



# Fisheries acoustics and deep learning

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**Olav Brautaset &**

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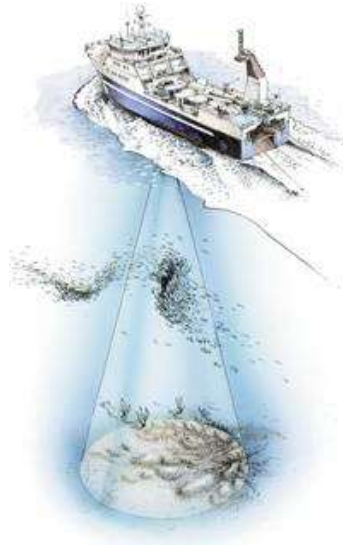
**Ketil Malde\***

\*Institute of Marine Research

\$Kongsberg Discovery

&Norwegian Computing Centre

# Fisheries advice based on acoustics



Acoustic trawl surveys



Survey estimation



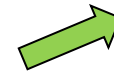
Assessments and harvest control rules



Catch statistics

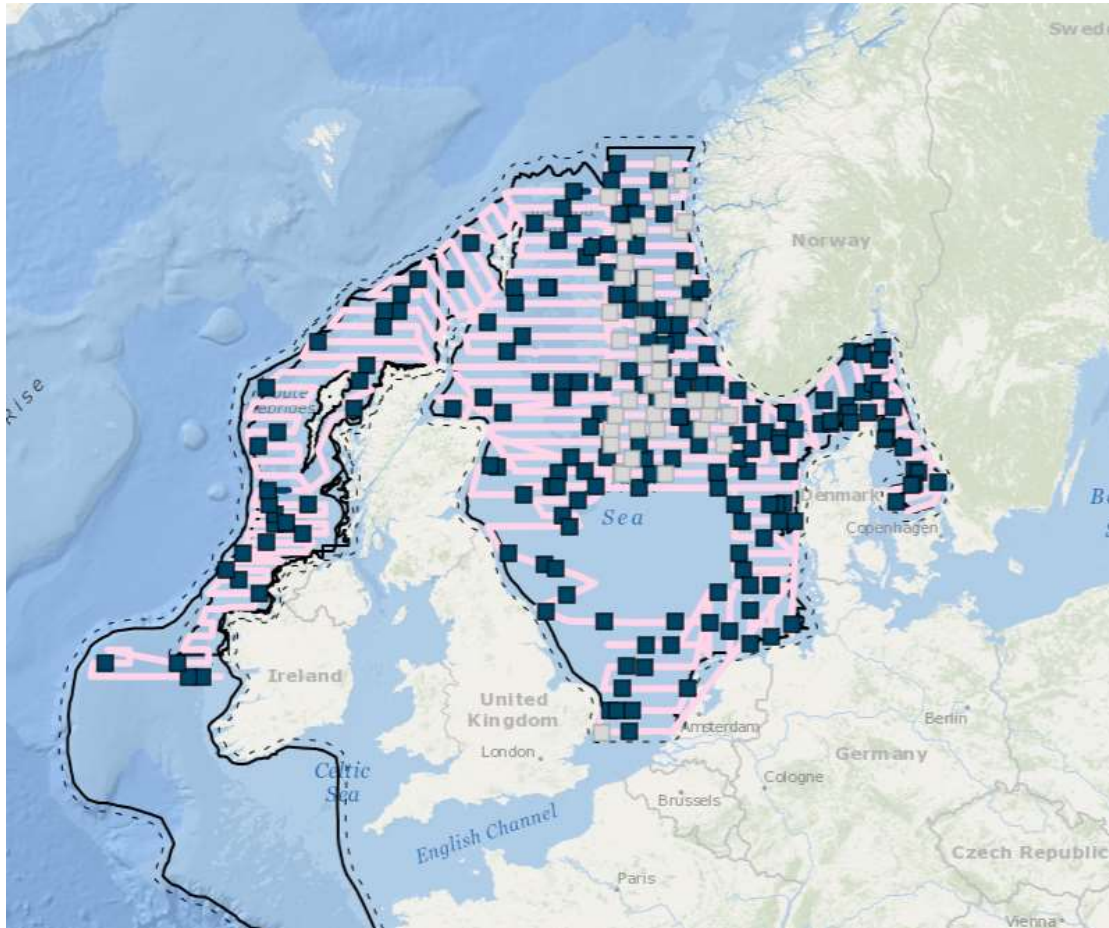


