

A decorative graphic on the left side of the slide. It features several circles: a large orange circle with a white border at the top left, a large teal circle with a white border in the center containing binary code and the word 'MERIDIAN', a medium blue circle to the right of the teal one, a small orange circle below the blue one, a light blue circle below the teal one, and a small orange circle at the bottom left. A series of vertical orange bars of varying heights are positioned between the teal and blue circles.

MERIDIAN

The Ketos Package

Fabio Frazao

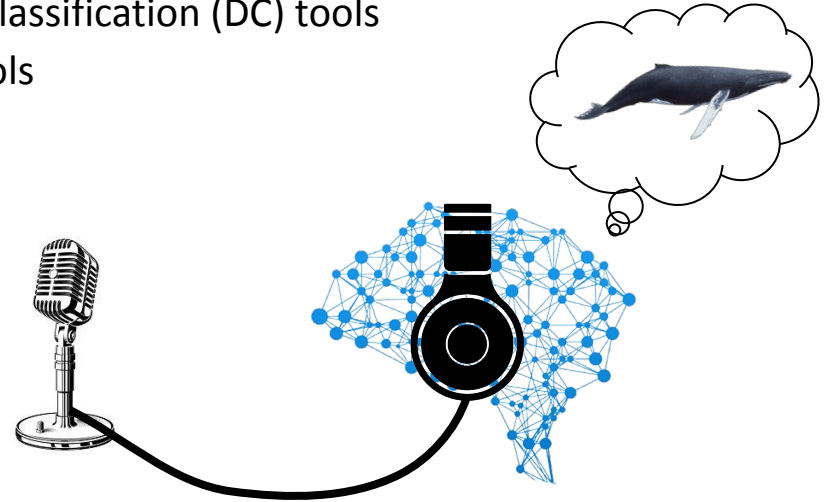
MERIDIAN, Institute for Big Data Analytics,
Dalhousie University, Halifax, Canada

Introduction



Deep learning can ...

- help us create better acoustic detection and classification (DC) tools
- change the way we develop and use these tools



Deep learning in marine bioacoustics



Luo et al.: JASA Express Letters <https://doi.org/10.1121/1.5085647> Published Online 4 January 2019

Convolutional neural network for detecting odontocete echolocation clicks

Wenyu Luo, Wuyi Yang^{ab} and Yu Zhang
Key Laboratory of Underwater Acoustic Communication and Marine Information
Technology of the Ministry of Education, College of Ocean and Earth Science,
Xiamen University, Xiamen, China
luowenyu@stu.xmu.edu.cn, wuyi.yang@xmu.edu.cn, yuzhang@xmu.edu.cn

Marine Mammal Species Classification using Convolutional Neural Networks and a Novel Acoustic Representation

Mark Thomas¹, Bruce Martin², Katie Kowarski², Briand Gaudet², and Stan Matwin^{1,3*}

SCIENTIFIC
REPORTS
nature research

Deep neural networks for automated detection of marine mammal species

Yu Shiu^{1,2*}, K. J. Palmer^{1,3}, Marie A. Roch¹, Erica Fleishman², Xiaobai Liu², Eva-Marie Nosal², Tyler Helble¹, Danielle Cholewiak⁴, Douglas Gillespie² & Holger Klinck¹

SCIENTIFIC
REPORTS
nature research

ORCA-SPOT: An Automatic Killer Whale Sound Detection Toolkit Using Deep Learning

Christian Bergler¹, Hendrik Schröder², Rachael Xi Cheng³, Volker Barth¹, Michael Weber¹, Elmar Nöth¹, Heribert Hofer^{2,4,5} & Andreas Maier²

JASA ARTICLE

Beluga whale acoustic signal classification using deep learning neural network models

Ming Zhong,¹ Manuel Castellote,^{2,3} Rahul Dodhia,¹ Juan Lavista Ferres,¹ Mandy Keogh,² and Arian Brewer²

