The State-of-the-Art Machine Learning in Underwater Acoustics

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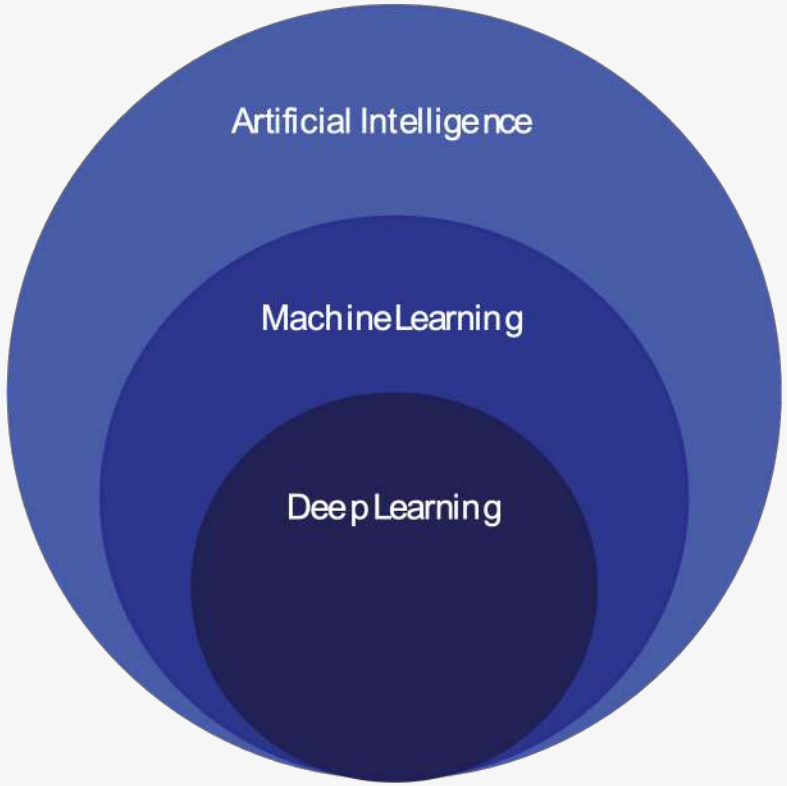
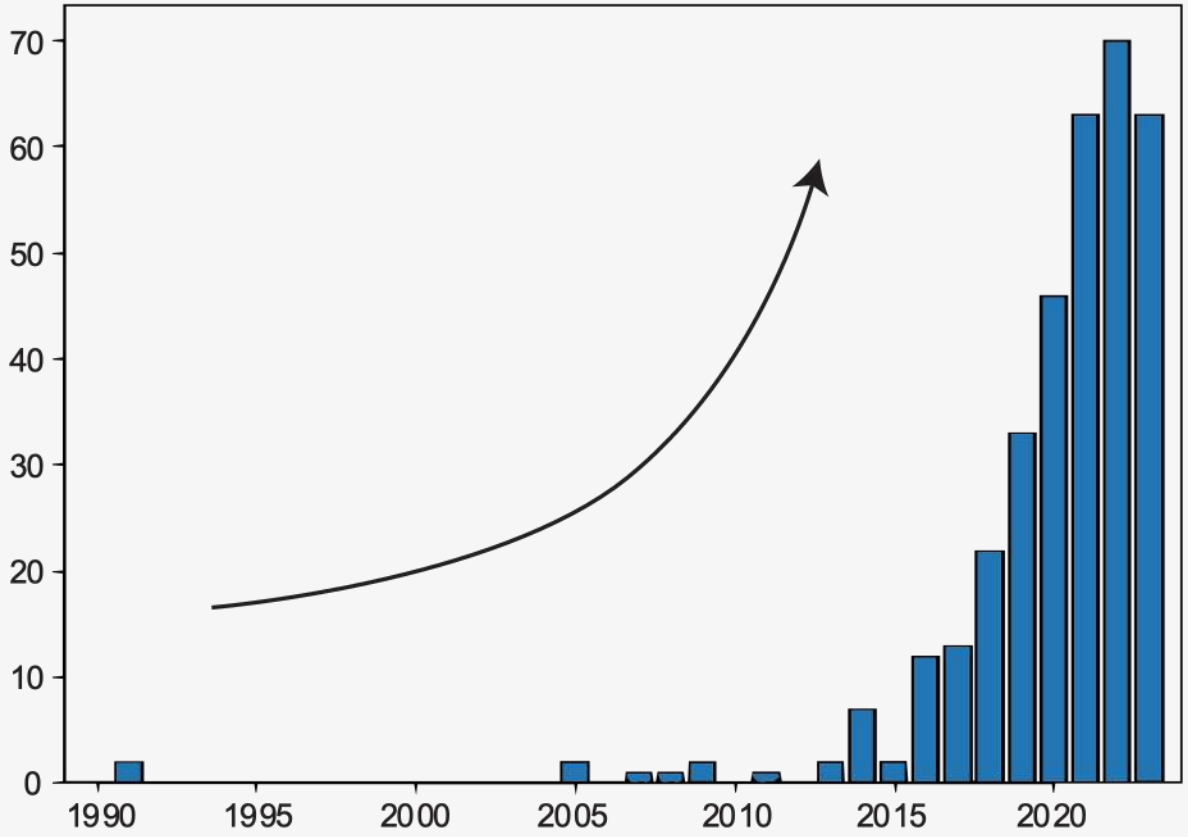
Machine Learning

"The use and development of computer systems that are able to learn and adapt without following explicit instructions, by using algorithms and statistical models to analyze and draw inferences from patterns in data."



