Real-time machine learning-based user authentication via daily activities using wireless signals

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Hello!

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Major: Electrical Engineering

Fun Fact: My favorite candy is Kit Kat.

Hello!

Name: Rishika Sakhuja

Major: Computer Engineering

Fun Fact: I have collected over 100 keychains from all of the places I have travelled to.

Hello!

Name: Sachin Mathew

Major: Computer Engineering and Computer Science

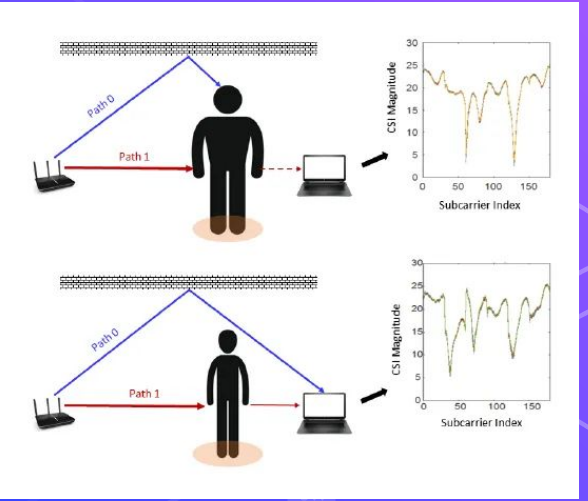
Fun Fact: In high school I ate gallon of sorbet in under an hour and I my body will never be the same.

Objective

- Recognize human activity using WiFi signals represented by Channel State Information (CSI)
- User- authentication with a device-free approach
- Develop a deep learning based user authentication to accurately identify each user

CSI

- CSI measures how a Wi-Fi signal propogates from a transmitter to a receiver.
- Wi-Fi signals are separated into several subsignals by frequency.
- With 2 transmitters, 2 receivers, and 30 subcarriers that can be read, our setup gives us 120 streams of CSI data.



Implementation for Classification

- As the repetitions have variable length, and the input can be arbitrarily long, an RNN is best.
- Use an LSTM to compare 1 second of input at a time, then forget input buffer upon classification and begin classifying next action

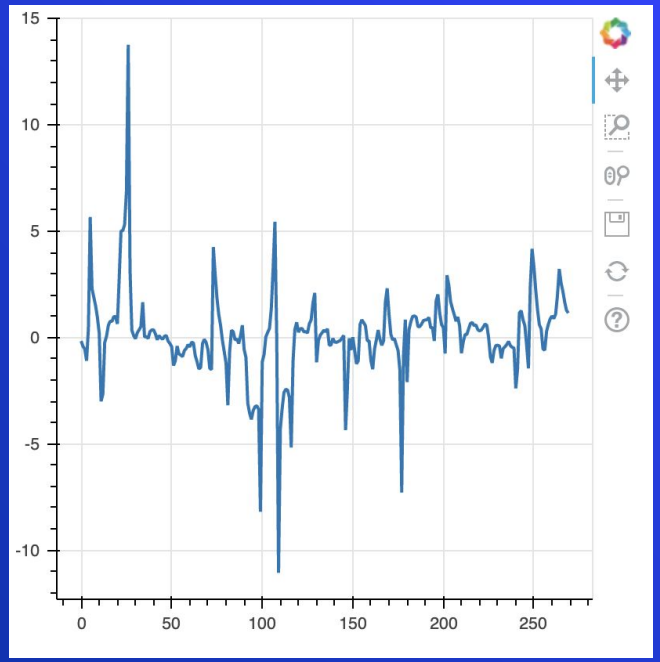
CSI Stream Segmentation

- Separates signals into small, classifier friendly sections.
- Implemented through checking where stream intersects (within some threshold) with the mean of a rolling window.
- Send the indices of these nodes to the classifier.

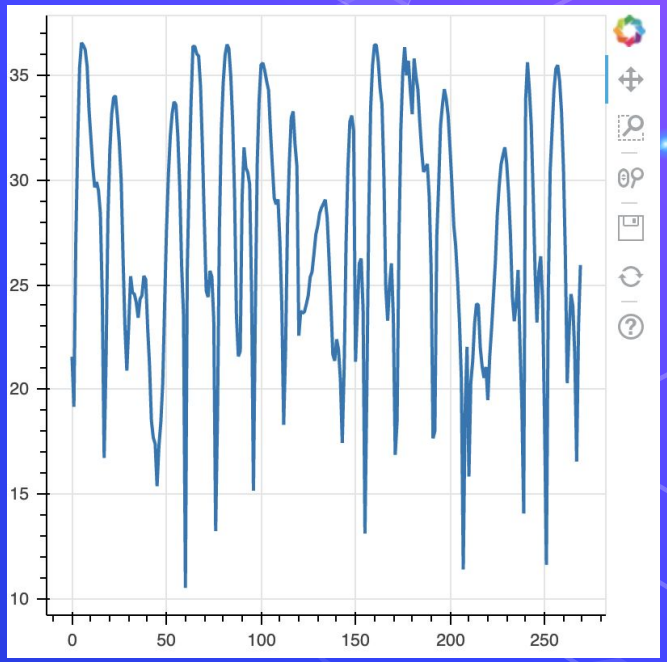
Visualization Tool- Bokeh

- Purpose of visualization tool was to graph CSI data in realtime
- Graphed sample CSI data and observed spikes which meant that the user was performing an activity at that time
- 270 subcarriers