¹AI for Good Research Lab, Microsoft, Redmond, Washington 98052, USA
²Alaska Fisheries Science Center—National Oceanic and Atmospheric Administration (NOAA) Fisheries and Joint Institute for the Study of the Atmosphere and Ocean (JISAO), University of Washington, Seattle, Washington 98195, USA

Performance of a Deep Neural Network at Detecting North Atlantic Right Whale Upcalls

Oliver S. Kirsebom,^{1,4} Fabio Frazao,¹ Yvan Simard,^{2,3} Nathalie Roy,³ Stan Matwin,^{1,4} and Samuel Giarl

¹Institute for Big Data Analytics, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada

²Fisheries and Oceans Canada Chair in underwater acoustics applied to ecosystem and marine mam-

mals, Marine Sciences Institute, University of Quebec at Rimouski, Rimouski, Quebec, Canada

³Maurice Lamontagne Institute, Fisheries and Oceans Canada, Mont-Joli, Quebec, Canada

⁴Institute of Computer Sciences, Polish Academy of Sciences, Warsaw, Poland

SCIENTIFIC
REPORTS
nature research

Deep Machine Learning Techniques for the Detection and Classification of Sperm Whale Bioacoustics

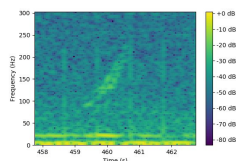
Peter C. Berman¹, Michael M. Bronstein^{1,2,3}, Robert J. Wood^{3,4}, Shane Gero⁵ & David F. Gruber^{3,4}

- Deep learning works, is now a mature technique
- Often outperforms more conventional DC algorithms
- However, these algorithms are not always accessible to marine acousticians (or application developers supporting marine scientists)

Ketos - at a glance



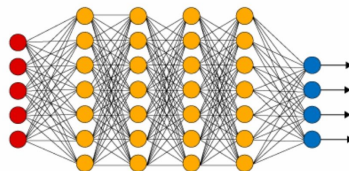
Audio
processing



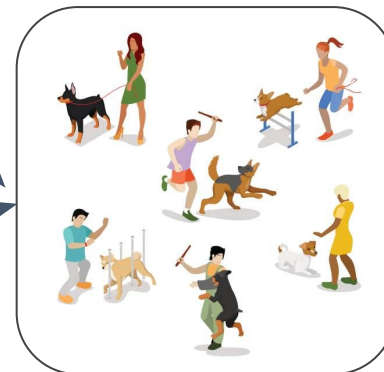
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1	filename	label	start	end
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3	IML-BA_Sample_2019-06-02_065235.wav	1	0	3
4	IML-BA_Sample_2019-06-08_012119.wav	1	0	3
5	IML-BA_Sample_2019-06-21_201729.wav	1	0	3
6	IML-BA_Sample_2019-06-29_124902.wav	1	0	3
7	VAS_Sample_2019-06-06_052058.wav	1	0	3
8	VAS_Sample_2019-06-06_052147.wav	1	0	3
9	VAS_Sample_2019-06-06_052545.wav	1	0	3

