Applying ML Methods on Hydroacoustic Data for Fish Classification

STA490 Group 2
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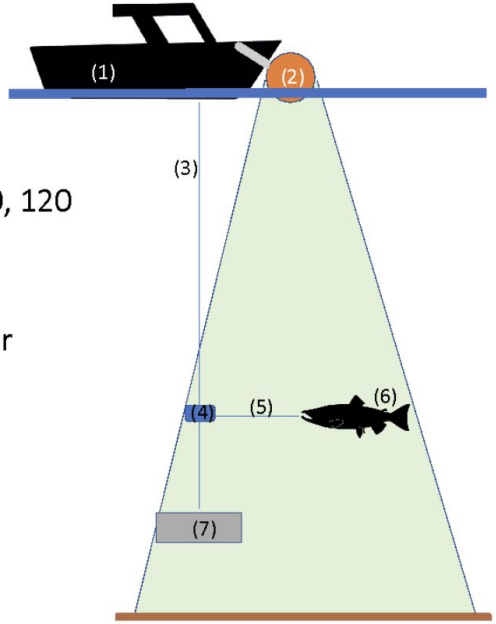
Research Question & Purpose

- **RQ: How to best classify fish species from hydroacoustic measurements using machine learning methods?**
- Classifying fish species in Ontario lakes using hydroacoustic data
- Invasive → Non-invasive
- Cost Effective

Data

Experimental Design

1. Acoustic workboat
2. Acoustic plate attached to boat w/ 70, 120 and 200kHz transducers
3. Main line, attached to downrigger
4. Drop-loop knot attached to fish tether
5. 1m long monofilament lead
6. Fish w. small ziptie to lower jaw
7. 2lb cannonball weight (at ~15-17m)



New Data Collection Method
- 249 target strength at each ping

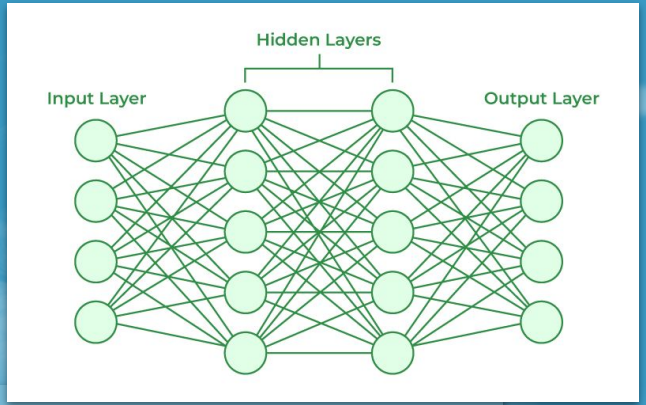
Binary Classification
- Lake Trout, Smallmouth Bass

Fish information
- e.g., species, sizes

Behaviour information
- e.g., angle, depth

Methods & Results

Why we use Neural Network?



- An artificial mathematical model
- Constitutes of **layers of neurons**, **activation functions** and **connections** between neurons in different layers
- Broadly used in **classification tasks** with optimal performance
- Adjust model behaviours by **changing weights of connections and tuning parameters**

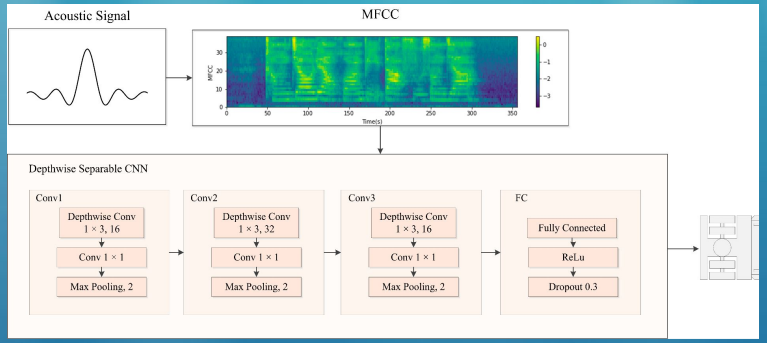
Methods & Results

1

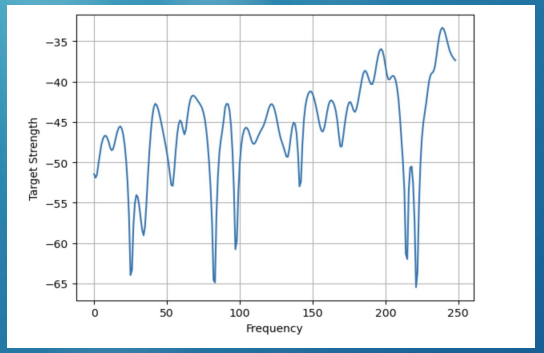
1D Convolutional Neural Network (CNN)

