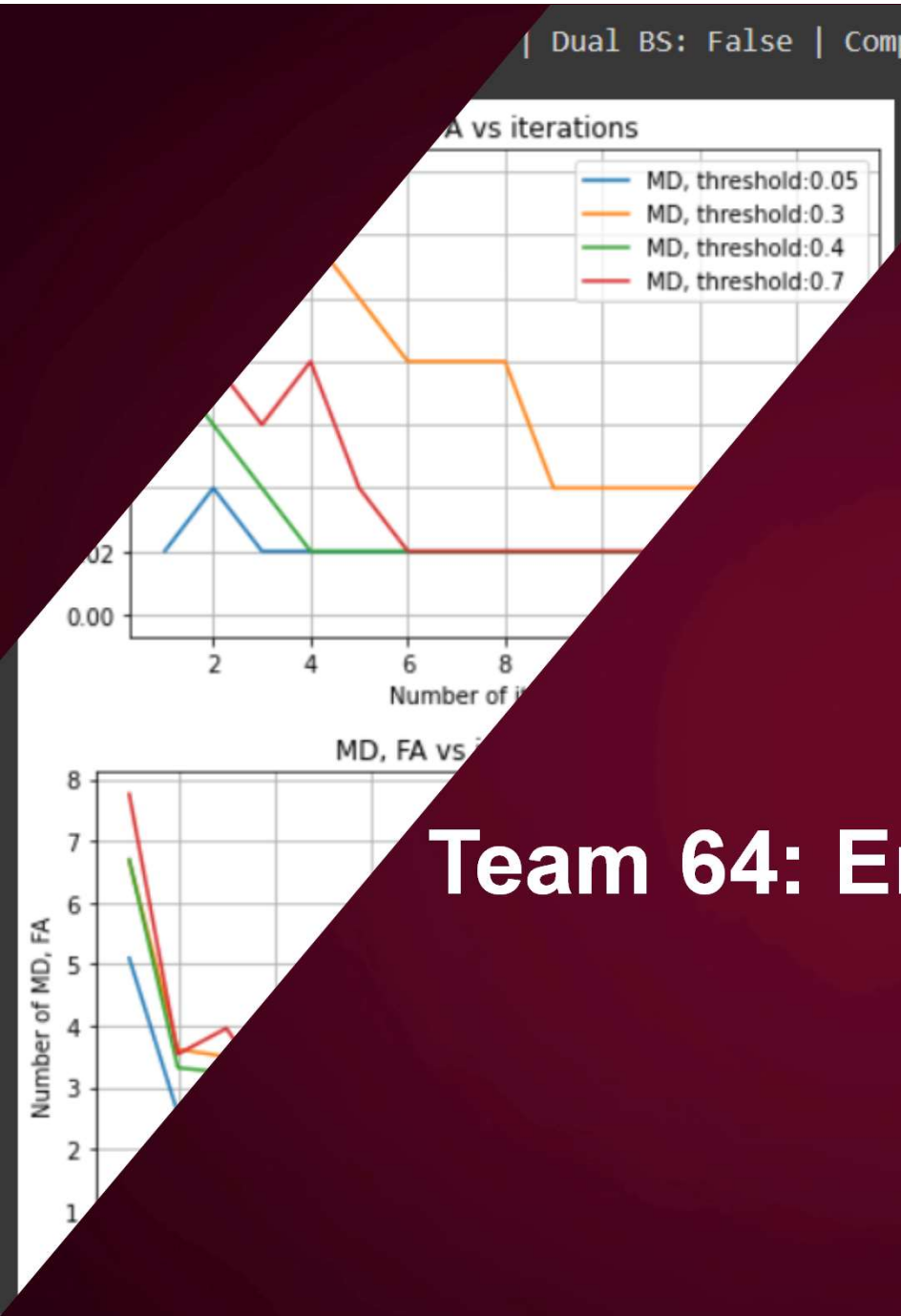


Team 64: Enhancing User Detection
Bi-Weekly Update 4

Holly Roper

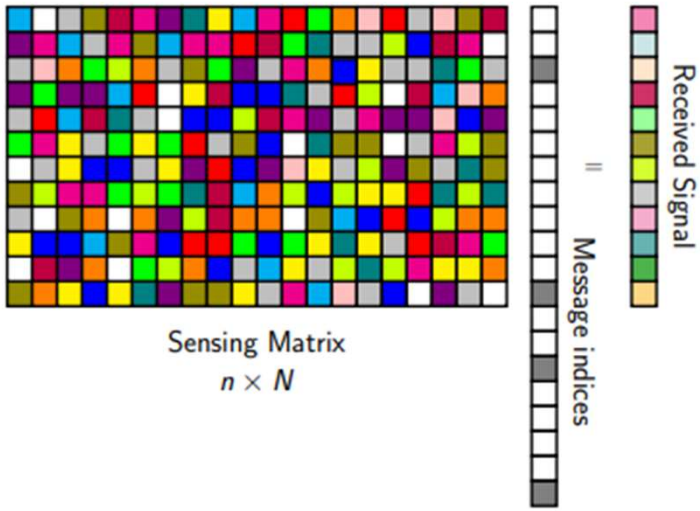
Sponsor: Dr. Krishna Narayanan

Jamison Ebert

TA: Max Lesser

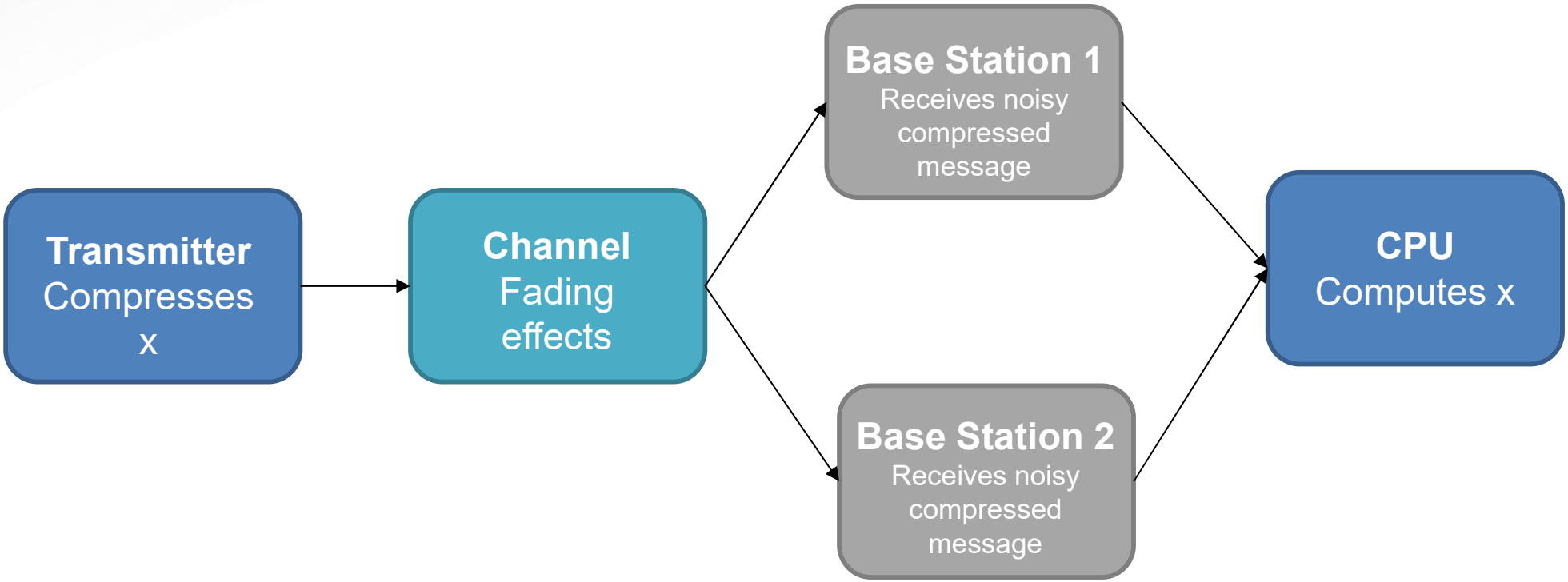
Project Summary

