香港中文大學(深圳)
The Chinese University of Hong Kong, Shenzhen

SCHOOL OF DATA SCIENCE
數據科學學院

# Introduction of Sound, Speech, and Singing Voice

**Xueyao Zhang**

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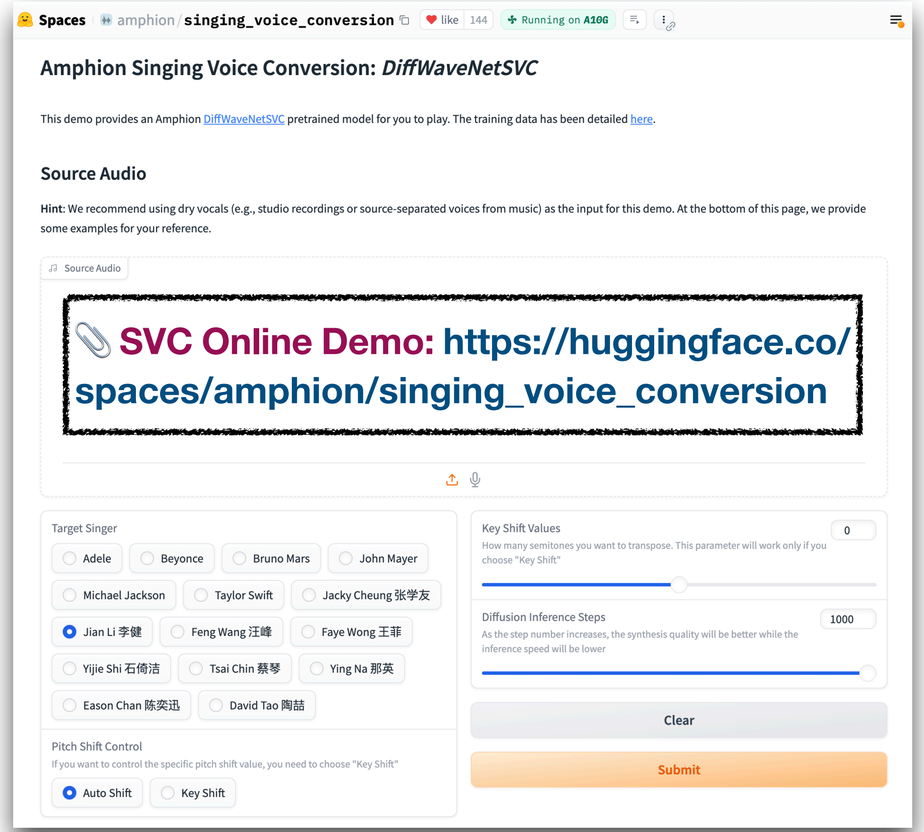
# About me

**Xueyao Zhang (张雪遥)**

- **Second-year PhD student**, Supervised by Prof Zhizheng Wu
  School of Data Science, CUHK-Shenzhen
  Homepage: https://www.zhangxueyao.com/

- **Amphion v0.1's co-founder**
  Project: https://github.com/open-mmlab/Amphion **(3.9k stars)**

- **Research interest: "AI + Music"**, especially on:
  - Singing Voice Processing
  - Music Generation




Let your favorite singer sing your favorite song!

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# How to create a sound using Python?

- CSC3160: Fundamentals of Speech and Language Processing
  - Lecture 2: Colab notebook

