# EXPLOSION DETECTION WITH NOISE
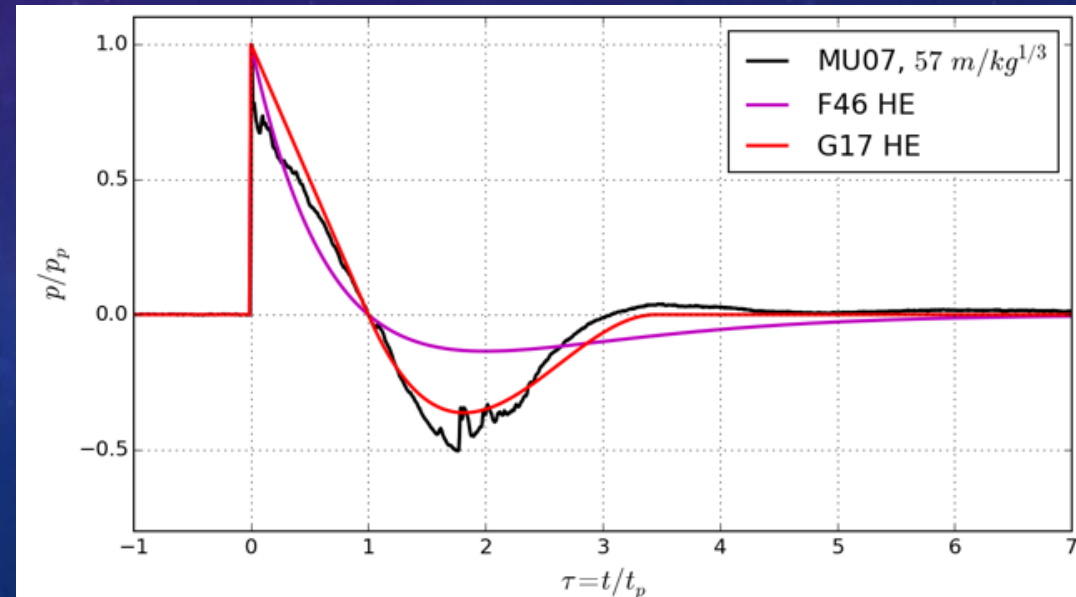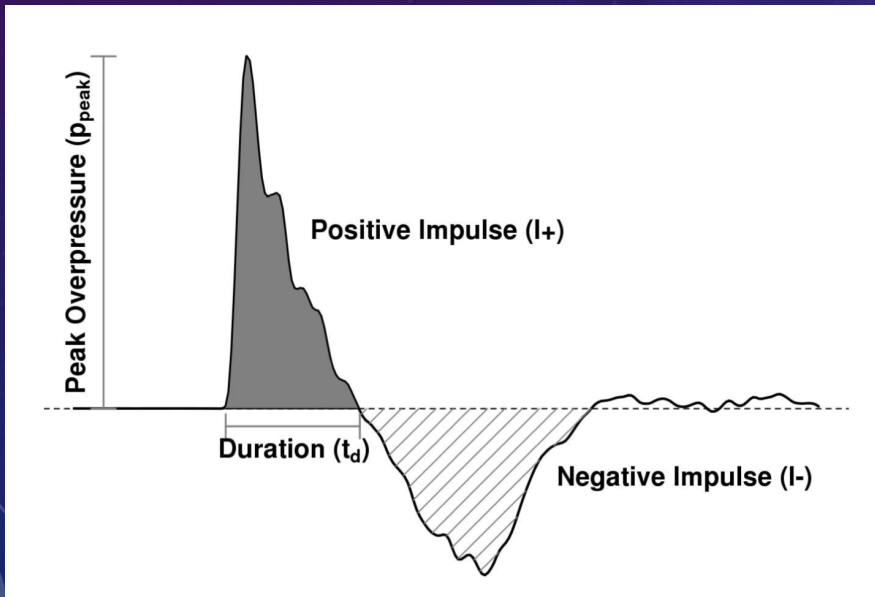
SAMUEL KEI TAKAZAWA