Annotation tables

Neural network
architectures

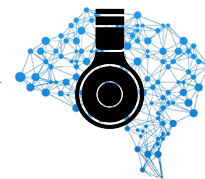


Training Database

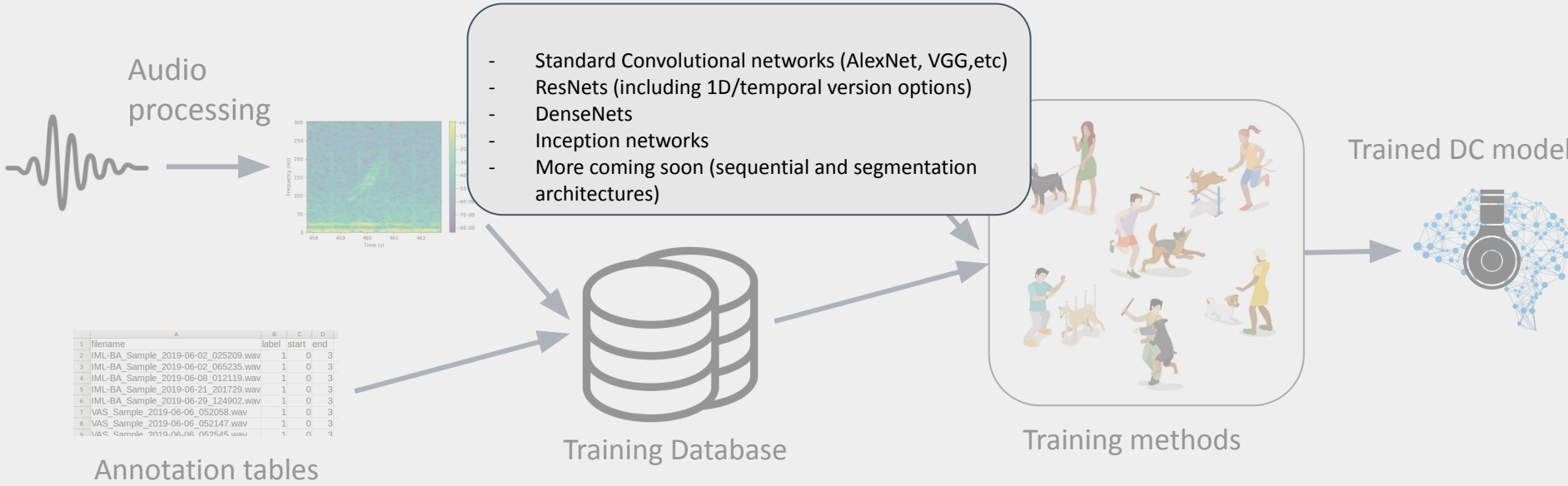


Training methods

Trained DC model



Ketos - at a glance



Ketos - at a glance



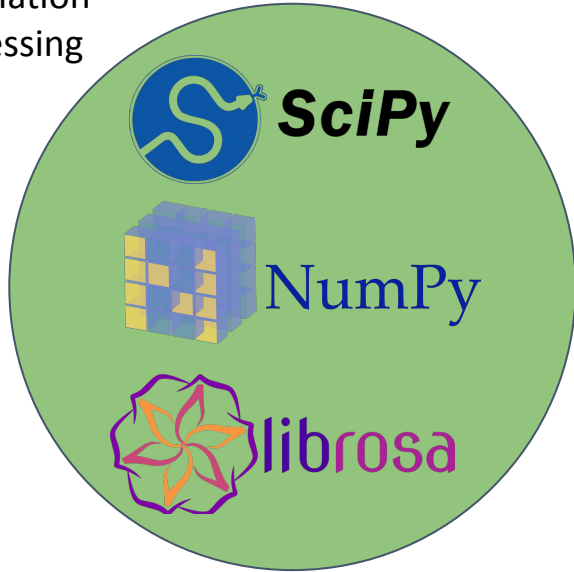
copyleft license

- Written in Python
- GNU GPLv3 license - freely available to use and modify
- Hosted on GitLab:
https://gitlab.meridian.cs.dal.ca/public_projects/ketos
- Documented code, including examples:
<https://docs.meridian.cs.dal.ca/ketos/>
- Tutorials, version history, and more ...
- Available on the Python Package Index (PyPi) - the official third-party software repository for Python

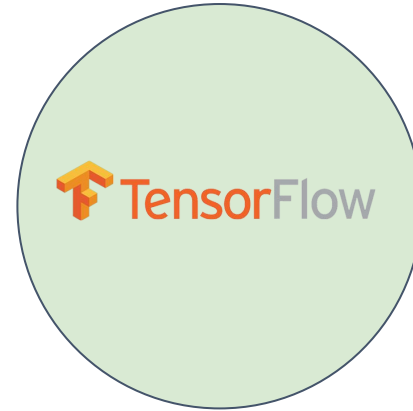
Built on top of open-source libraries



1. Audio data manipulation & processing



3. Machine learning, neural networks



2. Data handling & storage





Documentation - <https://docs.meridian.cs.dal.ca/ketos/>



ketos

Underwater acoustic detection and classification with deep neural networks



2.2

Introduction

Installation

▢ Tutorials

Creating a training database (Basic)

