TSFEL: Time Series Feature Extraction Library

Group 50
Time slot swapped with group 59

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Introduction

- Time Series feature extraction as one of the first steps of a Machine Learning pipeline
- Task at hand: Time series classification
- work repartition :
  - Sophia: Feature extraction, ML model for Classification
  - Denys: Neural Net model for Classification

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Whale Calls

Whale Dataset

Dataset that consists of 4000-length series, which corresponds to a two-second audio snippet sampled at a rate of 2kHz. The task at hand involves using an audio signal to determine whether a given recording is a right whale call or not

Statistical descriptors of a non Whale signal compared to statistical descriptors of a Whale signal

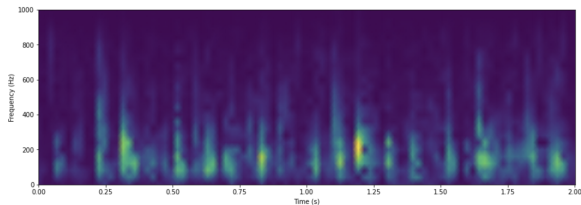| Signal \ Statistics	Standard Deviation	Kurtosis	Mean	Median Absolute Deviation	Skewness	Variance
Non Whale	0.1837	6.675	-0.000119	0.066	0.2633	0.03378
Whale Call	0.00557	0.073	-3.6×10^{-5}	0.0037	-0.061	3.11×10^{-5}

Spectrogram

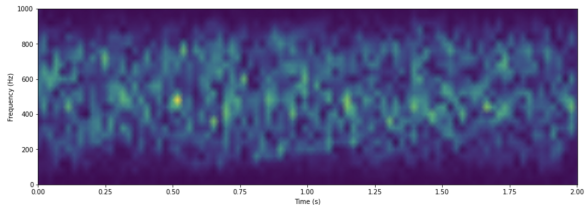Figure: Spectrogram of a Non Whale signal

Figure: Spectrogram of a Whale Call

Urban Sound

Urban Dataset

The objective is to categorize sounds present in an urban environment, using audio recordings of typical city sounds as time series data

10 classes:

- Air conditioner (600)
- Car horn (306)
- Children playing (600)
- Dog bark (600)
- Drilling (600)
- Engine idling (624)
- Gun shot (230)
- Jackhammer (668)
- Siren (607)
- Street music (600)

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Classification: Feature extraction

- Normalizing data with MinMax scaler
- Feature extraction with TSFEL
- Feature selection:
  - TSFEL provided function to remove highly correlated features
  - TSFEL provided function to remove low-variance features
- Normalize features
- Random Forest Classifier

Classification: Neural Net

- Model architecture uses:
  - 1D convolutional layer with a kernel size of 3, followed by batch normalization and a ReLU activation function
  - Max pooling layer with a pool size of 2
  - Dropout layer with a rate of 0.5
  - Fully connected layer with a ReLU activation function
  - Fully connected layer with a single output unit and a sigmoid activation function
- The model uses the Adam optimizer and binary cross-entropy loss function to train and evaluates accuracy as a performance metric
- The model is trained for 50 epochs with a batch size of 64 and a validation split of 0.2

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Whale dataset Results

	Feature Extraction ML	Neural Net
Accuracy	84.04%	67%
weighted Precision	0.84	0.71
weighted Recall	0.84	0.67
weighted F1-score	0.84	0.65

Urban Sound Results

	precision	recall	f1-score	support
Air_conditioner	0.89	0.92	0.90	300
Car_horn	0.83	0.72	0.77	153
Children_playing	0.68	0.72	0.70	300
Dog_bark	0.84	0.75	0.80	300
Drilling	0.85	0.88	0.87	300
Engine_idling	0.91	0.89	0.90	312
Gun_shot	0.90	0.90	0.90	115
Jackhammer	0.88	0.95	0.91	334
Siren	0.82	0.88	0.85	304
Street_music	0.69	0.64	0.66	300
accuracy			0.83	2718
macro avg	0.83	0.82	0.83	2718
weighted avg	0.83	0.83	0.83	2718

Accuracy: 82.74466519499633%

Figure: Results Urban dataset

📄 Tara Cox, Tim Ragen, Andrew Read, E. Vos, Robin Baird, Kenneth Balcomb, Jay Barlow, Jack Caldwell, Ted Cranford, L. Crum, A. D'amigo, G. D'Spain, Antonio Fernandez, J. Finneran, R. Gentry, W. Gerth, Frances Gulland, J. Hildebrand, Dorian Houser, and Douglas Wartzok.
Understanding the impacts of anthropogenic sound on beaked whales.
Journal of Cetacean Research and Management, 7(3)::189–209, 03 2006.

📄 Tsfel: Time series feature extraction library.
SoftwareX, 11:100456, 2020.