Extracting Absorption Coefficients from a Room Impulse Response using a Convolutional Neural Network with Domain Adaptation

Author: Ties Bloemen
t.t.j.bloemen@student.tudelft.nl

Supervisors: Jorge Martinez Castaneda, Dimme de Groot.

References are handed out during the presentation.

1) Introduction

The absorption coefficient of materials is hard to measure.

The current best simple estimator is the inverted Eyring's formula [1]:

$$\overline{\alpha}(f) = 1 - \exp\left(-0.163\frac{V}{ST_{60}(f)}\right) \quad (1)$$

Can a machine learning approach estimate the absorption coefficient better than the inverted Eyring's formula?

2) Background

- Augmented with data
- Using real datasets
- Frequency dependent
- Room impulse response or other

3) Methods

Preprocessing

- Resampled to 48 kHz
- Normalized amplitude
- Length set to 1 second

Loss functions

- DAREGRAM [2]
  - Domain adaptation
- MSE

Real data

- dEchorate [3]
- Omnidirectional
- Split into frequency bands and applied Eq (1)
- Average abs. coef. within acoustic setting

Simulated data

- Pyroomacoustics [4]
- Image source method [5]
- Reflection biased [6]
- Annotated materials dataset [7]
- Custom absorption profile
- Truncated normal distibution
- Comply with ISO3882:1 [8]

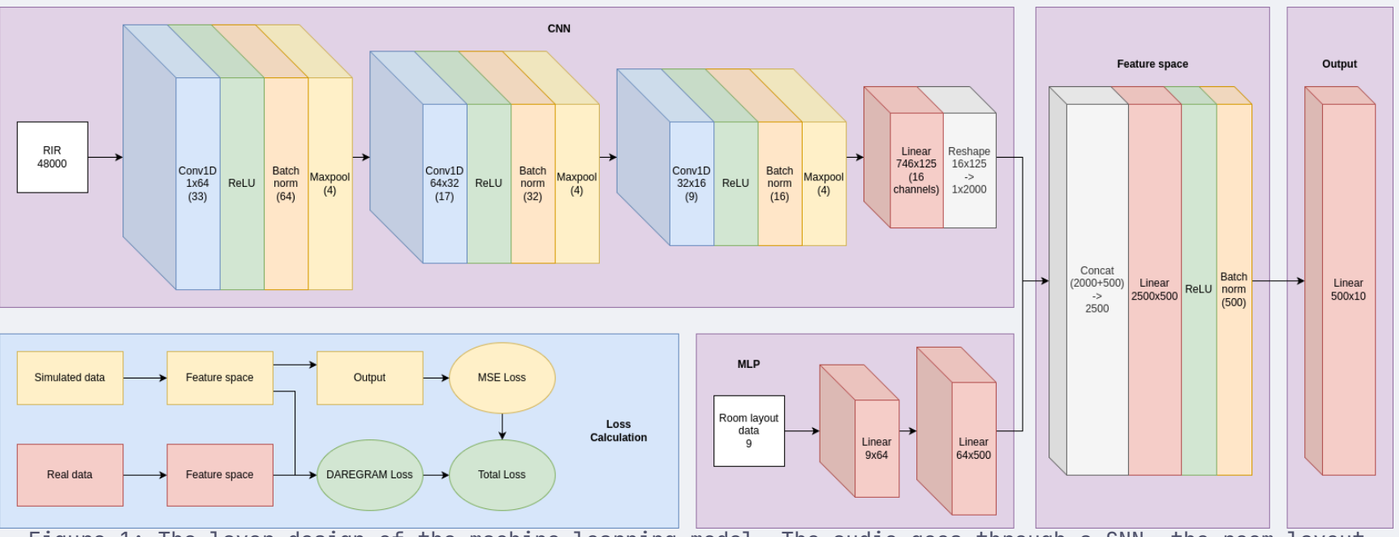

Figure 1: The layer design of the machine learning model. The audio goes through a CNN, the room layout data goes through a MLP. The loss calculation is added in the bottom left corner.

4) Results

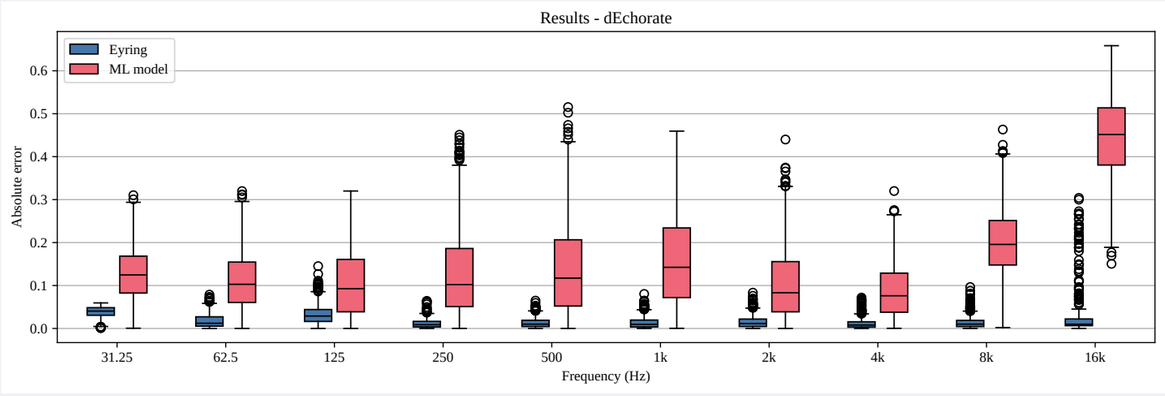

Figure #: The absolute error of the dEchorate dataset. It is plotted as a boxplot per octave band.

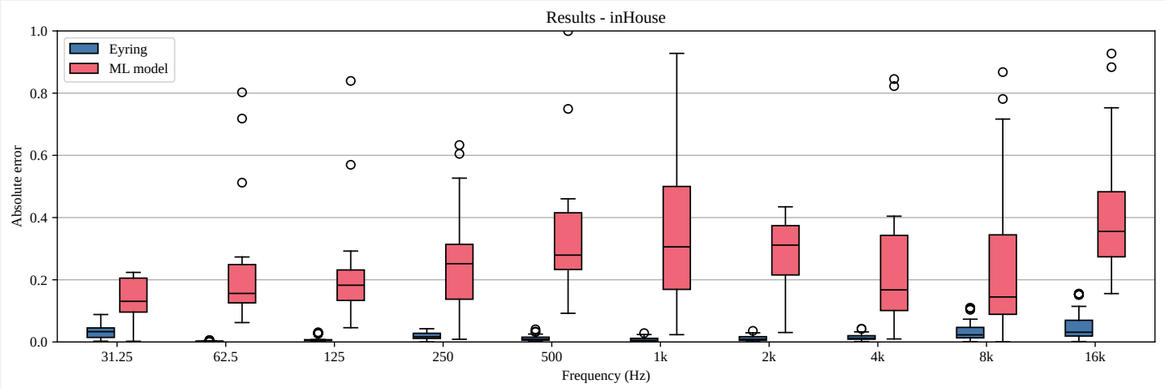

Figure #: The absolute error of the inHouse dataset. It is plotted as a boxplot per octave band.

5) Conclusions

The model performs significantly worse than the inverted Eyring's formula. Some causes could be:

- Amount of real datasets
- Realism of simulated data
- Distribution of decay times

6) Future work

- Trying different machine learning models
- Different auxiliary data
- Non-empty rooms
- Creating datasets of absorption coefficients in real rooms.
- Searching for optimal hyperparameters