Agency for Science, Technology and Research
SINGAPORE

Evaluation on Audio-LLMs and Beyond

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Mar. 7, 2025

Event: Lorong AI

Address: WeWork @ 22 Cross Street, Singapore 048421, Level 3, Event Space

LLM - Can do a lot of things in just One Model

- LLM solves problems by following human instructions
  - Why does the sky appear blue during the day? -> QA
  - Summarize the following article in one paragraph. -> Summarization
  - What is the sentiment of the above sentence? -> Sentiment Analysis
  - Write a Python function that returns the factorial of a number. -> Coding

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But before this LLM era, we usually need one model for one task.

What is next? One model for all tasks? An intelligent agent?

An intelligent system takes all the surrounding information, E.g. as humans

- Information
  - Textual data
  - Audio and speech
  - Image and video
  - Sensor data
  - Numerical or structured data
  - Location and geospatial data
  - Knowledge, reasoning, and others

Towards AGI –
Artificial General Intelligence

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Towards AGI –
Artificial General Intelligence

- Our Focus: AudioLLM: Audio-based Large Language Models

Agenda

- What is AudioLLM? (in comparison with previous speech models)
- Design of new evaluation methods.
- AudioBench: A Universal Benchmark for Audio Large Language Models – NAACL 2025
- What is next?

From 1990s - Now

Conventional Audio / Speech Solutions

"One task - one model" paradigm

- Automatic Speech Recognition – Whisper, Conformer, Wav2Vec 2.0
- Speech Translation – Whisper, SeamlessM4T, Translatotron 2
- Audio Captioning – CLAP, PANNs, AudioCLIP
- Sentiment Recognition – EmoReact, emotion2vec

Characteristics:

- Usually supervised learning
- Predefined prediction space

From 2023 - Now

AudioLLM – One Model for all audio/speech understanding tasks

Audio + Human Instruction = Answer

Audio LLM

The man is laughing because xx. /
It was xx's speech given in 1989. /
…

Why there is a man laughing? /
When and where was this speech given? /
Can you help me transcribe the speech? /
Is it an indoor or outdoor environment? / …

Characteristics:

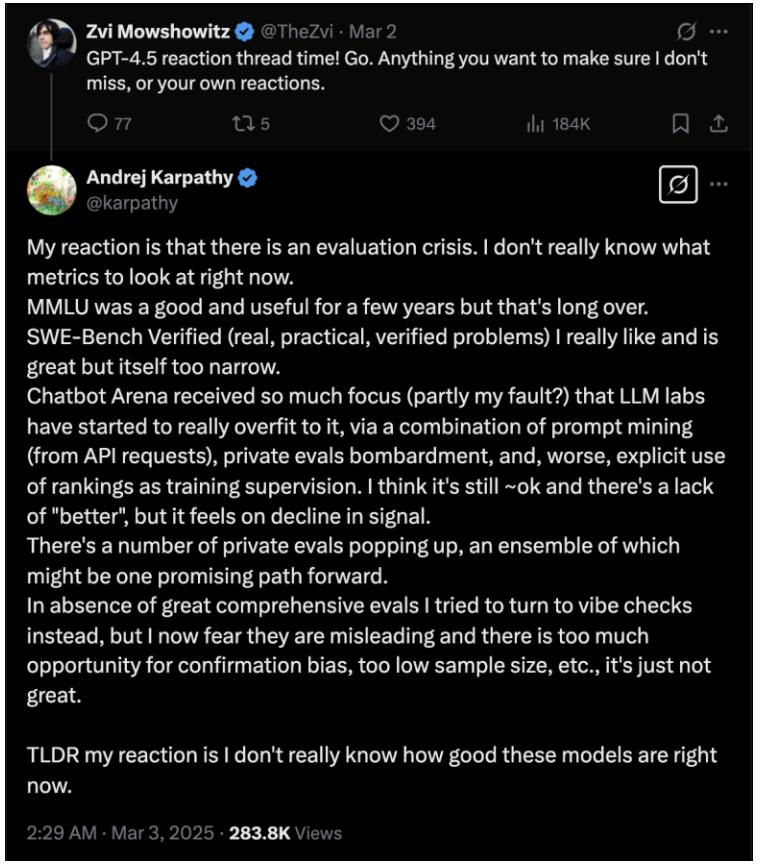
- Complete the task by following human instructions
- Can generalize to zero-shot / unsupervised scenarios
- Response in human language

Before Model Development: Evaluation

- We need the performance measure.
  - To know what is the ideal case.
  - To monitor the progress of model training.
  - To compare models and methods.
  - …

How do researcher evaluate LLMs?