Its application in Underwater Acoustics

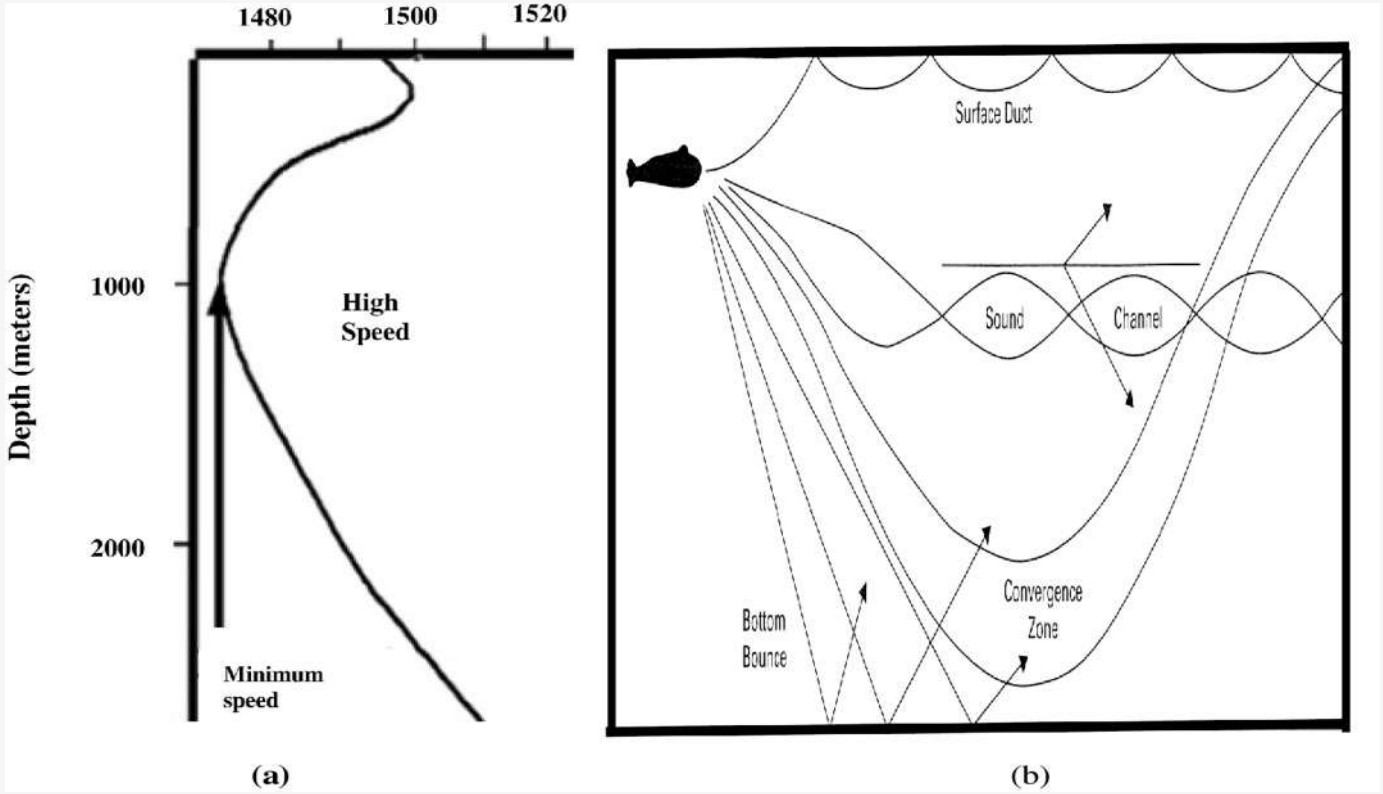


Detection

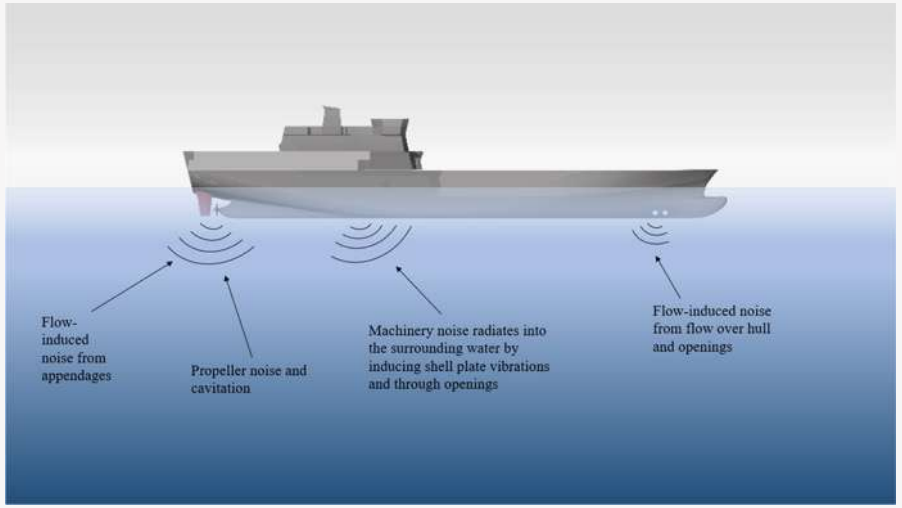
Localization

Recognition

The Challenges



$$SNR(dB) = SL - TL - (NL - AG)$$



A survey

Ocean Engineering 298 (2024) 117252

Contents lists available at ScienceDirect

Ocean Engineering

journal homepage: www.elsevier.com/locate/oceaneng

Review

A survey on machine learning in ship radiated noise

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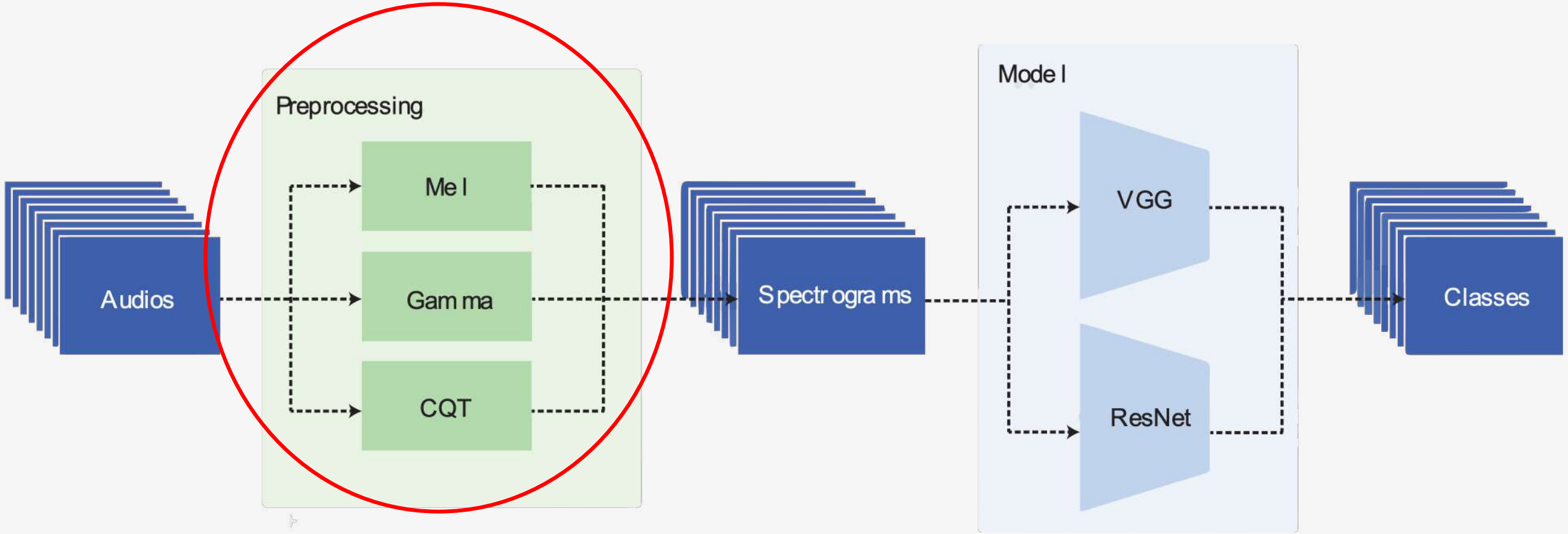
ARTICLE INFO

Keywords:
Ship radiated noise
Machine learning
Survey
Deep learning
Underwater sound

ABSTRACT

The utilization of machine learning in analyzing ship radiated noise (SR-N) is undergoing rapid evolution. Because the omnipresent background noise strongly depends on the highly variable environment, the application of such techniques poses challenges. Furthermore, publicly available labeled datasets are scarce. Motivated by this, there has been a surge in the number of publications regarding the implementation of machine learning in the monitoring of SR-N within the past few years. This comprehensive survey delineates the state-of-the-art machine learning techniques applied to SR-N, with a specific focus on passive measurements. Recent developments are categorized into several sub-areas, namely; publicly available datasets, data augmentation, signal denoising, feature extraction, detection, localization, and recognition of SR-N. Additionally, future research directions are explored.