Model

1D CNN



Structure of a normal CNN



Plot of the 1D input

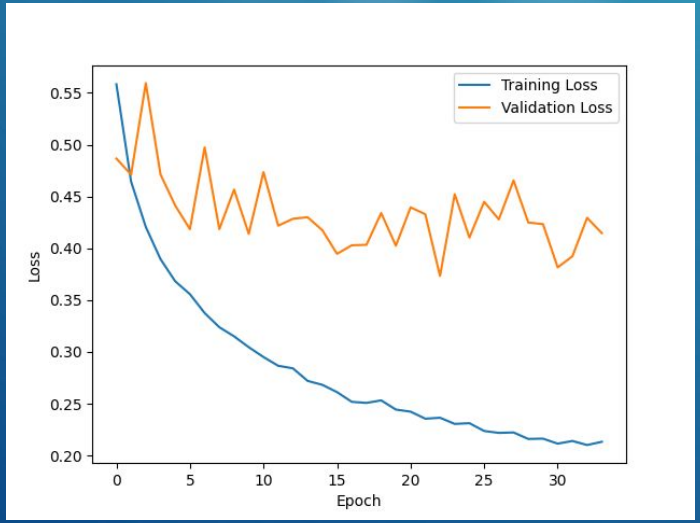
- **CNN:** A computer vision model that automatically learns the **spatial structures of features** from the input.
- We used **1D CNN**: each data point would be a 1D array for a given time ping, representing target strengths over a given range of frequency.

Why using 1D CNN?

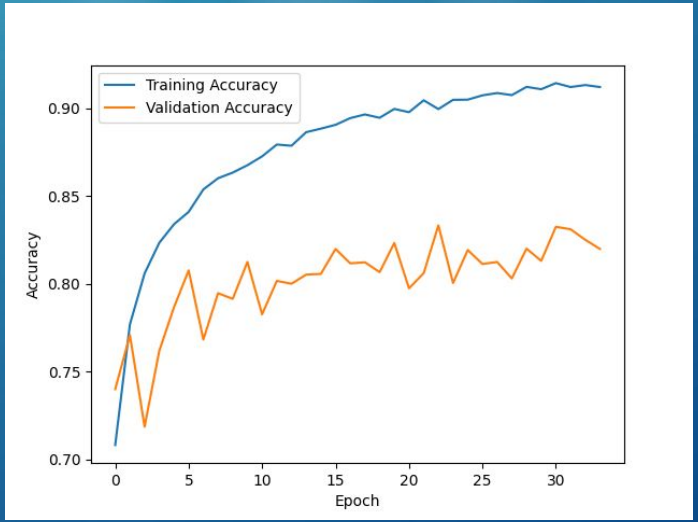
- Allows us to **directly use each row** in the dataset as input, **less computationally intensive.**
- **Interpretability:** identify **salient patterns of activations & range of frequencies** for different fish species