# THE PROJECT

- Monitoring for nuclear non-proliferation.
  - RedVox app
    - Smart phone app that can collect audio data
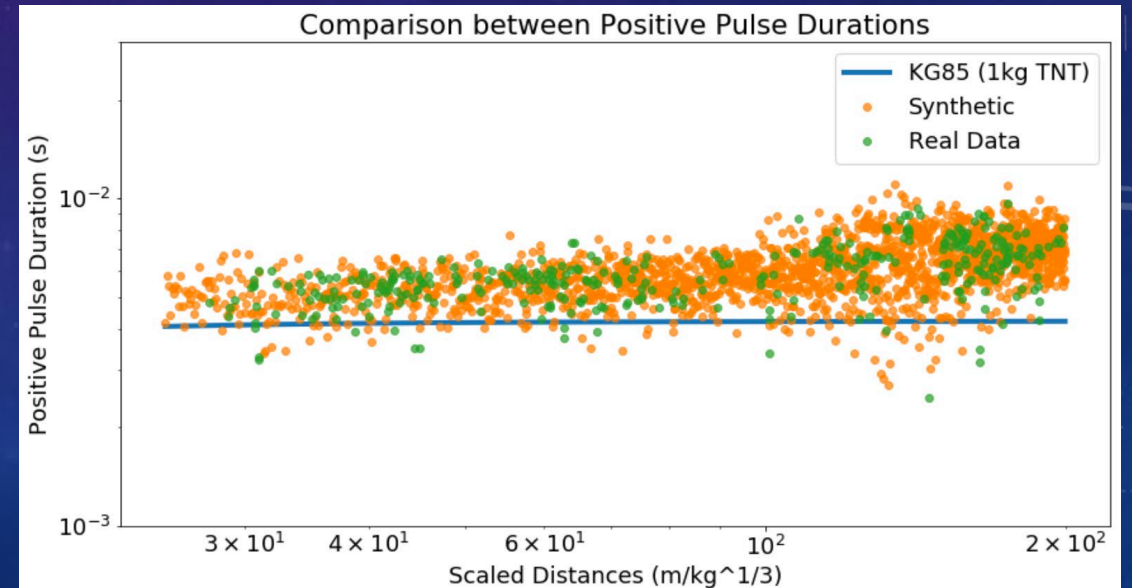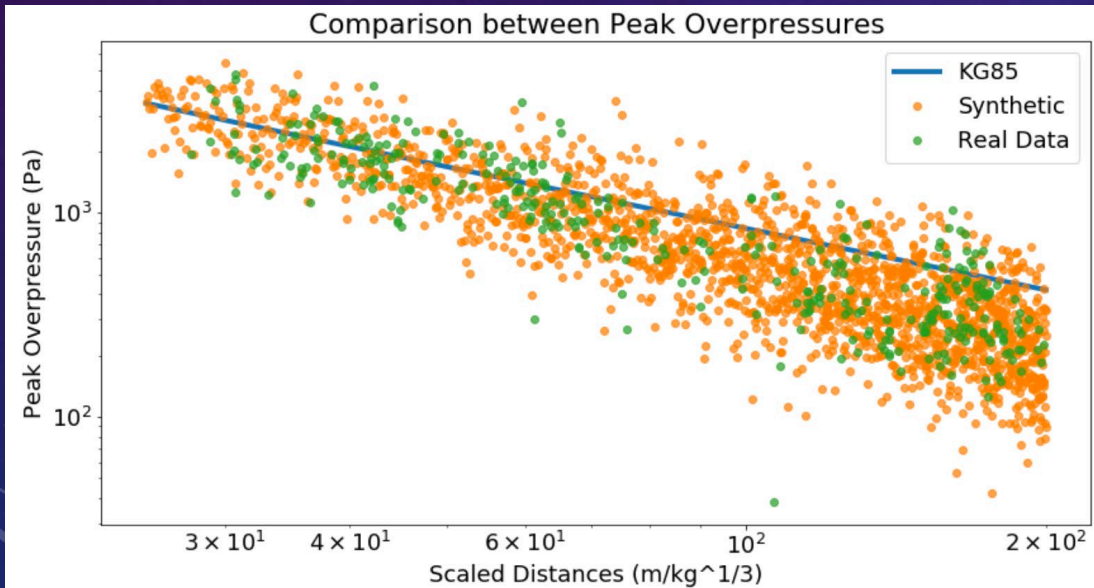  - Machine Learning
    - Detect events and anomalies