- With the rise in mMTC, a cell-free paradigm has been proposed to handle all the users
- In this paradigm, being able to accurately identify which users are active is critical
- Applying LISTA to the user activity detection problem in a cell-based system
- Evaluating the performance of LISTA in a cell-free system



mMTC: massive machine type communication; only a subset of users are active at any given point in time

Project Overview



Project Timeline

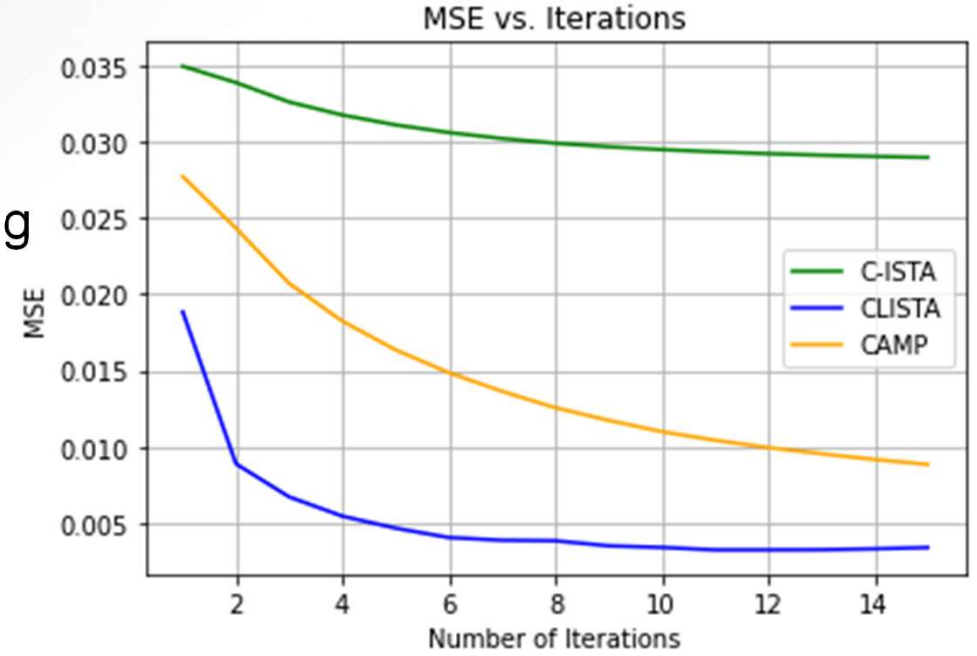
Implement unlearned algorithms	Implement LISTA	Add noise to algorithms	TISTA	Complex Rayleigh Fading	Unlearned 2 BS	Misdetections and False Alarms	Learned 2 BS