正弦波是一种周期性波动的数学模型，其公式通常写作：

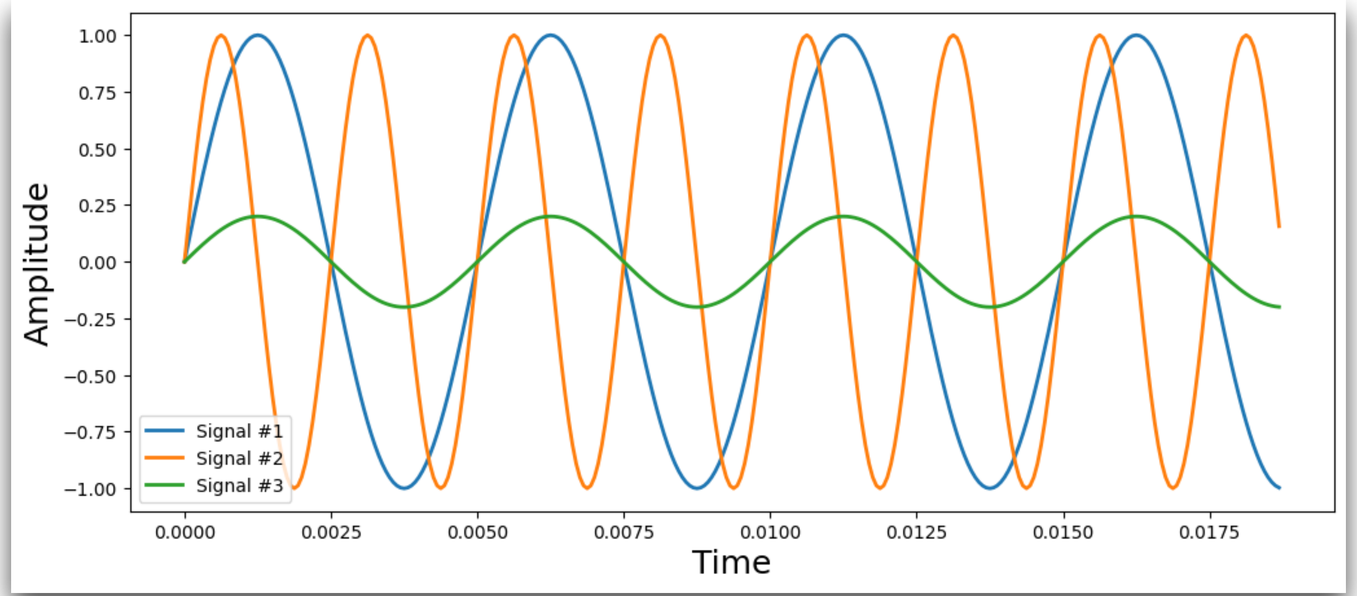
$$y(t) = A\sin(2\pi ft + \phi)$$

其中：

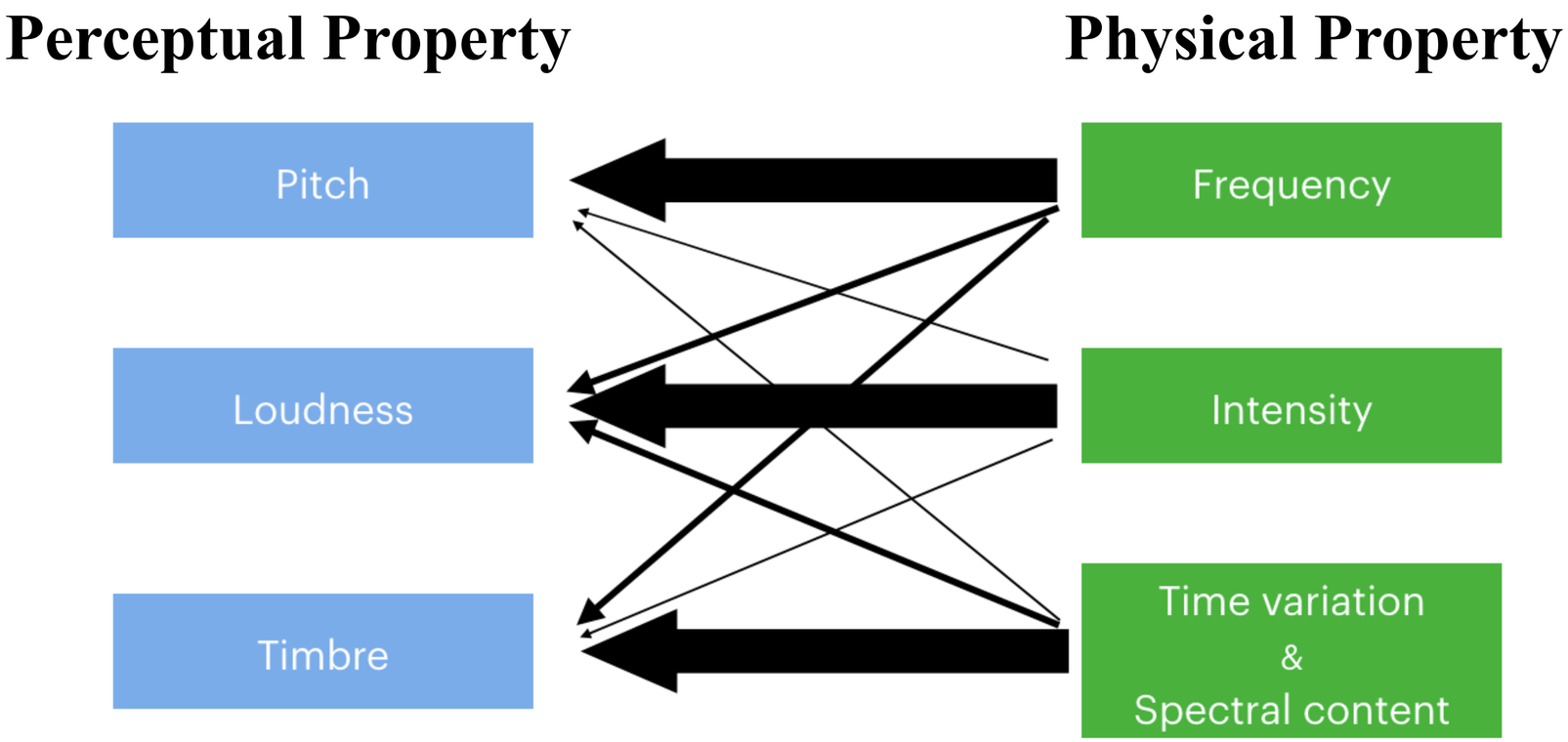
- $y(t)$ 表示时间 $t$ 时刻的波形值。
- $A$ 是波形的振幅，即波形的最大值和最小值之差的一半。
- $f$ 是频率，表示单位时间内波形重复的次数，单位是赫兹（Hz）。
- $t$ 是时间，通常以秒为单位。
- $\phi$ 是相位，表示波形在时间轴上的偏移量，单位是度或弧度。

