# Adaptive Cloud-based Indoor Positioning System Using Wi-fi Fingerprints

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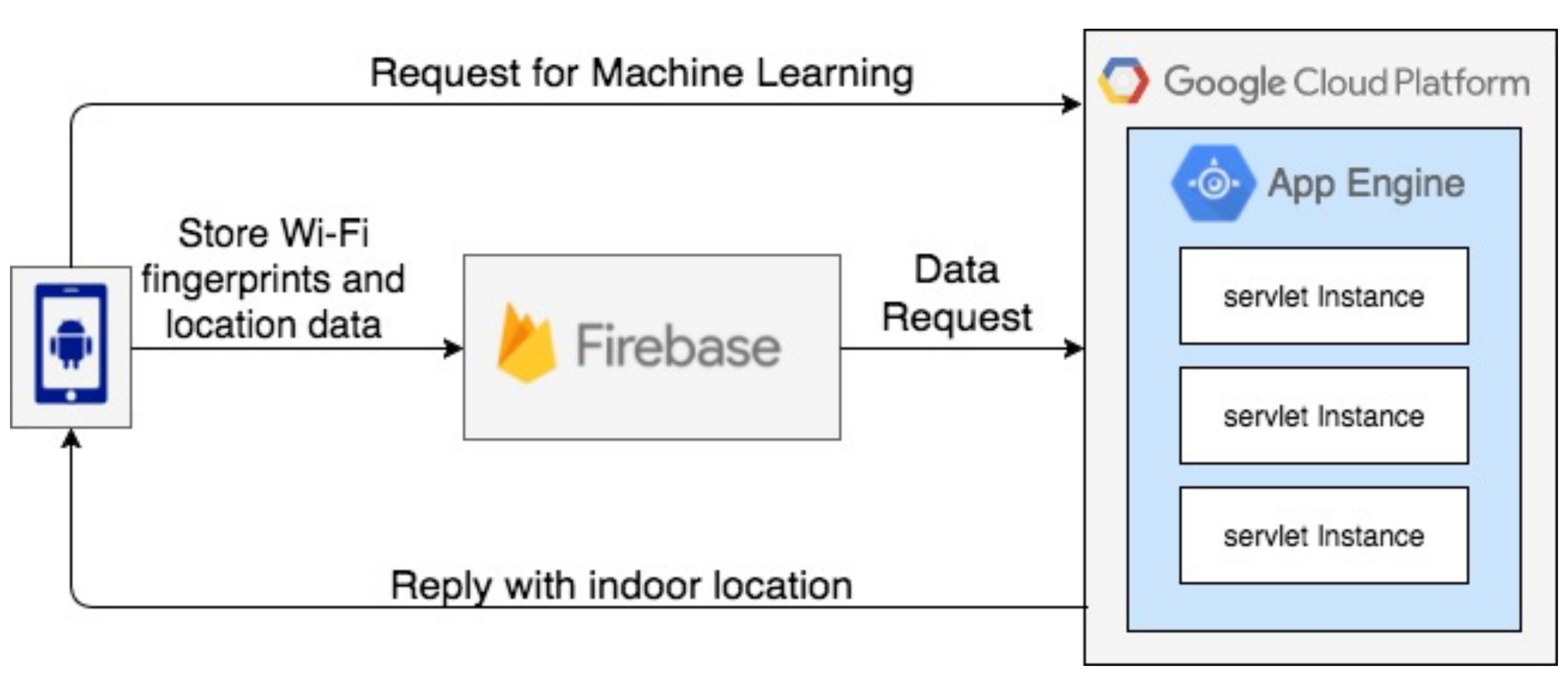
## Abstract

Global Positioning Systems (GPS) are highly accurate at predicting outdoor locations; however, due to signal attenuation, they are unreliable in indoor locations. Wireless mobile devices can be used to collect location fingerprints based on sensor readings and Wi-Fi signal strengths, and we have demonstrated the uses of machine learning algorithms to predict indoor locations based on these fingerprints within 2 meter accuracy.