# THE DATA

- Synthetic High Explosion Data
    - Generated based Parameters from real data
    - Applied to Explosion model developed by Dr. Garces
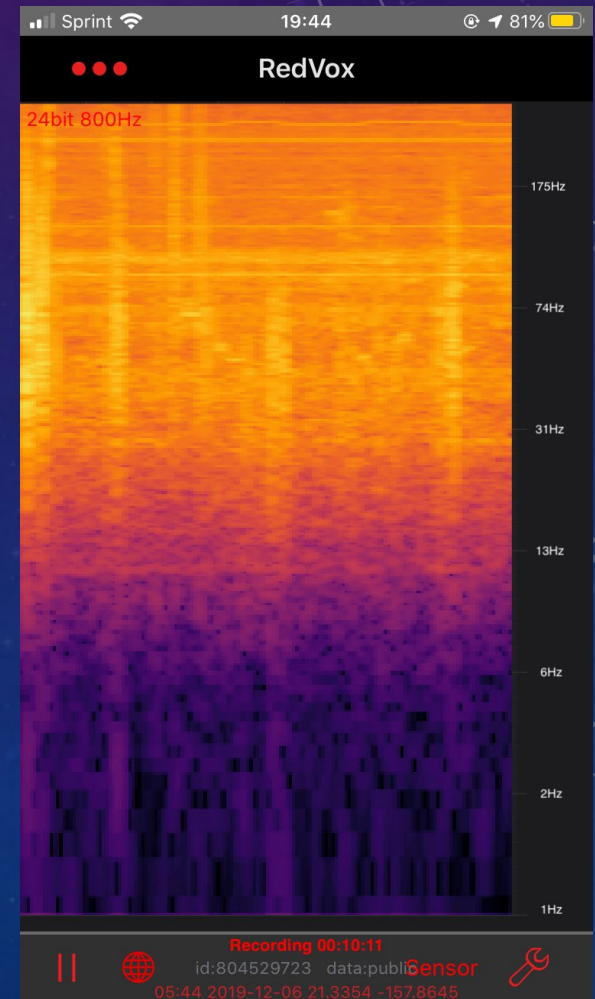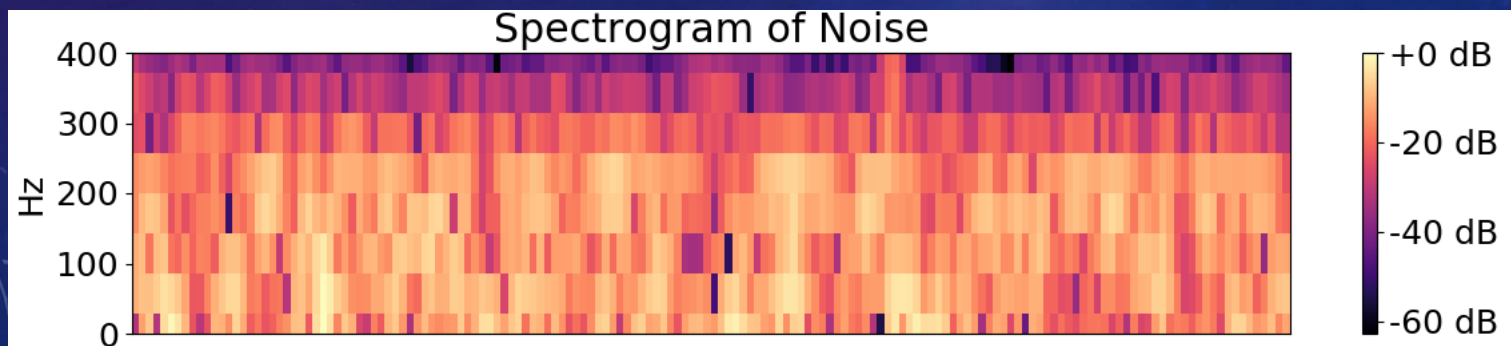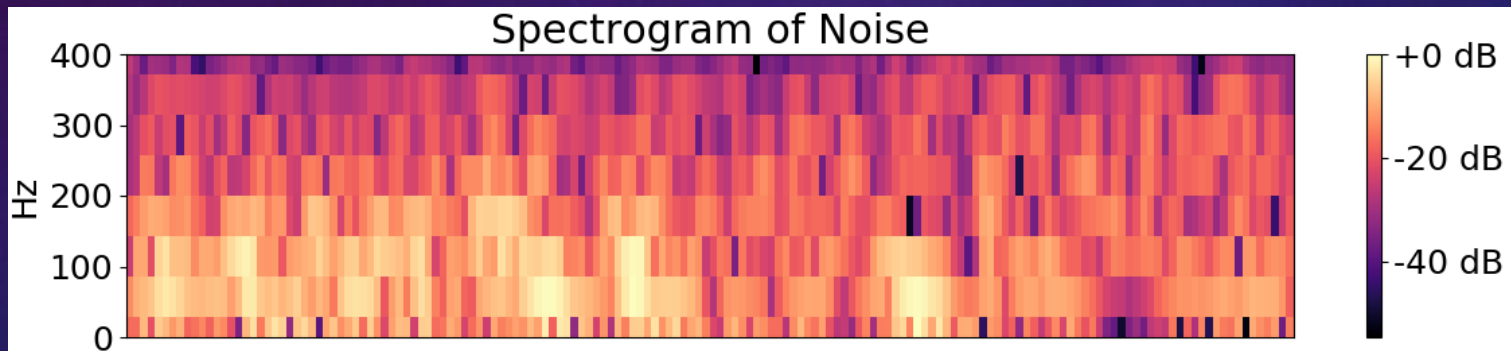    - Scaled Range: 25 – 200 m/kg$^{1/3}$