正弦波在物理学中非常重要，它可以用来描述许多自然现象，如声波、电磁波、机械振动等。

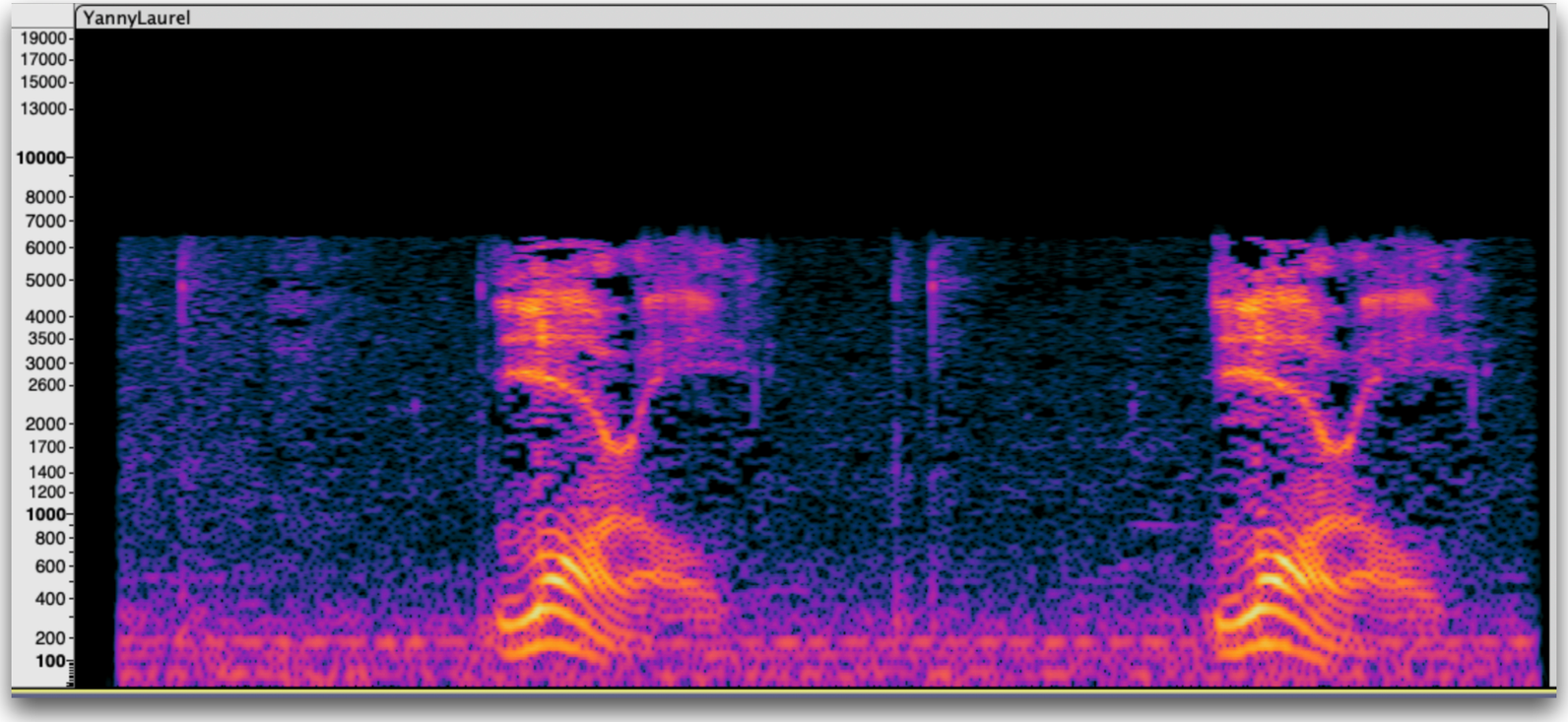
```
# Time points
time = np.arange(beginTime, endTime, samplingInterval);

# Create three sine waves
signal1 =     np.sin(2*np.pi*signal1Frequency*time)
signal2 =     np.sin(2*np.pi*signal1Frequency*2*time)
signal3 = 0.2*np.sin(2*np.pi*signal1Frequency*time)
```