The common pipeline: An example

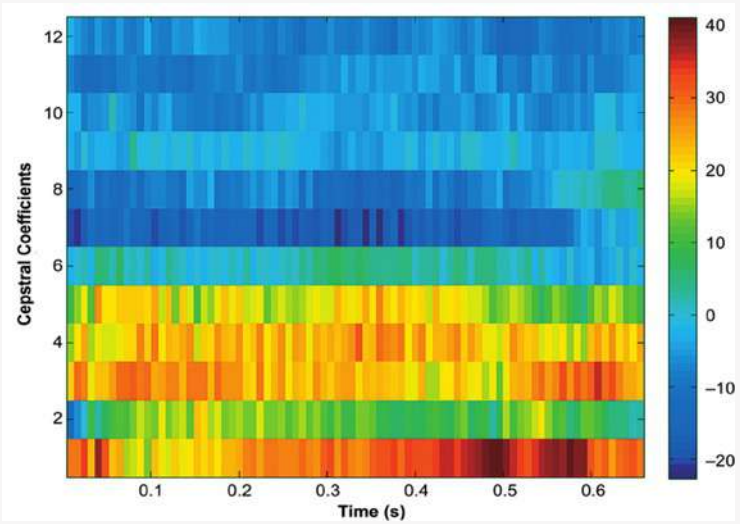


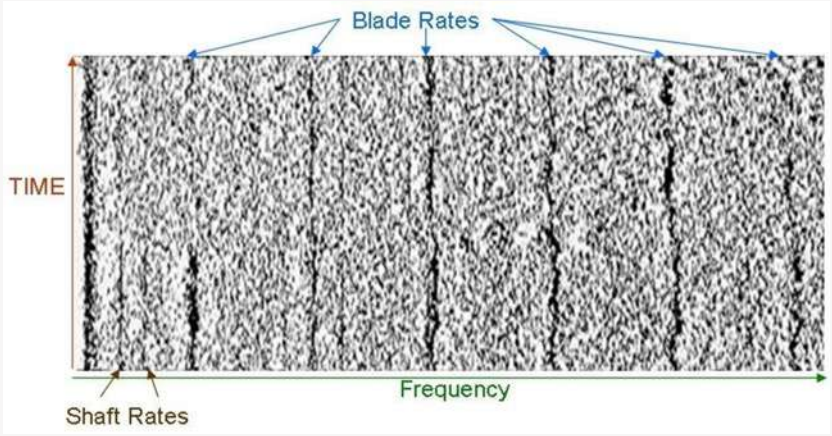
Domingos, Lucas CF, et al. "An investigation of preprocessing filters and deep learning methods for vessel type classification with underwater acoustic data." *IEEE Access* 10 (2022): 117582-117596.