Unlearned Algorithms

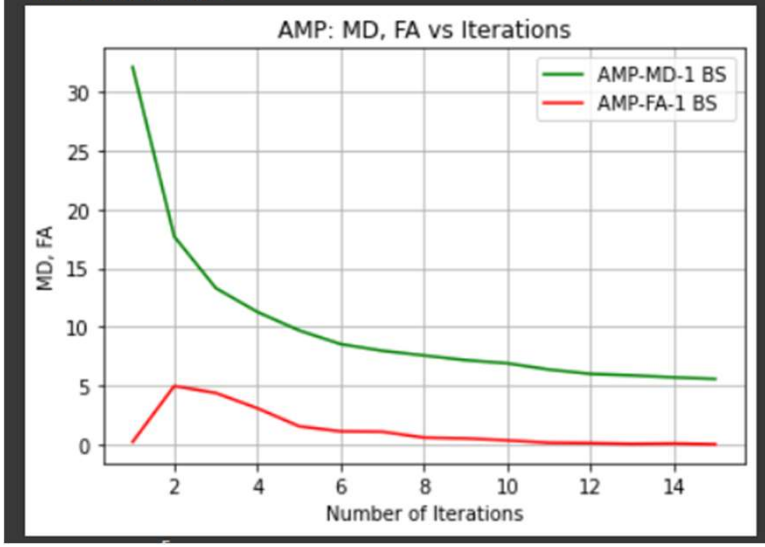
Accomplishments since last update 15 hrs of effort	Ongoing progress/problems and plans until the next presentation
-CAMP is working -Dual BS AMP is working -Misdetection and False alarm plots -Creating functions to run ISTA, AMP for specific processes	Continue creating functions to make code readable and user friendly

Misdetection: The user is active, but we did not notice
False Alarm: We say the user is active, but they are not

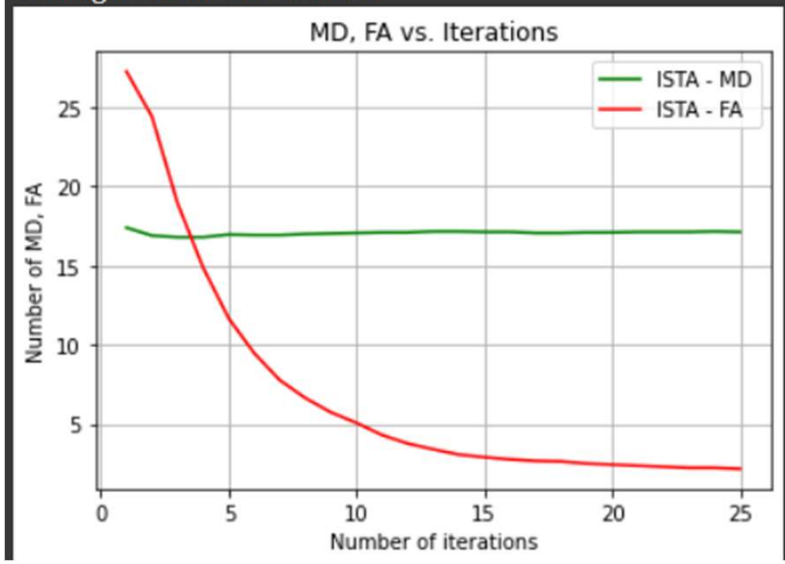
Complex Rayleigh Fading
SNR: 5dB →




```
Noise: True | Fading: True | Dual BS: False | Complex: True
SNR: 5
Num_iter: 15 | Avg: 30
Threshold: 0.4
```

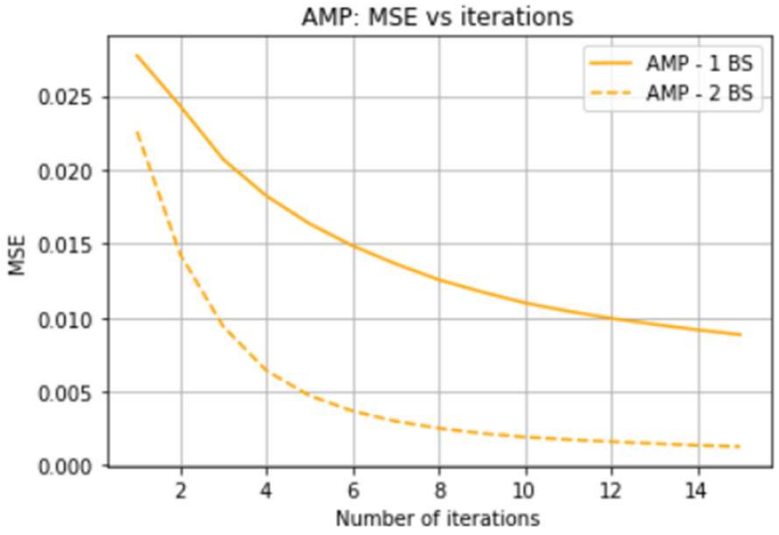



```
Noise: True | Fading: True | Dual BS: False | Complex: True
SNR: 5
Num_iter: 25 | Threshold: 0.4
Averaged over 30 trials
```