# Three elements of sound: Pitch, Loudness, and Timbre



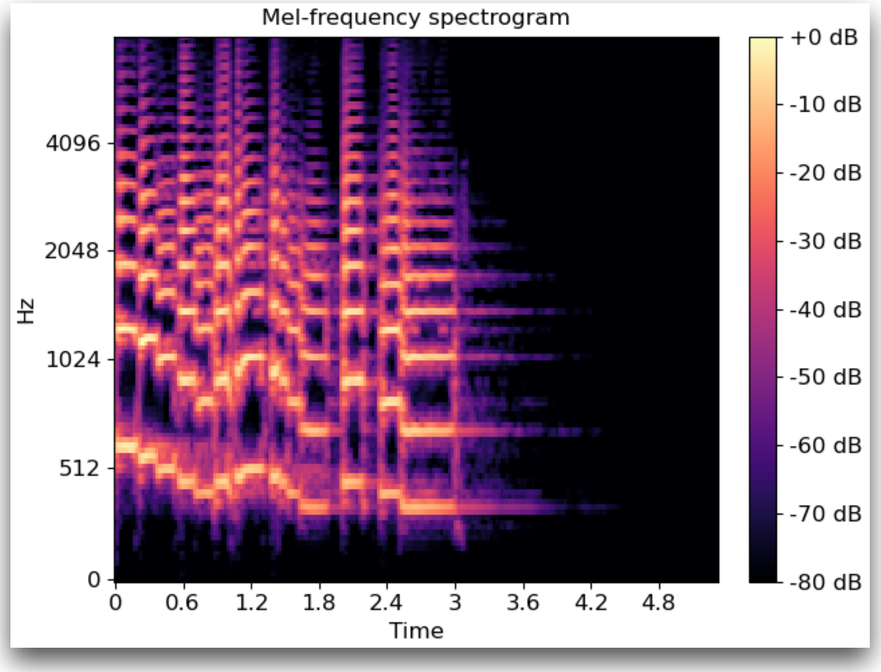
# Perceptual Property: “Yanny” or “Laurel”?



