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Foundations of Networks

The code of for this assignment can be found in the following repository:
https://github.com/lombardero/nw-indoor-loc

Objective

The objective of this experiment is to perform precise indoor location using Wifi signal strengths from 4 different access points. The idea behind the task is that the decay on the signal strength will be a good indicator of the distance from the access point.
To identify the location of the user, we will scan the room as uniformly as possible to form a grid of points where the 4 access point readings are known. Once these readings are done, at any point of unknow coordinates, four readings of the same four access points can be used to approximate the location. In this assignment, we will use the Nearest Neighbor and K-Nearest Neighbor algorithms to predict the data.

Location

The room chosen for this assignment is the "Nicholas Hall", located in the eleventh floor of NYU's Stern School of Business. The room is shaped as an "L", approximately 15 * 11 meters.

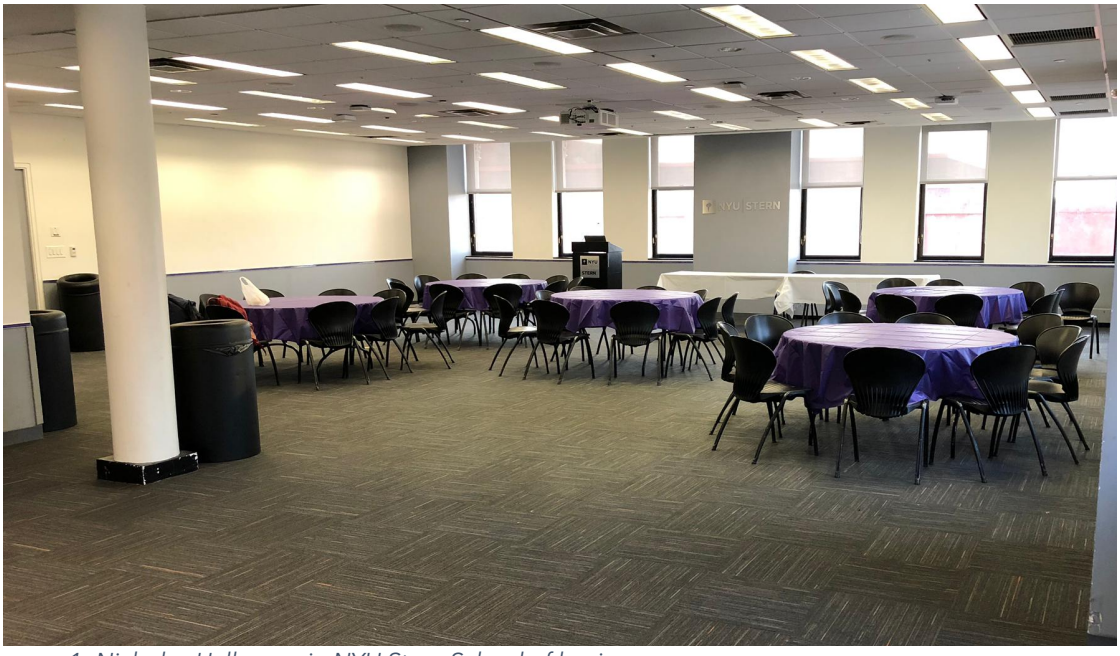

Image 1: Nicholas Hall room in NYU Stern School of business

Readings

Training data: we collected a total of 36 points evenly spread through the room (approximately two meters each). The four access points readings are known.

Test data: we collected a total of 20 points in different locations than the training data. This data will be used to assess how well does the model predict the locations.
The image below shows the geometrical distribution of the train and test data.

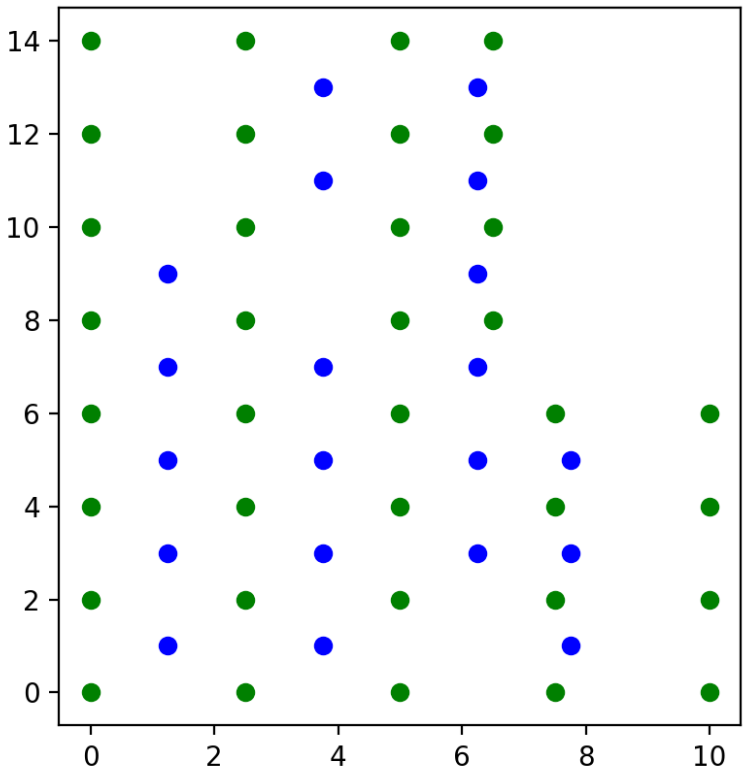

Image 2: Distribution of the train data (green) and test data (blue) throughout the room

Results

Nearest Neighbor

The results from the Nearest Neighbor are quite poor. The lowest error is two meters, and the largest is around 12 meters, which is basically the opposite side of the room. The error for each test points can be seen below. The minimum error of two meters is understandable, as all points of the test data are taken at around 1.5 meters from the training data.
The average error using NN is 6 meters.