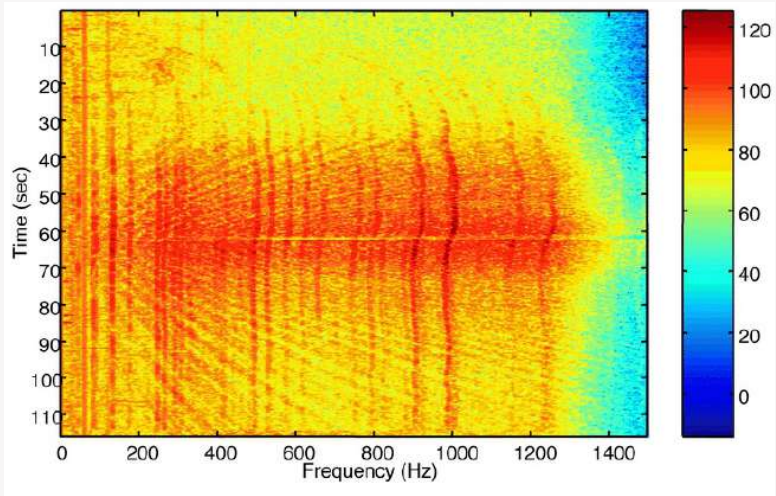
Preprocessing

Time Frequency Representations

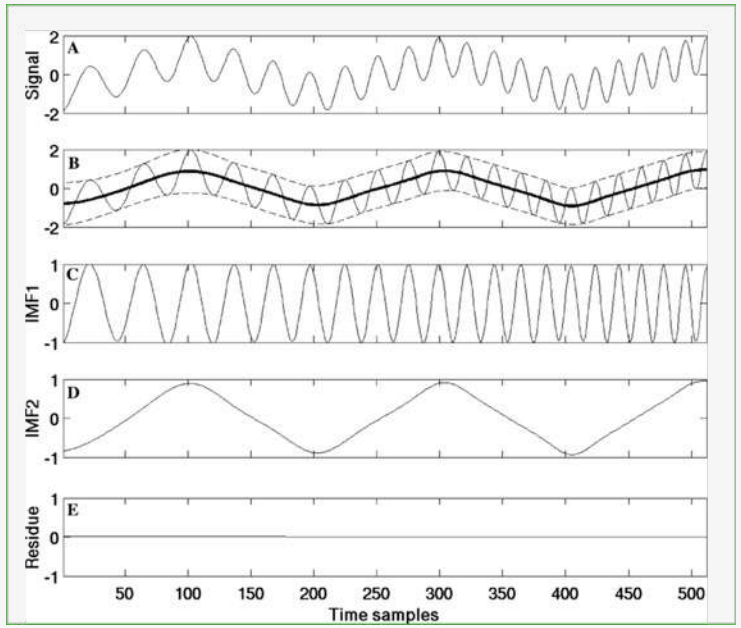
Speech-based



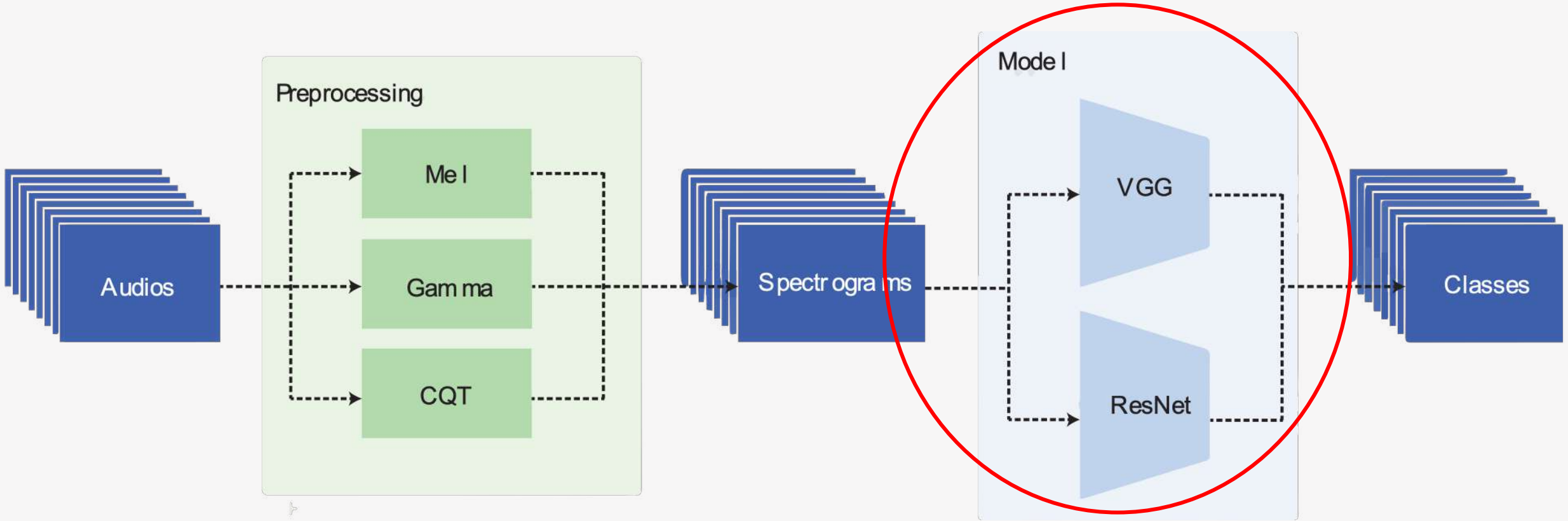




