Adversarial Machine Learning Against Voice Assistant Systems

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Meet the Team

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Minor(s): Statistics, Economics

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Major: ECE

Background

- Voice Assistant Systems
  - User authentication via voice recognition
- Adversarial Attacks
  - Added perturbations to incite misclassifications

Objective

- To study the security of voice assistance systems under adversarial machine learning
- Generate adversarial audio samples to fool voice assistant systems

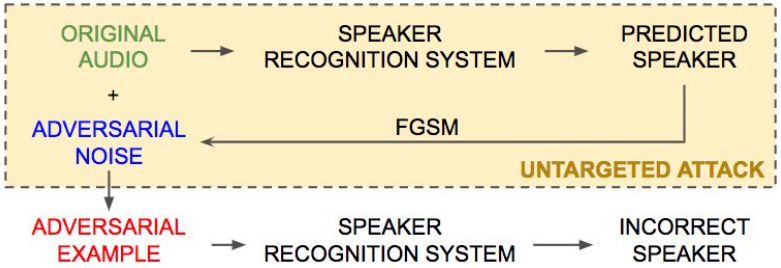
Methods

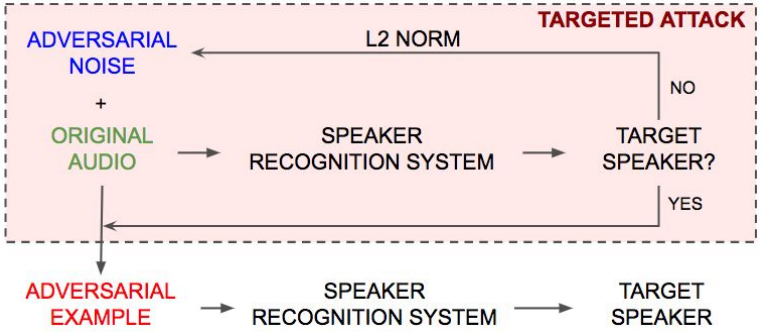
- Identify speaker recognition model to attack
  - X-Vector model
    - State-of-the-art speaker recognition model
    - Deep neural network
  - Implemented in TensorFlow, a machine learning framework in Python

Layer	Layer context	Total context	Input x output
frame1	$[t-2, t+2]$	5	120x512
frame2	$\{t-2, t, t+2\}$	9	1536x512
frame3	$\{t-3, t, t+3\}$	15	1536x512
frame4	$\{t\}$	15	512x512
frame5	$\{t\}$	15	512x1500
stats pooling	$[0, T)$	T	1500Tx3000
segment6	$\{0\}$	T	3000x512
segment7	$\{0\}$	T	512x512
softmax	$\{0\}$	T	512xN

Methods

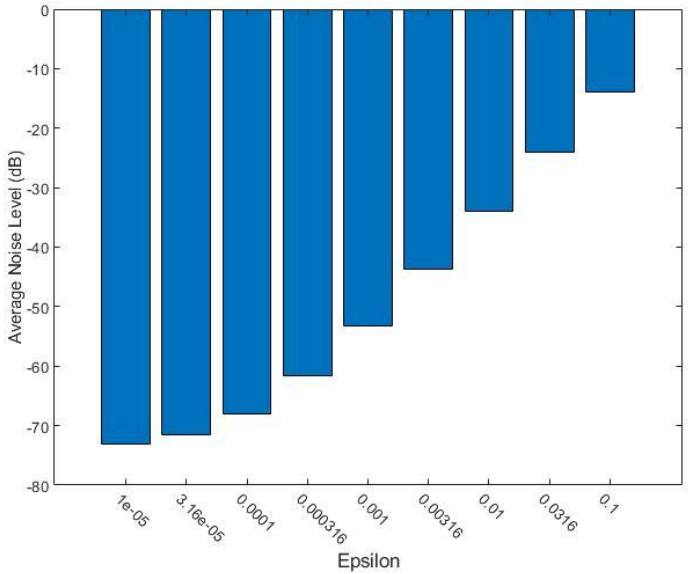
- Untargeted Attack
  - Alter audio signal to misclassify as incorrect speaker
  - Add a linear perturbation to original signal using Fast Gradient Sign Method (FGSM)
- Targeted Attack
  - Change audio signal to imitate a targeted speaker
  - If prediction does not match desired speaker, noise is modified to more closely match target speaker
  - Targeted attack works iteratively

