Spontaneous conversational speech synthesis

The making of a podcast voice – breathing, uhs & ums and some ponderings about appropriateness

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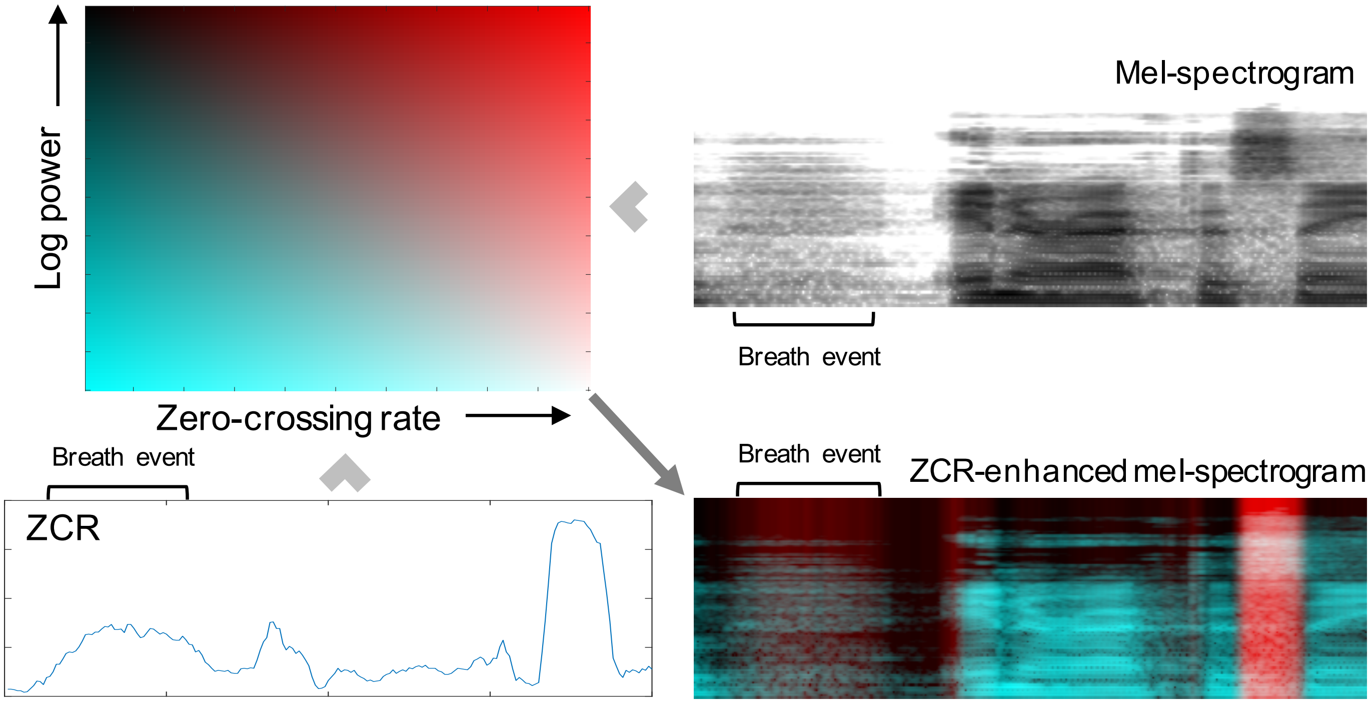
Why synthesise spontaneous conversational speech?