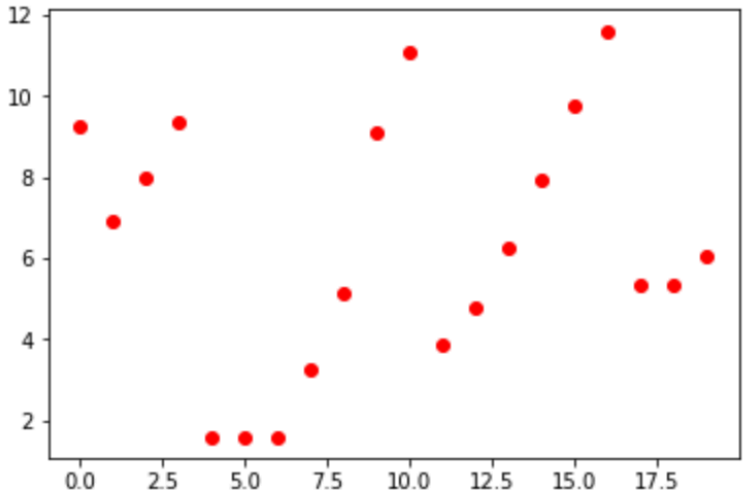

Image 3: Distance errors obtained using Nearest Neighbor

K Nearest Neighbor

In this model, we used the three "closest points" in terms of access point readings in the space, and averaged its results, to predict the location. The results are fare better, and more constant throughout the dataset. The maximum error halved, and the prediction error is lower than 2m in around 50% of the data.

The average error using KNN is 3 meters.

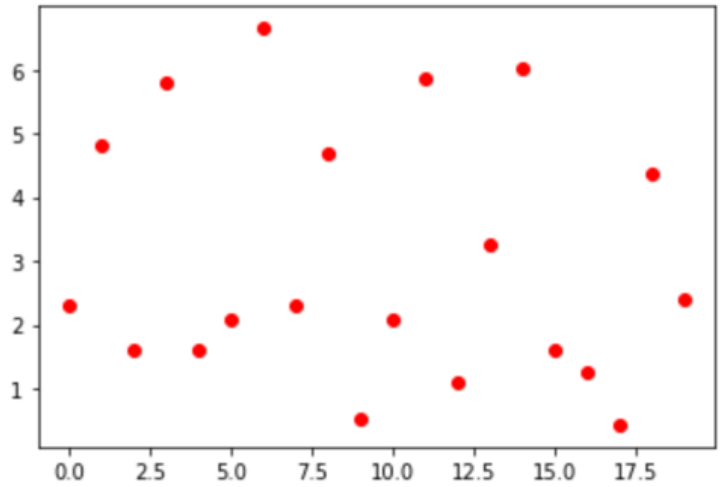

Image 4: Distance errors obtained using KNN

Conclusion

We will keep the KNN model, as it is far more precise. Below is a mapping of the points and predictions.

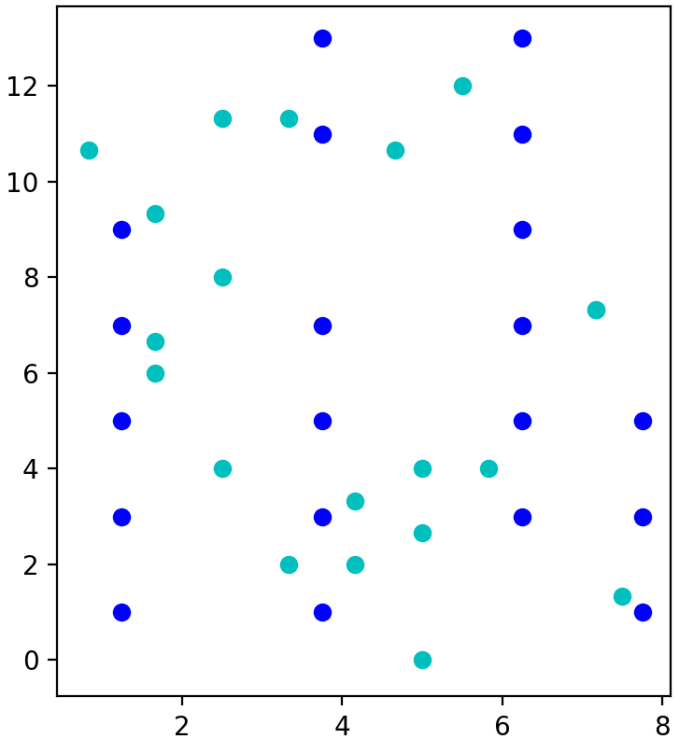

Image 5: Test set data (blue), and predicted locations (cyan)

The model is still improvable, but it is much better than with the initial approach of using a single Nearest Neighbor. To keep improving the precision, two approaches can be tested:

- Gathering additional access points (reading 5 or 6 access points instead of 4 could reduce some mistakes due to the signal imperfection)
- Increasing the number Nearest Neighbors averaged. Trying out four, five or more Nearest neighbors could reduce the imperfections of the predictions.