# THE DATA

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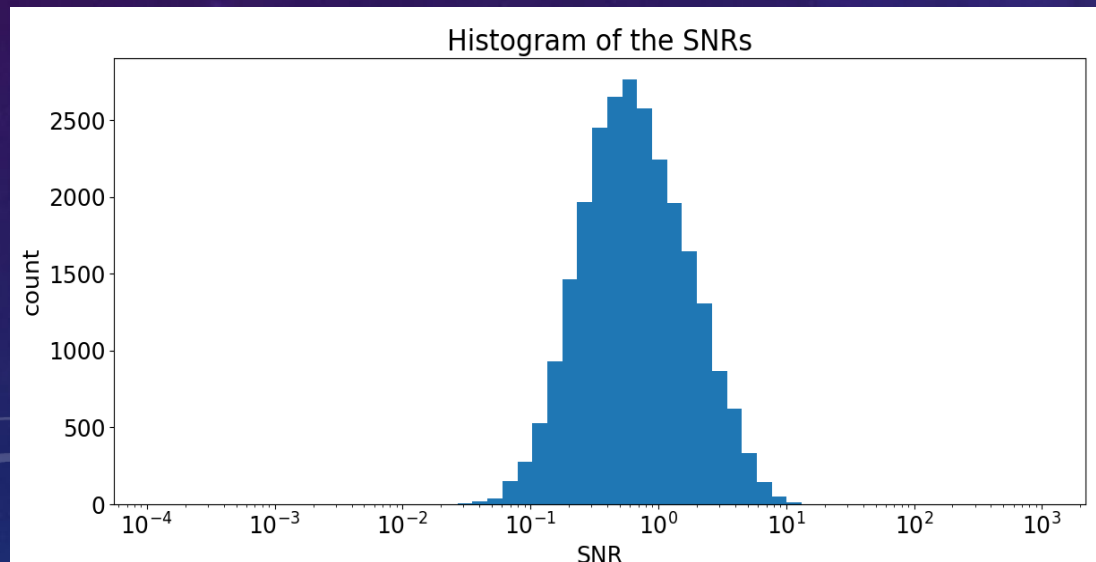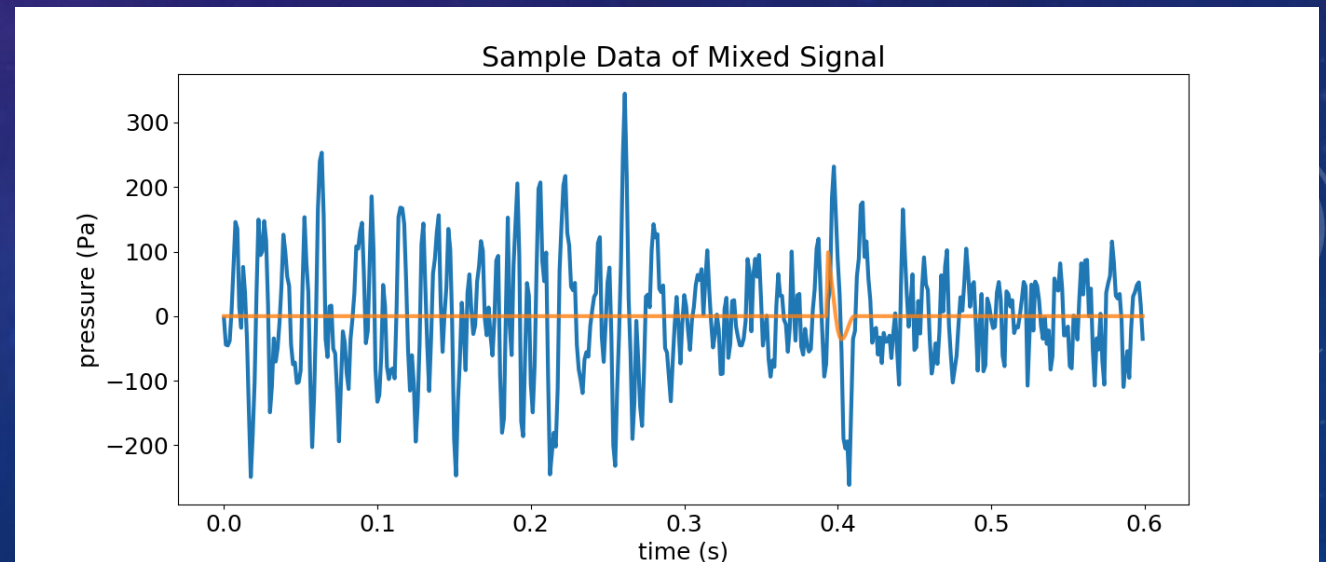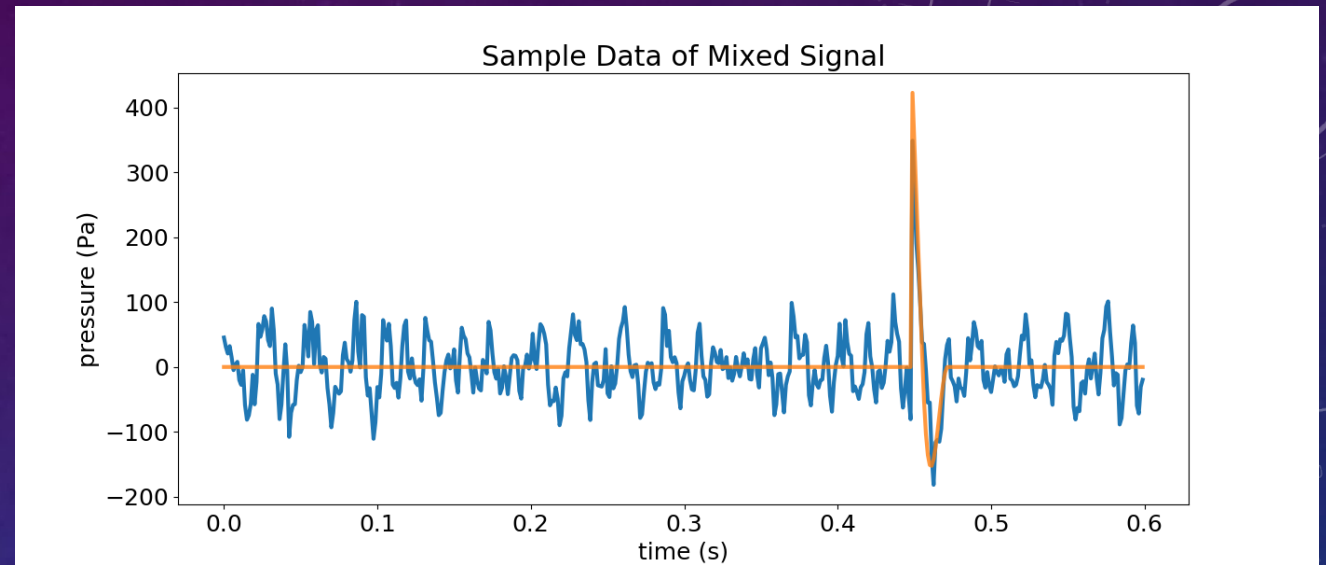  - Scaled Distance: $25 - 200$ m/kg$^{1/3}$