- Multiple choices questions
  - Unnatural for its common use cases
- Open-ended questions
  - How can we judge answer A is better than B?
- Human rating
  - Troublesome, no immediate feedback



Comments from X.com for GPT4.5 Release
March 3, 2025
TLDR: It is hard.

How do researcher evaluate AudioLLMs?

- Status: No unified paradigm yet.
- The new evaluation should incorporate the major paradigm shift.
  1. One model that handles (any) audio/speech tasks
  2. Complete task by human instructions
  3. Open-ended answer generation

How do researcher evaluate AudioLLMs?

- Status: No unified paradigm yet.
- The new evaluation should incorporate the major paradigm shift.
  1. One model that handles (any) audio/speech tasks → The more, the better
  2. Complete task by human instructions → Instruction following measurement
  3. Open-ended answer generation → Judgement by LLMs with/without references

AudioBench: A Universal Benchmark for AudioLLMs

- Task categories: Speech Understanding, Audio-Scene Understanding, Voice Understanding (Paralinguistic), Music Understanding, Singlish Understanding, ...

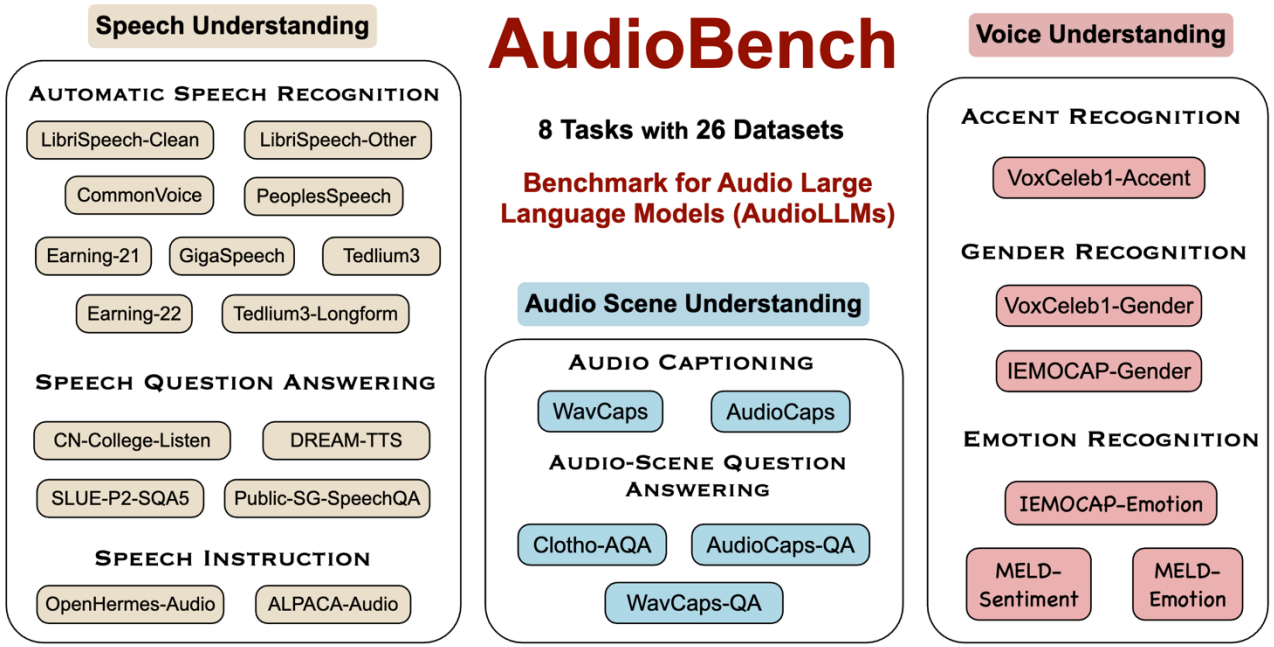
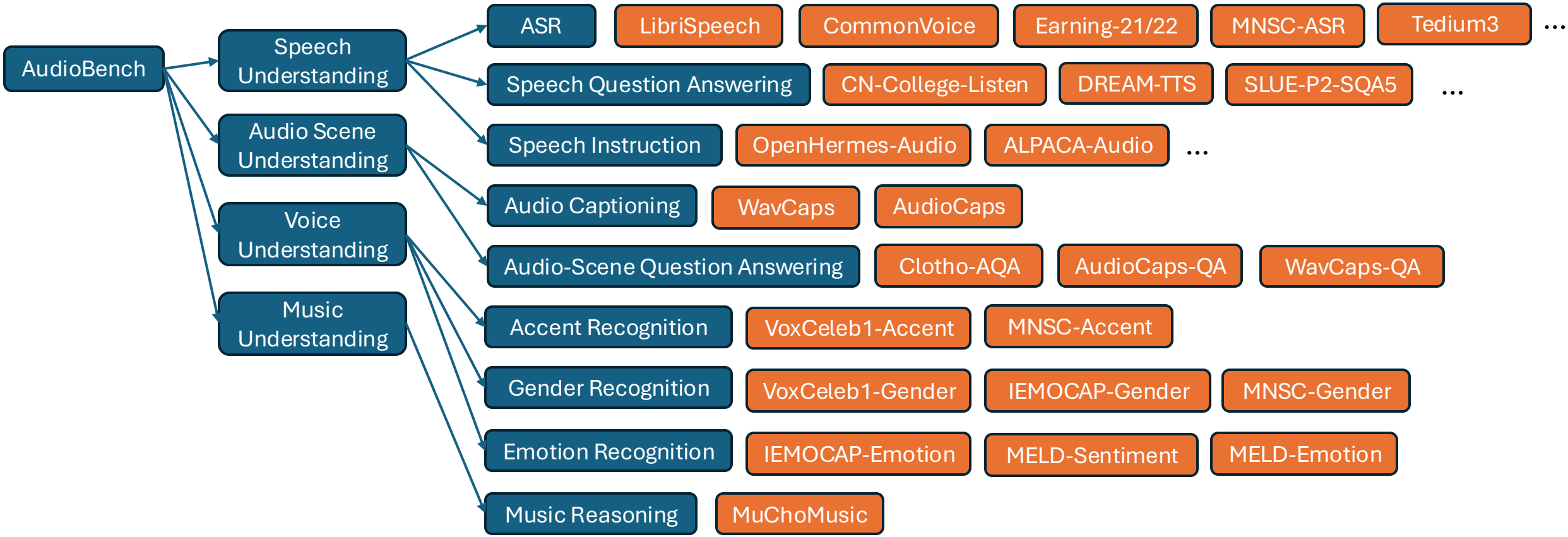


