Applications of machine learning
to the detection and classification of underwater acoustic signals.

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1 INTRODUCTION

Machine learning techniques, specially using deep neural networks, have recently brought advances to computer vision, natural language processing and many other areas of research.

Here we present four projects that apply deep learning to detection and classification tasks in underwater acoustics and an open source library aimed at facilitating the use of these techniques by researchers.

2 CLASSIFICATION PROJECTS

Differentiating between pilot and killer whales

Results
Accuracy: 98.44%

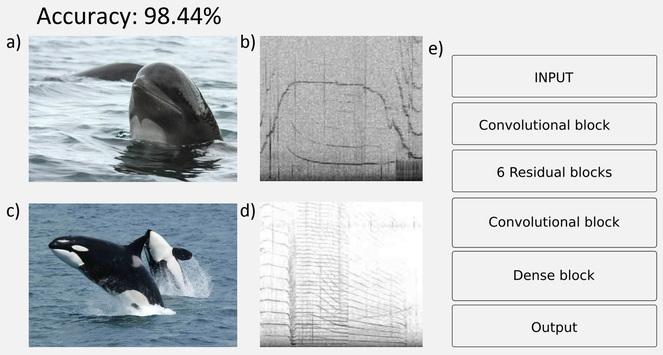


Figure 1: Using a residual network (ResNet) to classify pilot and killer whales.
a) Pilot whale. b) Spectrogram of a pilot whale call. c) Killer whale. d) Spectrogram of a killer whale call. e) Simplified diagram of network architecture.

Matching individual killer whale calls

Results
Accuracy: 94.6%

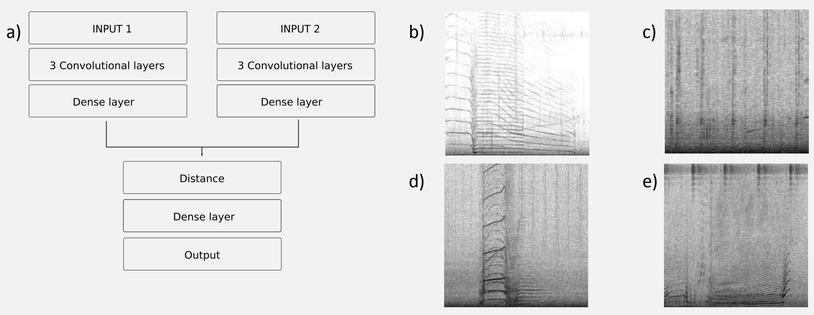


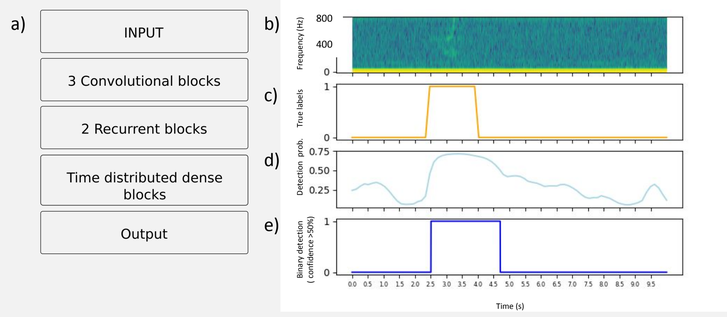
Figure 2: Using a siamese network to match killer whale calls produced by the same individuals. a) Simplified diagram of network architecture. b-e) Spectrograms of killer whale calls produced by different individuals.

Data source: WHOI

Deep learning can help us build sound detectors and classifiers that can adapt to new environments

3 DETECTION PROJECTS

Detecting baleen whales with a sequence to sequence model



Results
Accuracy: 87.1%
Precision: 72.3%
Recall: 36.2%

Data source: ONC

Figure 3: Using a sequence to sequence model to detect baleen whales.
a) Simplified diagram of network architecture b) Spectrogram with a humpback whale call. c) Ground truth label. d) Model output (detection probability). e) Filtered output.

Detecting arctic cods with a convolutional neural network

Results
Accuracy: 98.4%
Precision: 72.7%
Recall: 66.7%

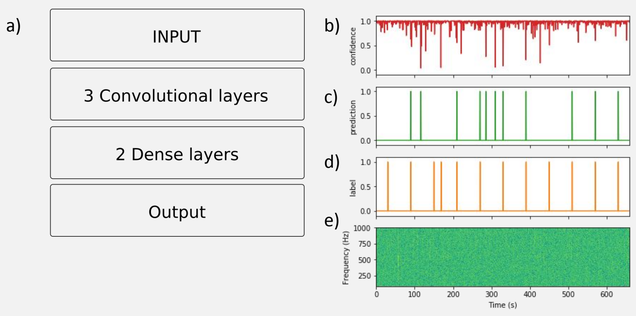


Figure 4: Using a convolutional neural network to detect baleen whales.
a) Simplified diagram of network architecture b) Detection confidences.
c) Model output. d) Ground truth labels. e) Input spectrogram.

4 KETOS

Ketos is an open source (GPL v3) Python package that provides:

- Data handling tools
- Signal processing methods
- Useful network architectures

Documentation, including tutorials and installation instructions can be found at:

https://docs.meridian.cs.dal.ca/ketos/

5 CONCLUSION

Deep neural networks show great promise as versatile detectors and classifiers in underwater acoustics.
We have developed an open source Python package that facilitates the implementations of such tools.
This package is under continued development and we welcome contributions and collaborations.

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