**Audio Analysis and Intelligence Integration Using ML & LLMs**

1. **Instrument Detection and Proportion Estimation**

This is an identification of music instruments in an audio recording and calculation of their relative percentages by machine learning models such as YAMNet. It is done through preprocessing (normalization, resampling), feature extraction (spectral, model embeddings), and classification to map audio segments into instrument classes. Results are given in JSON format, highlighting the percentage contribution of each instrument (e.g., guitar: 35%). The solution spans a broad variety of instruments, resolves overlapping sounds, and stores analysis automatically for future reuse. Methodology shown below,



**Fig.1** Methodology of Instrument Detection and Proportion Estimation

1. **Predicting Virality of the Song**

In this section, created an end-to-end song virality prediction system by resolving data quality problems, handling extreme class imbalance using strategic sampling, and feature engineering key audio features (mood score, energy-danceability interaction). Dataset using [[Spottify-1-Million-Track]](https://www.kaggle.com/datasets/amitanshjoshi/spotify-1million-tracks). In modeling, we crafted a bespoke ANN architecture with dropout and batch normalization optimized for recall on viral cases, which are few. Used SHAP/LIME for interpretability. The deployment itself entailed the development of a simple-to-use Gradio interface, feature mismatch resolution through training/inference pipeline alignment, and the incorporation of strong port handling. Simplifying the preprocessing pipeline, ensuring backward compatibility with dummy columns by being consistent in predictions while keeping explanations open using visualization tools, were some of the most important enhancements. This end-to-end solution brings data science to real-world use, offering accurate predictions as well as actionable intelligence for use in the music domain.



**Fig.1** Methodology of Predicting virality of song.