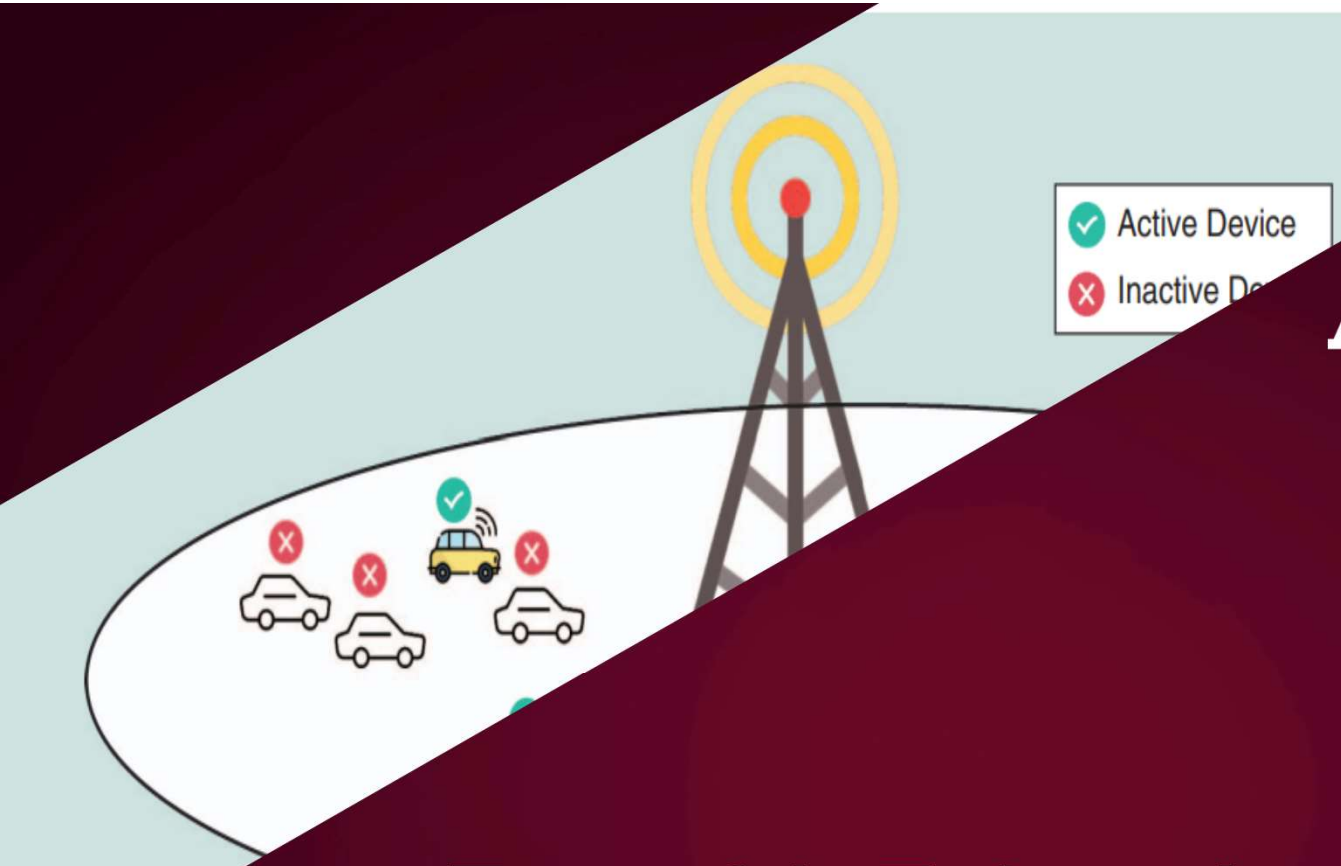

Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 64: Enhancing User Detection
Bi-Weekly Update 3