Estimating Catch at Age

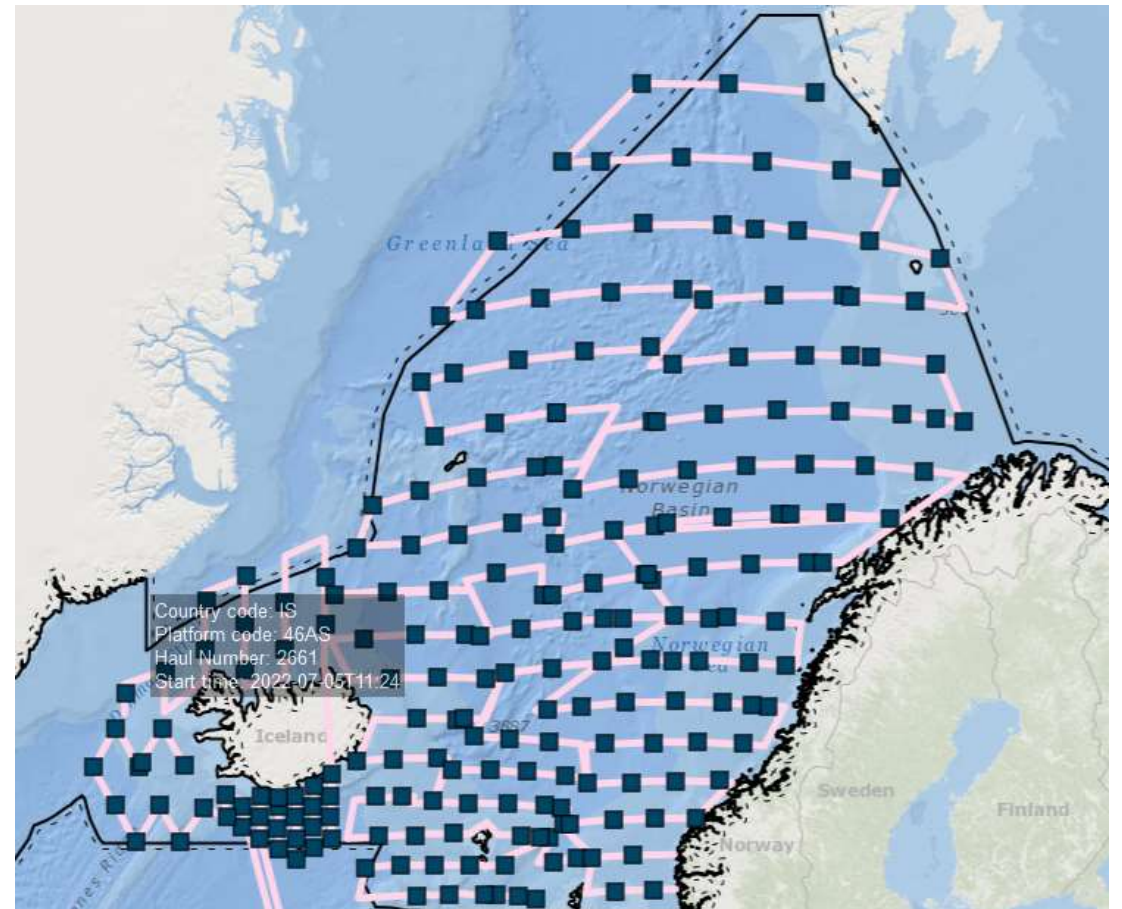


# Fisheries advice based on acoustics

North Sea Herring and Pelagic Ecosystem Survey

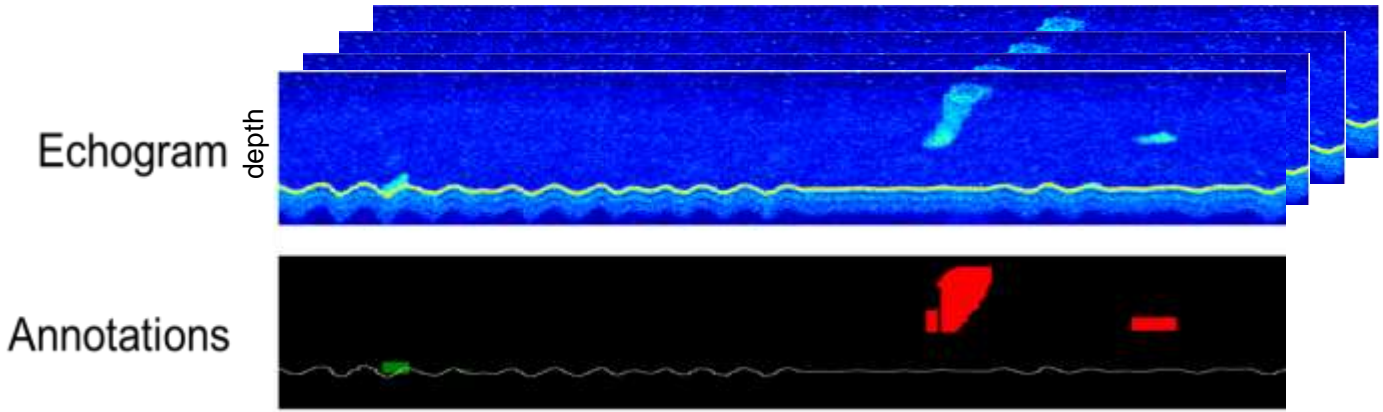


International ecosystem summer survey in the Nordic Seas



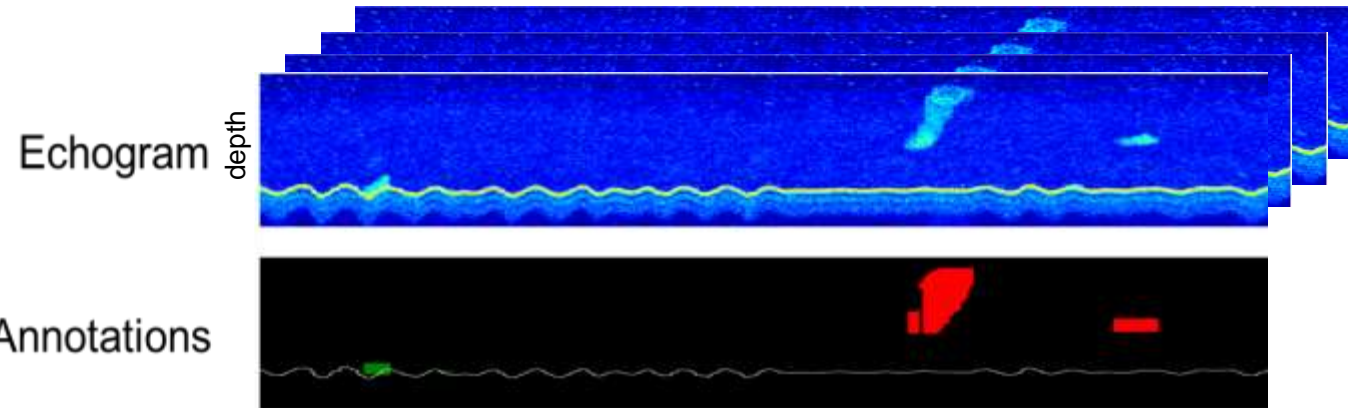
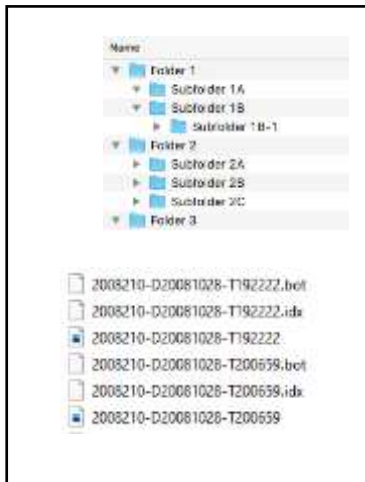


# Acoustic Target Classification (ATC)

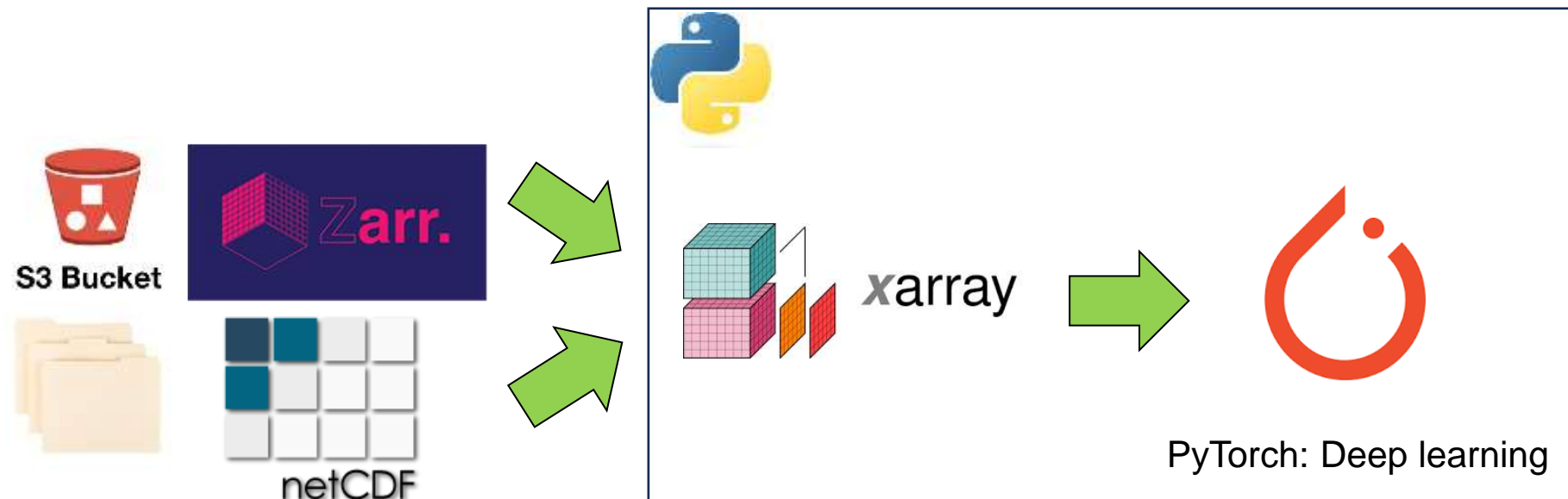


# Data for training models

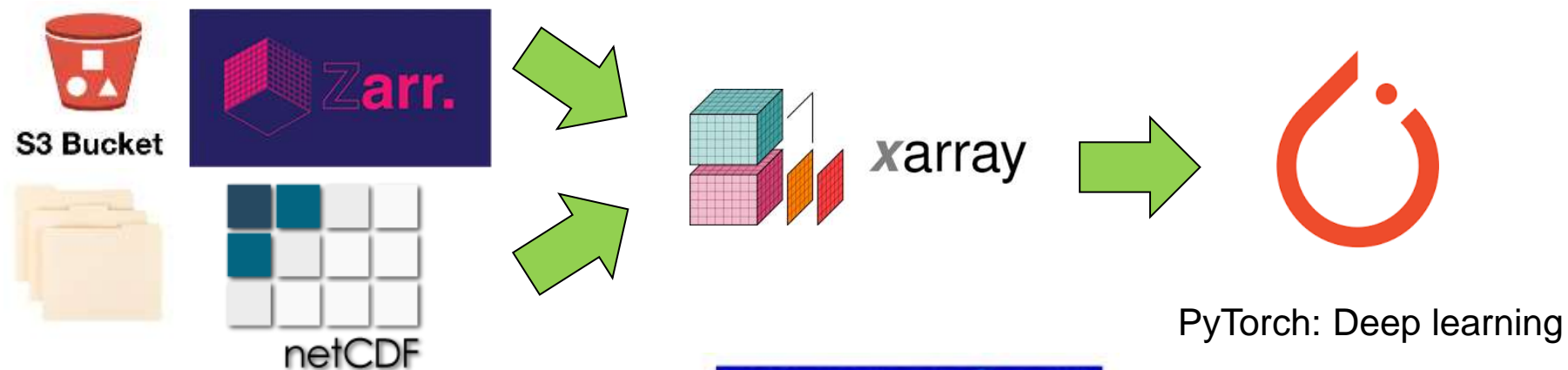
Annotated historical data from ~295 surveys