# THE DATA

- Noise collected via RedVox app on phone
    - Holmes Hall (top)
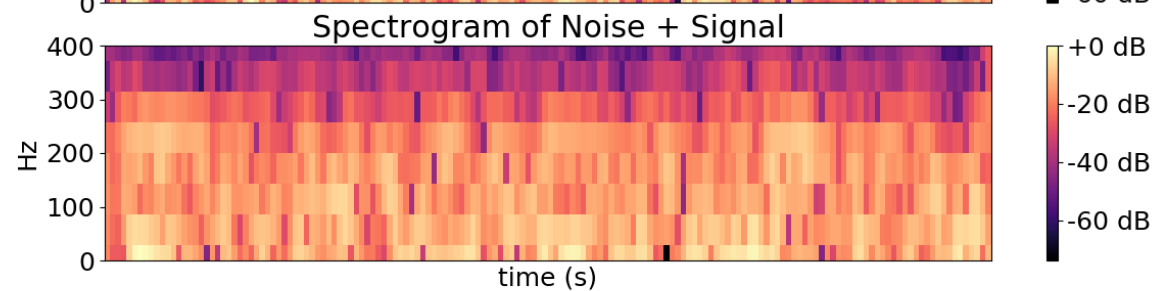    - Oak Ridge National Laboratory (bottom)

