

# AI Audio Enhancement Research

## Project Status & Future Roadmap

A comprehensive overview of our progress in digital audio processing and AI model development

# What is this project about

Can we use AI to upscale lossy audio files to near-lossless audio quality?

## Benefits:

- Reduce streaming bandwidth if native to streaming devices
- Optimize disk space for downloaded audio files
- Allow lossless streaming on Bluetooth devices
- Highly distributed IoT networks for audio processing

# Tools

## AI

- Model - 1D U-Net architecture
  - PyTorch for ML
- Hosted through Kaggle

## Audio Processing

- Librosa
  - Strong audio processing library for python

## What Went Well

### Deep Understanding of Digital Audio Processing

- Extensive research into **digital audio compression** techniques
- Comprehensive study of **digital audio conversion**
- Strong foundation in **lossy vs. lossless** audio format differences

### AI Model Development Progress

- Successfully initiated the **beginning stages** of our AI model
- Established baseline architecture for audio quality enhancement

# Challenges Encountered

## Dataset Limitations

- Lack of diverse datasets for comprehensive training
- Limited availability of high-quality audio samples

## AI Interpolation Training

- Current output of AI model needs refinement on interpolation methodology
- Use original lossless metadata for interpolation parameters

## Defintion upon definition

- The deeper you go the more definitions for more things you find

## Key Features:

- Audio quality visualization
- Comparative analysis between audio files
- AI upscaling output

# Future Plans & Roadmap

## AI Model Enhancement

- Create/find data sets
- Focus on improving model's ability to properly interpolate
- Optimize for native implementation on less powerful devices

## Streaming Simulation

- Create **mock streaming service** to simulate natural streaming conditions
- Create client that can playback all version of the audio, display graphs and also the metadata of files.

# Key Learnings & Technical Insights

## Digital Audio Processing Mastery

- Comprehensive understanding of **audio compression algorithms**
- In-depth knowledge of **perceptual audio coding**
- Expertise in **quality assessment methodologies**

## Research Methodology

- Systematic approach to AI model development
- Evidence-based evaluation of audio enhancement techniques
- Iterative improvement process for optimal results



# Sprint 1 overview

- Week 1: Defined **terminology** - began **audio evaluation**
- Week 2: **More terminology** - Continued evaluation - **audio I/O** - Began **AI model development**
- Week 3: ***Even more terminology*** - Meta-data handling. Differentiating data sets
- Week 4: **Surprise! more terminology** - Graph Construction/Modeling - **AI training**

## Next Steps & Immediate Actions

### Sprint 2

1. **Acquire additional datasets** from diverse sources
2. **Refine AI model architecture** to support advanced interpolation
3. Create **Mock streaming** frontend and backend

## Technical Implementation Overview

## Backend Architecture

- Audio file processing - chunking for streaming
- Python-based processing pipeline

## Analysis Components

- Audio preprocessing and normalization
- Spectrogram generation and analysis
- Quality metrics calculation and comparison

