

Challenges Involved in Pandemic Prediction using Acoustic Epidemiology (Sound Analysis)

Audio Sound Acquisition

Diverse Audio Sound Sources

- Smart home devices (e.g., Alexa, Google Home, Lenovo Smart Display, Apple HomePod, etc.)
- Smart phone
- Smart watch
- Laptop/computers
- Smart earphones/headset
- Car voice control system
- Audio collecting apps (e.g., AI4COVID-19, Coughdetect, Healthmode, Virufy, etc.)
- Data repository (e.g., MySQL, SQL Server, MongoDB, Oracle, etc.)

Diverse File Formats

- File formats (WAV, MP3, M4A, AAC, etc.)
- Sampling rates (48kHz, 44.1kHz, 22.05kHz, 8kHz, etc.)
- Bit rates (320kbps, 192kbps, 128kbps, 96kbps, etc.)

Variance in Recording Devices

- Microphone self-noise diversity due to:
 - SINR
 - Encoding
 - Amplification
 - Compression

Audio Features Extraction

- Spectral entropy
- Spectral contrast
- Band power (BP)
- Tonal centroid features (tonnetz)
- Mel frequency cepstral coefficients (MFCCs)
- Root mean square energy
- Local Hu moments
- Maximum frequency (MaxF)
- Zero crossing rate
- Cochleagram
- Spectral bandwidth
- Wavelet transform
- Mel-spectrogram
- Spectral spread (SSp)
- Chroma energy normalized statistics
- Spectral roll off (SRO)
- Spectral asymmetric coefficient (SAC)
- Spectral slope (SSI)
- Spectral flux
- Spectral kurtosis coefficient (SKC)
- Chromagram STFT
- Constant-Q chromagram
- Spectral flatness (SF)
- Spectral centroid

AI Engine

Machine Learning Models

- K nearest neighbor (KNN)
- Support vector machine (SVM)
- Logistic regression (LR)
- Random forest (RF)
- Extreme gradient boosting (XGBoost)
- Naïve Bayes
- Principal component analysis (PCA)

Deep Learning Models

- Deep neural networks (DNNs)
- Convolutional neural networks (CNNs)
- Recurrent neural networks (RNNs)
- Autoencoders
- Generative adversarial Networks (GANs)

Ensemble Models

- CNN + SVM
- SVM + LR
- KNN + RF
- KNN + XGBoost
- CNN + XGBoost
- CNN + RNN

Preprocessing/Compensation

Environmental Noise Removal

- Spectral Gating
- Low/High/Bandpass filters
- Butterworth Filter
- Chebyshev Filter

Environmental Noise Robustness

- Time Stretch
- Pitch Shift

Data Enrichment

Machine Learning Based

- Transfer learning
- Generative adversarial networks (GANs)
- Deep neural networks (DNNs)

Analytical Methods Based

- Kriging
- Interpolation
- Matrix Completion