A decorative graphic on the left side of the slide. It features several circles in orange, light blue, and dark blue. A central dark blue circle contains the word 'MERIDIAN' in white capital letters, surrounded by a pattern of small, multi-colored numbers. To the right of this central circle is a series of vertical orange bars of varying heights, resembling a bar chart or a stylized waveform.

# Acoustic detection and classification using deep neural networks

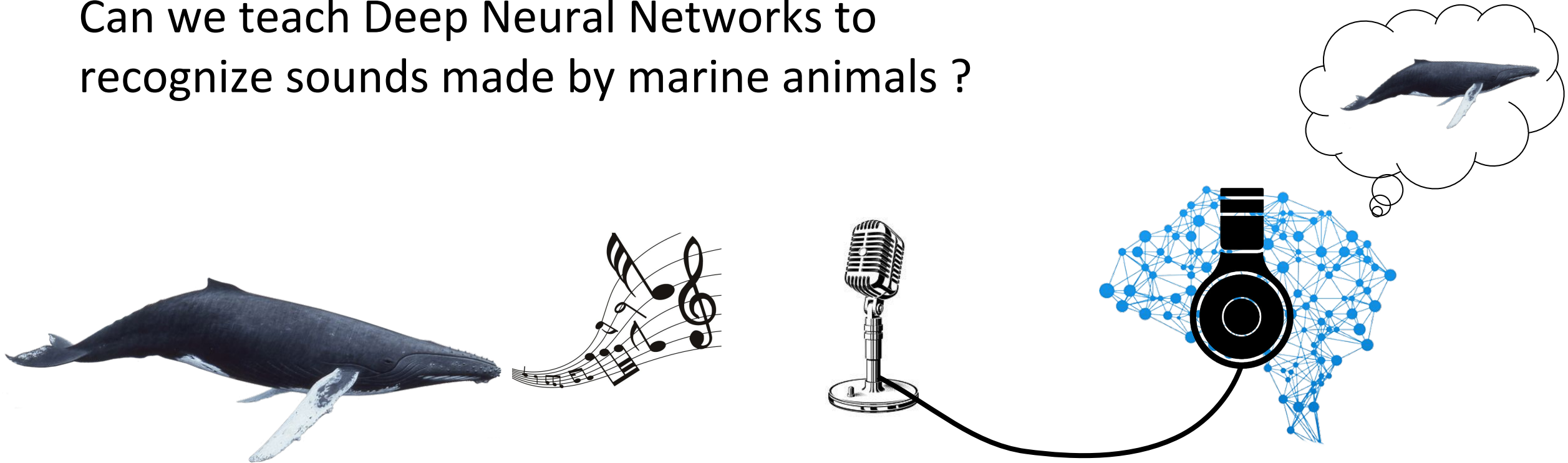
**Oliver Kirsebom**

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

## The Question:



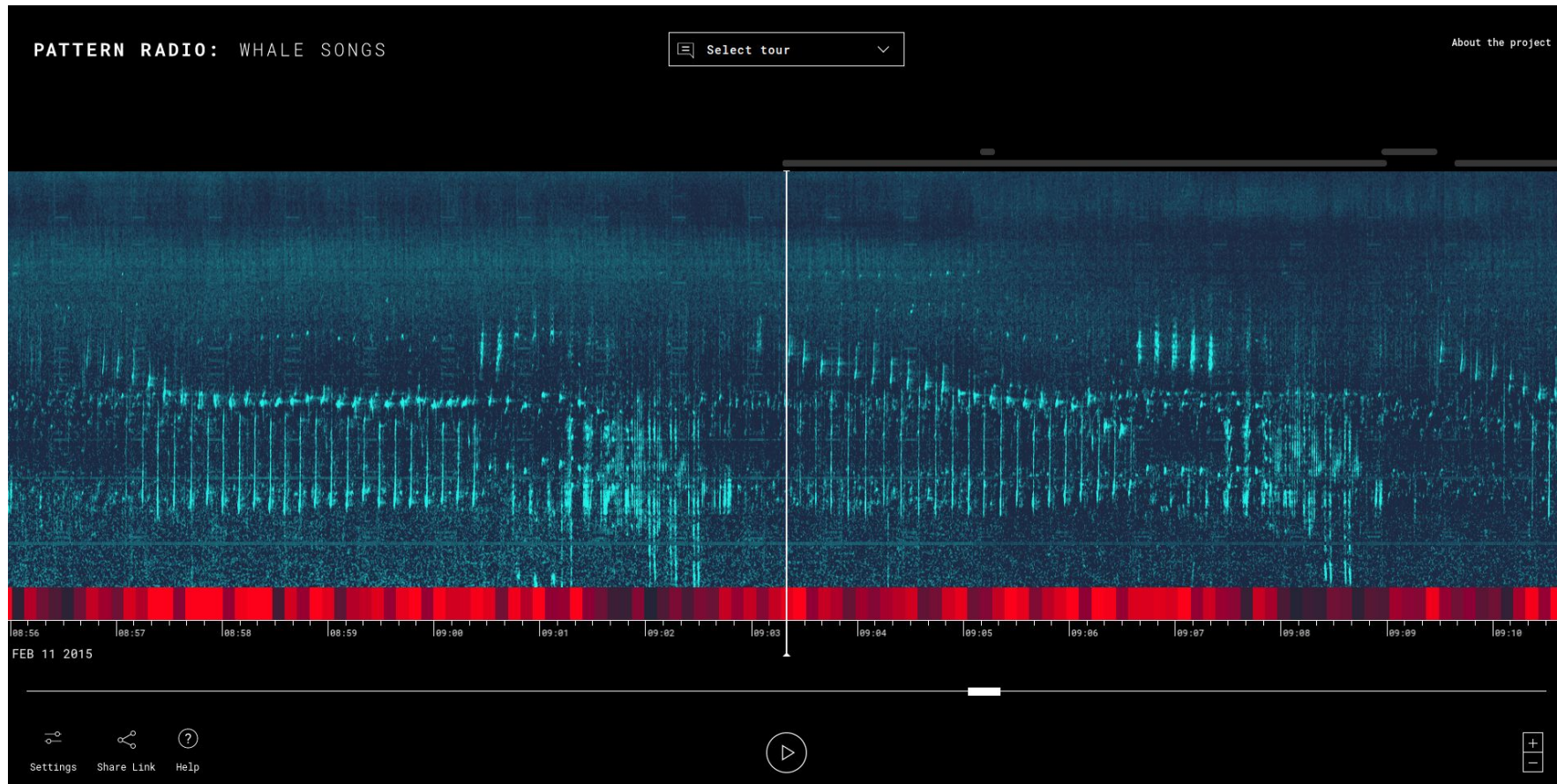
Can we teach Deep Neural Networks to recognize sounds made by marine animals ?