# THE DATA

- SNR calculated by RMS-Energy
  - Top: 0.76
  - Bottom: 0.07

# THE DATA

- Spectrogram
  - Top Holmes
  - Bottom Oak Ridge
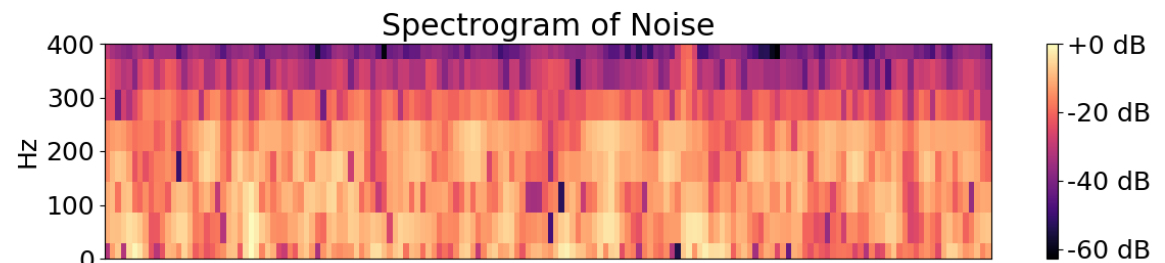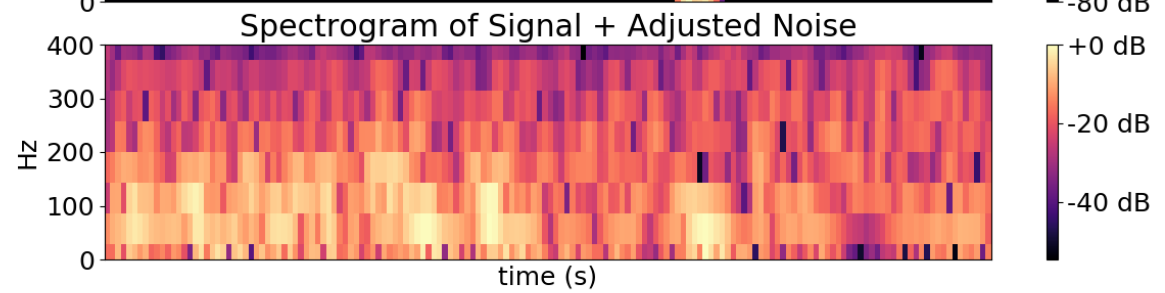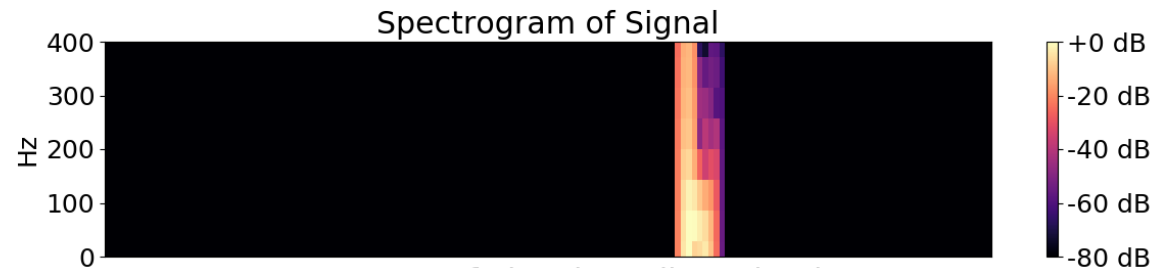
# MACHINE LEARNING

- Fully Connected DNN
  - 3 Dense layers (256, 256, 2)
  - ReLU and softmax
  - Categorical Crossentropy

- 1D Convolutional Network (CNN)
  - 2 1Dconv layers (64 filters, kernel size 12)
  - Max Pooling, Flatten
  - Dense
  - ReLU and softmax
  - Categorical Crossentropy