Creating a training database (Extended)

Training a ResNet classifier

Creating a detector

▢ Modules

▢ How to contribute

▢ Versions

Docs » Tutorials » Tutorial: Training a Binary ResNet Classifier

[View page source](#)

Tutorial: Training a Binary ResNet Classifier

Note

You can download an executable version (Jupyter Notebook) of this tutorial and the data required to follow along [here](#).

North Atlantic Right Whale detector-part 1

This is the first of a two parts tutorial illustrating how to build a deep learning acoustic detector with ketos.

We'll use the database built in the [Creating a training database](#) tutorial, in which we converted raw audio files to spectrograms of the North Atlantic Right Whale's stereotypical upcall. If you didn't follow that tutorial, you can find the resulting database in the .zip file linked at the top of this page. There you will also find an executable version of this jupyter notebook, in case you want to follow along.

Our final goal is to have a detector that can take a long .wav file (e.g.: 30 min) and tell us where within that file are the right whales upcalls.

The core part of such detector will be a binary classifier that takes 3-s long spectrograms and classifies them into "contains an upcall" or "does not contain an upcall". We will treat these two classes as "1" and "0". This is what we'll cover in this tutorial.

The [second part](#) will take this binary classifier and turn it into a detector.

Contents:

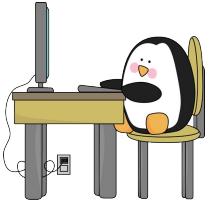
- [1. Importing the packages](#)
- [2. Creating the data feed](#)
- [3. Creating and training the Neural Network](#)

The lines below define the random seeds used in the tutorial. This is necessary to ensure that you get the precisely the same results every time you run the code.

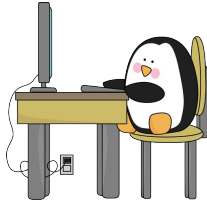
Typical Ketos users



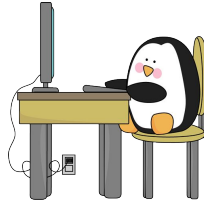
Acoustic data analyst



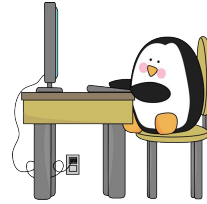
Application developer



Deep learning developer



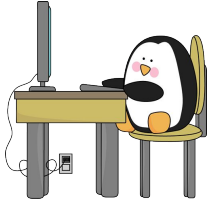
Deep learning researcher



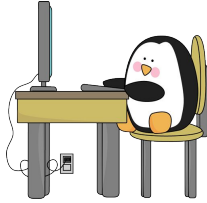
Typical Ketos users



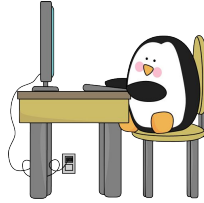
Acoustic data analyst



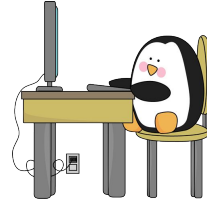
Application developer



Deep learning developer



Deep learning researcher



- Has domain expertise
- Has some basic programming experience (if using ketos directly)
- Interested the application of detectors/classifiers to their data
- Mostly follows the default routes/uses pre-trained models