Results

Losses and Accuracy



Best validation loss:0.37329



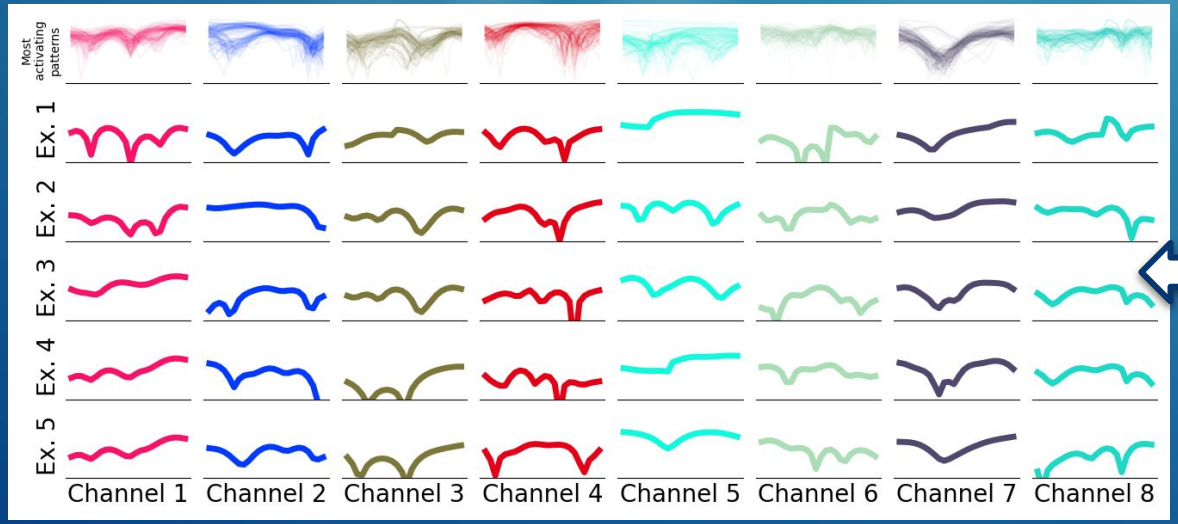
Best validation accuracy:0.83

By using the corresponding weights on test set, we obtained:

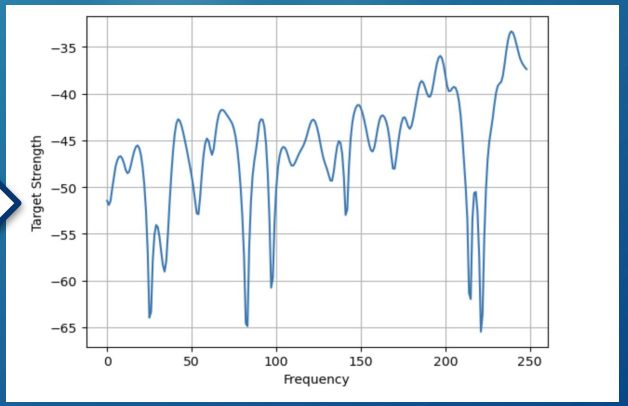
Test loss: 0.58981 Test accuracy: 0.82613 Test AUC 0.8746

