Neural Networks

Applied to indoor wireless localization

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Fundamental of Indoor Localization

Inspired by L. Miao's "Calibration-free wireless indoor localization (CAFLOC)."

- GPS-like navigation for indoor settings.
  - GPS signals are easily blocked by physical objects.
- Significant advantages to the population.
  - Public safety and luxurious investment.
- WiFi signal was used to bridge the target device and reference device.
  - WiFi is widely used and Received Signal Strength (RSSI) efficiency.
- Geometric mapping is used due to complexity of environment.

Roles of Neural Network in Localization

Obtaining and formatting trainable dataset for the Neural Network.

Applying the PCA to better assist the Network.

Using Multi-Layered Perceptron to train and achieve the result.

Background

Localization Technique

Fingerprint Mapping

Offline phase: Database building

- Site survey of all RSS signals on a reference device at all known locations.
- Collected by Wi-fi module built in the device i.e. 802.11 protocol.

Online phase: testing

Process

- Current measured values(features) from the sensor node(AP) adapted to requested form i.e. fingerprint vector
- Compares fingerprint vector against one in database and locate the target .

Defects

Defects

- Adds computational complexity
- IEEE 802.11 do not define how RSS should be presented
- Temporal variance of RSS

Related Works

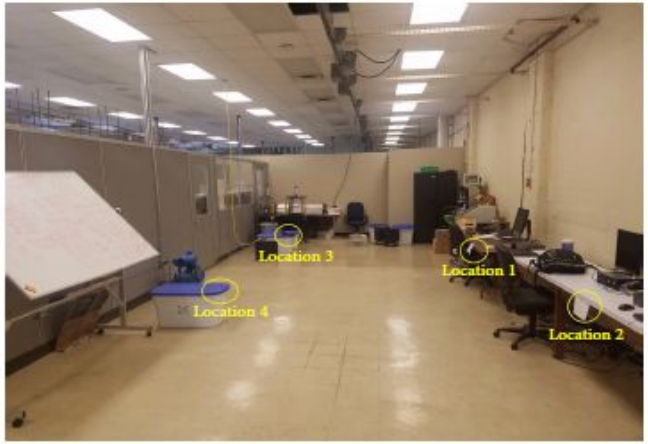


Fig. 2: VET170B: Location of the Experiment

	L1	L2	L3	L4	Average
Nearest Neighbor	**23%**	**48%**	100%	88%	64.75%
CAFLOC1	83%	91%	96%	96%	91.5%
CAFLOC2	93%	91%	100%	100%	96%

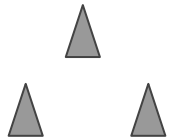
CNN & Regression model for localization

- To take care of temporal variance of RSS, CNN based method is described by Jang et. al [1]
- Zou et.al [2] proposed the deep regression model using DNN-CNN-Dempster shafer.

Our Attempt

- We tried to solve the localization problem just by using simple 2-layered perceptron and for the scenario it worked well.

3 locations



Methods

- We picked 3 locations in a room(MGB 202A) 2 meters apart from one another in a triangle.
- Used the application WifiInfoView.exe to gather data.
- Used the RSSI values of the strongest wireless access points for each scan.
- We took 1000 scans per location for a total of 3000 scans. We put these scans in a vector and stored it into a file.
- Half of the scans had non existent values where the access point dropped out of range. The scans with nan values were thrown out.

Methods

- The network we used was a multilayer net.
- The network had 2 hidden layers with 64 hidden units. Because of the small number of locations in our test we did not need a bigger net.
- The hidden layers used ReLU and Sigmoid activation functions.
- And the output layer used categorical-cross entropy and softmax.
- We trained the network on our data set for 100 epochs and had 20% validation split.