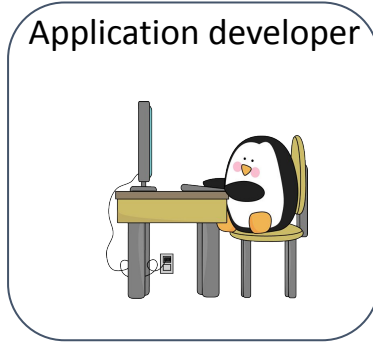
Typical Ketos users



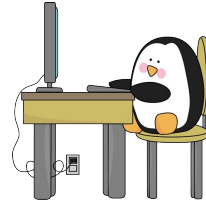
Acoustic data analyst



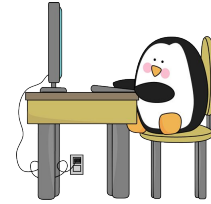
Application developer



Deep learning developer



Deep learning researcher

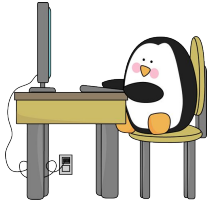


- Experienced software developer
- Not (necessarily) experienced in machine learning/data analysis
- Interested in developing applications (web, desktop, etc) around trained detectors/classifiers.
- The product of their work is used by data analysts (allowing them to benefit from ketos indirectly)

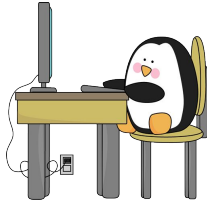
Typical Ketos users



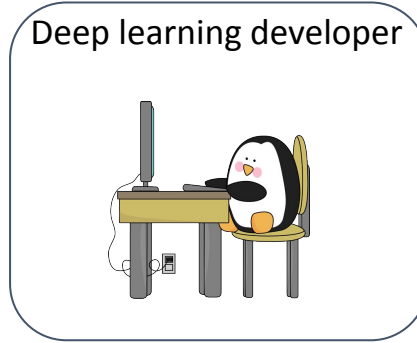
Acoustic data analyst



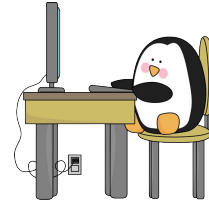
Application developer



Deep learning developer



Deep learning researcher

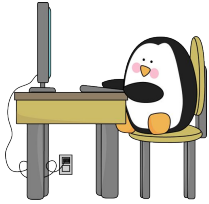


- Has experience with data analysis and machine learning
- Is interested in applied deep learning: wants to build models that work for a given acoustic application
- Not interested in developing new machine learning methods

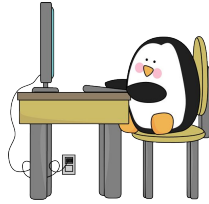
Typical Ketos users



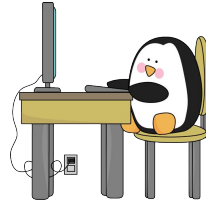
Acoustic data analyst



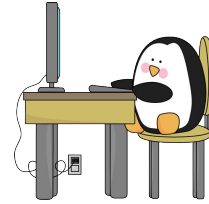
Application developer



Deep learning developer



Deep learning researcher



- Has expertise with data analysis and machine learning
- Is interested in developing new machine learning methods (for acoustics)

Interfaces



Ketos can be used with different interfaces:

- Scripts
- Command-line interfaces
- Jupyter notebooks
- In the backend of web/desktop applications
- Through other applications/frameworks compatible with the exported models

Interfaces



Command-line interface for headless operation onboard a floating data collection station