Results

Explainability



Salient activation patterns

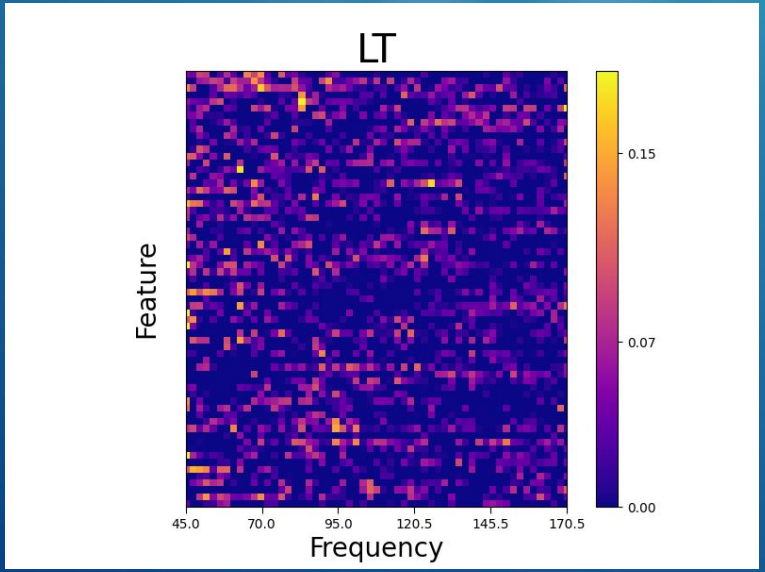


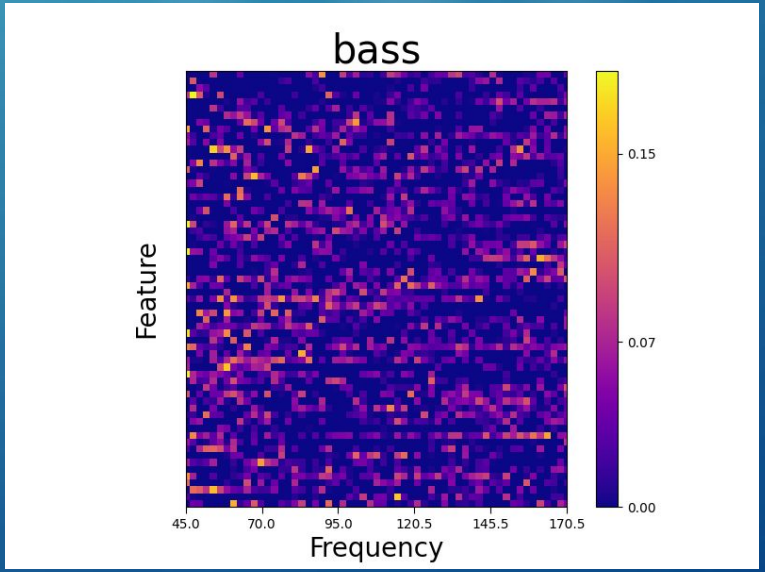
Plot of the 1D input

During prediction, the model assigns high activation when it detects these patterns over the frequency-response curve.

Results

Explainability





The classifier weights indicates **crucial regions** of the frequency-response curve.
Combined with the previous plot, we can identify **important frequencies along with the most activating pattern.**

Methods & Results

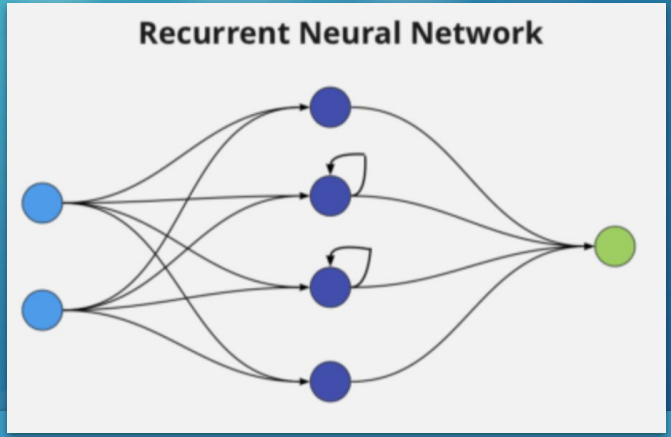
2

Recurrent Neural Network

Model

RNN

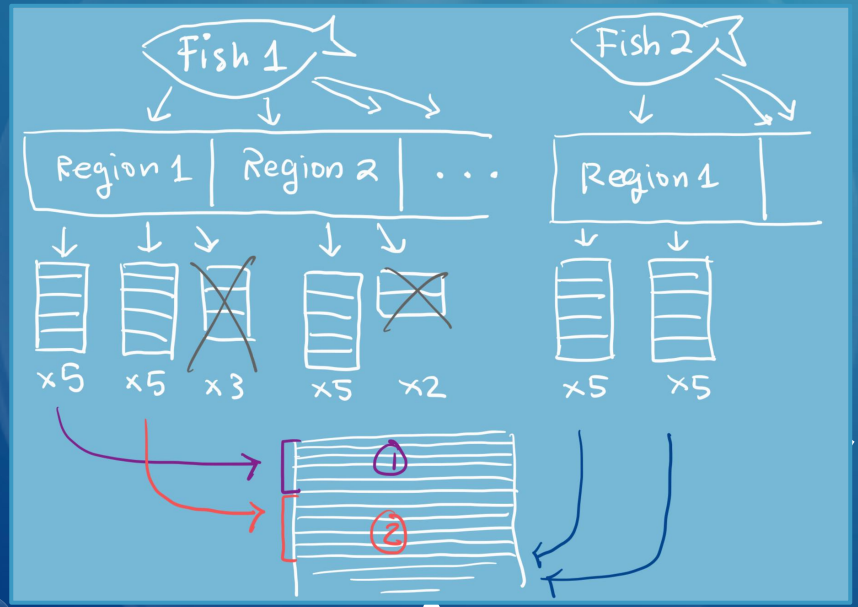
- **RNN:** a deep learning **feedback** model that employs **sequential** or **time series data** (Marhon et.al, 2013).
- Built-in memory allows retention of temporal information
- We created the input data by grouping observations into regions



Why using RNN?