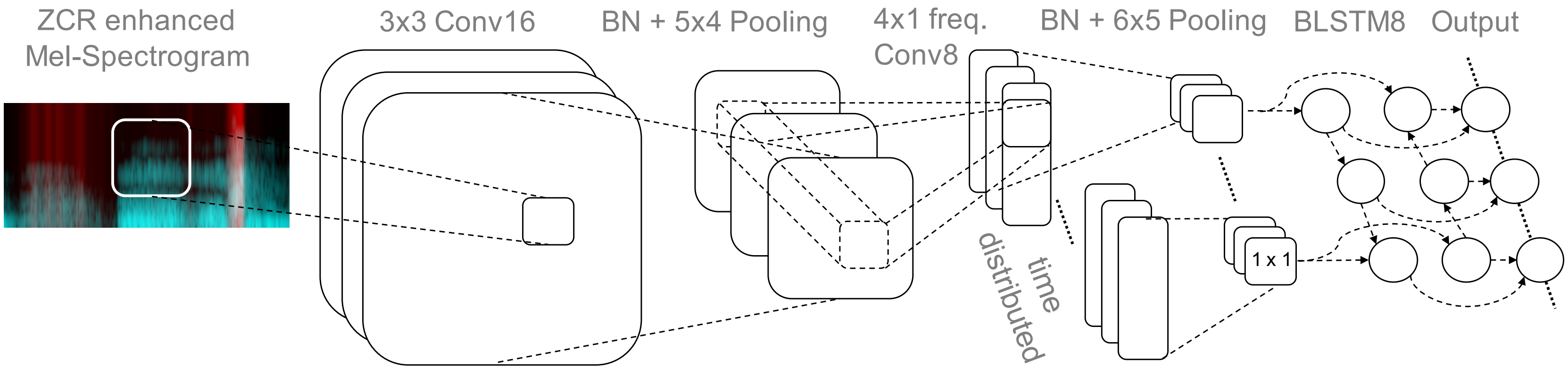
Types of TTS corpora

	Traditional TTS corpus	Public domain Audiobook	Public domain Conversational Podcast
Recording conditions	Controlled	Uncontrolled	Uncontrolled
Type of speech	Read / acted	Read / acted	Spontaneous / semi-planned
Amount of data	Limited to resources	Unlimited	Unlimited
Transcriptions	Available	Available	Not available
Segmentation to utterances	Decided on pre-recording	Sentence / paragraph level post-recording	Not existent
Nr of speakers	1	1	2 or more
Disflucencies	no	no	yes

Detecting breath events and overlapping speech for segmentation & utterance selection



CNN-LSTM speaker dependent breath detector



ThinkComputers Corpus (TCC)

- Weekly podcast
- Tech news, product reviews
- 150 h available copyright free
- No transcriptions
- 2 speakers mixed into a single channel

ThinkComputers Podcast #180

June 5, 2019 by Bob Buskirk

Speaker with most air time was selected

27 episodes -> 9 hours of clean breath groups

Transcription

Fully automatic using ASR and forced alignment:

Google Speech API, video model – best accuracy

IBM Watson Speech to Text – generic hesitation label

Gentle forced aligner – distinguish between *uh* & *um*

6218 breath groups orthographically transcribed, filled pauses *uh* and *um* identified and transcribed, other disfluencies indicated with a nr per utterance

Text-to-Speech

Tacotron 2 spectrogram prediction framework

waveform synthesis: Griffin-Lim algorithm

Pronunciation accuracy was improved by phone-level transcription and transfer learning with a read-speech voice

J. Shen, R. Pang, R. J. Weiss, M. Schuster, N. Jaitly, Z. Yang, Z. Chen, Y. Zhang, Y. Wang, R. Skerry-Ryan, R. A. Saurous, Y. Agiomyrgiannakis, and Y. Wu, “Natural TTS synthesis by conditioning WaveNet on mel spectrogram predictions,” in Proc. ICASSP, 2018, pp. 4779–4783.

R. Mama, “Tacotron-2 Tensorflow implementation,” https://github.com/Rayhane-mamah/Tacotron-2

Perceptual evaluation: *appropriateness*

Goal: to see how the podcast voice was perceived, compared with voices trained on:

a) read speech

b) lab-recorded, manually annotated spontaneous conversational speech

“How well does the speaking style match the content of the utterance?”