Decompositions



The common pipeline: An example



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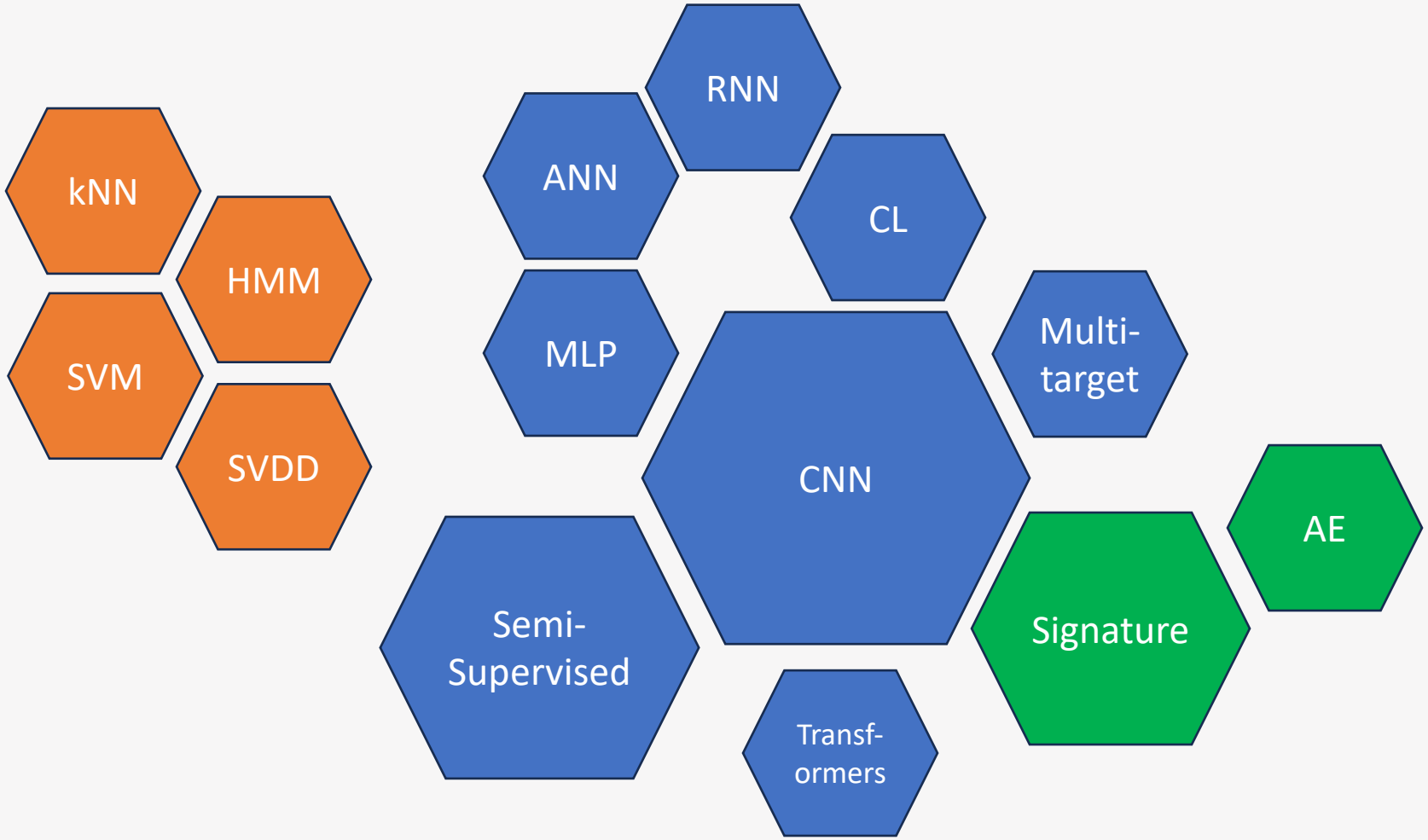
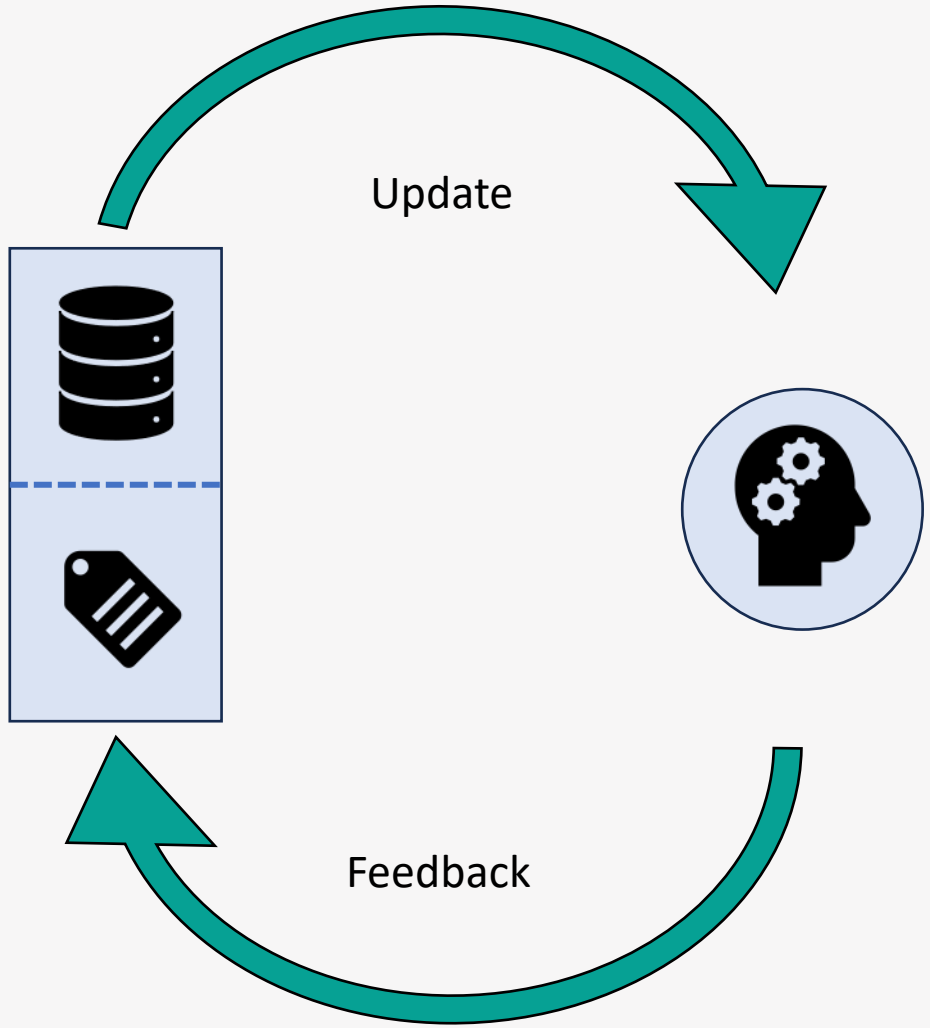
Model