# Data for training models



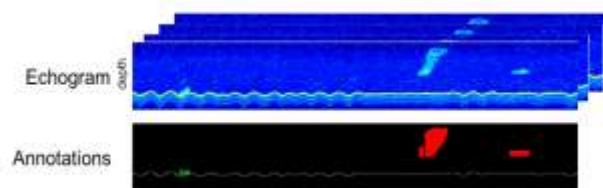
# Data for training models



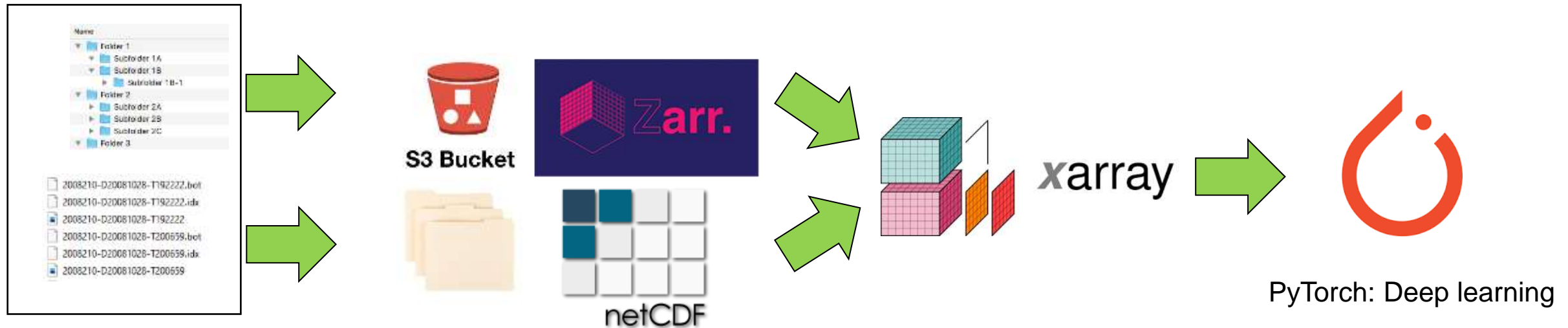
The SONAR-netCDF4 convention for sonar data, version 2.0

ICES WGFASST - Open Data subgroup

Version 2.1 (working draft): Generated at 2023-02-08 04:44:21 UTC



# Data for training models

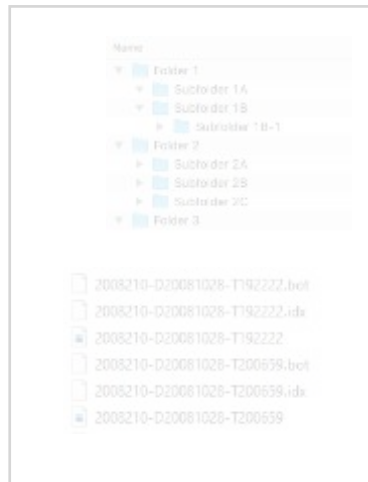


Applying calibration, missing NMEA information, logdistance errors, aligning frequencies, folder structure changing over time, proprietary data formats changing over time, extracting labels; formats changing over time, +++





# Data for training models



**All annotations and backscatter data are embedded as a list of xarray objects!**



xarray



PyTorch: Deep learning



2012

# ImageNet Classification with Deep Convolutional Neural Networks

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Ilya Sutskever  
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University of Toronto  
hinton@cs.utoronto.ca



# ICES Journal of Marine Science



ICES Journal of Marine Science (2019), doi:10.1093/icesjms/fsz057

Contribution to the Themed Section: 'Applications of machine learning and artificial intelligence in marine science'

## Quo Vadimus

### Machine intelligence and the data-driven future of marine science

Ketil Malde<sup>1,2\*</sup>, Nils Olav Handegard<sup>1</sup>, Line Eikvil<sup>3</sup>, and Arnt-Børre Salberg<sup>3</sup>

<sup>1</sup>Institute of Marine Research, Bergen, Norway  
<sup>2</sup>Department of Informatics, University of Bergen, Norway  
<sup>3</sup>Norwegian Computing Center, Oslo, Norway

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## WGMLEARN

Working Group on Machine Learning in Marine Science

Initiated by: (2016)

Chair: Arnt-Børre Salberg, Line Eikvil

Machine learning designates the statistical methods that learn to perform a task (classify elements, predict values, etc.) by inferring properties and patterns from a set of known data (training set) and then can perform the same task to provide predictions on a new set of data (test set). These methods have the potential to considerably accelerate the processing of the massive amount of data collected in marine science, particularly for the fisheries science process.

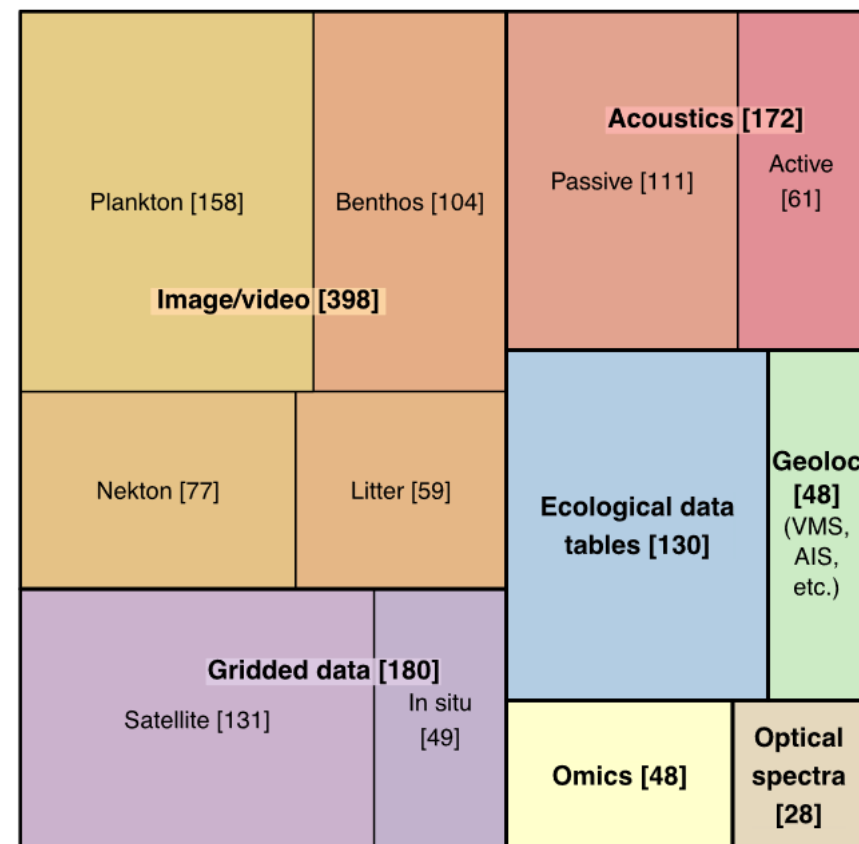
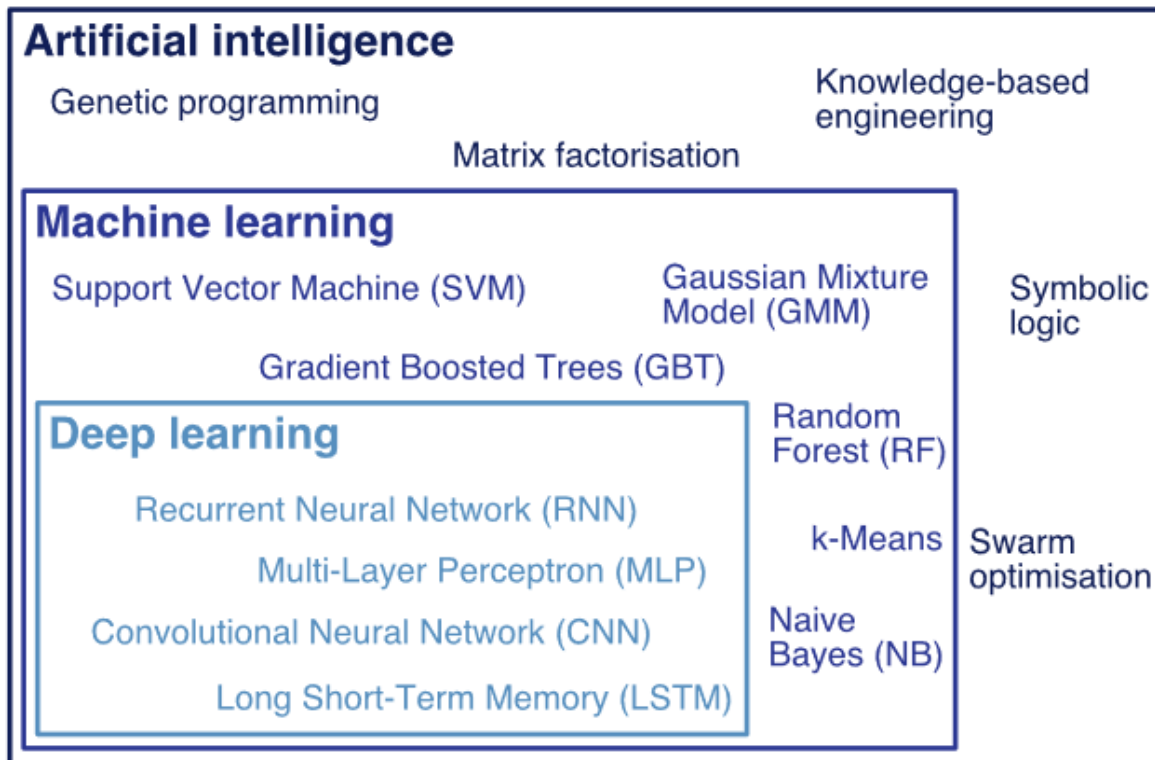
The objectives WGMLEARN are to:

- review the current applications of machine learning in marine science as well as the new developments in machine learning that would be of potential interest
- identify key challenges
- inform data collection and storage to enable the use of machine learning on marine data archives
- identify trends and future needs, to promote the use of relevant machine learning technologies

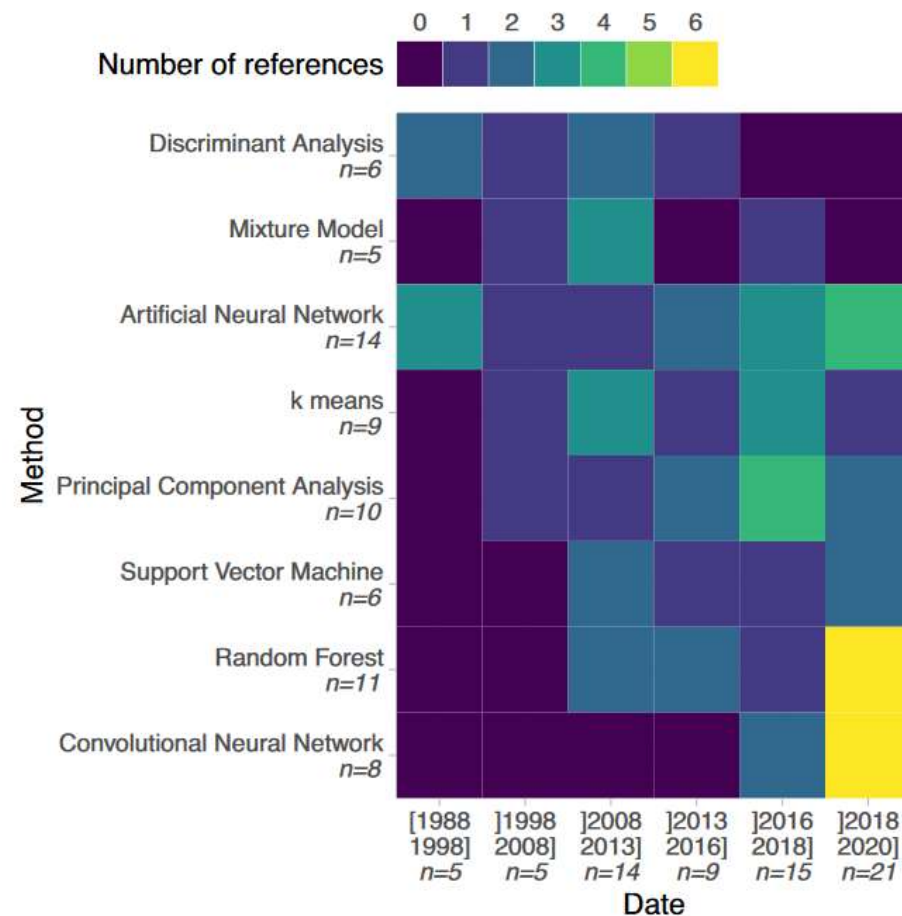
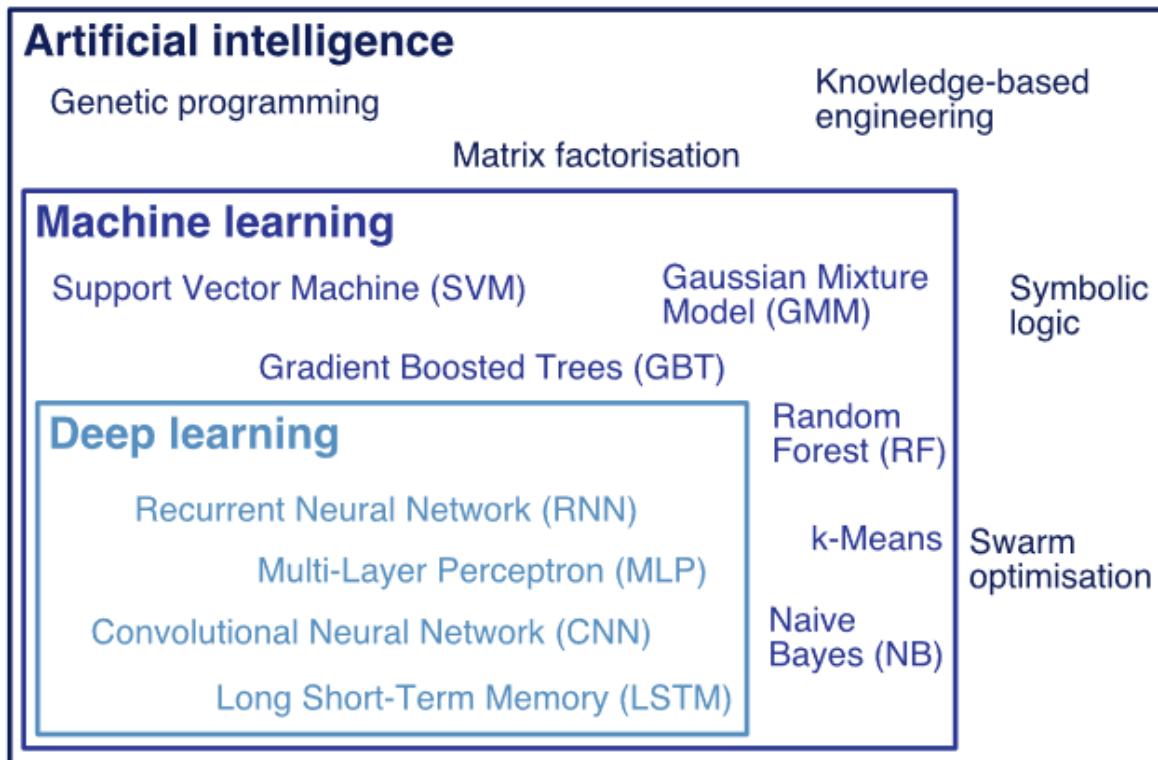
LINKS

- View all members of this group
- DISTSG RESOLUTIONS
- View latest WGMLEARN report
- View WGMLEARN poster
- GO TO SHAREPOINT SITE
- CONTACT US