Evaluation of appropriateness for different genres

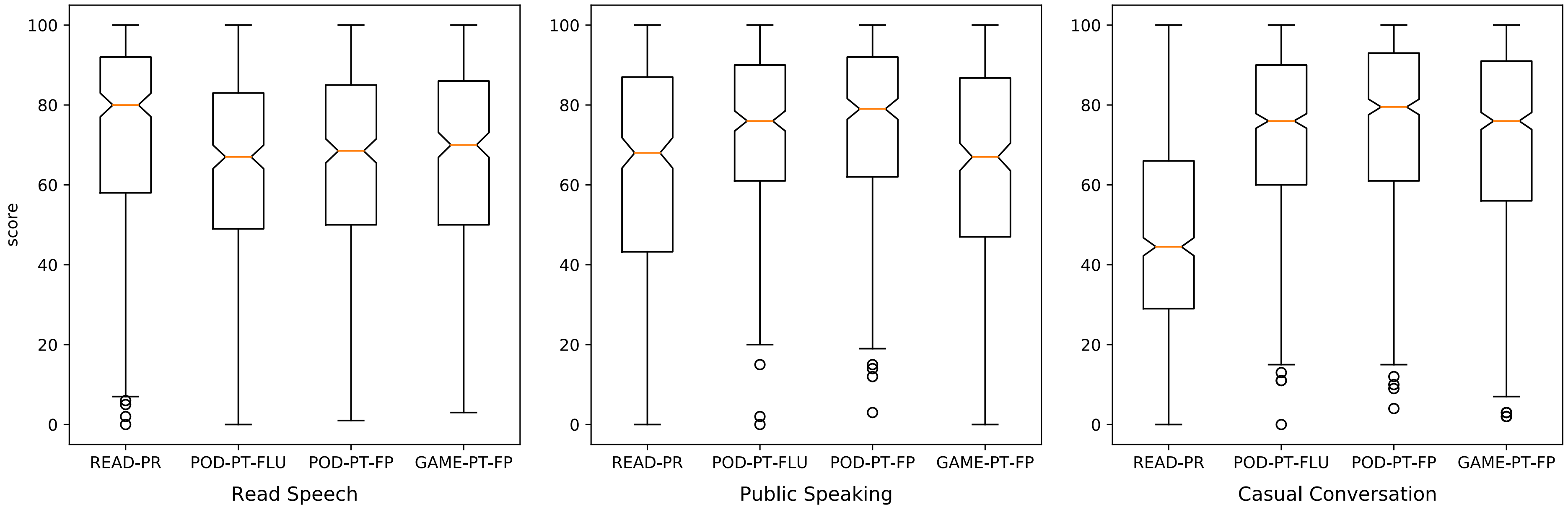
- Read speech: 10 utterances originating from the Arctic Corpus
- Public speaking: 10 utterances transcribed from political speeches and keynote talks; 7 of the prompts contain FPs
- Casual conversation: 20 utterances from a corpus of casual spontaneous conversations from a TTS corpus, 11 of the prompts contain FPs

Synthetic voices

- POD-FP: TC corpus; FPs transcribed
- POD-FLU: Fluent breath groups from TC; no FPs
- READ-PR: Voice trained on audiobook data; no FPs
- GAME-FP: Lab-recorded spontaneous speech; FPs transcribed

Mushra-like listening test results

“How well does the speaking style match the content of the utterance?”



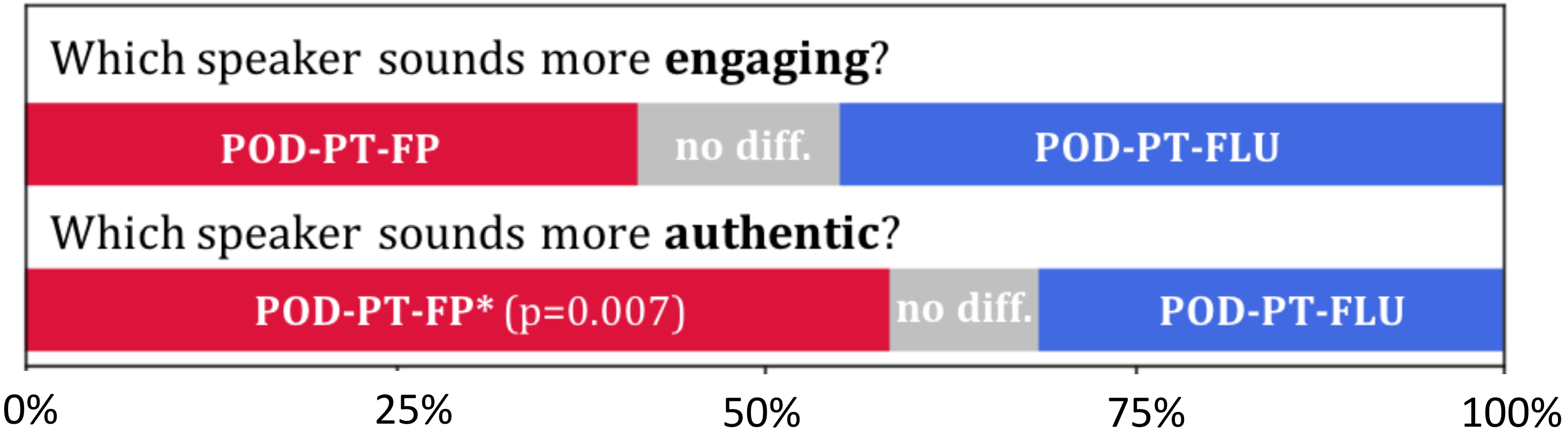
Samples at: http://www.speech.kth.se/tts-demos

Evaluations from a perceptual point of view

Can we use speech synthesis to understand perceptual aspects of spontaneous speech phenomena?

