Machine Learning for Channel-Based User Scheduling in Ad Hoc Systems

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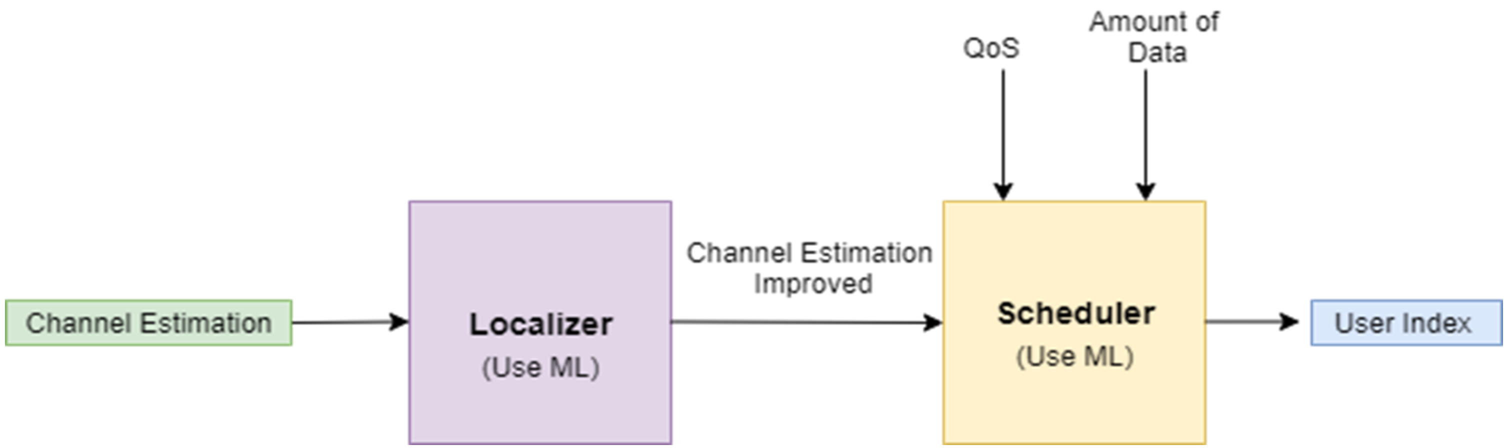
This project is funded in part by the National Science Foundation, award number 1659871.

BACKGROUND

- In 5G, massive number of users being served by cellular networks.
- Currently, machine learning (ML) algorithms are used to schedule users in centralized systems.
- Investigate ML algorithms for ad hoc networks to schedule users.



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MOTIVATION

Improve performance in applications:

- Internet of Things/Wireless Sensor Networks
- Machine-to-machine communication
- Vehicle-to-vehicle communication
- Healthcare systems
- Use machine learning to predict channel and other parameters