The Answer:



<https://patternradio.withgoogle.com/>

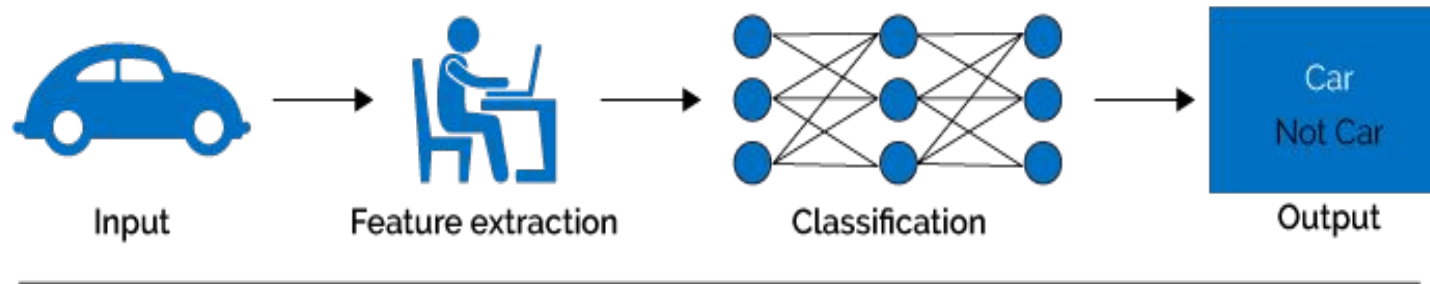


The Effects of Noise on Aquatic Life, Den Haag, 7-12 July 2019

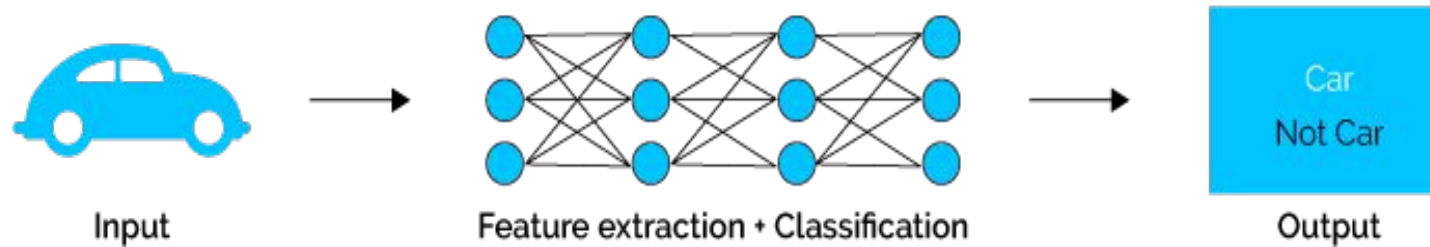
# Promises and challenges



## Machine Learning



## Deep Learning



Come see our poster :-)



# Poster #40

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

**Fabio Frazao<sup>1,2</sup>, Oliver S. Kirsebom<sup>1,2</sup>, Amalis Riera<sup>1,3</sup>, Stan Matwin<sup>1,2</sup>**

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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 neural network 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) Confusion matrix of the neural network.

#### Matching individual killer whale calls

**Results**  
Accuracy: 94.6%

Figure 2: Using a neural network to match killer whale calls produced by the same individual. (a) Spectrogram of a killer whale call. (b) Spectrogram of a killer whale call produced by a different individual. (c) Confusion matrix of the neural network.

### 3 DETECTION PROJECTS

#### Detecting baleen whales with a sequence to sequence model

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

Figure 3: Using a sequence to sequence model to detect baleen whales. (a) Spectrogram of a baleen whale call. (b) Spectrogram with a baleen whale call. (c) Ground truth. (d) Predicted sequence probabilities. (e) Heatmap of the model.

#### Detecting arctic cods with a convolutional neural network

**Results**  
Accuracy: 95.4%  
Precision: 72.7%  
Recall: 66.7%

Figure 4: Using a convolutional neural network to detect arctic cods. (a) Spectrogram of an arctic cod call. (b) Spectrogram with an arctic cod call. (c) Ground truth. (d) Predicted sequence probabilities. (e) Heatmap of the model.

### 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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