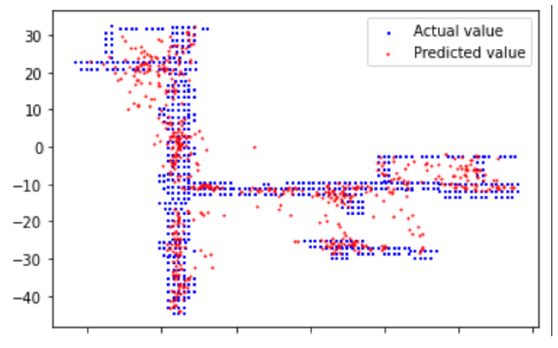
Design Overview



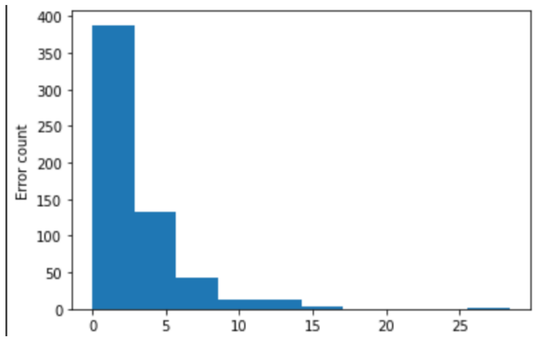
SciKit Random Forest Regressor with 100 nodes per decision tree with 2000 decision trees. Averaged across the trees to obtain final prediction

Final Result and Conclusion

- Random Forest has mean absolute error of 2.77 m only for objects on Bahen's 8th floor
- Further improvements: decrease error, use real-world data, increase fidelity



Scatter plot of actual values and predicted values



Histogram of mean absolute error