Preference tests on the impact of filled pauses

2 Interspeech keynotes 10-27 second long paragraphs with and without FPs:



"Would you want a robot to sound hesitant? Why or why not?"

Yes – 45%	Undecided – 19%	No – 36%
Yes, sounds more authentic and genuine.	indifferent	No, because it would sound more human-like.
sounds far more realistic	Unsure, closer to no because I don't think it's really necessary but it also depends on the reason for it.	not really
Yes, more realistic	I have no idea.	No, it might make it too human and be somewhat uncanny valley
Yes, it makes it more human and relatable.	**As long as I knew it was a robot and was not done without my knowledge**	No. It is not a good idea I think.
Yes so it sounds more like a person and more relatable.	Only if it was trying to fake being a human. Otherwise it sounds too artificial.	**No, because it would sound too human like. Over the phone, I wouldn't be able to tell I am talking to a robot.**
Yes, gives human factor	it would not bother me to be honest	No - Robots should know exact answers
yes as its more realistic as a humans voice	Yes, and no. Yes, because it makes it sound more like a regular person but ultimately no, because it can be harder to listen to and transcribe.	No, it would possibly make it more difficult to determine whether you're talking to real person or a machine.
Yes, it does sound a bit more human that way.	if it makes it sound more real	No, I feel uncomfortable blurring the lines between what sounds naturally human and what is machine
Yes, makes it seem more human.		No. I want robots to sound authoritative.
Yes more real effect		No as I'm not sure it's an important factor
Yes, because it would sound more human.		No as I would want it to speak correctly at all times.

“Would you want a robot to sound hesitant? Why or why not?”

Yes – 45%	**Undecided – 19%**	**No – 36%**
Yes as it sounds more like a human voice		no
yes, its more realistic and makes me feel like i'm listening to a real person.		**No so you know its a robot**
Yes if the goal was to make it sound human. It all depends upon the use of the robot. Customer service robot then yes but maybe an automated robotic vacuum then maybe no. Context would be key.		**No. I like the audio clear cut between machine and human.** Perhaps though it is important in other cultures or languages to have different intonation and beats in order to get information across efficiently.
Yes, much more easy to listen to for prolonged periods		
I think it's comforting to have a hesitant voice from them - things like phone calls make me anxious and having something more human sounding on the other end makes it more comfortable.		
Yes sounds more human		
yes as its more realistic		
Why not? More human-like sounds like a very good idea		

Take-home messages:

1. We can **automatically process** and annotate found speech data accurately enough for TTS.

2. Realistic TTS is more **genre-dependent** than citation style synthesis –> new research directions.

3. More control is needed, but we can already conduct experiments that reveal **perceptual aspects of spontaneous speech phenomena** such as disfluencies, which would have been difficult using natural speech.

More details in:

É. Székely, G. E. Henter, and J. Gustafson, “Casting to corpus: Segmenting and selecting spontaneous dialogue for TTS with a CNN-LSTM speaker-dependent breath detector,” in Proc. ICASSP, 2019, pp. 6925–6929.

É. Székely, G. E. Henter, J. Beskow, and J. Gustafson, “Spontaneous conversational speech synthesis from found data,” submitted to Interspeech 2019.

É. Székely, G. E. Henter, J. Beskow, and J. Gustafson, “Off the cuff: Exploring extemporaneous speech delivery with TTS,” accepted to Interspeech Show & Tell 2019.

É. Székely, G. E. Henter, J. Beskow, and J. Gustafson, “How to train your fillers: uh and um in spontaneous speech synthesis,” submitted to SSW 2019.

Questions?

Interchangeability of *uh* and *um*

Prompts from recorded discussions on the design of a remote control (AMI corpus)

3 conditions:

1) FP type copied from original recording
2) FP opposite type as original
3) FP type decided automatically, by merging the two labels into one before training the voice

Perceptual test

- Pairwise evaluation between the three conditions.
- Listeners were made aware they were evaluating synthetic speech with FPs and asked which one hesitated more realistically.
- They also had the option to select that both are plausible or neither is plausible.