Figure 1: Overview of **AudioBench** datasets.

AudioBench

- Collections of Evaluation Tasks



AudioBench

- Evaluation Measurement
  - ASR – Word Error Rate
  - Speech Translation – BLEU score
  - Speech QA? -> Model-as-a-judge (LLAMA-3-70B-Instruct)

What emotions do you detect in the speaker's voice (frustration, anger, excited, neutral, happiness, surprise, sad)?

AudioLLM (SALMONN)

Model Answer:
The speaker is expressing frustration and anger in their speech.

Reference Answer:
Based on the speaker's speech patterns, it seems like they are feeling anger.

Judgement LLM Model

Judgement model:
Explanation: The reference answer is "anger", while the model's answer is "frustration and anger". I think the model's answer is accurate and relevant to the reference, as it not only mentions anger but also adds frustration, which is a closely related emotion.
Rating: 1

AudioBench

- Evaluation of AudioLLMs and Cascade Models

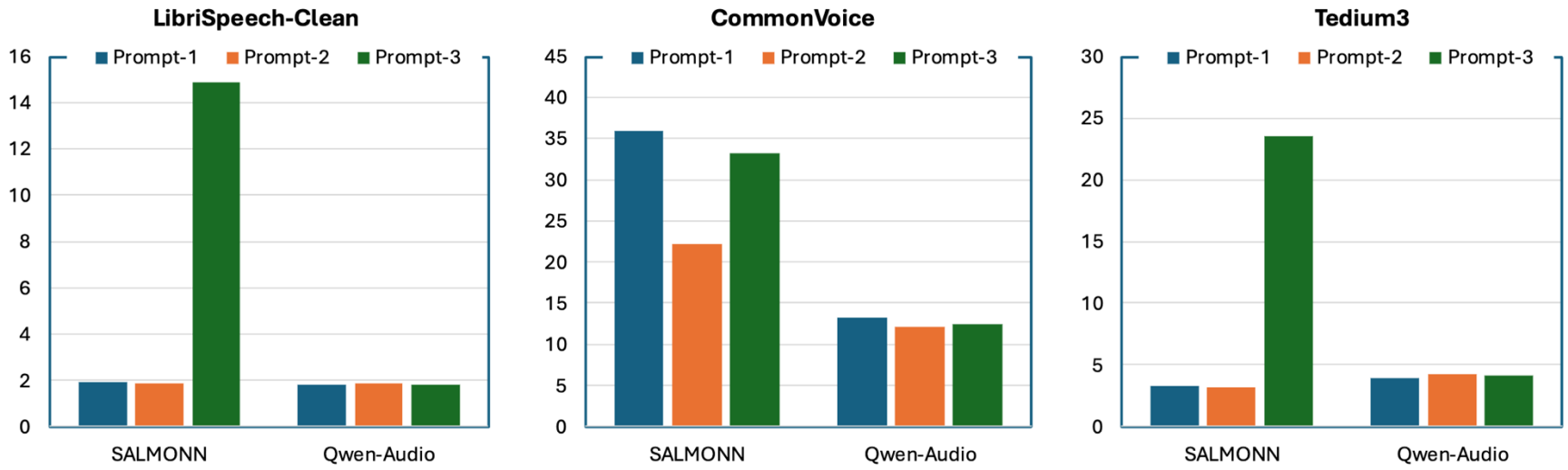
Dataset Name	AudioLLMs				Whisper+Llama3
	SALMONN	Qwen-Audio-Chat	WavLLM	Qwen2-Audio-Instruct	
Speech Understanding					
LibriSpeech-Clean$_{(\downarrow)}$	55.58	2.25	**2.10**	3.20	1.83
LibriSpeech-Other$_{(\downarrow)}$	41.80	**4.16**	4.80	6.07	3.71
CommonVoice-15$_{(\downarrow)}$	33.75	11.65	14.53	**11.44**	9.89
PeoplesSpeech$_{(\downarrow)}$	34.33	30.72	37.92	**22.32**	14.54
GigaSpeech$_{(\downarrow)}$	14.22	13.32	15.49	**11.89**	9.51
Tedlium3$_{(\downarrow)}$	8.56	**4.00**	6.62	6.39	3.81
Tedlium3-Longform$_{(\downarrow)}$	**18.39**	45.29	45.37	95.35	4.75
Earning-21$_{(\downarrow)}$	**26.87**	38.46	64.47	98.65	11.77
Earning-22$_{(\downarrow)}$	**36.38**	51.18	66.72	98.84	15.61
CN-College-Listen	50.51	60.85	65.43	**74.50**	85.25
SLUE-P2-SQA5	78.24	76.12	**83.92**	80.05	82.99
DREAM-TTS	55.93	57.76	64.56	**66.70**	86.09
Public-SG-SpeechQA	56.77	57.47	**58.55**	58.31	64.94
OpenHermes-Audio	19.20	11.00	22.40	**44.80**	63.0
ALPACA-Audio	12.40	9.60	21.60	**52.60**	70.8
Audio Scene Understanding					
Clotho-AQA	51.18	**58.20**	43.01	50.92	29.47
WavCaps-QA	**46.25**	38.68	26.25	44.47	17.38
AudioCaps-QA	47.03	**47.99**	29.84	45.75	16.71
WavCaps$_{(\text{M.J.})}$	21.16	29.25	6.40	**33.78**	3.45
AudioCaps$_{(\text{M.J.})}$	34.37	**47.99**	4.17	40.78	2.47
WavCaps$_{(\text{METEOR})}$	17.72	**24.02**	9.78	21.34	13.89
AudioCaps$_{(\text{METEOR})}$	21.20	**27.70**	6.70	19.89	7.95
Voice Understanding					
IEMOCAP-Emotion	21.56	27.34	45.91	**49.30**	34.43
MELD-Emotion	33.06	**50.57**	41.07	40.54	33.36
MELD-Sentiment	41.87	43.87	50.08	**53.49**	43.87
VoxCeleb1-Accent	28.06	**45.70**	37.65	29.19	39.33
VoxCeleb1-Gender	88.90	70.56	70.51	**99.12**	53.41
IEMOCAP-Gender	**51.60**	51.13	45.29	49.30	51.50

AudioBench

- What about diverse prompts?