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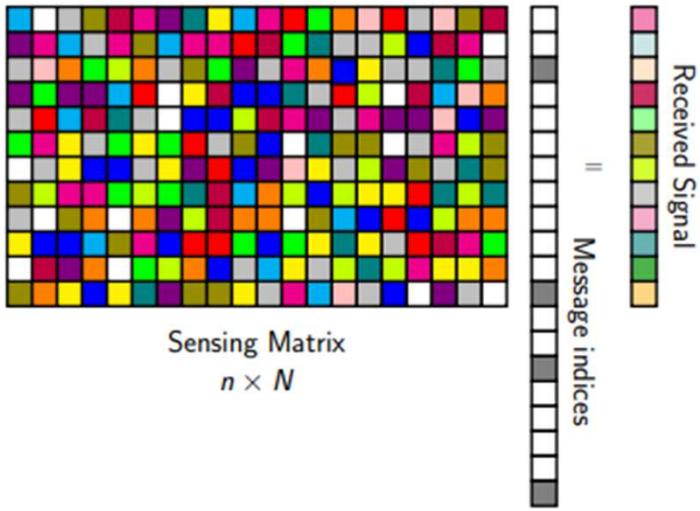
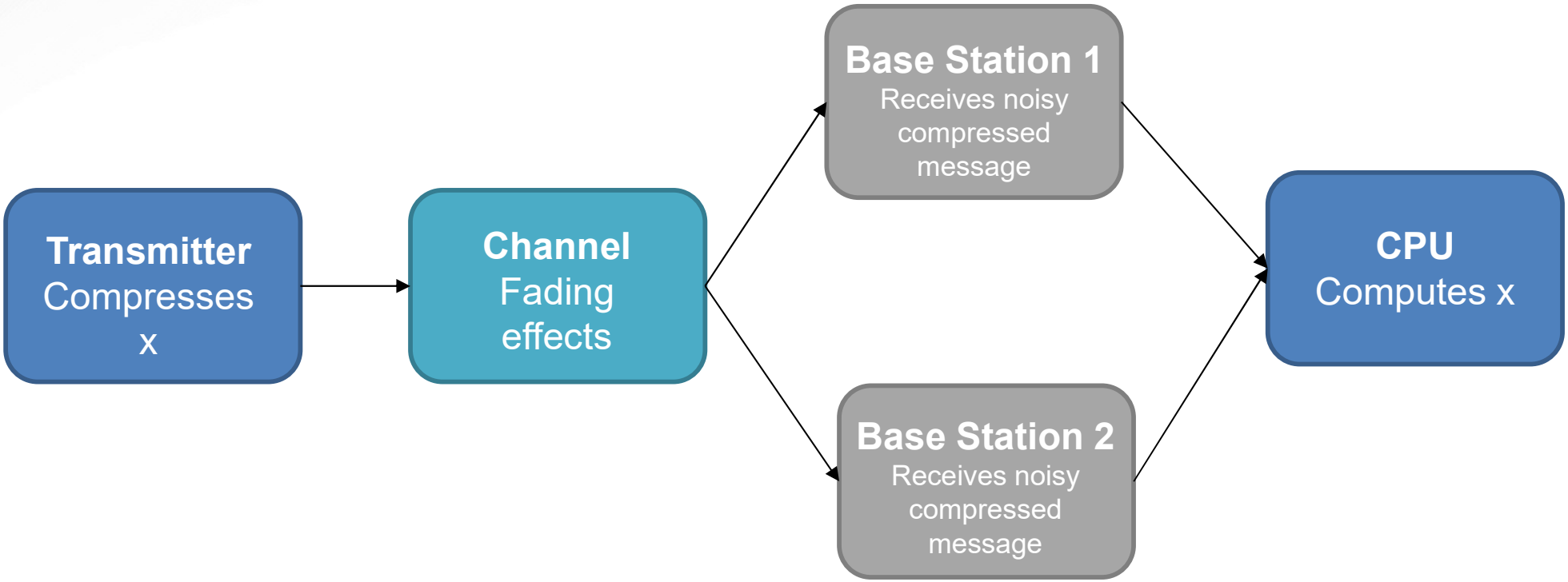
Project Summary

- 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 all algorithms	Implement TISTA	Add Complex Rayleigh fading	Unlearned algorithm two base station baseline	Learned algorithms two base station approach

The ISTA's

ISTA	LISTA	TISTA
$\mathbf{x}^{l+1} = \eta((\mathbf{I} - \frac{1}{L}\mathbf{A}^T\mathbf{A})\mathbf{x}^l + \frac{1}{L}\mathbf{A}^T\mathbf{y})$	$\mathbf{x}^{l+1} = \eta((\mathbf{I} - \frac{1}{L}\mathbf{A}^T\mathbf{A})\mathbf{x}^l + \frac{1}{L}\mathbf{A}^T\mathbf{y})$	$\boldsymbol{r}_t = \boldsymbol{s}_t + \gamma_t \boldsymbol{W}(\boldsymbol{y} - \boldsymbol{A}\boldsymbol{s}_t),$ $\boldsymbol{s}_{t+1} = \eta_{MMSE}(\boldsymbol{r}_t; \tau_t^2),$
Unlearned, iterative	Three trainable parameters: term multiplying x, term multiplying y, and alpha	One trainable parameter: gamma (step size)
Not computationally expensive	Greatly decreases MSE Has 20mil+ trainable variables	Requires less RAM

AMP and CAMP

- Calculate residual error
- Update estimate of x
- Onsager correction term

$$\mathbf{z}^t = \mathbf{y} - \mathbf{A}\mathbf{x}^t + \mu^t$$

$$\mathbf{x}^{t+1} = \eta(\mathbf{x}^t + \mathbf{A}^T\mathbf{z}^t; \tau)$$

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

$$z^t = y - Ax^t + \frac{1}{2\delta}z^{t-1}(\langle\frac{\partial\eta^R}{\partial x_R}(x^{t-1} + A^H z^{t-1}; \lambda^{t-1})\rangle + \langle\frac{\partial\eta^I}{\partial x_I}(x^{t-1} + A^H z^{t-1}; \lambda^{t-1})\rangle)$$