# Machine learning in marine ecology: an overview of techniques and applications

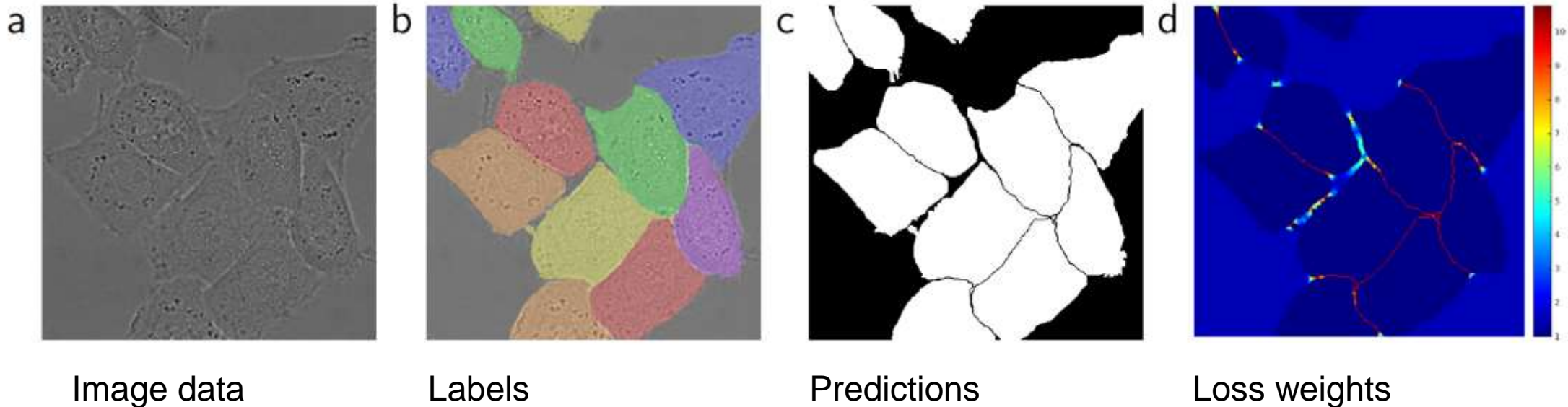


# Machine learning in marine ecology: an overview of techniques and applications



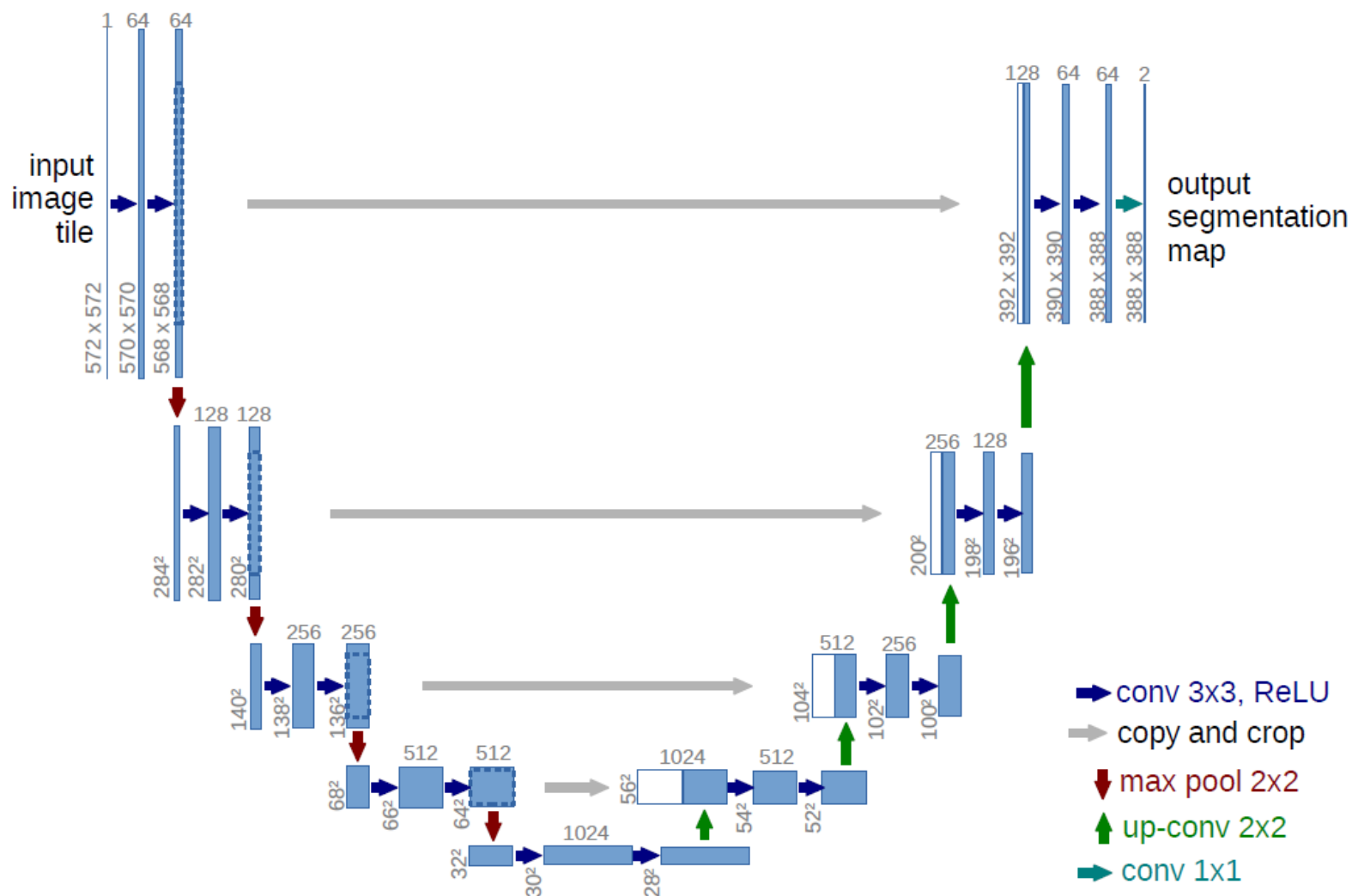


# Deep learning: The U-net

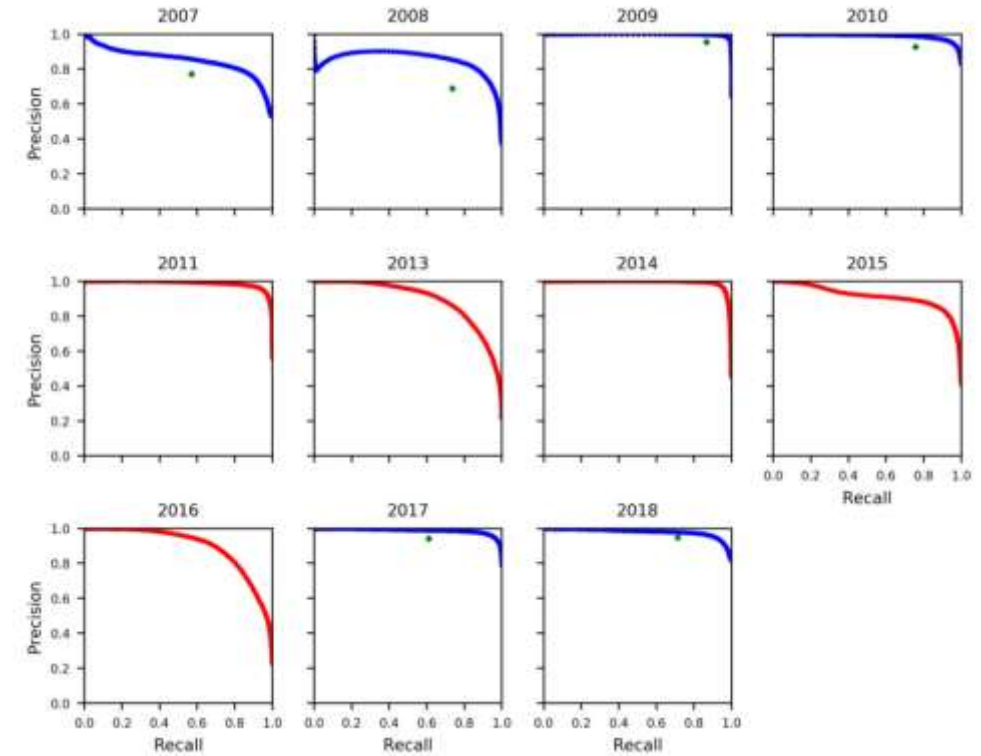
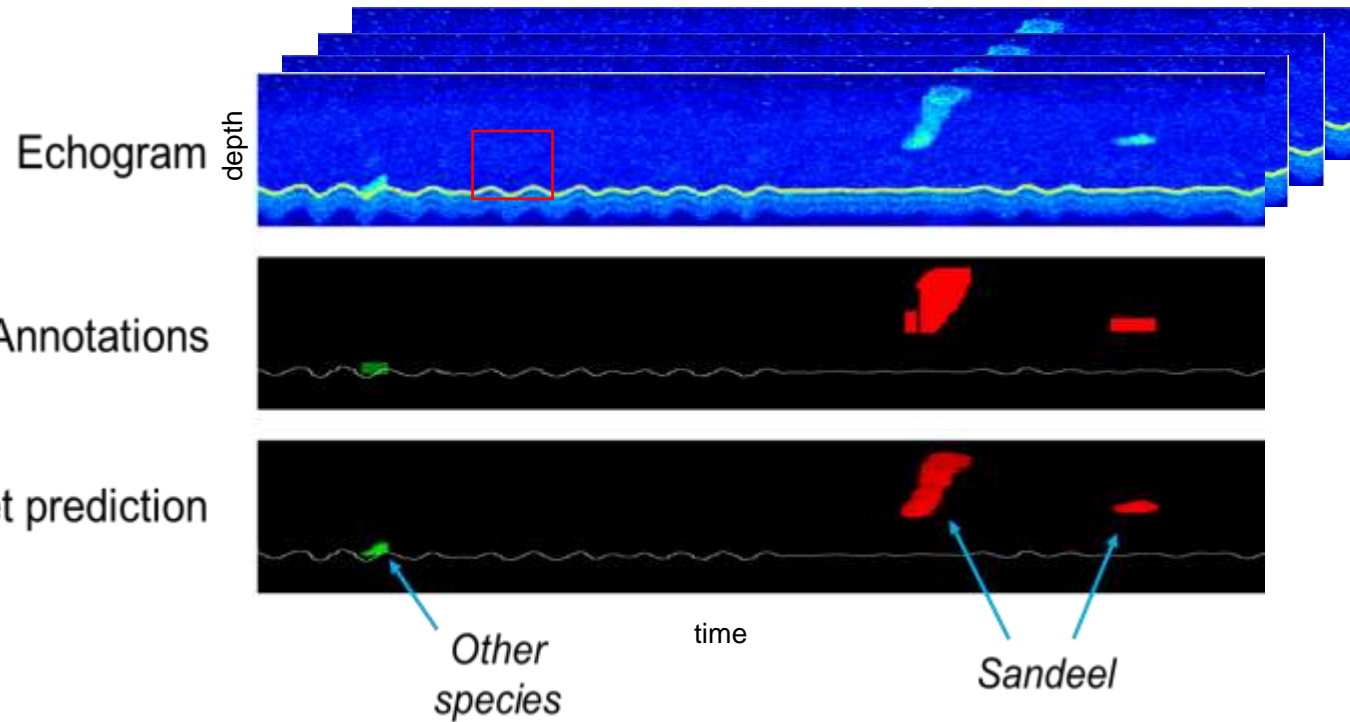