Results

- 69% of all utterances were considered realistic, and only in 7% of the cases was neither considered realistic.

- Overall, there was no significant difference between copying the type of FP or using the opposite.

- Letting the system decide outperformed the other two options, in particular for FPs in the middle of the utterance.

Demo
Off the cuff: Extemporaneous speech delivery with TTS

Extemporaneous speech: a type of public speaking which uses a structured outline but is otherwise delivered conversationally, off the cuff.

TTS evaluation from the production point of view:

What if you are the speaker, not the listener?

Is it possible to simulate responsiveness to audience with spontaneous TTS?

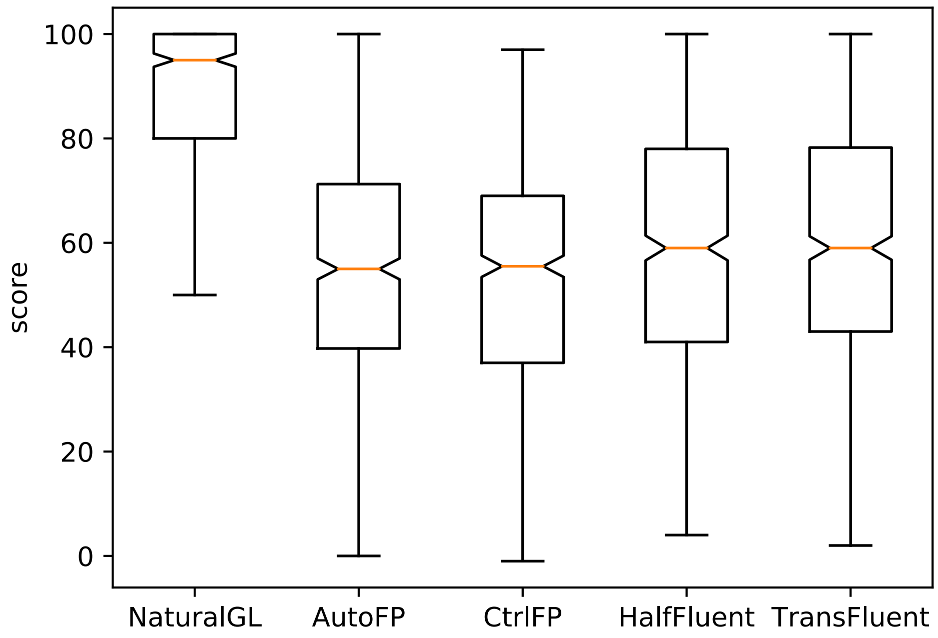
Evaluation of pronunciation accuracy

Improved by phone-level transcription and transfer learning with a read-speech voice

Voice	Nr of pronunciation errors
Grapheme-level input with transfer learning	49
Phoneme-level input and random initialisation	43
Phoneme-level input with transfer learning	13

Pronunciation assessment of 400 Harvard sentences.

Perceptual evaluation of fluent speech



Next steps

Breath as an *input* feature for implicit prosody control

- Traditional TTS corpora: utterance length is given, the reader adjusts breathing
- Spontaneous BG corpus: dynamic relationship between breath and length of utterance, related to speech planning

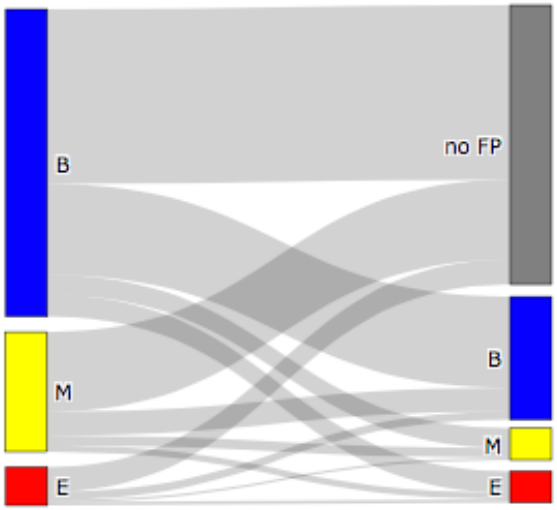
Next steps

Further evaluating TTS in the context of *appropriateness*:

How does speech transfer across genres?