kNN
HMM
SVM
SVDD
RNN
ANN
CL
MLP
Multi-
target
CNN
AE
Semi-
Supervised
Signature
Transf-
ormers

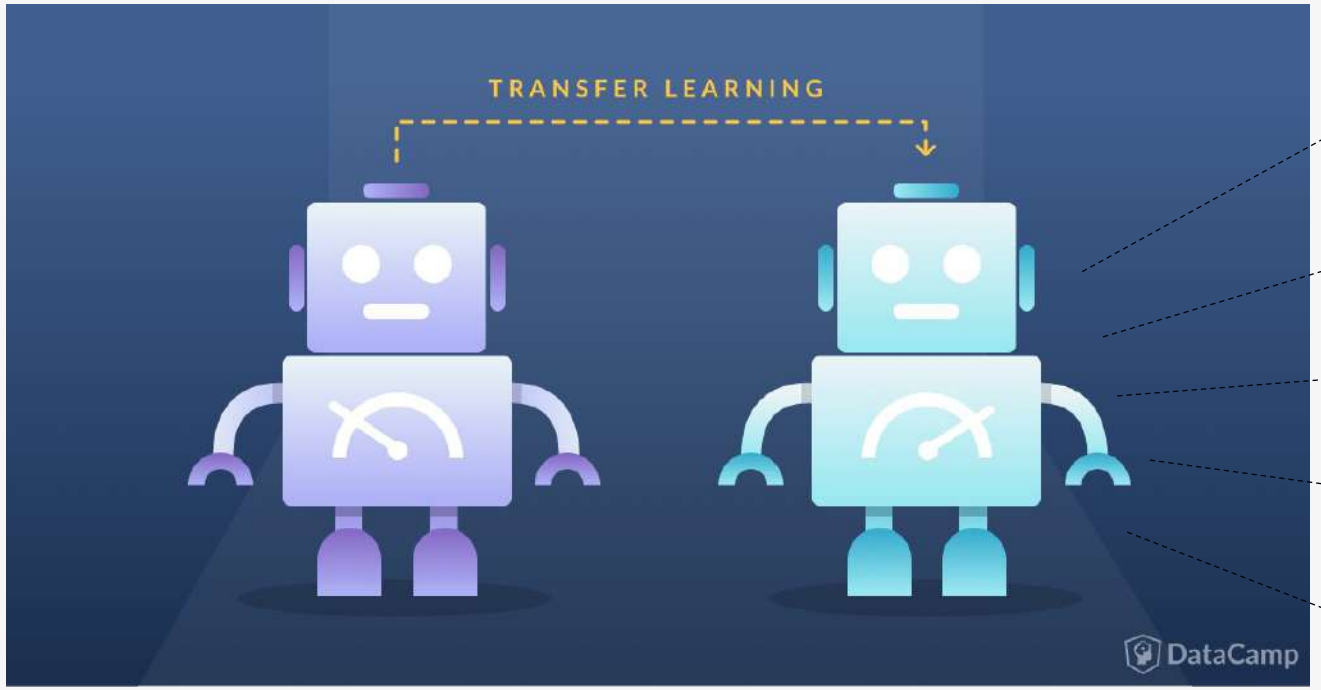
The need for data

- Supervised learning
  is the state-of-the-art method

- VGG16: 138 million parameters!!