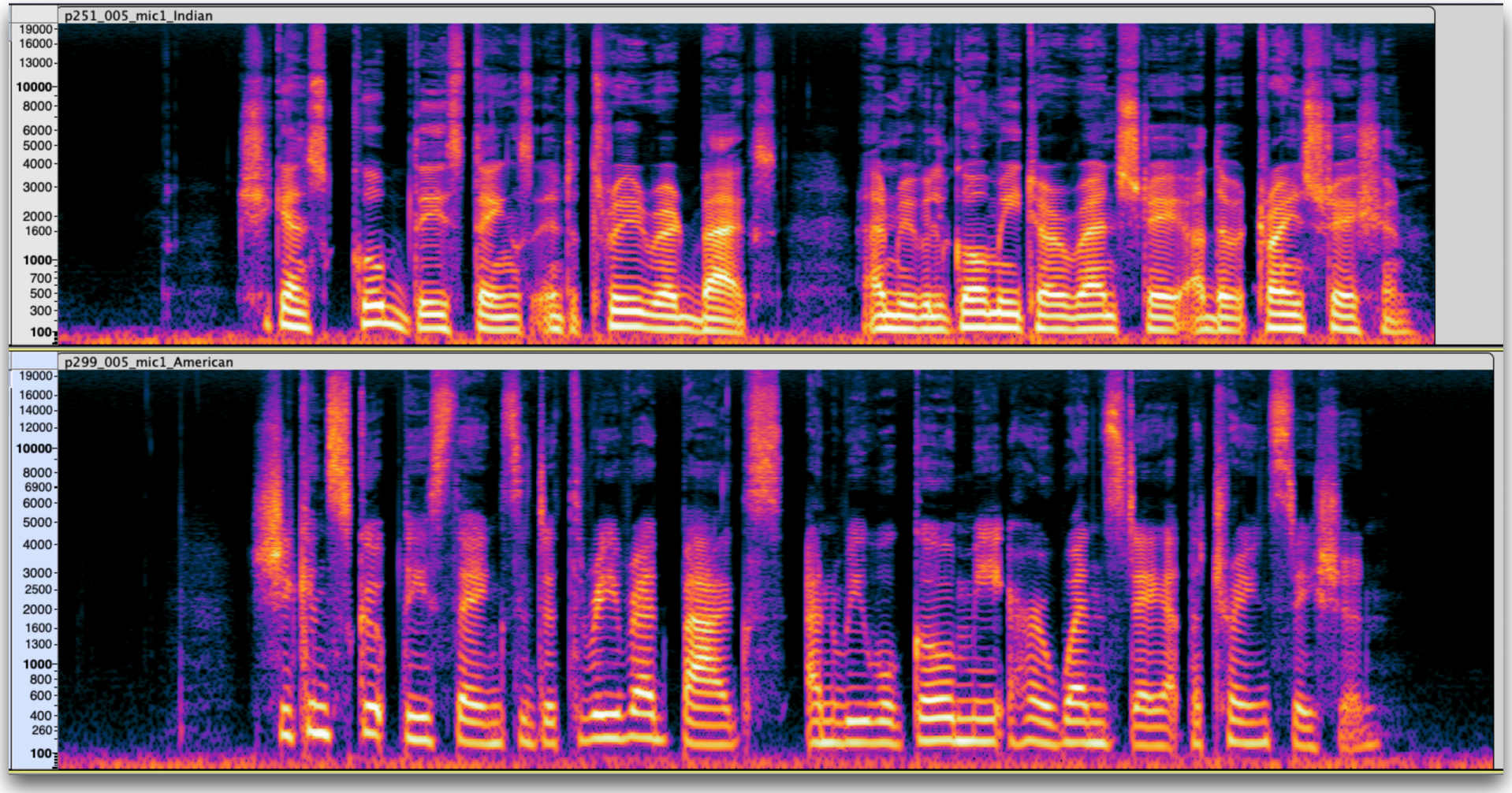

“Yanny” or “Laurel”?