https://5gsoc.org.uk/why-use-5g/what-is-5g/

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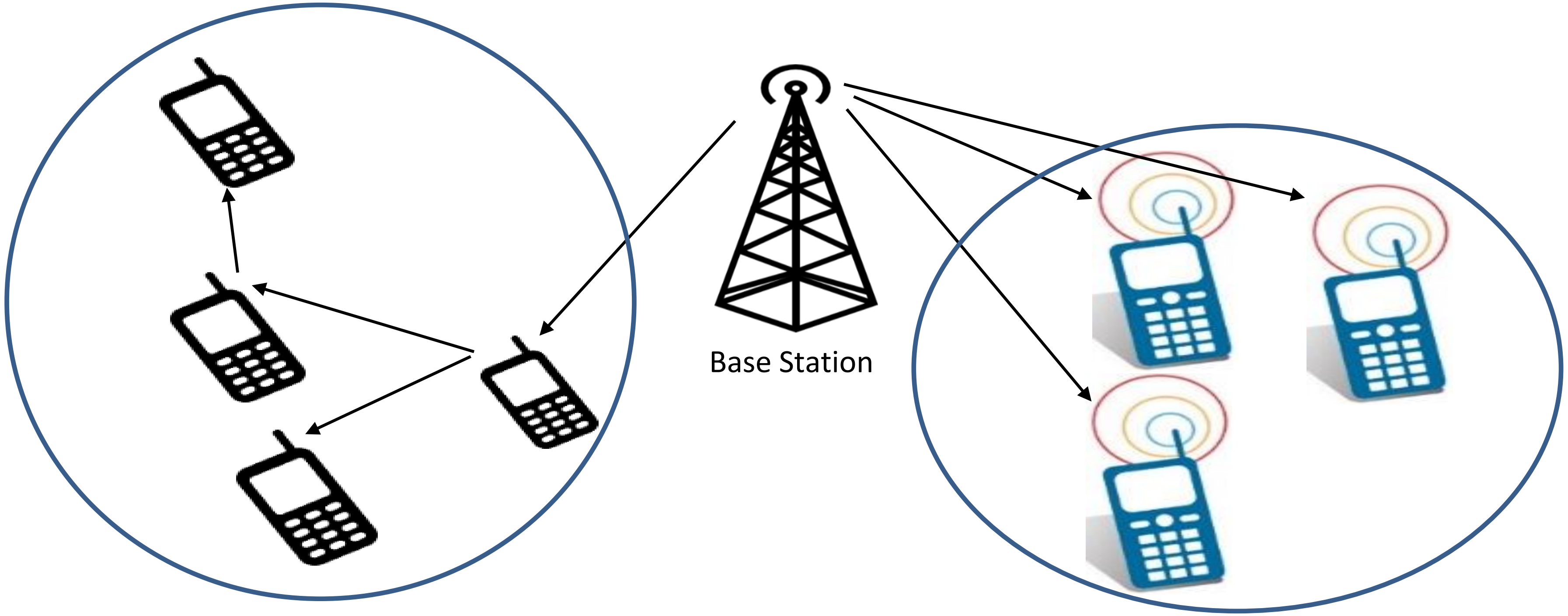
PROBLEM STATEMENT

- Rely on ML in ad hoc systems to schedule users in order to reduce burden on base stations.
- Implement and evaluate ML methods for parameter estimation



