Auto-annotation for Voice-enabled Entertainment Systems

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Motivation

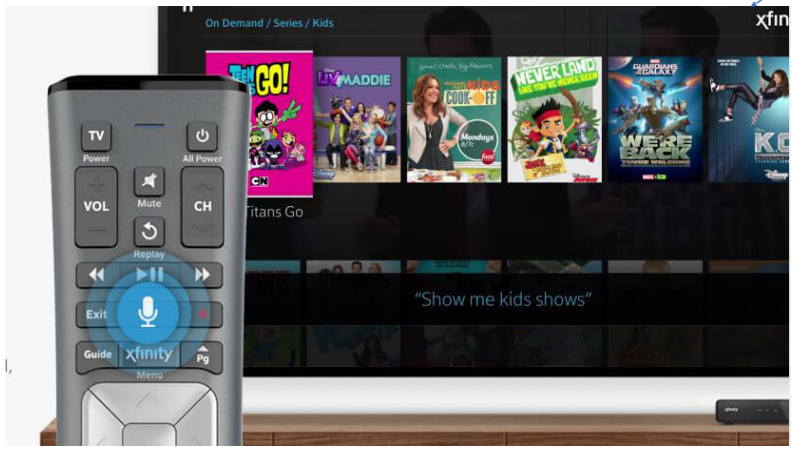
- Voice-activated intelligent entertainment systems are prevalent in our daily lives

in specialized domains
shifting customer trends

Labeled audio data

time consuming
labor intensive

Automatic Speech Recognition



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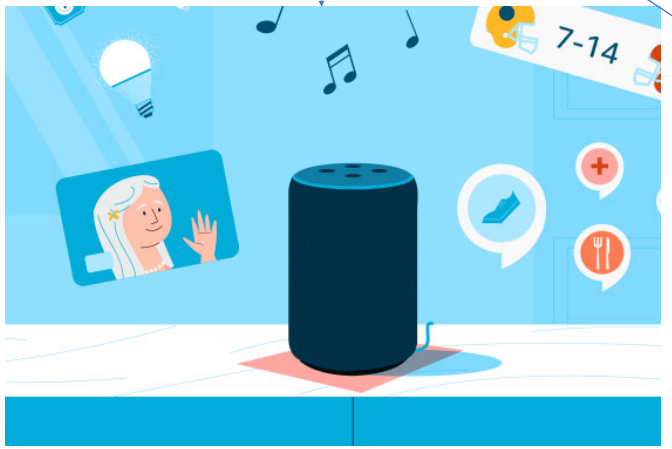
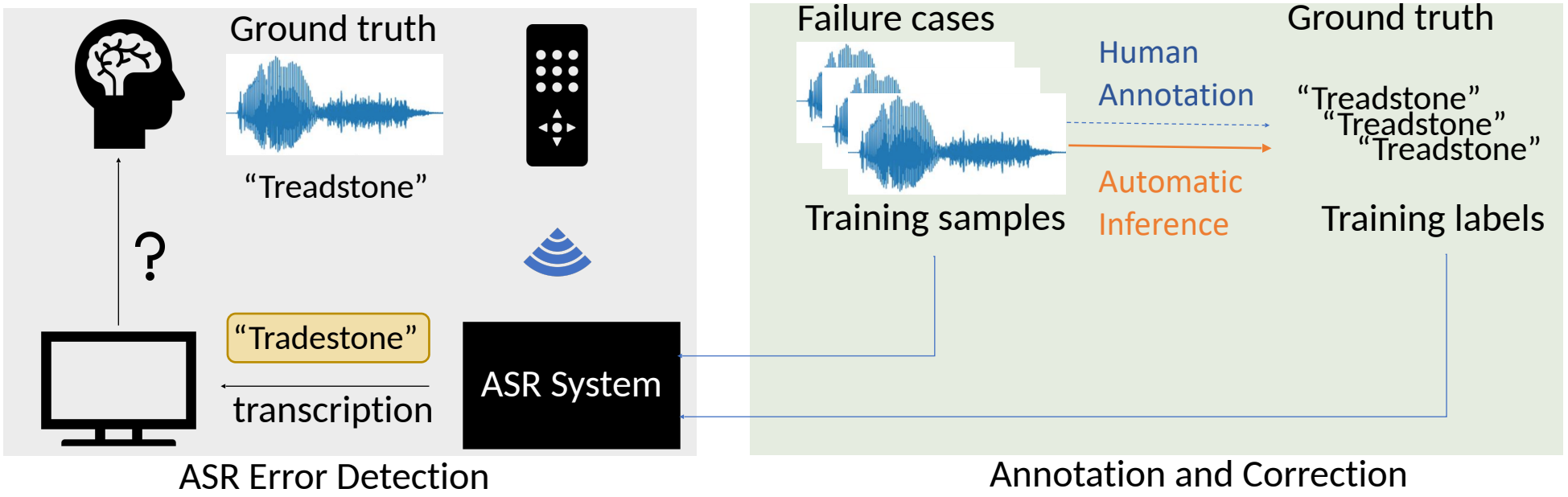