E.g. ASR Instructions

- "Please help me transcribe the speech into text.",
- "Transcribe the spoken words into written form.",
- "Listen to the speech and provide the text version.",
- "Transform the speech into a text document as transcriptions.",
- ...



Most recent models are becoming robust towards diverse prompts.

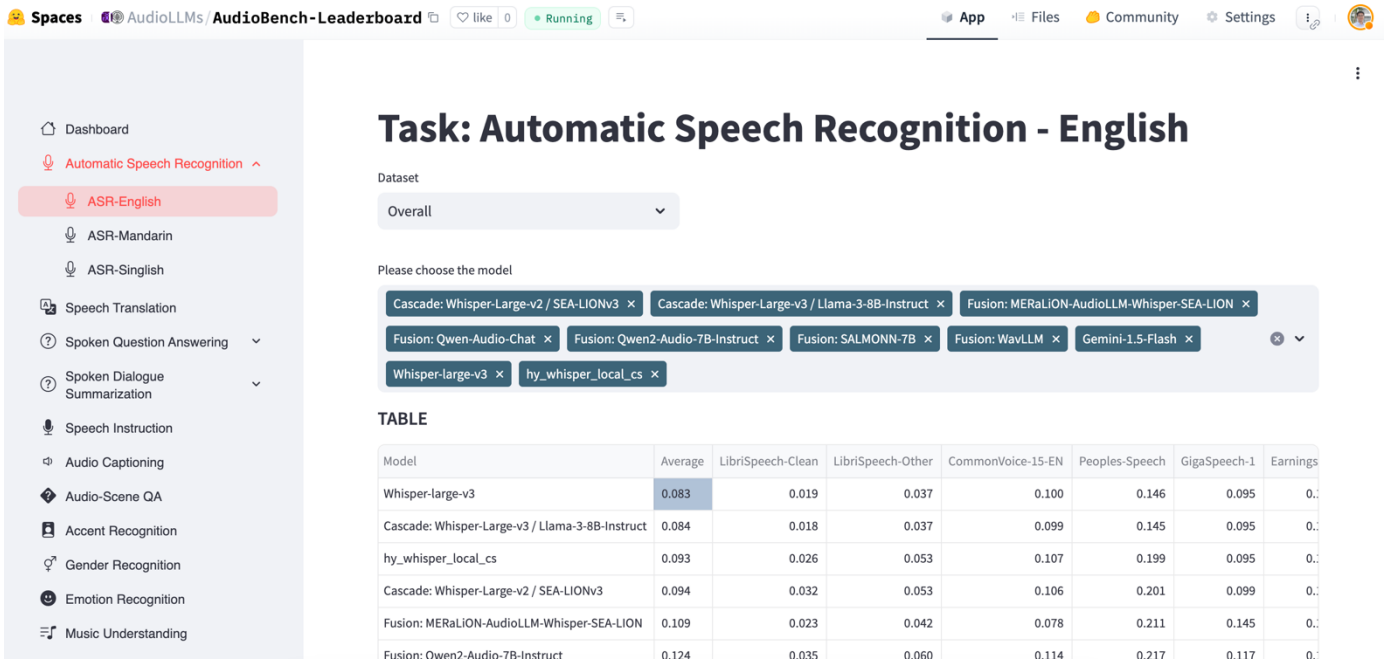
AudioBench

Correlation between judgement models

- What judgement model should we use?
  - LLAMA-3-8B-Instruct
    - Not have enough capability
  - GPT4o
    - Costly and will have version updates
  - LLAMA-3-70B-Instruct
    - Can fit in 1 H100 GPU after int4 quantization
    - Good instruction following and judgement quality
    - High correlation with GPT4o (especially for reference-based judgements)