Nodes in this subnetwork receive the data via ad hoc communications

Nodes in this subnetwork receive the data directly from the BS

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CHALLENGES

Real time hardware implementation

Acquiring data for training

Identifying ML algorithm

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EXPERIMENTAL METHODS

- Use GNU Radio Companion to operate USRP kits

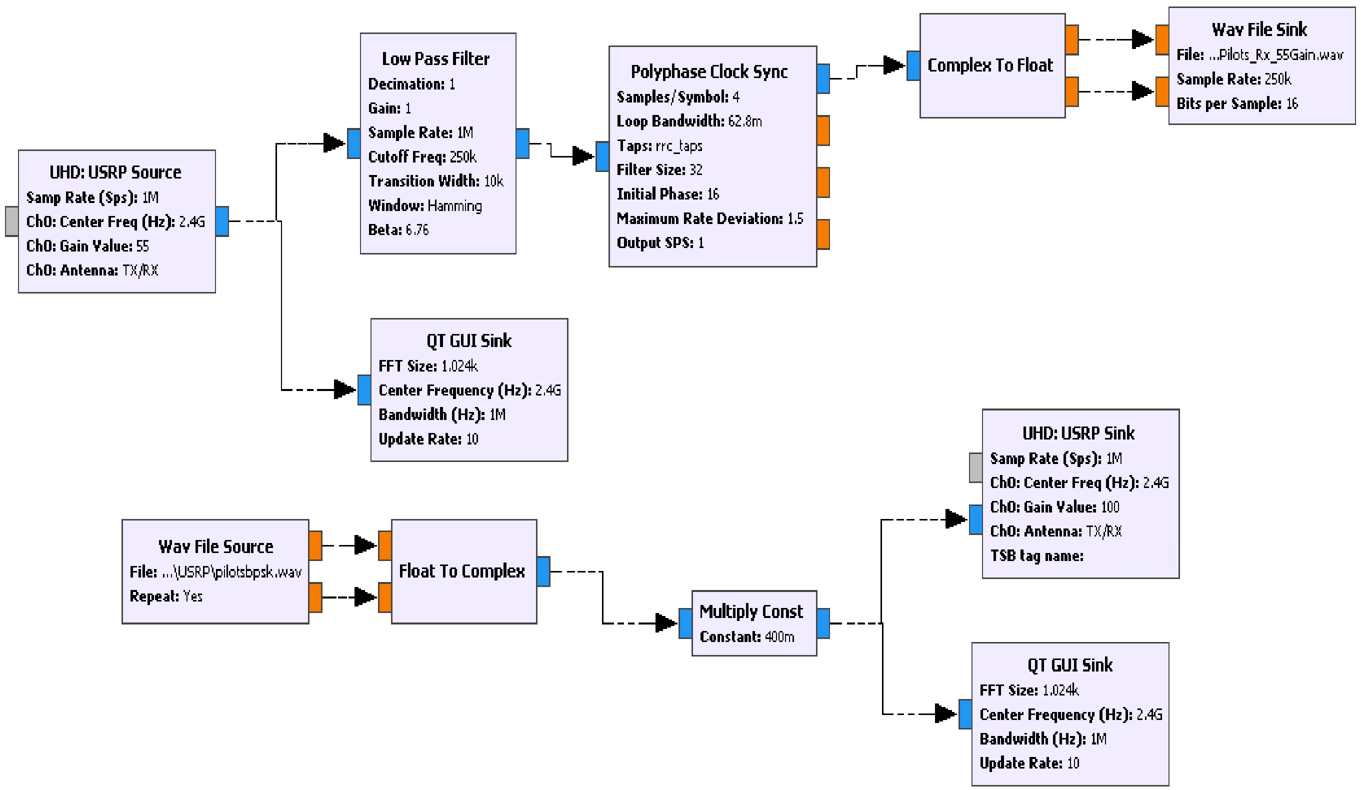

Figure 1: Depicted is a receiver (Rx) and transmitter (Tx) block in GNU Radio software used in the USRP kits.

Figure 2: The USRP B200 Radio with an antenna attached at the Tx/Rx port.

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EXPERIMENTAL METHODS

- Received Signal (GNU Radio Software)