Amazon Alexa

Google Nest Hub

Proposal

- Identify errors and provide reasonable corrections in ASR systems automatically
- Obtain training data for production-level ASR systems in an **unsupervised** manner



RoadMap

- Motivation
- Proposal
- Prior work
- Auto-annotation Methods:
  - Utterance-based
  - Interaction-based
- Evaluation
- Conclusion

Prior Work

- Fully Supervised
  - Lexical and acoustic features of query reformulation [Tang, et al. 2019; Errattahi, et al. 2018; Errattahi, et al. 2016]
  - Audio-only interactions [Hong and Findlater. 2018]
- Weakly supervised
  - acoustic audio event detection [Kumar and Raj. 2016, Kumar et al. 2017]
- Production-level
  - human-in-the-loop [Amazon SageMaker]

RoadMap

- Prior work
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  - Utterance-based :
    - transcriptions only
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    - transcriptions + interaction events (app, tune, keypress)
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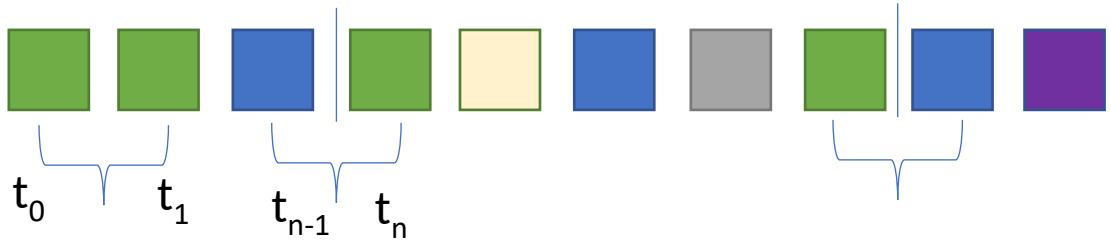
Data: utterance sessions

- Each query is issued by the same device.
- Each non-first query occurs within 45 seconds of the last. (Tang et al., 2018)



transcriptions are grouped by device and sorted by time

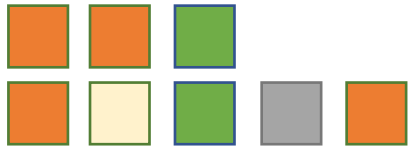
If t_n-t_{n-1} > 45s, have a session = events[t_0 : t_{n-1}]

Sessions: [, ,]

[[{‘time': 'Mon Oct 7 00:11:19 2019', 'transcription': 'NBC America'}
{‘time': 'Mon Oct 7 00:11:23 2019', 'transcription': 'NBC America'},
{‘time': 'Mon Oct 7 00:11:35 2019', 'transcription': 'NBC'}]

Utterance-based Detection and Annotation

- Step 1: Identifying erroneous transcriptions
  - Session



☑ have more than one utterances

☑ contain repeats

  - Query  → Erroneous

☑ Number of session > T_s

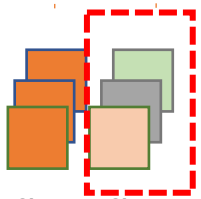
☑ Repeat likelihood > T_{rep}

☑ Median of time interval between repeats < T_t

- Step 2: Automatic annotation with query reformulation patterns

query = Log house

sessions



q_{err} $q_{i'}$

☑ more than one utterances

☑ no repeated transcriptions

☑ second last query is erroneous

☑ Median of time interval < T_t

- Extract possible candidates from all sessions
- Select correction by confidence

$$P(q_i' \mid q_{err}) = \frac{count(q_i', q_{err})}{count(q_{err})}$$

('Log House', 'Loud House'), 0.44

('Log House', 'The Loud House'), 0.125

…

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Interaction-based Detection and Annotation

- Three scenarios where subsequent user interactions lead to a confirmed transcription