CAMP

$$x^{t+1} = \eta(x^t + A^H z^t; \lambda^t)$$

$$\eta(u + iv; \lambda) = (u + iv - \frac{\lambda(u + iv)}{\sqrt{u^2 + v^2}})\,\mathbb{I}_{\{u^2+v^2>\lambda^2\}}$$

Unlearned Algorithms

Accomplishments since last update 4 hrs of effort	Ongoing progress/problems and plans until the next presentation
-Dual BS ISTA -Completed derivations and code structure for CAMP	-Dual BS AMP -Debug CAMP

```
eta real: nan
eta imag: nan
eta real: nan
eta imag: nan
eta real: nan
eta imag: nan
[nan nan nan nan nan nan nan nan nan nan]
```

ISTA 2 BS

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} A_1 \\ A_2 \end{bmatrix} \begin{bmatrix} x \end{bmatrix} + \begin{bmatrix} w_1 \\ w_2 \end{bmatrix}$$

570×1 $\quad$ 570×1024 $\quad$ 1024×1 $\quad$ 570×1

Base Station 1:

$$y_1 = A_1 x + w_1$$

Base station 2:

$$y_2 = A_2 x + w_2$$

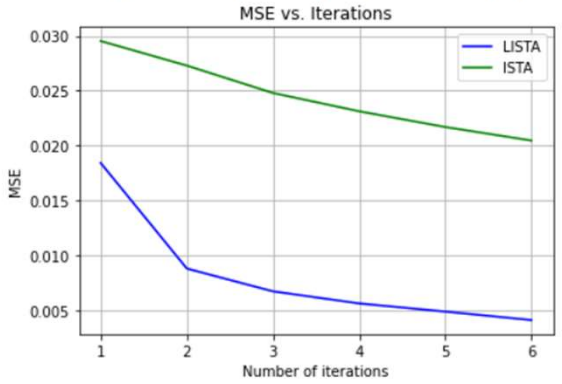
The following graphs have an SNR of 5 dB

Learned Algorithms

Accomplishments since last update 9 hrs of effort	Ongoing progress/problems and plans until the next presentation
-CLISTA converging after 5 layers -Set TISTA aside	-Get CLISTA to continue to trend down beyond 5 layers; hopefully to 15

CLISTA

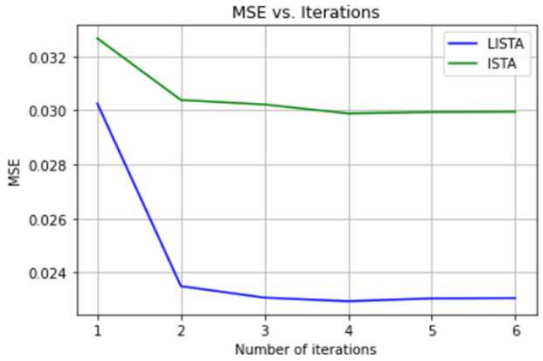
Learning rate: 0.0001 | Batch size: 128
Num epochs per layer: [19, 20, 17, 18, 20, 24] | Patience: 1



No noise or fading, but complex valued matrices
Early stopping never kicked in

Experimented with learning rate, number of epochs, batch size, and the patience on the early stopping call.

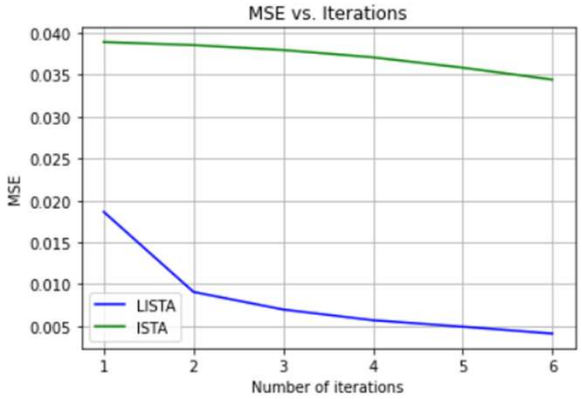
Learning rate: 0.0001 | Batch size: 128
Num epochs per layer: [19, 20, 17, 18, 20, 24] | Patience: 1
SNR of -15 dB



This is about the limit of noise that it could handle

CLISTA is barely affected by fading

Learning rate: 0.0001 | Batch size: 128
Num epochs per layer: [19, 20, 17, 18, 20, 24] | Patience: 1
CRF used



Execution Plan

Validation

We are evaluating MSE vs. iterations/layers.

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

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

So far ML has outperformed ISTA with and without noise and with fading.


Any questions?
Resume
KopywritingKourse.com