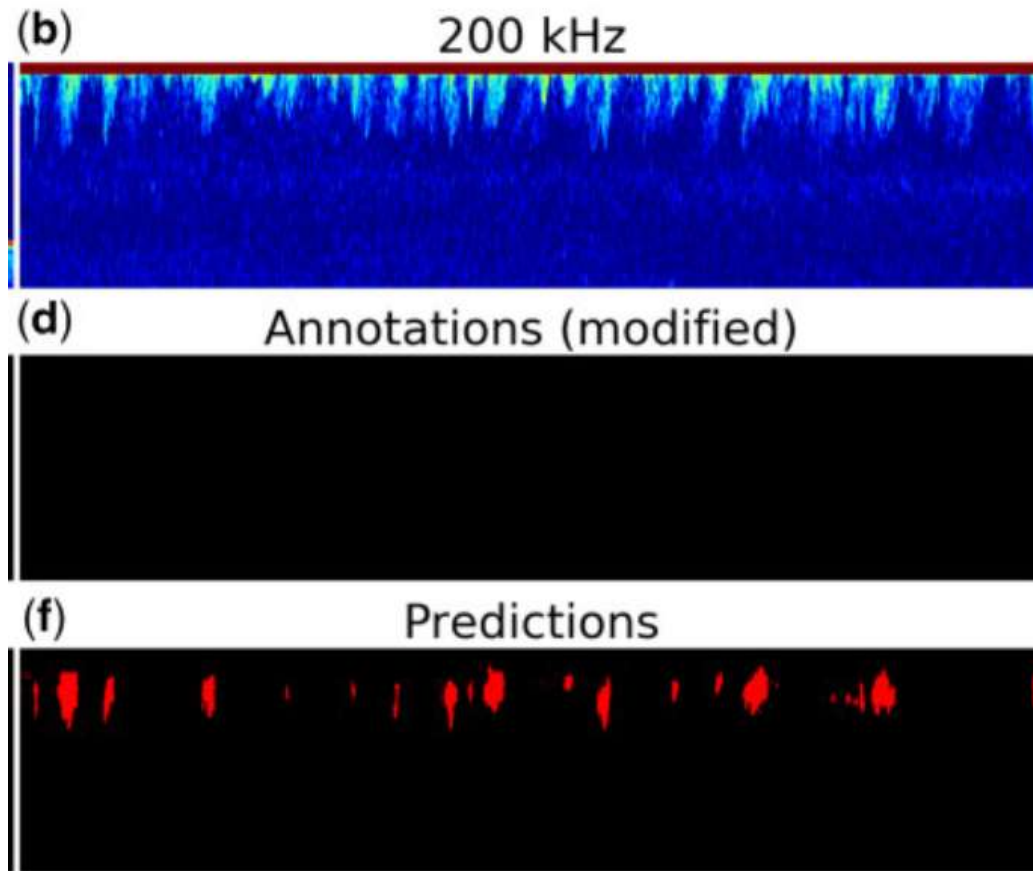
# Deep learning: The U-net



# Acoustic Target Classification (ATC) - Supervised learning



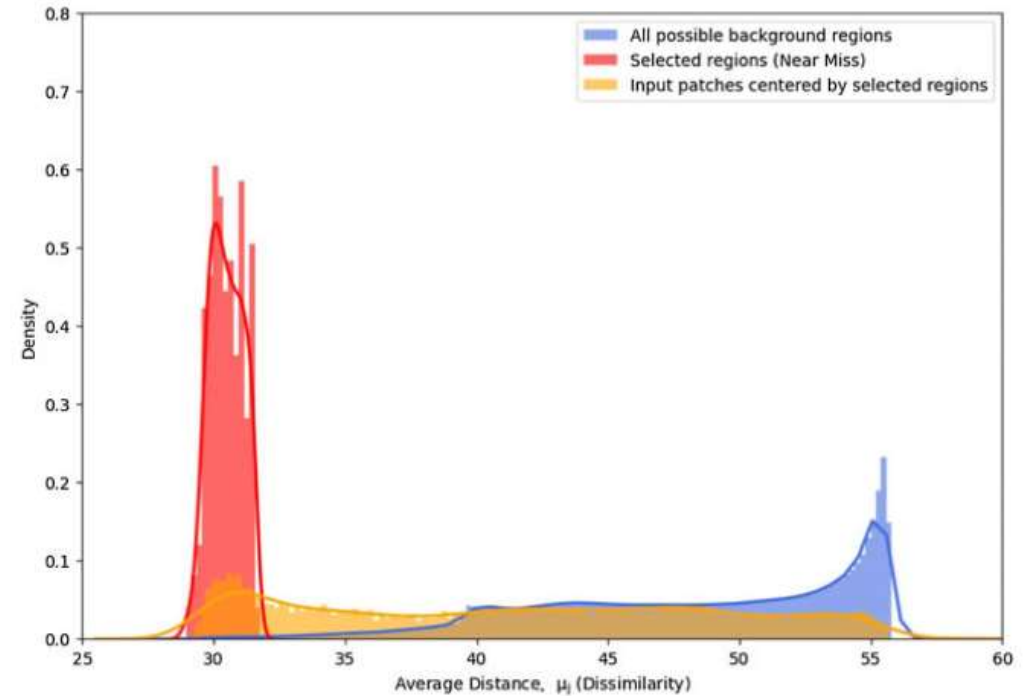
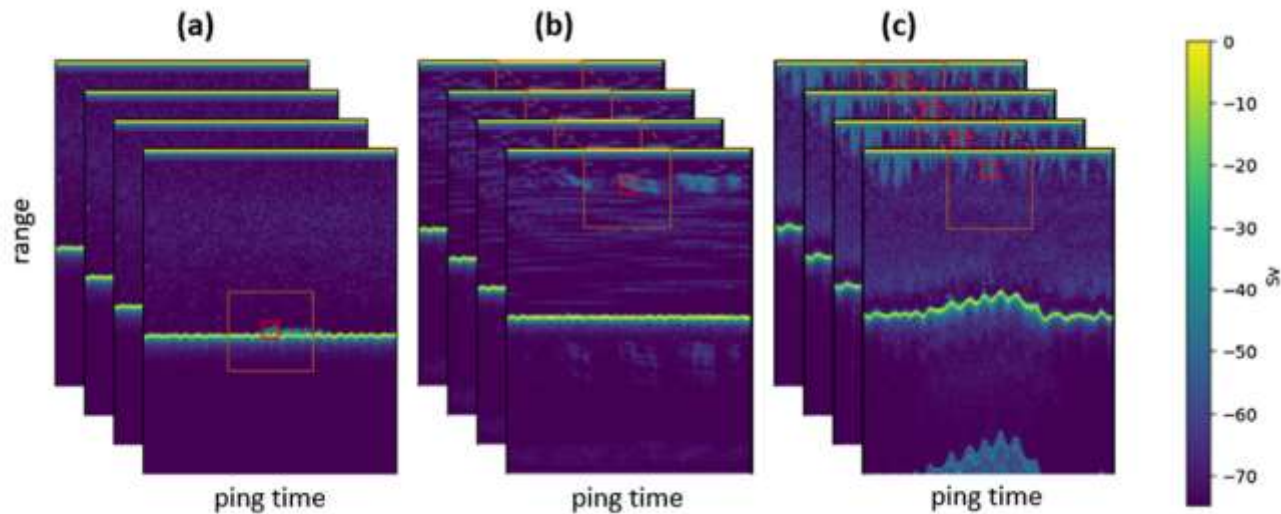
# ATC – highly unbalanced data sets