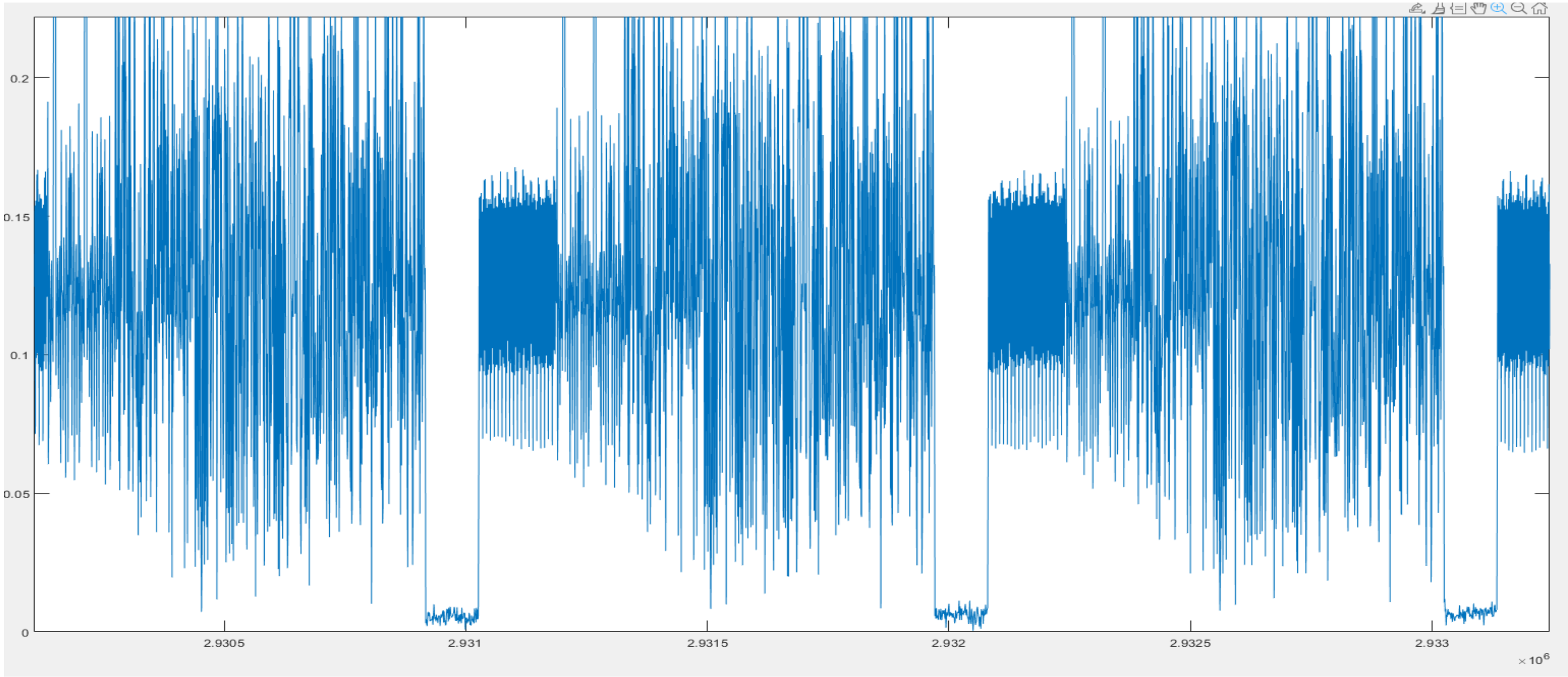

Figure 3: A MATLAB plot displaying the received signal obtained by the .wav file located at the Rx block in GNU Radio software development.

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EXPERIMENTAL METHODS

- Channel Estimation vs. Subcarriers (MATLAB) using kits

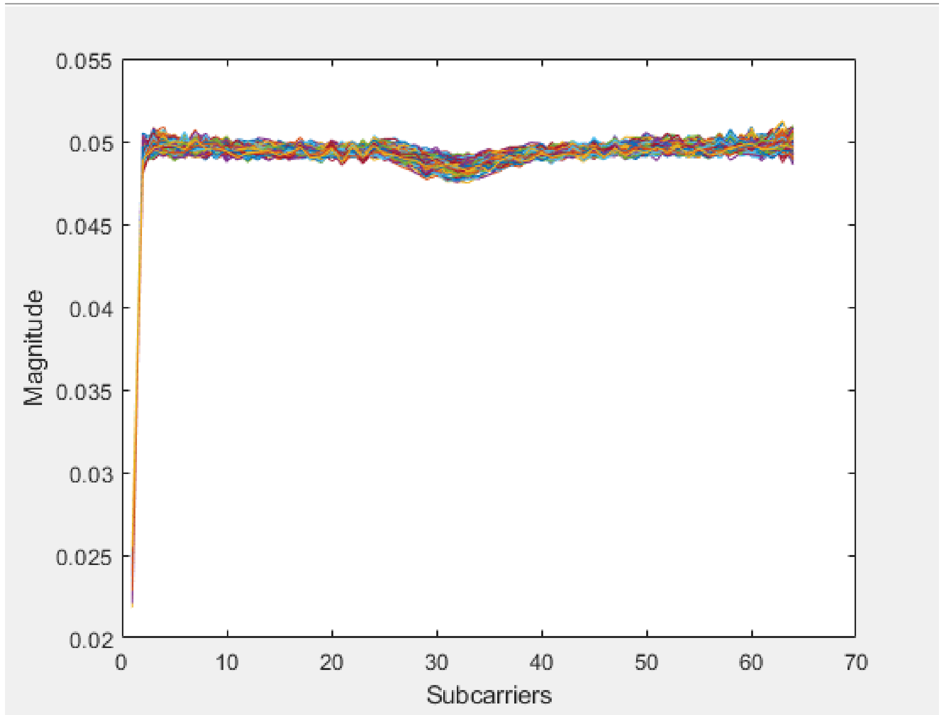

Figure 4: Channel estimation algorithm with good accuracy using USRP kit.