A different view: The foundation model



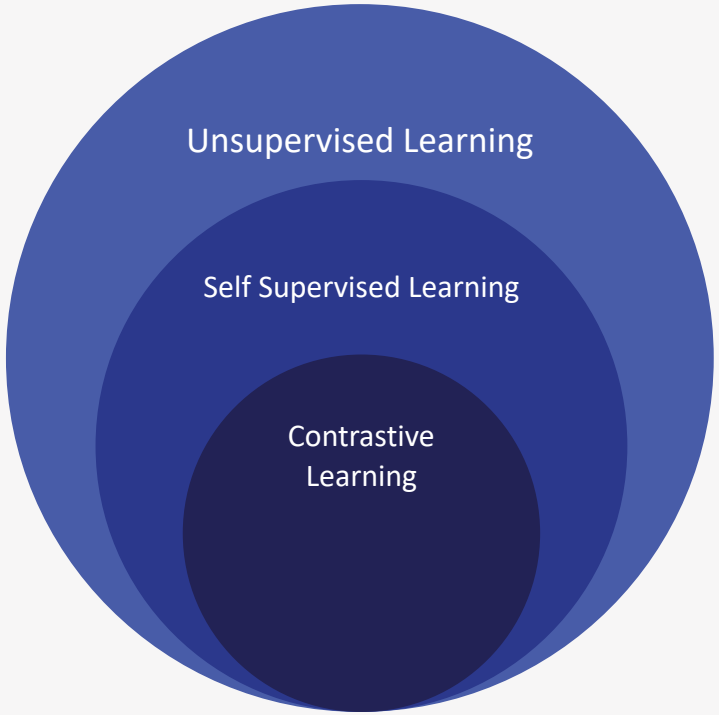
- Climate Change
- Earthquakes
- Nuclear Testing
- Marine Mammals
- Ships