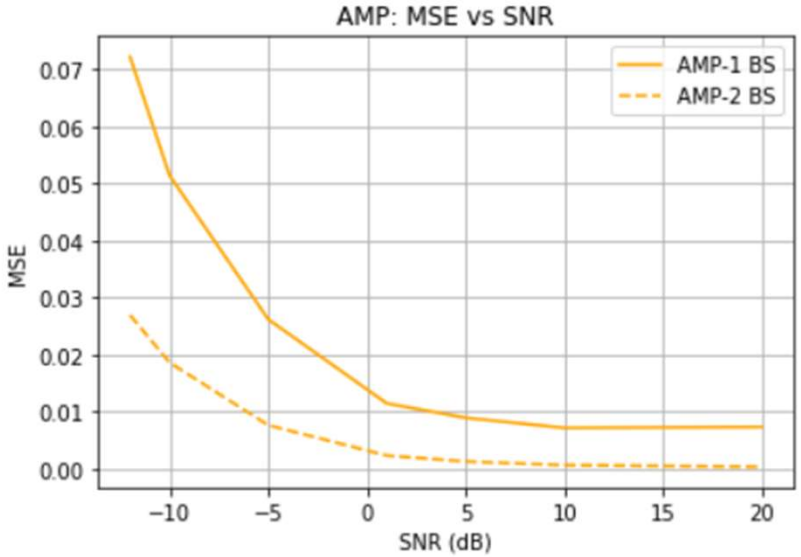


2 BS AMP

Noise: True | Fading: True | Dual BS: True | Complex: True
SNR: 5
Num_iter: 15
Averaged over 30 trials

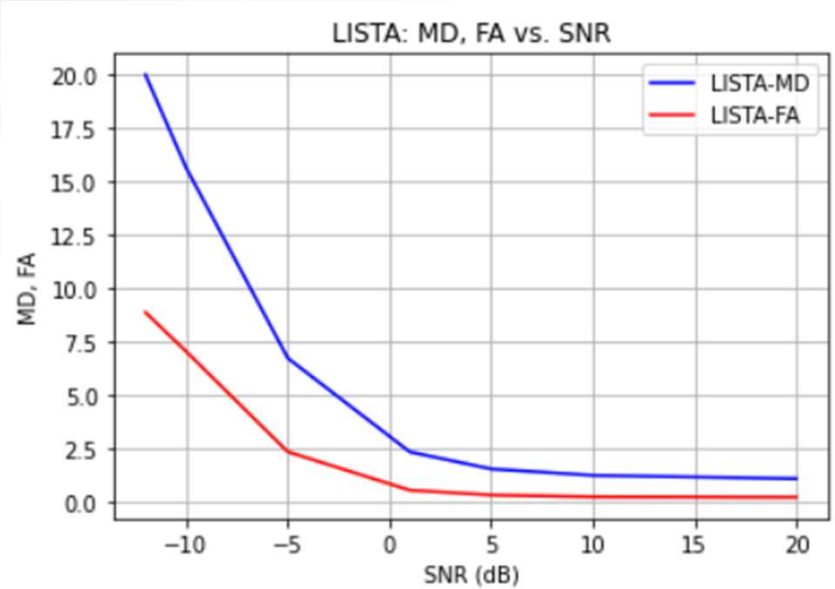


Noise: True | Fading: True | Dual BS: True | Complex: True
Num_iter: 15
Averaged over 30 trials