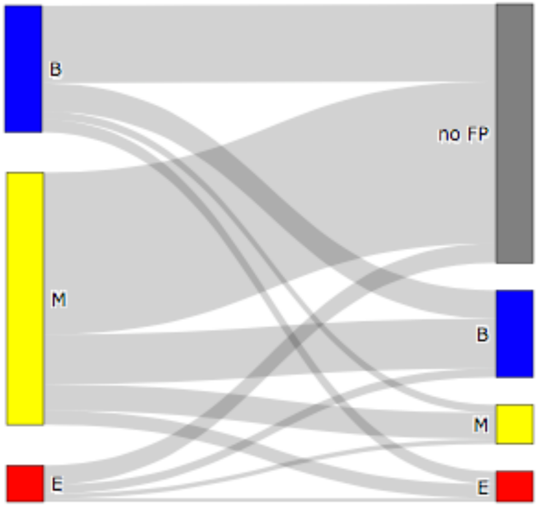
Citation-style TTS did a mediocre job on everything, but now genre transfer starts to matter.

um

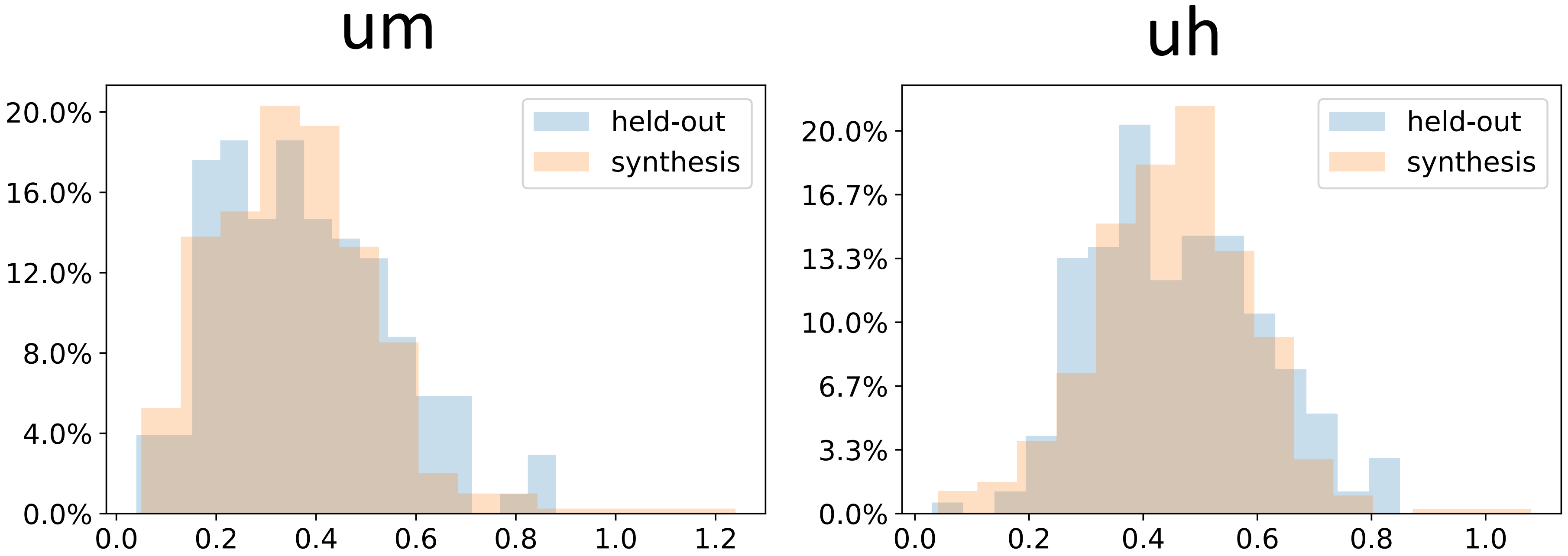


original synthesis

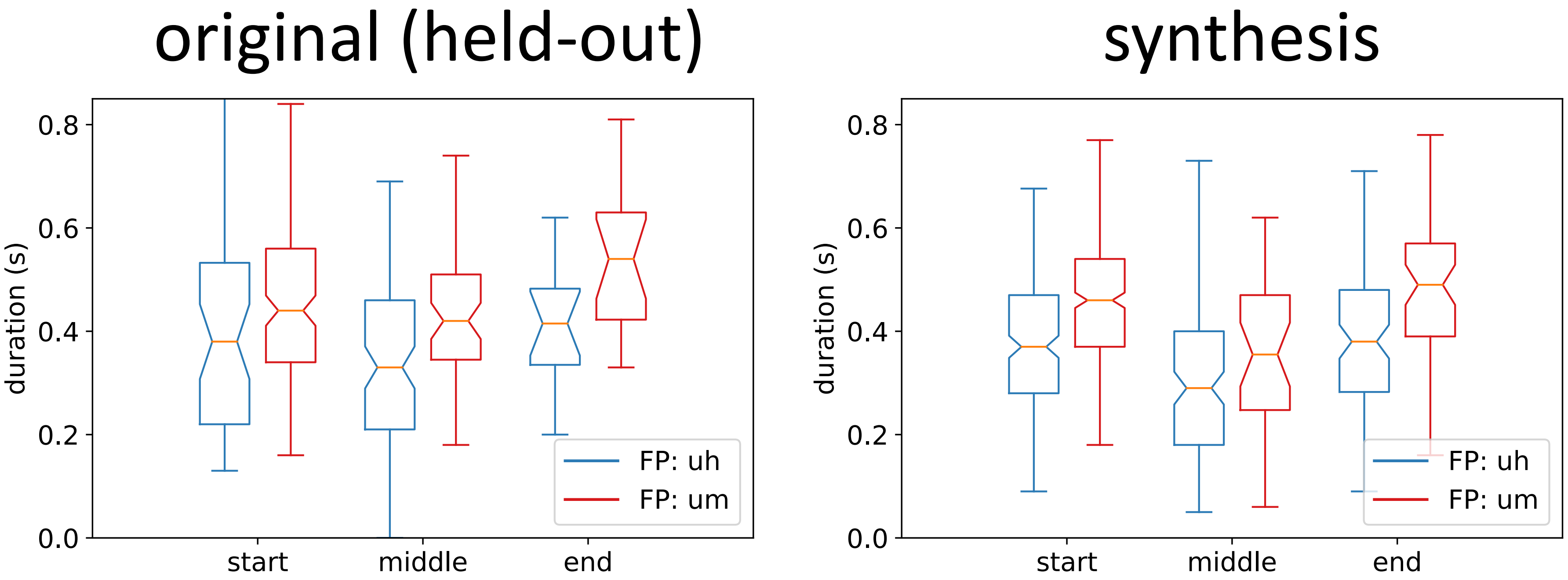
uh



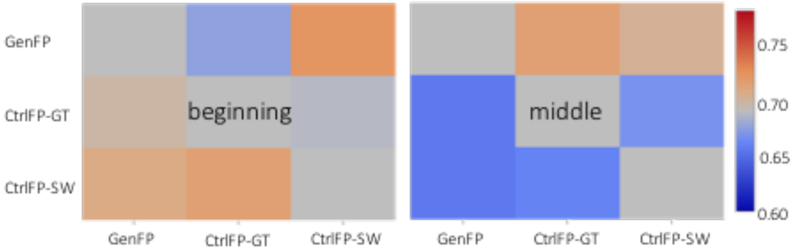
original synthesis


um
uh
held-out
synthesis
held-out
synthesis
20.0%
16.0%
12.0%
8.0%
4.0%
0.0%
0.0
0.2
0.4
0.6
0.8
1.0
1.2
20.0%
16.7%
13.3%
10.0%
6.7%
3.3%
0.0%
0.0
0.2
0.4
0.6
0.8
1.0

Length of uh and um in different BG positions



Perceptual evaluation of disfluent speech



Conclusions

✓Breath detection works well in extracting utterances out of messy dialog data for TTS corpus

✓Spontaneous TTS beats TTS from read speech for spontaneous speech genres in terms of appropriateness

✓We can relinquish control over FPs without quality loss

Overview

1. From podcast to TTS corpus: Breath detection
2. Spontaneous conversational speech synthesis

    - TTS and evaluation
    - How to deal with uhs and ums?
    - Demo

3. Future work

Filled pauses in spontaneous TTS

Previously*:*

A) Where should we put them?