Input          Hidden Layers



ReLU
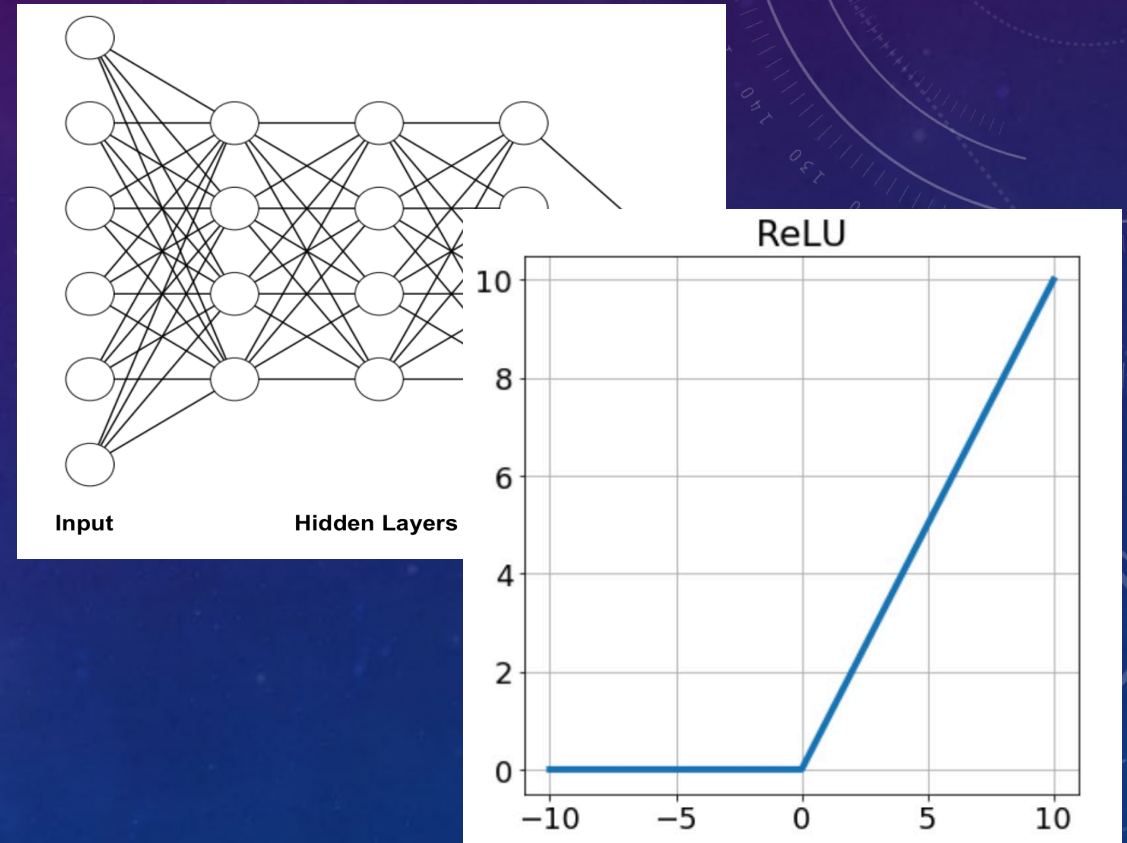
# RESULTS

- Trained with Data + Holmes Noise
  - DNN: 80.3% Accuracy on Test
  - CNN: 99.8% Accuracy on Test
    - 18 wrong (False Negatives)