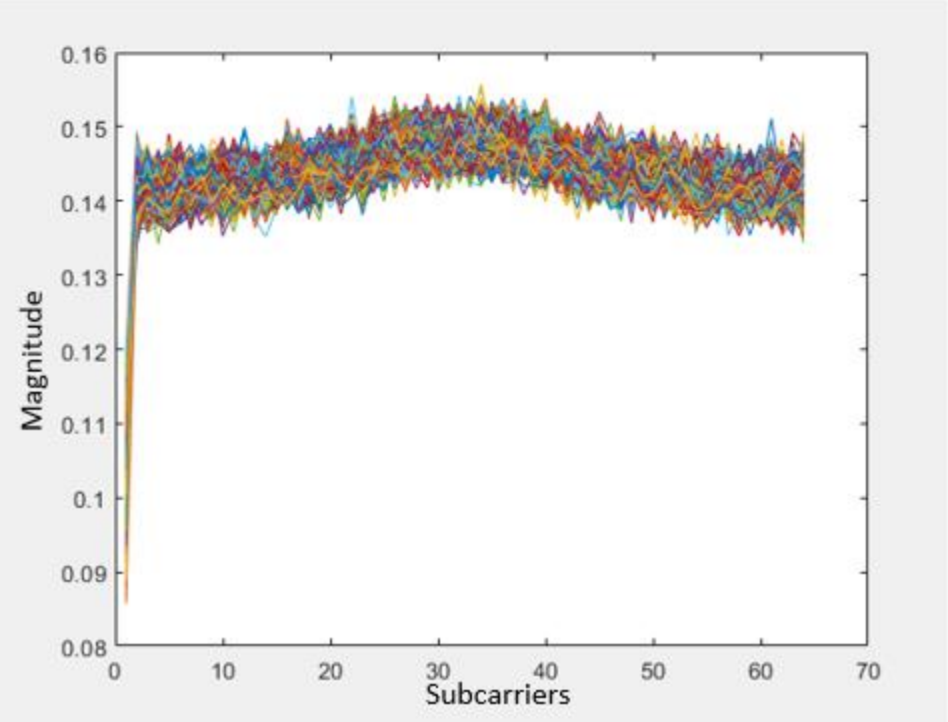

Figure 5: Channel estimation algorithm with bad accuracy using USRP kit.

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EXPERIMENTAL METHODS

❑ Artificially generated dataset of channels (MATLAB)

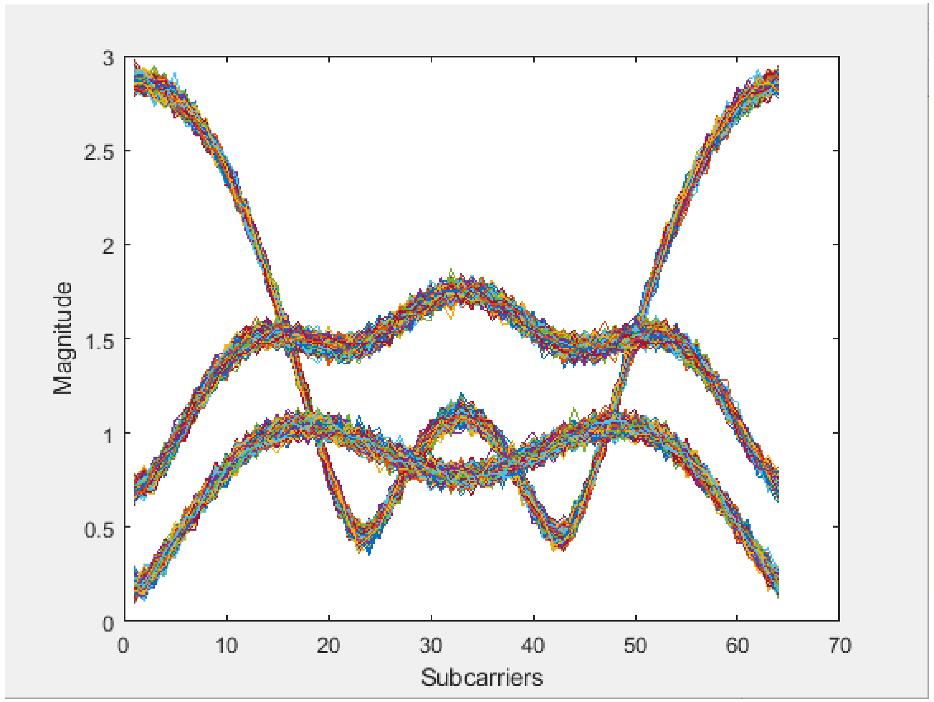

Figure 6: Artificially generated channel estimations with an SNR value of 30 dB at 3 different data points.