0.2%



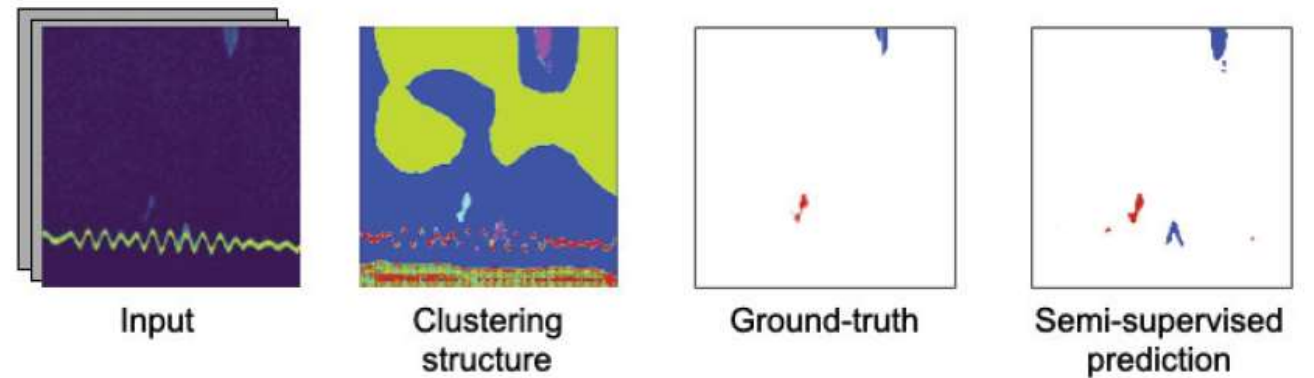
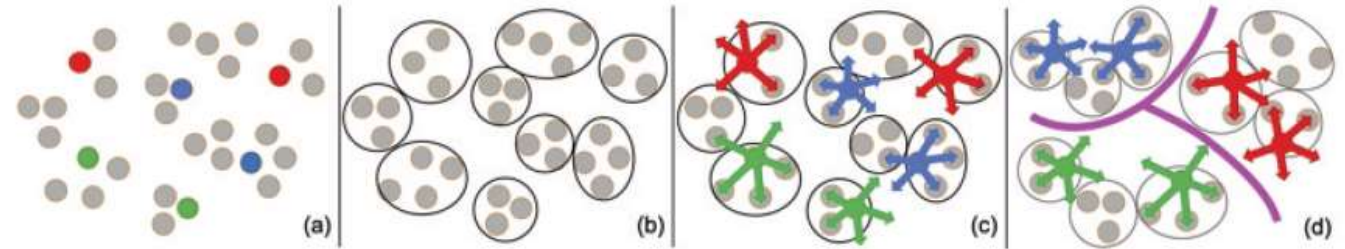
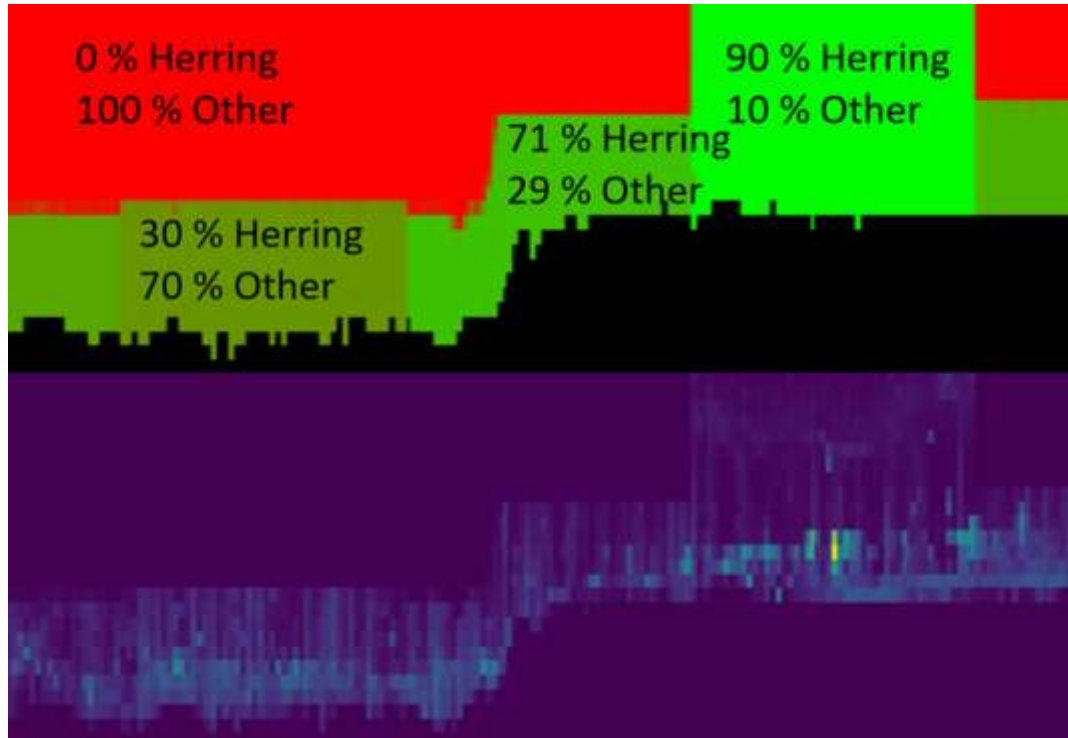
# ATC – highly unbalanced data sets



(a) "Similarity-Based Background" patch selection



# Machine learning and deep learning models



Broutaset et al. (in prep)

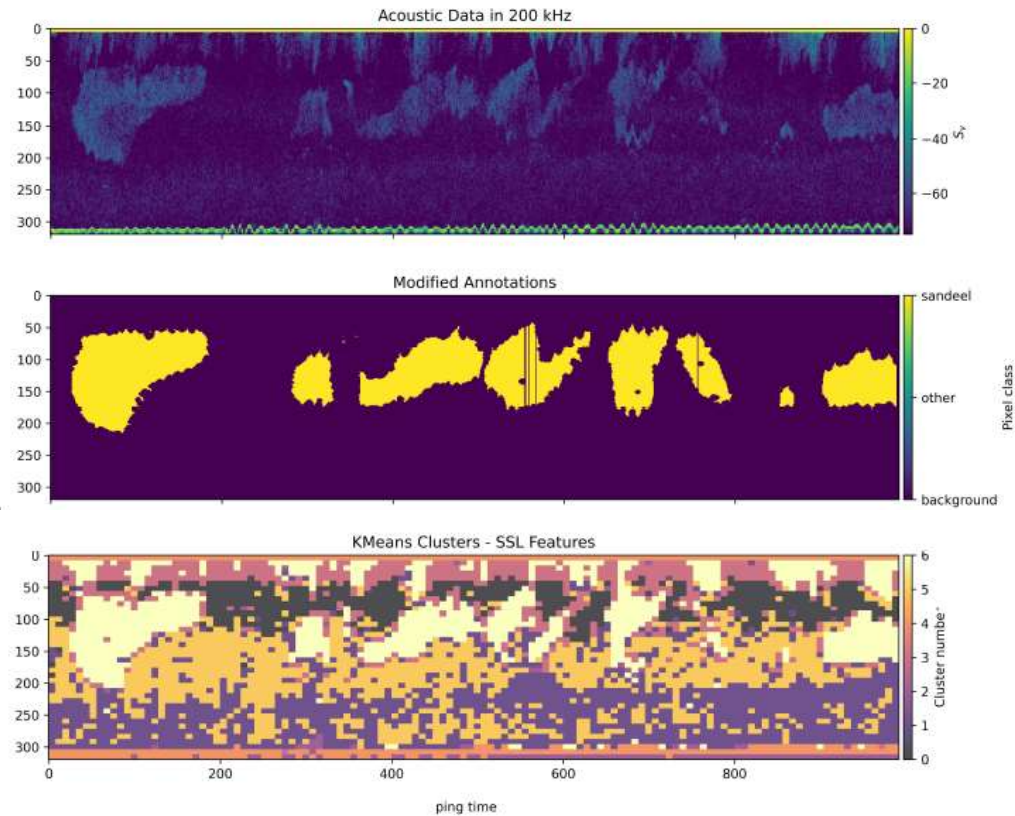
COMPANY SHARED



Choi et al. (2023)  
Choi et al. (2021)



# Machine learning and deep learning models



## Self-Supervised Learning for Annotation-Free Analysis of Acoustic Data

Ahmet Pala<sup>1</sup>, Anna Oleynik<sup>1</sup>, Ketil Malde<sup>2</sup>, and Nils Olav Handegard<sup>2</sup>

<sup>1</sup>Department of Mathematics, University of Bergen, Allegaten 41, 5008 Bergen, Norway

<sup>2</sup>Institute of Marine Research, Nordnesgaten 50, Bergen 5005, Norway

March 4, 2024



# Machine Learning Engineering for Production

## Model-centric view

Take the data you have, and develop a model that does as well as possible on it.