# Spectrogram: Visualization of Sound

- Librosa
  - librosa.feature.melspectrogram

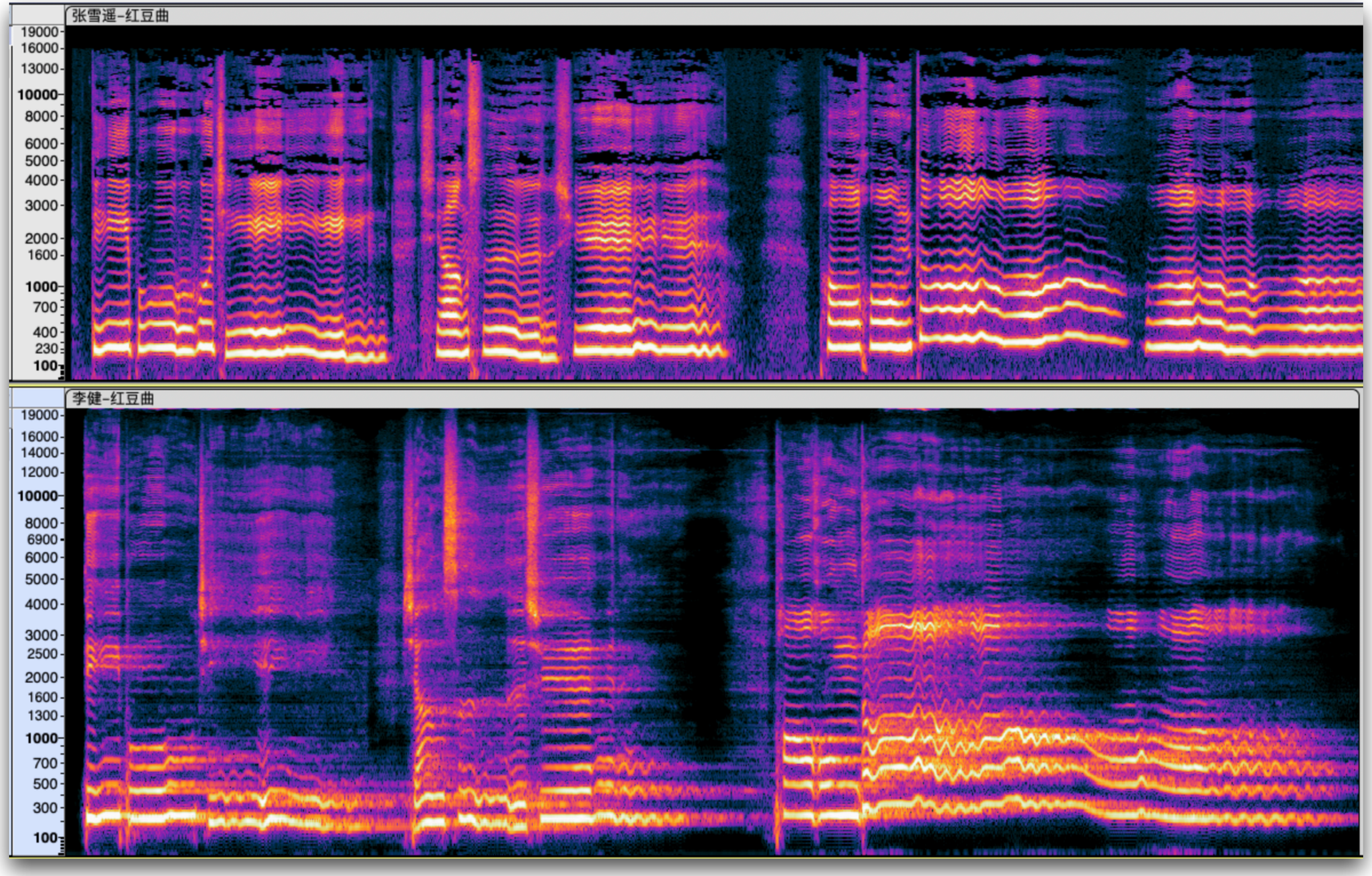


# Speech — Sound that owns semantic information




**A same utterance spoken by different people in different accents**

# Singing Voice — A More Beautiful Speech




**Xueyao**

**Li Jian**

# Magic of Singing Voice Conversion

| | Source | Conversion Results [1] | Ground Truth |
|---|---|---|---|
| 韩红 to 李健 | | | |
| 齐秦 to 李健 | | | |
| 张学友 to 李健 | | | - |
| 林志炫 to 李健 | | | - |
| 陶喆 to 李健 | | | - |

| Source | Reference | Results |
|---|---|---|
| 李健《异乡人》 | Xueyao | |
| | Peking Opera Performer | |
| Peking Opera《苏三起解》 | Xueyao | |

[1] **Xueyao Zhang**, et al. Leveraging Content-based Features from Multiple Acoustic Models for Singing Voice Conversion. Machine Learning for Audio Workshop, NeuIPS 2023.

# THANKS