- Additional Test with Data + Oak Ridge Noise
  - DNN: 77.6% Accuracy on Test
  - CNN: 99.4% Accuracy on Test
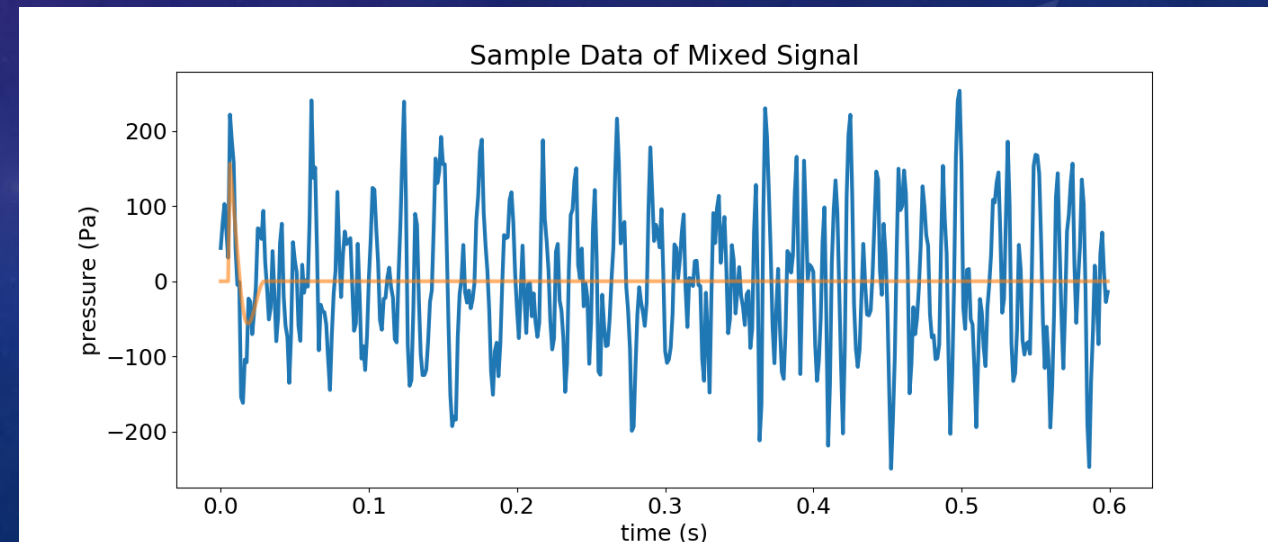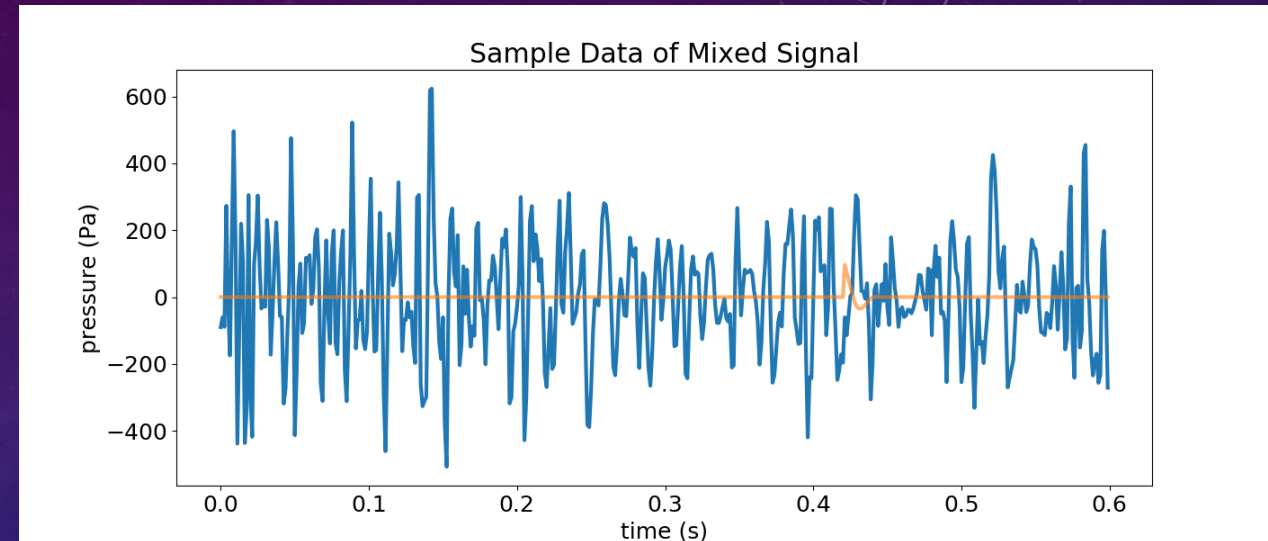
# FUTURE WORKS

- Fine Tuning
  - Dropout
  - Activation Functions
- Transfer Learning
  - For Data with Oakridge Noise
- Feature Extractions
  - Positive Pulse Durations
  - Peak Overpressure
- Real Explosion Data

# THANK YOU FOR LISTENING

Kinney, G. & Graham, K. (1985) Explosive Shocks in Air, Springer-Verlag, 282 pp.

Garces M. (2019) Explosion Source Models. In: Le Pichon A., Blanc E., Hauchecorne A. (eds) Infrasound Monitoring for Atmospheric Studies. Springer, Cham.

Kim, K. & Rodgers, A. 2017. Influence of low-altitude meteorological conditions on local infrasound propagation investigated by 3-D full-waveform modeling, Geophys. J. Int., 210, 1252–1263.

Schnurr, J., Kim, K., Garces, M., & Rodgers, A. (2019) Improved Parametric Models for Explosion Pressure Signals Derived From Large Datasets. In Review.