Visualization Tool- Bokeh



- Data for sitting
- 270 subcarriers



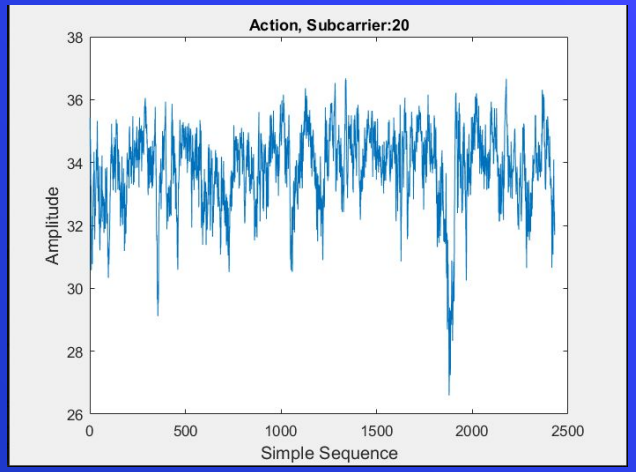
- Data for squatting
- 270 subcarriers

Experiments

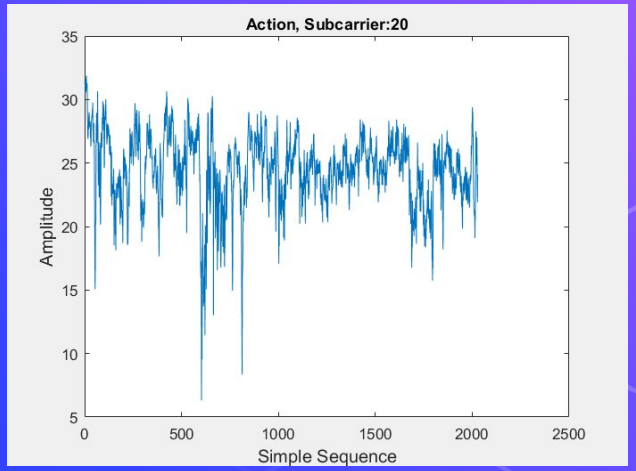
- Designed three experiments (Running, walking, sitting)
- Had 4 participants
- Ran the experiment for about a minute per person per activity

CSI Preprocessing Graph Introduction

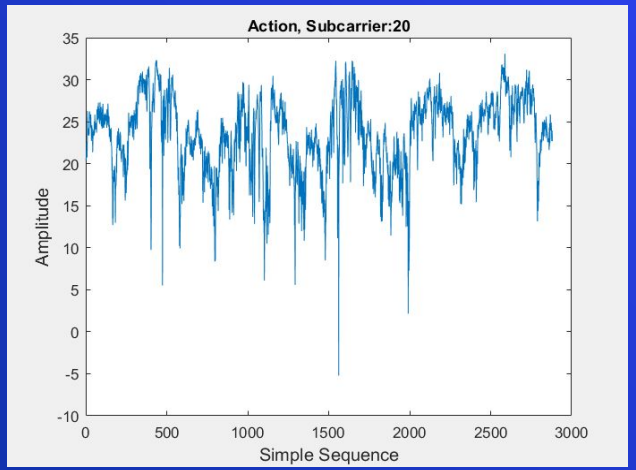
- Simple Sequence - time sequence (~ 1 minute)
- Amplitude - Useful for activity recognition and identifying users based on large scale movements
- Smaller Amplitude → Less movement
- Larger Amplitude → More movement
- Spikes → Ambient Noise or tiny movements



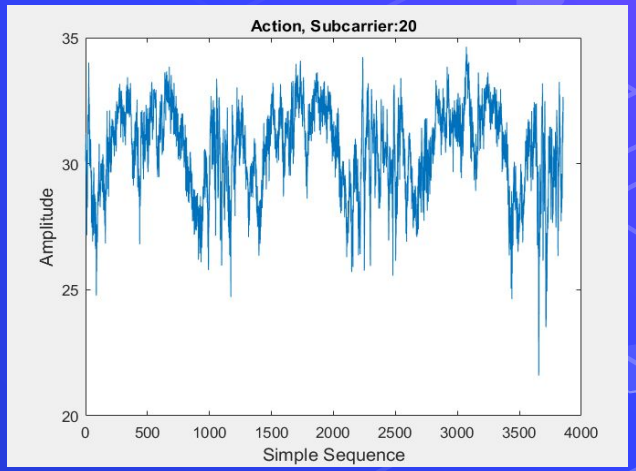
Person 1 Running



Person 2 Running



Person 3 Running



Person 4 Running

CSI Data Observations

- Each person had a different amplitude so they each runner had a different perspective of what “running” means to them
- By collecting enough samples of people running, we can understand the runner’s identity based on their amplitude

Questions?