**Analysis of Subjective and Objective Audio Quality Assessments**

**1. Introduction**

* **Objective:**  
  The project aimed to analyze the correlation between subjective MUSHRA test ratings and objective perceptual loss metrics.
* **Significance:**  
  Combining subjective and objective measures is crucial in audio quality assessment to provide a comprehensive understanding of how different audio environments affect perception.

**2. Methodology**

**2.1 Audio Data Preparation**

* **Selection of Audio Samples:**  
  Five dry audio samples with distinct spectral characteristics were selected, including Drum, Flute, Guitar, Piano, and Trumpet.
* **Creation of Audio Versions:**  
  Three versions of each audio sample were created, simulating different environments:
  + Small Office Environment
  + Opera Hall
  + Reverb Hall (with a reverberation time of at least 1.5 seconds)
* **Tools and Software:**
  + **Freesound.org:** For selecting audio samples.
  + **Audacity:** For applying environmental settings such as room size, pre-delay, reverberance, damping, tone low and high, wet gain, dry gain, and stereo width.

**2.2 Perceptual Loss Calculation**

* **Process:**
  + Audio files were loaded, and a psycho-acoustic pre-filter was applied to enhance perceptually important frequencies.
  + The Mean Squared Error (MSE) loss was calculated between the original and modified audios.
  + Perceptual loss was then derived from the MSE using the pre-filtered audio.

**2.3 webMUSHRA Setup**

* **Listening Test Methodology:**  
  The webMUSHRA tool, which employs the Multiple Stimuli with Hidden Reference and Anchor methodology, was developed for conducting subjective listening tests.
* **Configuration:**
  + The tool was configured using YAML files.
  + The original audio served as the hidden reference.
  + Participants used the interface to play each audio stimulus and provide ratings.

A screenshot of a computer

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**2.4 MUSHRA Listening Experiment**

* **Experiment Design:**  
  Participants were instructed to rate the audio samples on a scale from 0 to 100, where 0 is the least identical and 100 is the most identical to the reference. The ratings were recorded in a CSV file, including metadata such as demographics, stimuli, and trial IDs.

**3. Data Analysis**

* **Preprocessing:**  
  The rating stimuli were normalized to ensure consistency and matched with the conditions used in perceptual loss calculations.
* **Aggregation:**  
  The mean rating score was calculated by grouping instruments and conditions. The perceptual loss data was combined with the aggregated MUSHRA scores.
* **Outlier Detection:**  
  The Z-score method was used for detecting outliers with a threshold of 2.

**4. Results**

**4.1 Correlation Analysis**

* **Pearson Correlation:**  
  A linear relationship between perceptual loss and MUSHRA ratings was observed with a correlation coefficient of -0.5987 (p-value = 0.0086).
* **Spearman Rank Correlation:**  
  A monotonic relationship was noted with a correlation coefficient of -0.6622 (p-value = 0.0028).
* **Kendall Tau:**  
  An ordinal association was identified with a coefficient of -0.4665 (p-value = 0.0082).

**4.2 Visualization**

* **Graphs:**
  + Bar and line plot showcasing the mean MUSHRA ratings and perceptual loss for all conditions.

A graph with a line and a line

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* + Scatter plot comparing mean MUSHRA ratings against perceptual loss.

A graph with colored dots

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**4.3 Summary**

* The subjective ratings (MUSHRA) were inversely correlated with objective perceptual loss, suggesting that higher perceptual loss leads to lower MUSHRA ratings.
* The negative correlations across various statistical tests indicate significant findings supported by low p-values.

**5. Conclusion**

* **Findings:**  
  The study demonstrates a clear inverse correlation between subjective audio quality ratings and perceptual loss metrics. This highlights the importance of combining both subjective and objective measures in audio quality assessment.
* **Future Work:**  
  Future research could explore additional factors influencing subjective ratings and extend the study to larger datasets.