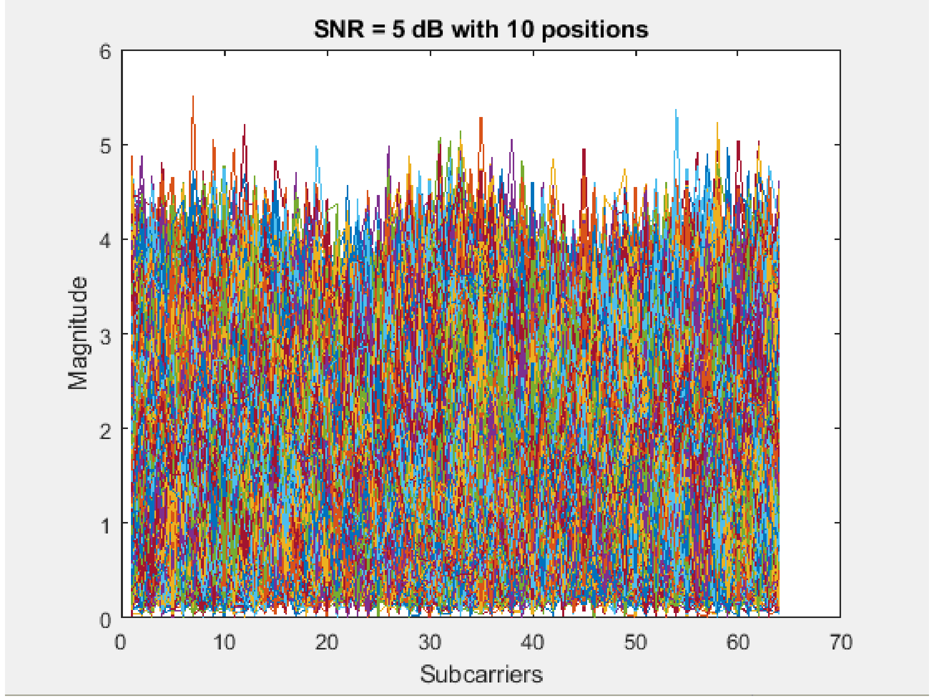

Figure 7: Artificially generated channel estimations with an SNR value of 5 dB at 10 different data points.

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EXPERIMENTAL METHODS

- Supervised learning classification algorithms:
  - Logistic Regression (LG)
  - Support Vector Machine (SVM)