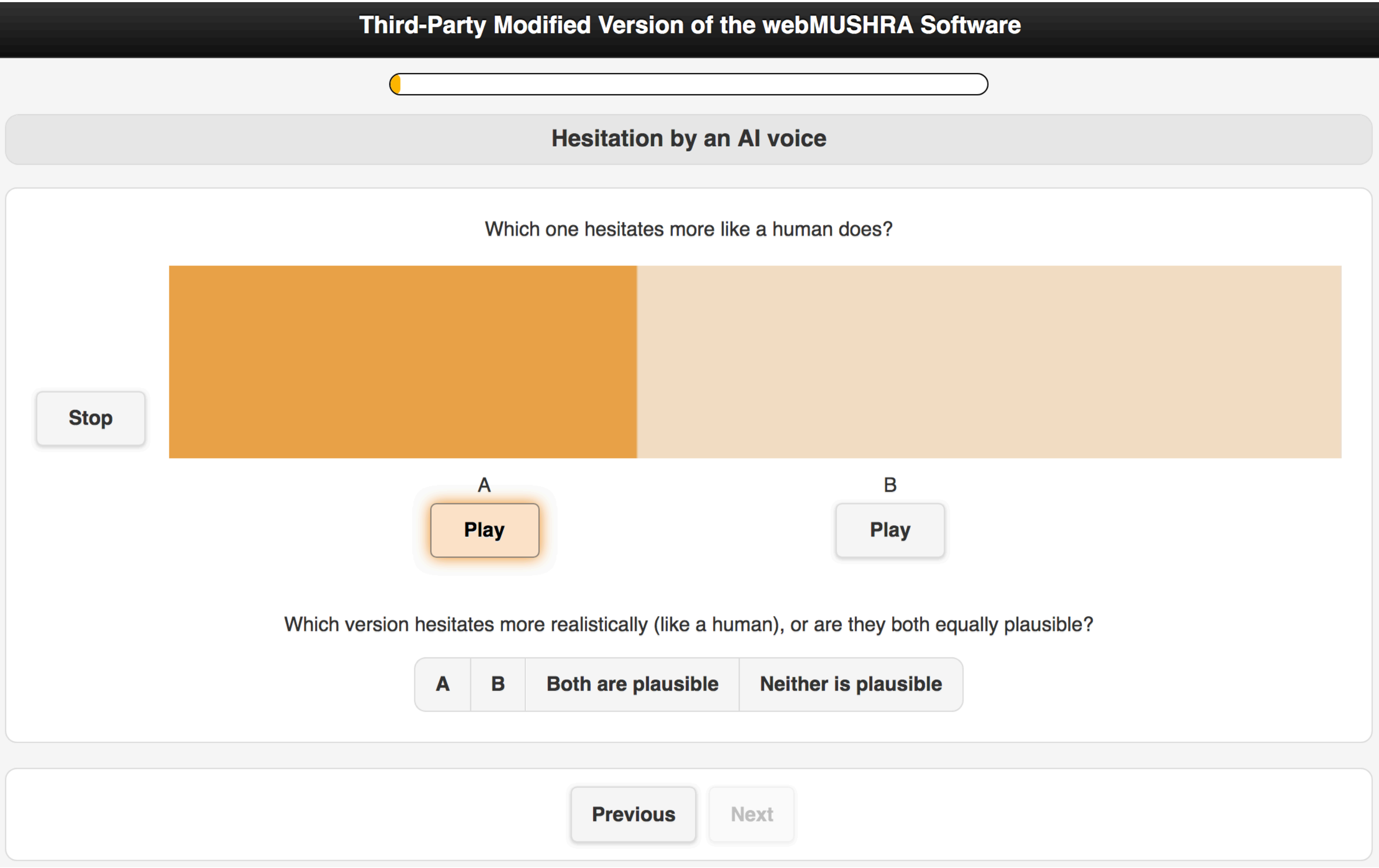
B) How should they sound?

- Conclusion: It is not enough to put them in the right place, they should also sound right.

Now:

C) What should we do with them?

- Conclusion: As long as they sound right, it matters less where they are.



Third-Party Modified Version of the webMUSHRA Software

Hesitation by an AI voice

Which one hesitates more like a human does?

Which version hesitates more realistically (like a human), or are they both equally plausible?

How to train your fillers?

1) How to gain control over uh and um when synthesising *disfluent* speech?

2) What is the best way to synthesise *fluent* speech out of a disfluent corpus?