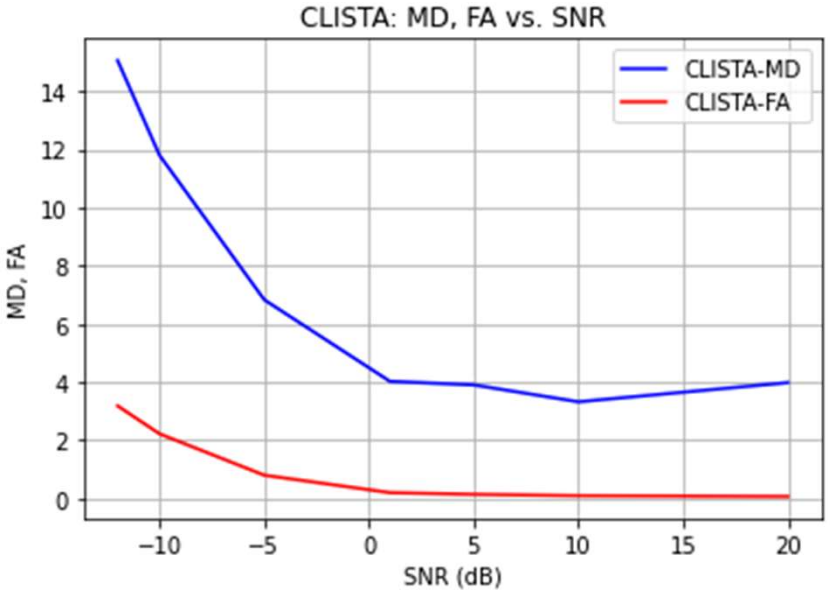


Learned Algorithms

Accomplishments since last update 5 hrs of effort	Ongoing progress/problems and plans until the next presentation
-MD, FA plot vs. SNR -Trying to get set up on the TAMU server so I can run CLISTA in background	2 BS implementation Compiling code neatly, creating functions for readability, and incorporating mathematical descriptions



5 layers, 20 epochs
Noise only



5 layers, 20 epochs
Noise and fading

The two fuctions in the next cell are the implementation of these two equations.

The Onsager Correction term:

$$\mu^t = \frac{1}{n}\mathbf{z}^{t-1}\sum \eta'(r_j^{t-1};\tau_{t-1})$$

The Eta function:

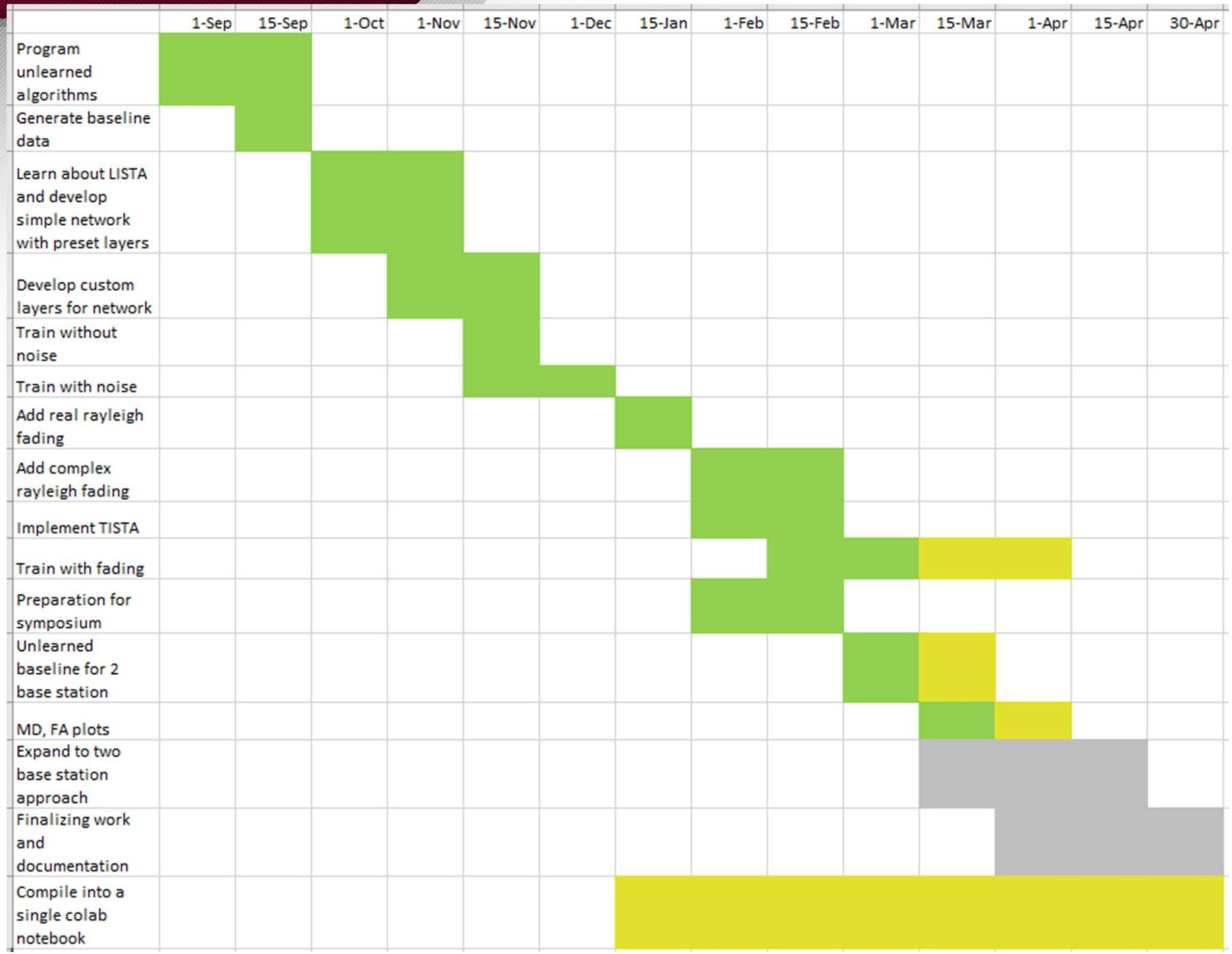
$$\eta(u;T) = \begin{cases} u - T & \text{if } u \geq T \\ u + T & \text{if } u \leq -T \\ 0 & \text{else} \end{cases}$$

Also included are system parameters. Where n is the number of measurements, N is the number of total users, and k is the number of active users.

[ ]
```
def onsager(z, r, tau):
  n = len(z)
  return (z/n) * np.sum(eta(r, tau) != 0)

def eta(u, T):
  return (u - T)*(u >= T) + (u + T)*(u <= -T)

# initial parameters
n = 270
N = 1024
k = 40
```


1-Sep
15-Sep
1-Oct
1-Nov
15-Nov
1-Dec
15-Jan
1-Feb
15-Feb
1-Mar
15-Mar
1-Apr
15-Apr
30-Apr
Program unlearned algorithms
Generate baseline data
Learn about LISTA and develop simple network with preset layers
Develop custom layers for network
Train without noise
Train with noise
Add real rayleigh fading
Add complex rayleigh fading
Implement TISTA
Train with fading
Preparation for symposium
Unlearned baseline for 2 base station
MD, FA plots
Expand to two base station approach
Finalizing work and documentation
Compile into a single colab notebook

Validation

We are evaluating MSE vs. iterations/layers.

The project is considered a success if the ML outperforms ISTA/AMP:

- With no noise
- With noise
- With fading
- With noise and fading

Here performance is measured by MSE and number of MD/FA.