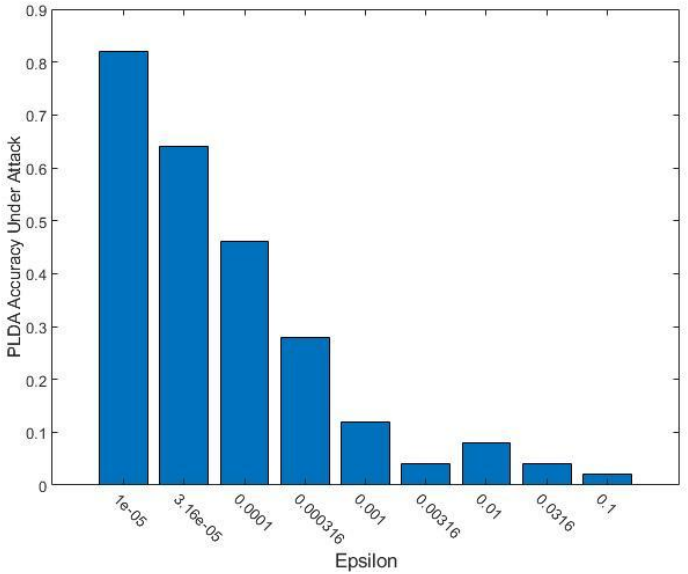




Results

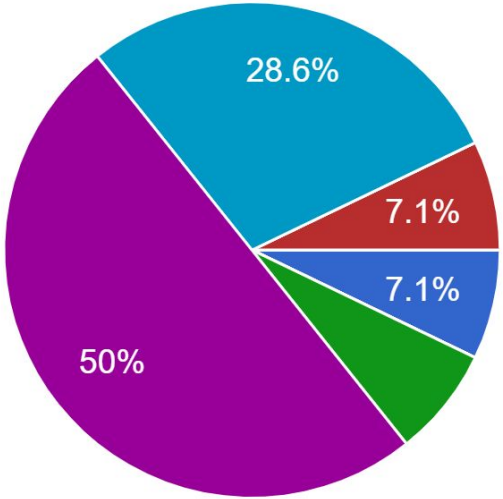
- Evaluated performance of untargeted adversarial samples on voice assistant system (X-Vector)





Results (cont.)