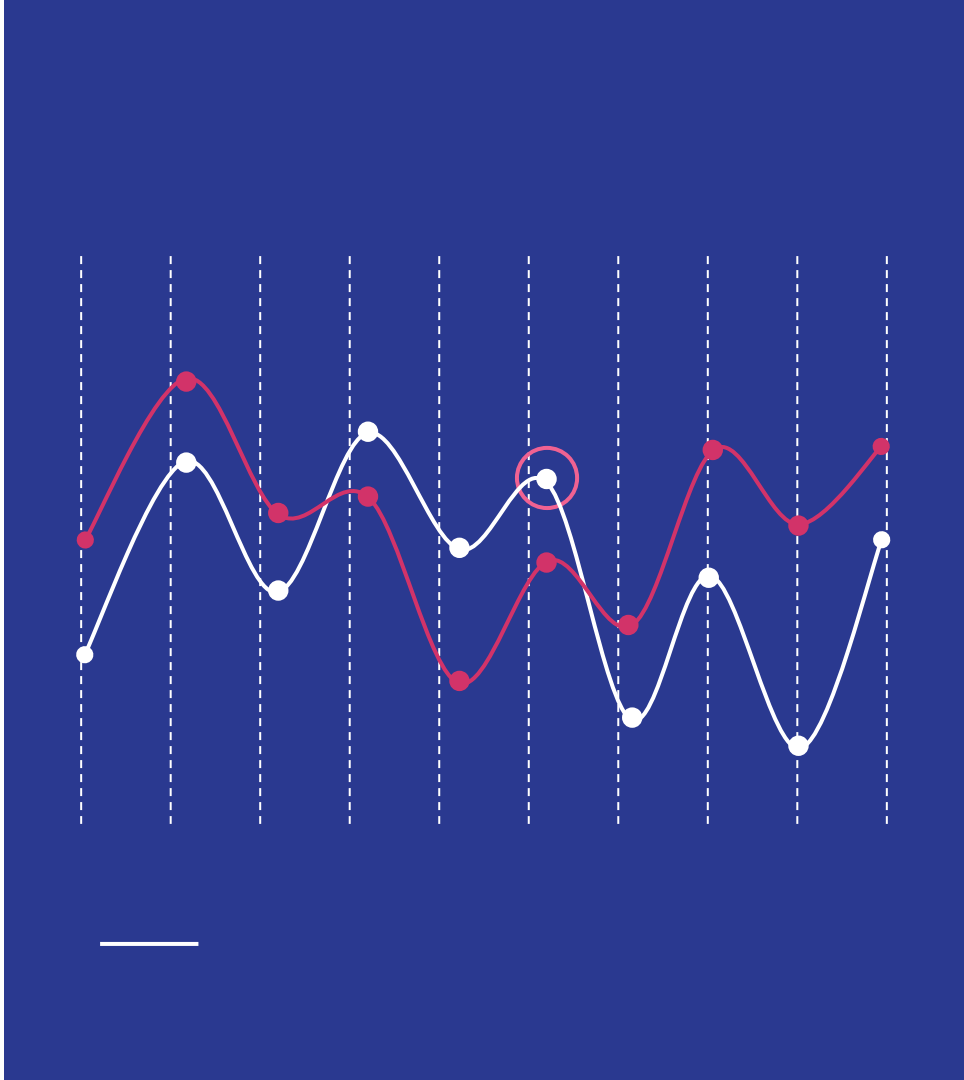
Results

Testing dataset

- Timing
- Recall PCA
- Standardizing Method

Interpreting

- Did not use Random tests
- About testing locations



Future Challenges & Prospects

Increase Scale

Larger footprints

- Spacing tests
- More Equipment

Dynamic Environments

- Testing
- Larger Networks

Integrated Tech

Integrate Database

- SQL, BigQuery

Integrate API

Increase Raw Data Efficiency

- New collection method
- Dedicated Devices

Application

Inventory Management

- Automated

Indoor Landmark Based Navigation

- Landmark Locations
- Store cardinality & distance with location

References

1. J. Jang and S. Hong, "Indoor Localization with WiFi Fingerprinting Using Convolutional Neural Network," *2018 Tenth International Conference on Ubiquitous and Future Networks (ICUFN)*, Prague, 2018, pp. 753-758. doi: 10.1109/ICUFN.2018.8436598
2. J. Zou, X. Guo, L. Li, S. Zhu and X. Feng, "Deep Regression Model for Received Signal Strength based WiFi Localization," *2018 IEEE 23rd International Conference on Digital Signal Processing (DSP)*, Shanghai, China, 2018, pp. 1-4. doi: 10.1109/ICDSP.2018.8631593