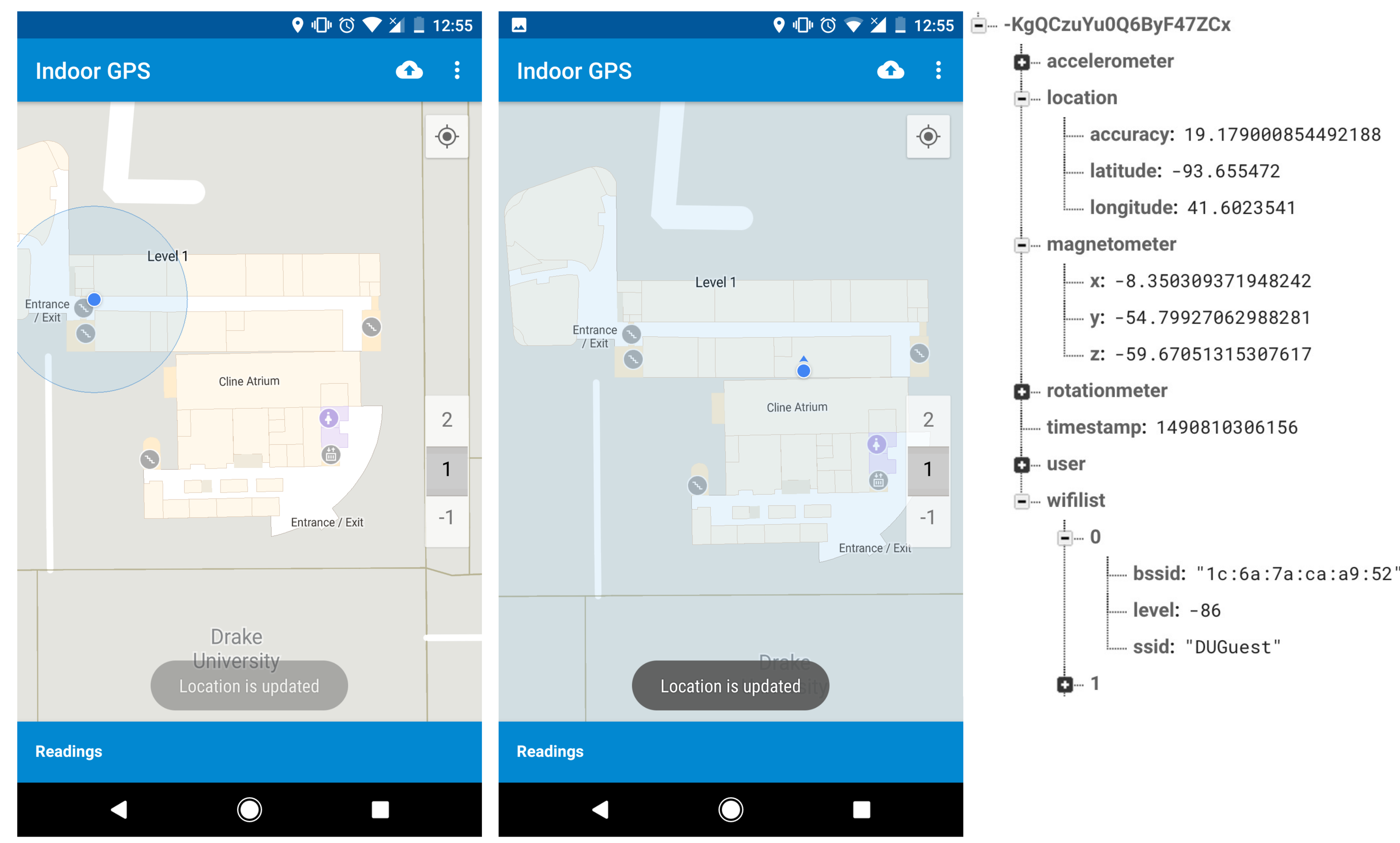
We propose an adaptive indoor positioning system that integrates with Google Maps and maintains a cloud-based database of Wi-Fi fingerprints. This system allows for both manual and passive collection of training points, automatic training, and seamless switching between the indoor models and other location services.

## Architectural Model




- App sends Wi-Fi fingerprints and location data to the Firebase Realtime Database
- App also sends a request for machine learning to the App Engine
- One of the servlet instances accepts the request and replies with an estimated indoor location
- App updates the location accordingly