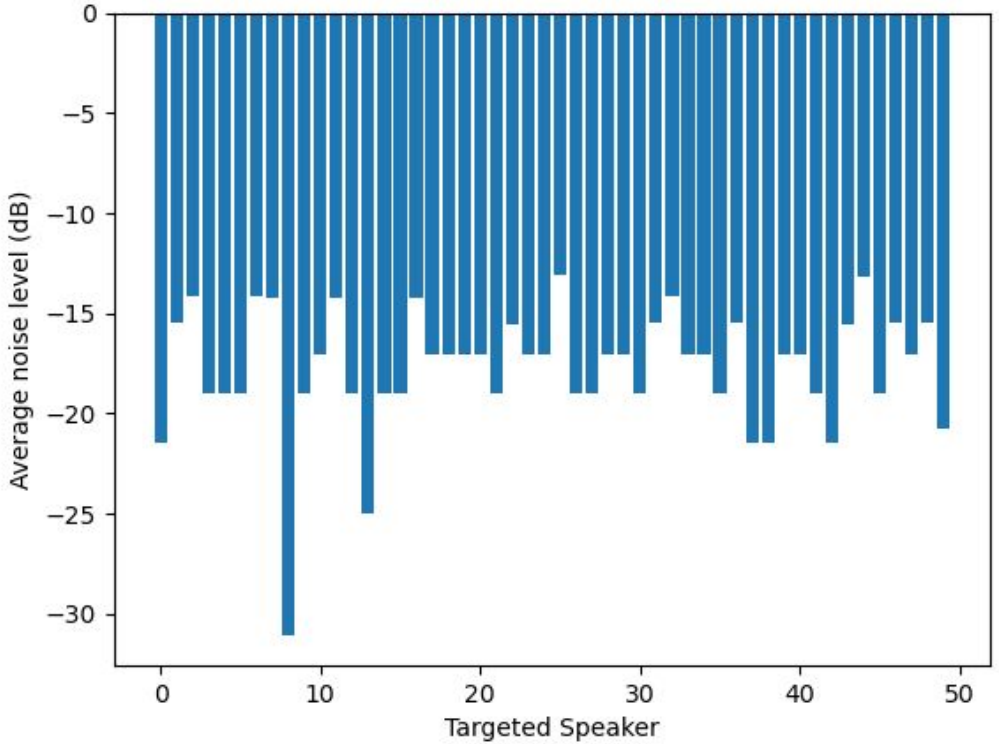
- Survey to determine the discernable threshold epsilon value



EPSILON = 1E-05
EPSILON = 3.16E-05
EPSILON = 0.0001
EPSILON = 0.000316
EPSILON = 0.001
EPSILON = 0.00316
EPSILON = 0.01
EPSILON = 0.0316
EPSILON = 0.1

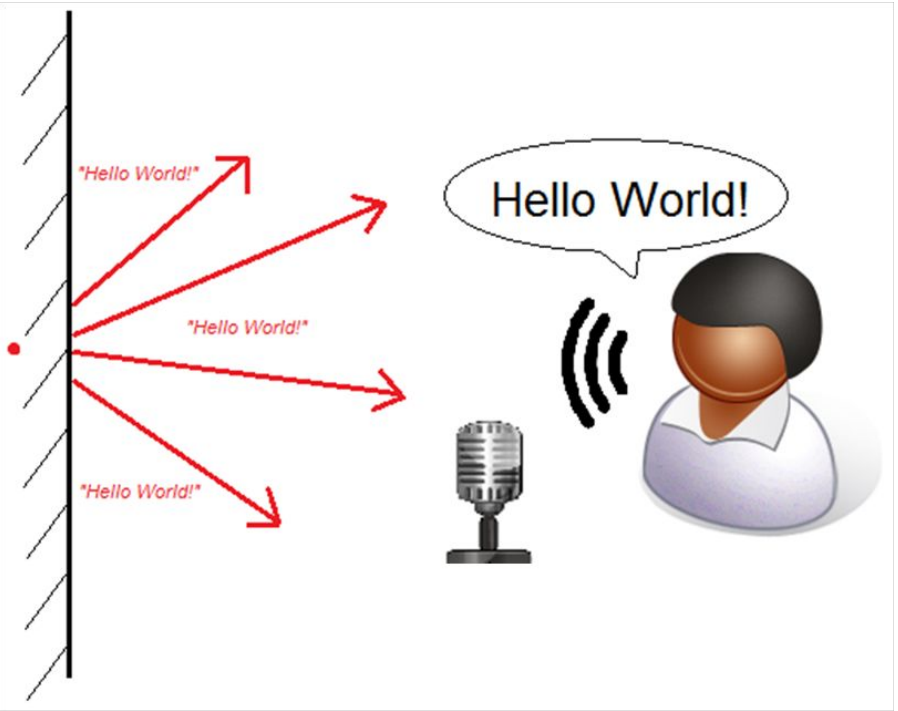
Results (cont.)

Targeted attacks:



Future Work

- Effect of room impulse response on attack efficacy
- Disguise attacks



Thank you!

Any questions?