## Data-centric view

The quality of the data is paramount. Use tools to improve the data quality; this will allow multiple models to do well.



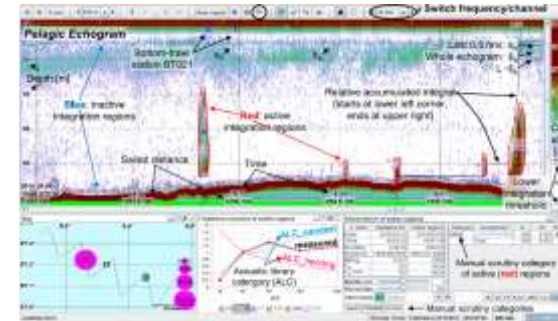
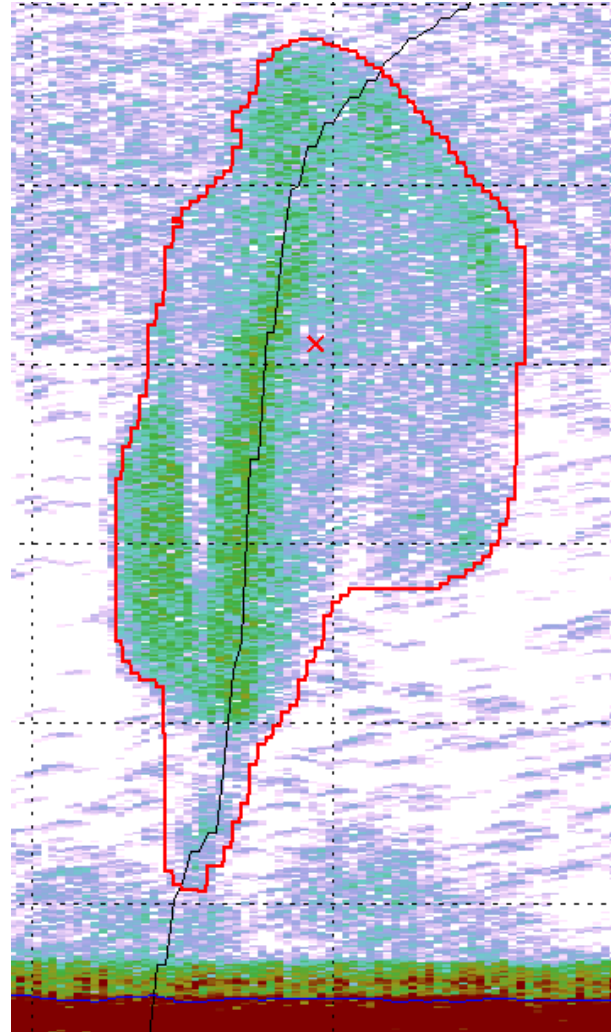
#1 Machine Learning Engineering for Production (MLOps) Specialization [Course 1, Week 1, Lesson 1]



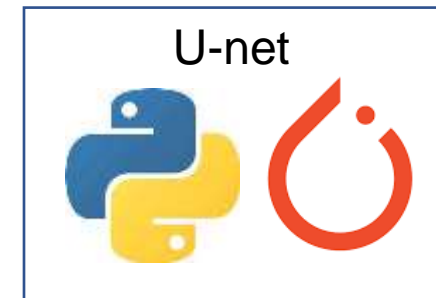
(Photo by Steve Jennings/Getty Images for TechCrunch)



# Machine Learning Engineering for Production

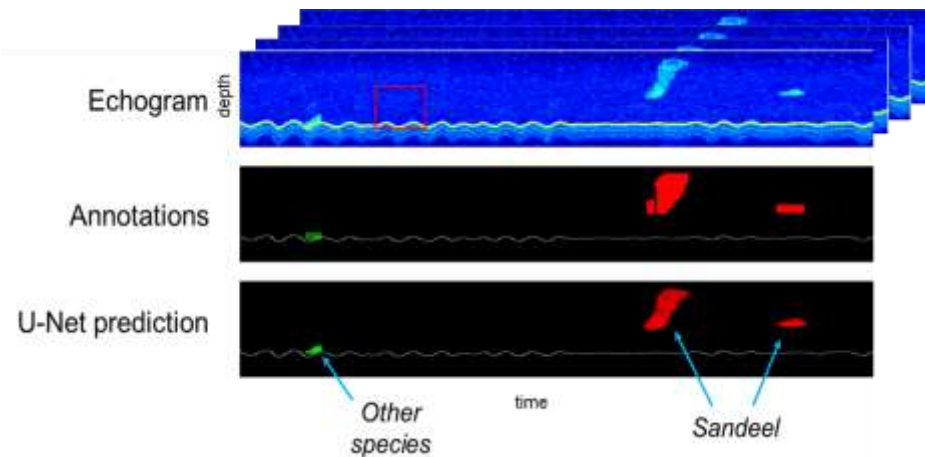


↕ LSSS API



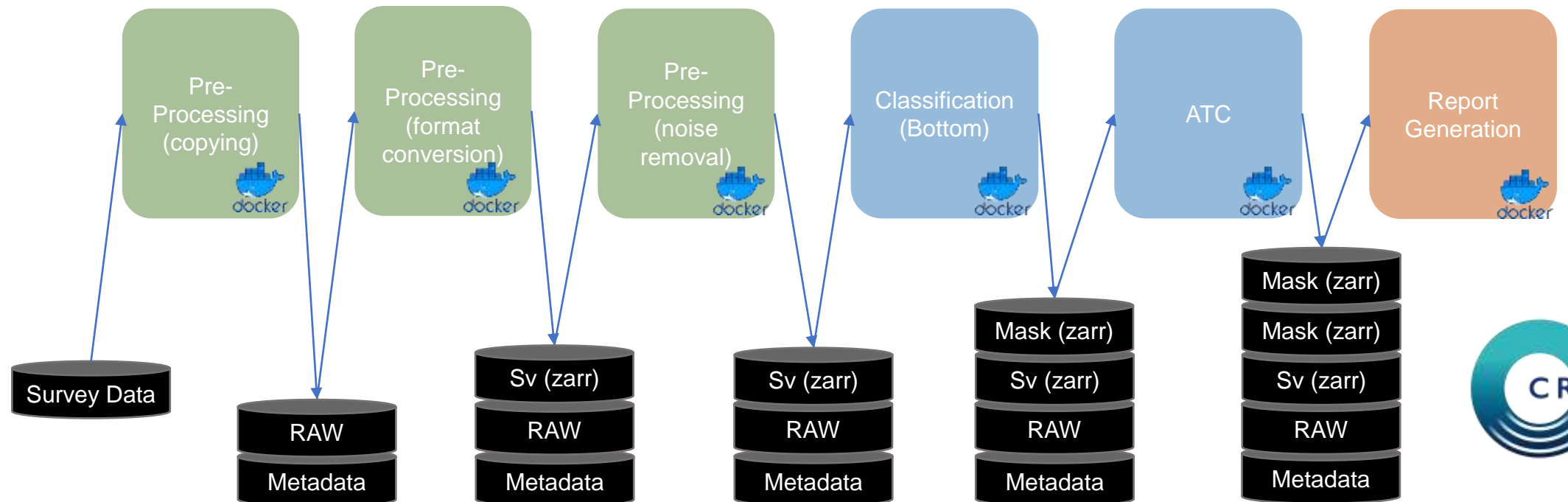
# Machine Learning Engineering for Production

Not straight forward to run traditional processing on the platforms (edge)





# Edge deployment





# Edge deployment

Model Training

Blue Insight



ICES format

Remote (EK, EM, ...)

Remote Docker repo

Remote Docker configurator

Start, Stop, pingrate

Sensor

Pre-Processing (copying)

Pre-Processing (format conversion)

Pre-Processing (noise removal)

Classification (Bottom)

Classification (unet)

Report Generation

RAW

Metadata

Sv (zarr)

RAW

Metadata

Sv (zarr)

RAW

Metadata

Mask (zarr)

Sv (zarr)

RAW

Metadata

Mask (zarr)

Mask (zarr)

Sv (zarr)

RAW

Metadata



Configuration

Settings

Survey Data



“Well, Mr. Frankel, who started this program, began to suffer from the computer disease that anybody who works with computers now knows about. It's a very serious disease and it interferes completely with the work. The trouble with computers is you \*play\* with them. They are so wonderful.” (Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character”?)



Funding: CRIMAC, Norwegian Research Council, under the SFI program