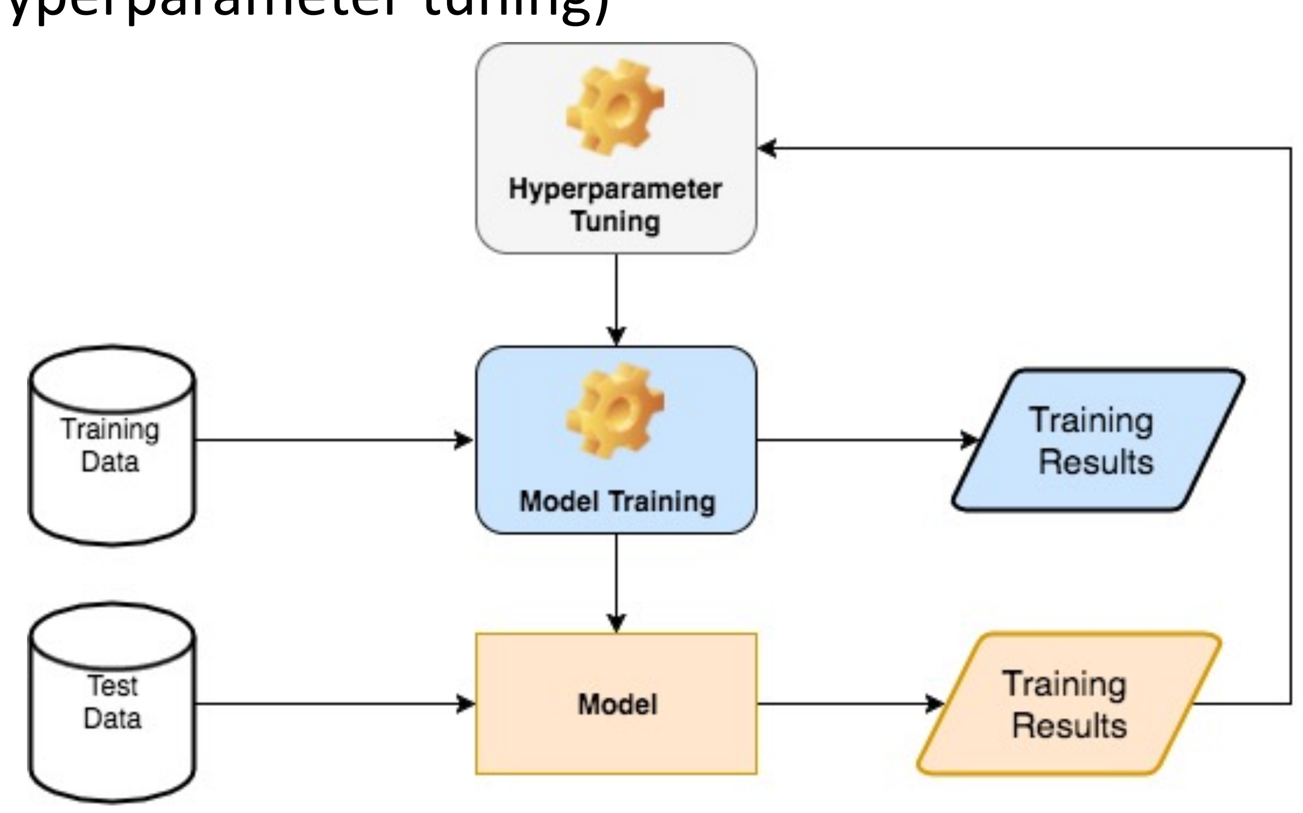
## Data Collection




- Sensors: Accelerometer, Rotation vector, Magnetic field, Wireless Wi-Fi
- Data collected from different buildings
- User is stationary or walking at a steady pace

## Methodology

- Wi-Fi fingerprints and location data are sent to the Firebase Realtime Database as training data
- Models are consistently trained on the AppEngine
- Each building will have their own model parameters
- Training models will be tuned using Grid Search (Hyperparameter tuning)

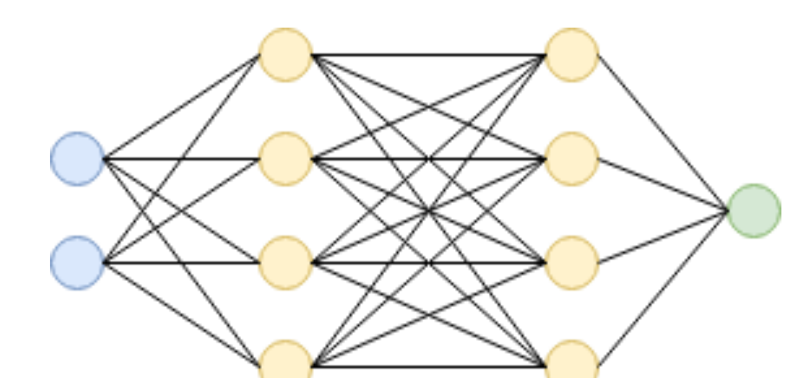



## Instance-based Approach

- Instance-based learners predict values for a new instance by comparing the distance between the new instance and the training instances
- From our previous research[2], k-Nearest Neighbor (k-NN) algorithm was the best performing algorithm with an accuracy of 2 meters
- However, to improve the speed of k-NN, data need to be divided into small sections

## Artificial Neural Networks

- Artificial Neural Network (ANN) consists of an input layer, some hidden layers and an output layer
- ANN works best with big data
- Several characteristics can be considered for training



## Conclusions

- Training models can be consistently tuned if we adopt a cloud-based approach
- k-NN performs better for small data, but ANN performs better for big data
- Data from more buildings need to be collected

## References

1. Alice Zheng, 2015, Evaluating Machine Learning Models -- A Beginner's Guide, https://www.slideshare.net/AliceZheng3/evaluating-machine-learning-models-a-beginners-guide
2. David Mascharka, and Eric Manley, 2016, Machine Learning for Indoor LocalizationUsing Mobile Phone-Based Sensors