https://www.dominodatalab.com/data-science-dictionary/sklearn/

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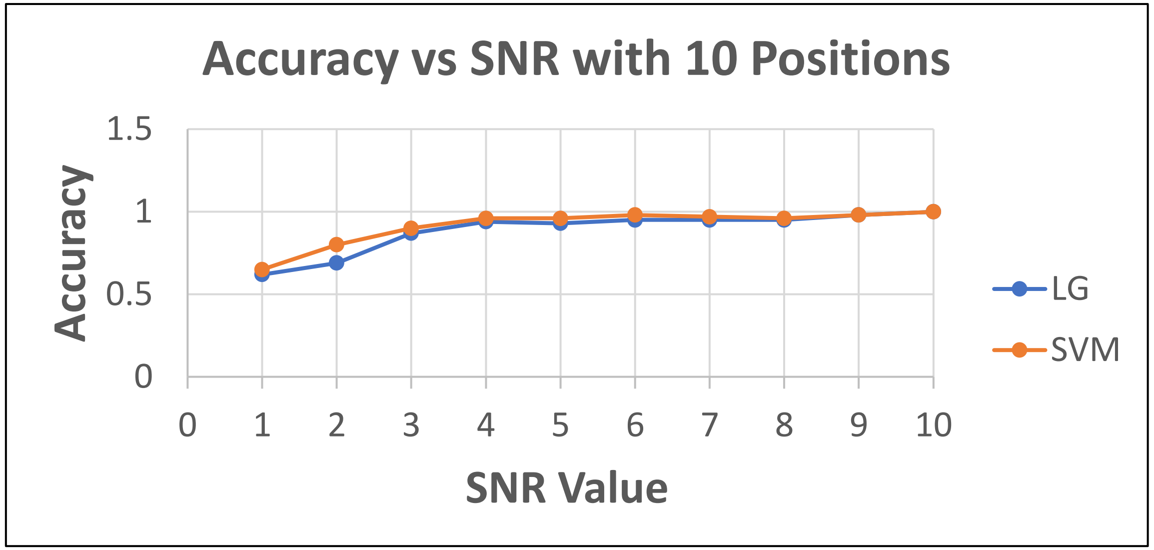
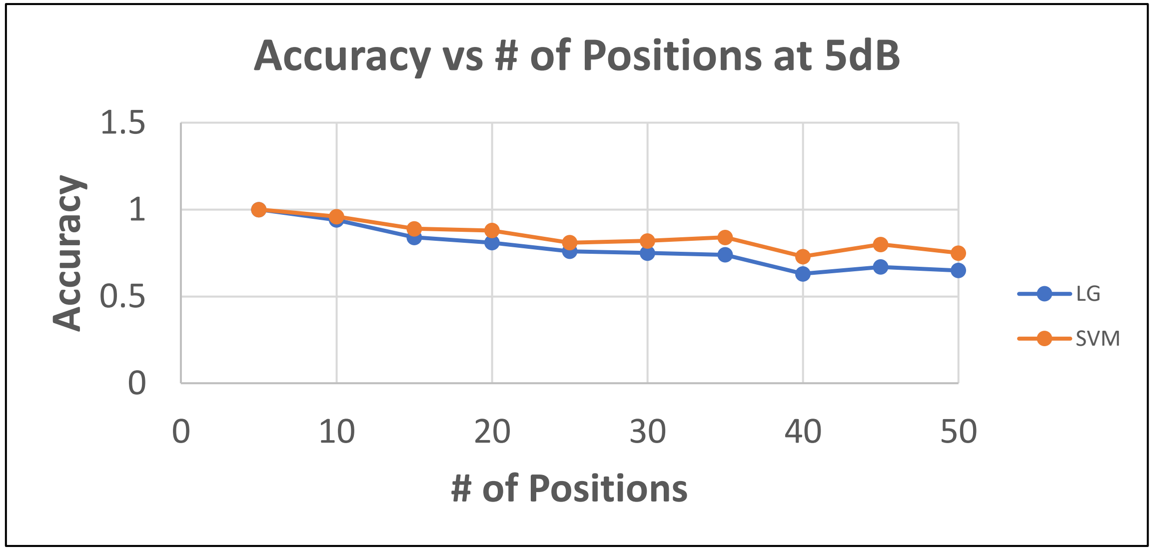
PRELIMINARY RESULTS

SenSIP INDUSTRY CONSORTIUM



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Metric     Value
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Accuracy   0.75
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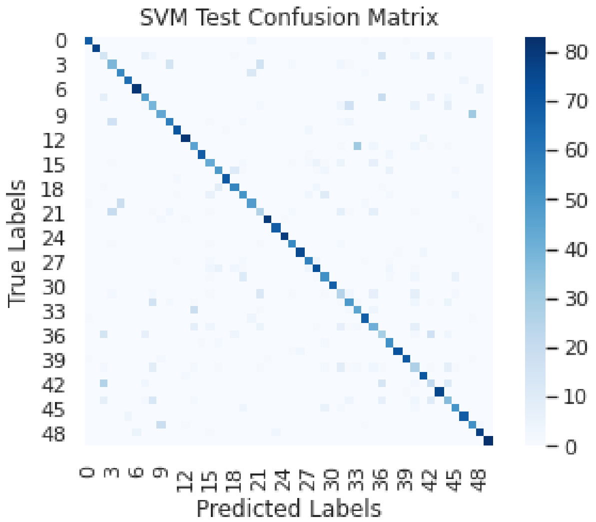

Figure 8: Confusion matrix using 50 different positions at a SNR value of 5dB. The accuracy represents the SVM algorithm correctly predicting the location of each curve (channel estimation magnitude).

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CONCLUSION/FUTURE WORK

- Attempted real time implementation with USRPs
- Demonstrated the ability of ML to predict the location of users which could then be used to estimate their channels
- Initial results work better with the SVM algorithm than LG algorithm
- Method to use hardware kits to represent real world environment
- Explore other classification algorithms

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