AudioBench - Resources

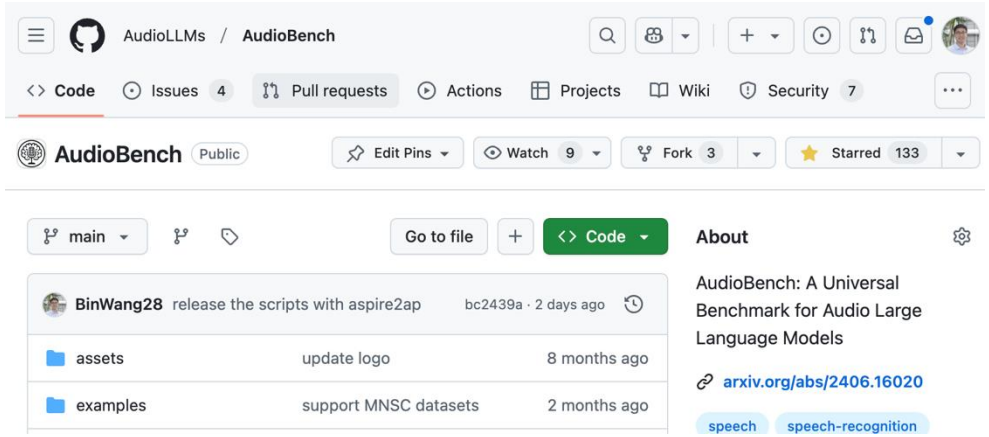
- Paper: https://arxiv.org/pdf/2406.16020 (NAACL 2025)
- Leaderboard: https://huggingface.co/spaces/AudioLLMs/AudioBench-Leaderboard



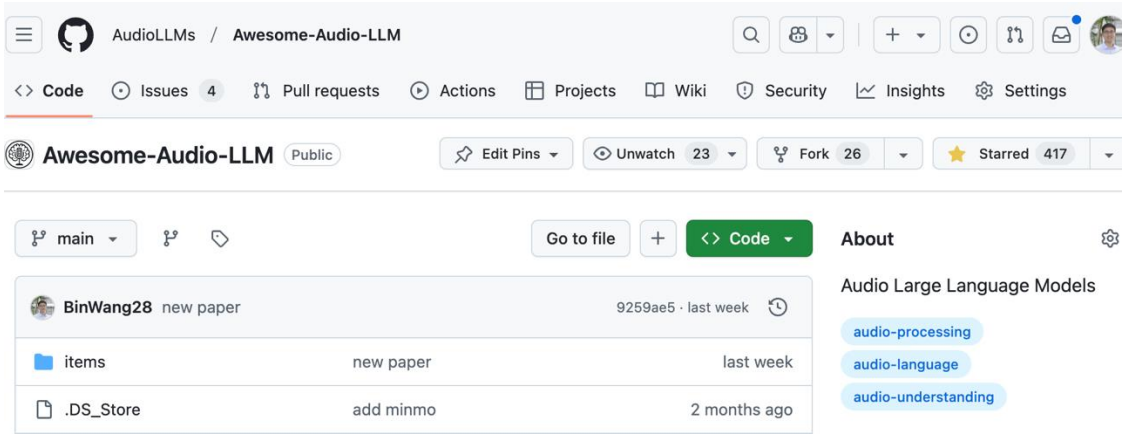
Wang, Bin, Xunlong Zou, Geyu Lin, Shuo Sun, Zhuohan Liu, Wenyu Zhang, Zhengyuan Liu, AiTi Aw, and Nancy F. Chen. "Audiobench: A universal benchmark for audio large language models." NAACL, 2025

AudioBench - Resources

- Paper: https://arxiv.org/pdf/2406.16020 (NAACL 2025)
- Leaderboard: https://huggingface.co/spaces/AudioLLMs/AudioBench-Leaderboard
- Toolkit: https://github.com/AudioLLMs/AudioBench



AudioBench Toolkit



Collection of AudioLLM Publications

What should we do next? AudioBench v2

- Instruction following of AudioLLMs
- Multilingual Support
- Multi-round Evaluation
- Evaluation on Speech Generation (Can hear and speak!)

Next Talks

- Our Models!
- MOWE-Audio (ICASSP 2025)
- MERaLiON-AudioLLM (Technical Report, Open-Sourced)