- Suitable for the **sequential structure** of our input data
- Reveals **hierarchical structure** within each region.

Input & Outcome



Balanced Acc: 0.800
AUC: 0.935

1 LSTM layer
1 hidden dense layer

Methods & Results

3

ResNet

WHY RESIDUAL NETWORK?

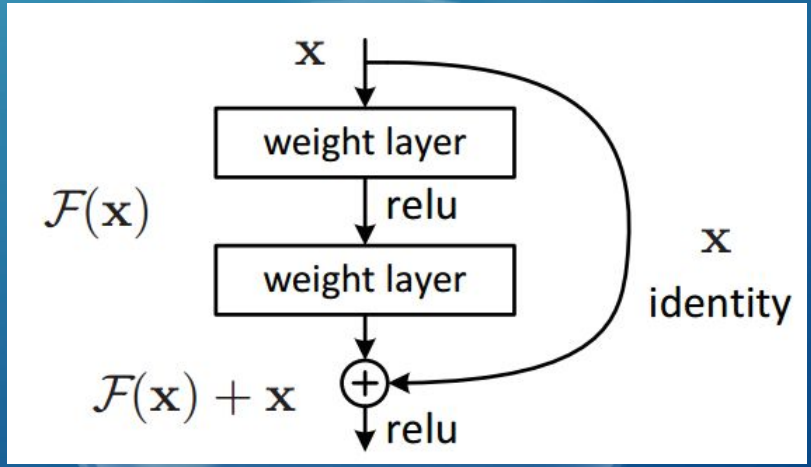
1. Resnet works the best with smaller datasets due to its ability to reduce the vanishing gradient effect

2. Resnet is also found to be more stable across different initializations and datasets compared to Fully connected Network

3. Resnet can be used on 1D array data where each time series is a frequency in our case.

MODEL : ResNet

- **Residual Network (Resnet)**: is a discriminative deep learning model learns the raw input of a time series and outputs a probability distribution.
- Apply custom ResNet designed for one-dimensional (1D) input data
- Incorporate traditional shortcut connections



Discussions

- **1D CNN**

  Identifies **salient patterns** in (Target Strength vs. Frequency) for different fish species.

  - However, 1D CNN does not account for hierarchical structures in our data.
- **RNN**

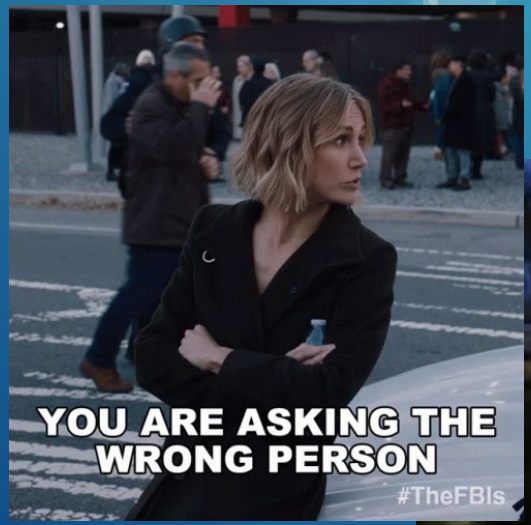
  Preserves information from individual fish, and accounts for the **hierarchical** data nature.

  - But, RNN is computationally slower and faces vanishing gradient problems.

- **ResNet**
  - Help to solve Vanishing Gradient Problem
  - Skip connections -> implemented between blocks

Next Steps

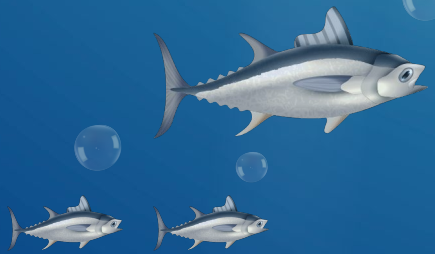
- We can further integrate ResNet onto RNN
- We can examine the feasibility and performance of Convolutional Recurrent Neural Network
- ... and potentially ResNet onto CRNN


YOU ARE ASKING THE WRONG PERSON
#TheFBIs


SOOOOO
ANY QUESTIONS???


LOS ANGELES
YOU HAVE TO ASK THEM

THANKS!



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