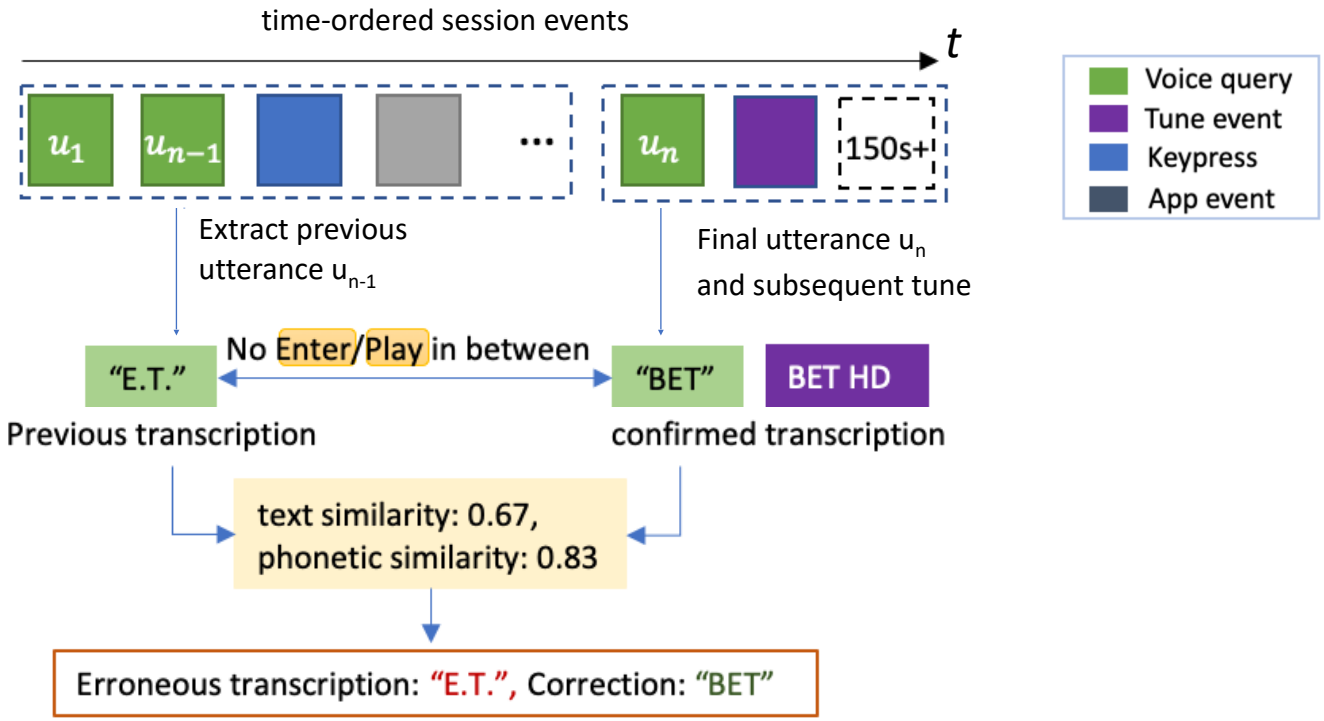
Scenario 1: User clicks a button, tunes to a program, then keeps watching > 30 seconds.

Scenario 2: User launches an app and stays for at least 30 seconds

Scenario 3: User tunes to a program and stays for at least 150 seconds.

Interaction-based Detection and Annotation

- After we confirm the transcription of the last voice query:
  - Look at the previous query from the same user to see if it points to a potential system error



Evaluation

- Utterance-based Detection and Annotation

Data	474 sessions with 925 utterances on 68 detected erroneous queries
Error detection	Precision: 77.49% Recall: 76.11%
Suggest correction	Accuracy: 69.76% WER would have reduced by 0.907

- Interaction-based Detection and Annotation

Data	225 queries with 15 utterance samples for 15 unique queries
Confirmed transcriptions	Accuracy: 99.60% WER of 0.002
Identify suspicious transcriptions	Accuracy: 87.1.%
Suggest correction	Accuracy: 80.0%

Methods	Suspicious transcriptions	Suggested annotation
Utterance-based Annotation	Academy	Pup Academy
	CNET Latino	Cinelatino
	Entouch	In Touch
	Murder in the First	Murder in the Thrist
	Joe Josie Wah	JoJo Siwa
	Antena*	Antenna
Interaction-based Annotation	Play Select	Player Select
	Just Go With It	Just Roll With It
	Find	Friends/Blind Date
	Stephen	Steven Universe
	60 Days N	60 Days In
	The Singer	The Masked Singer/Masked Singer

Conclusion

- We present an automated annotation system that provides an unsupervised approach to identify erroneous transcriptions and to suggest possible fixes for detected errors.

- Our auto-annotated training data reaches an overall word error rate (WER) of 0.002 and we obtained a reduction of 0.907 in WER after applying the auto-suggested fixes.

- Our system can be directly applied to improve annotation efficiency and robustness of ASR systems