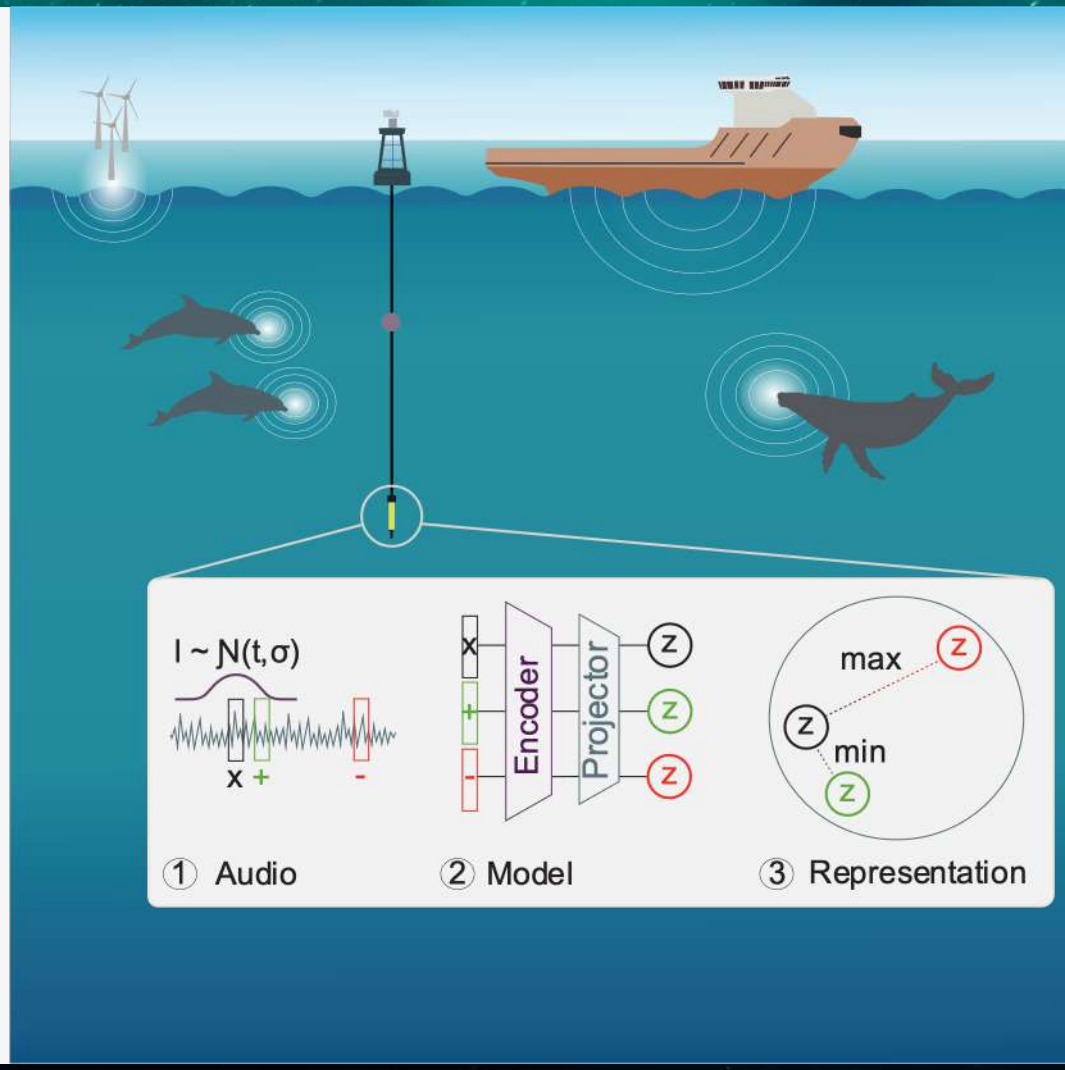
Ongoing research at CWI

Arwin Gansekoele

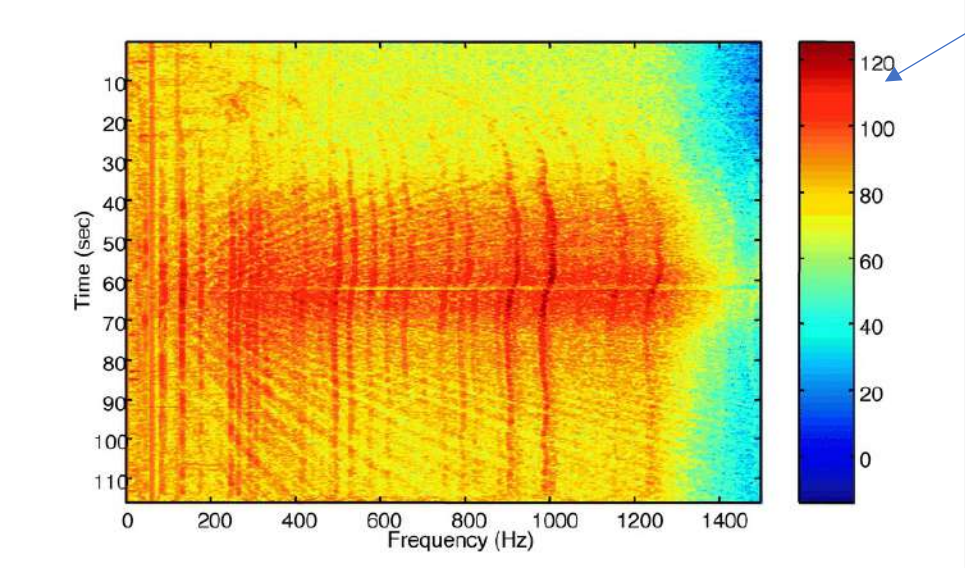
Rob van der Mei

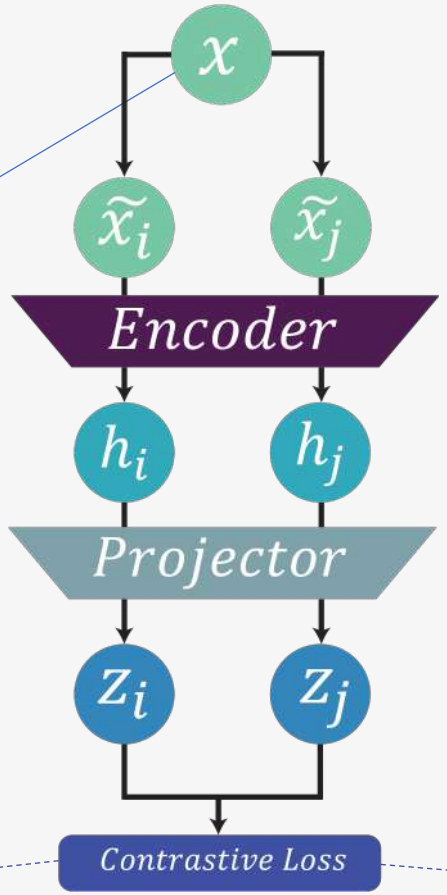
Sandjai Bhulai



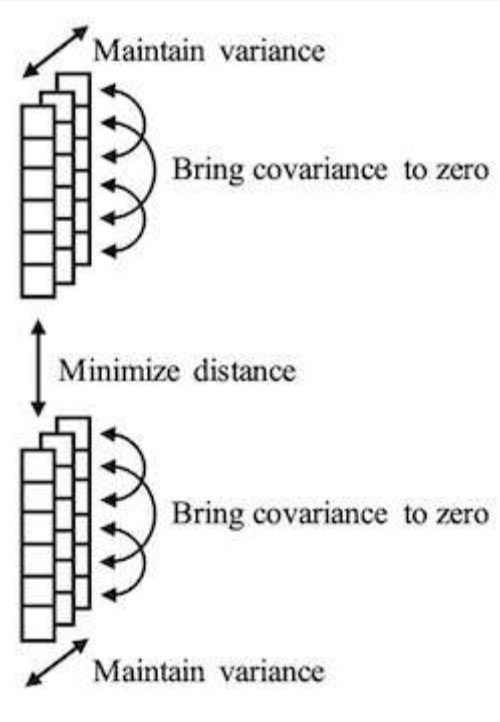


Ongoing research at CWI





VICReg



$$l(Z^I, Z^I) = \lambda s(Z, Z) + \mu[v(Z) + v(Z)] + \beta[c(Z) + c(Z)]$$

Questions, Insights, or Comments?

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