Raspberry Pi 3B

+

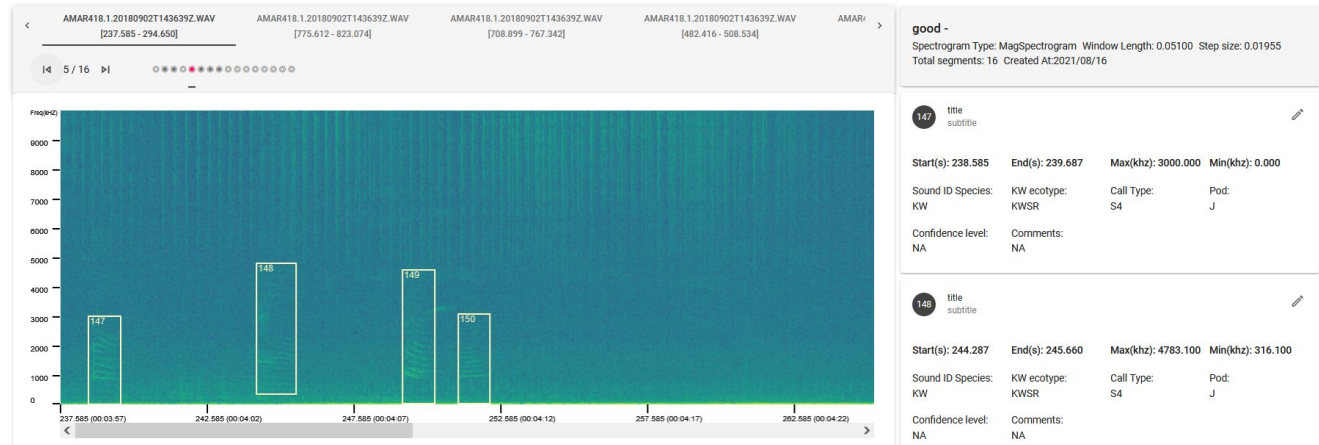


DFO/ Maurice Lamontagne Institute (MLI)

Interfaces



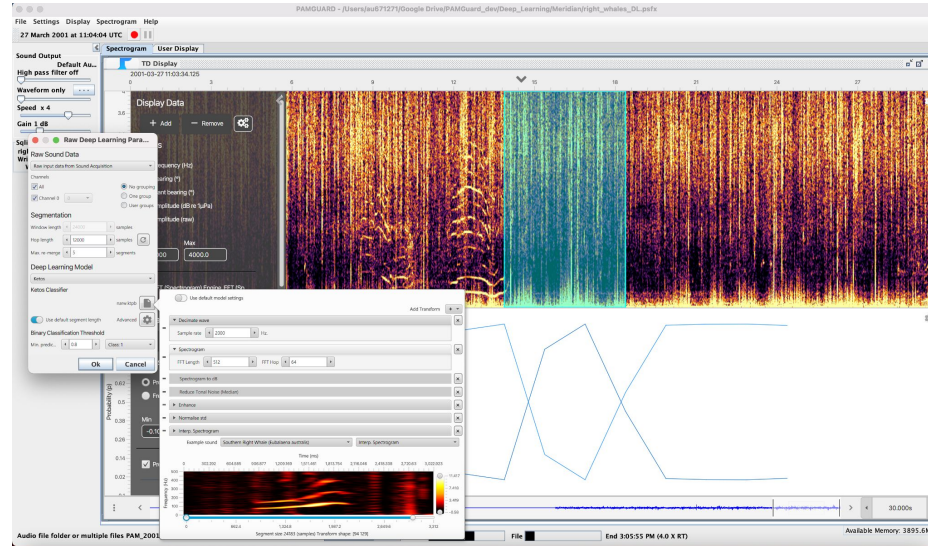
A web application
running Ketos in the
backend



Interfaces



Exported Ketos model being used by PAMGuard



Read more about the new PAMGuard deep learning module here: <https://conservationcoding.com/2021/06/07/deep-learning-in-pamguard/>

Summary



Deep learning can ...

- help us create better acoustic detection and classification (DC) models
- change the way we develop and use these models

Ketos ...

- is an open-source Python package for developing deep learning based acoustic detectors and classifiers
- provides neural network architectures, transfer learning capabilities, tools for dealing with larger-than-memory datasets, audio processing, saving and sharing of models, and more
- is accessible to different kinds of users
- Can be used with different interfaces
- offers documentation and step-by-step tutorials
- check it out at <https://docs.meridian.cs.dal.ca/ketos/>





Thank you!

