
black hat
USA 2018
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MANDALAY BAY / LAS VEGAS
YOUR VOICE IS MY PASSPORT
John Seymour and Azeem Aqil
#BHUSA / @BLACK HAT EVENTS

Introduction

Voice is starting to be used for authentication

Machine Learning Journal

Personalized Hey Siri

Vol. 1, Issue 9 • April 2018
by Siri Team

Apple introduced the "Hey Siri" feature with the iPhone 6 (iOS 8). This feature allows users to invoke Siri without having to press the home button. When a user says, "Hey Siri, how is the weather today?" the phone wakes up upon hearing "Hey Siri" and processes the rest of the utterance as a Siri request.

The feature's ability to listen continuously for the "Hey Siri" trigger phrase lets users access Siri in situations where their hands might be otherwise occupied, such as while driving or cooking, as well as in situations when their respective devices are not within arm's reach. Imagine a scenario where a user is asking his or her iPhone 6 on

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Google

Describe your issue

Step 3. Enjoy media or ask for personal information

Once you set up Voice Match, you can enjoy media using voice commands. You can also get get quick answers to these personal topics:

- Routines (in U.S), My Day (other countries)
- Calendars
- Flights
- Services
- Shopping lists
- Payments
- Photos

Voice Match & feature functionality

Media

Home control devices

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Schwab voice ID Service

Access your account with your voice.

Schwab's voice ID service allows you to access your account just by speaking one simple phrase, "At Schwab, my voice is my password."

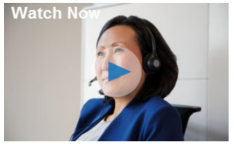
* Schwab's voice ID service is not available on all contact numbers.

No more personal questions. No more PINs.

Schwab is introducing a new voice ID service that uses voice biometrics technology to identify you by your unique voice. Whether you want to use our automated phone service or speak with one of our Financial Professionals, our voice ID service is one of the fastest and most convenient ways to securely identify yourself over the phone.

When you call us, you will simply be prompted to say the passphrase "At Schwab, my voice is my password" to be securely verified.

Need help? Call **800-435-4000**.



Frequently Asked Questions

- **Is my voiceprint really unique?**
  Yes, just like your fingerprint, your voiceprint is uniquely yours.
- **Will the voice ID service work if I have a cold?**
  Yes, our voice ID service verifies hundreds of voice characteristics, only a few of which are affected by a cold.
- **Does background noise affect performance?**
  Yes, like with speech recognition, background noise can negatively impact recognition. However, Schwab's solution offers the leading technology that has the best noise-canceling algorithms in the industry. Clients should be able to use voice biometric authentication from a location with typical noise.

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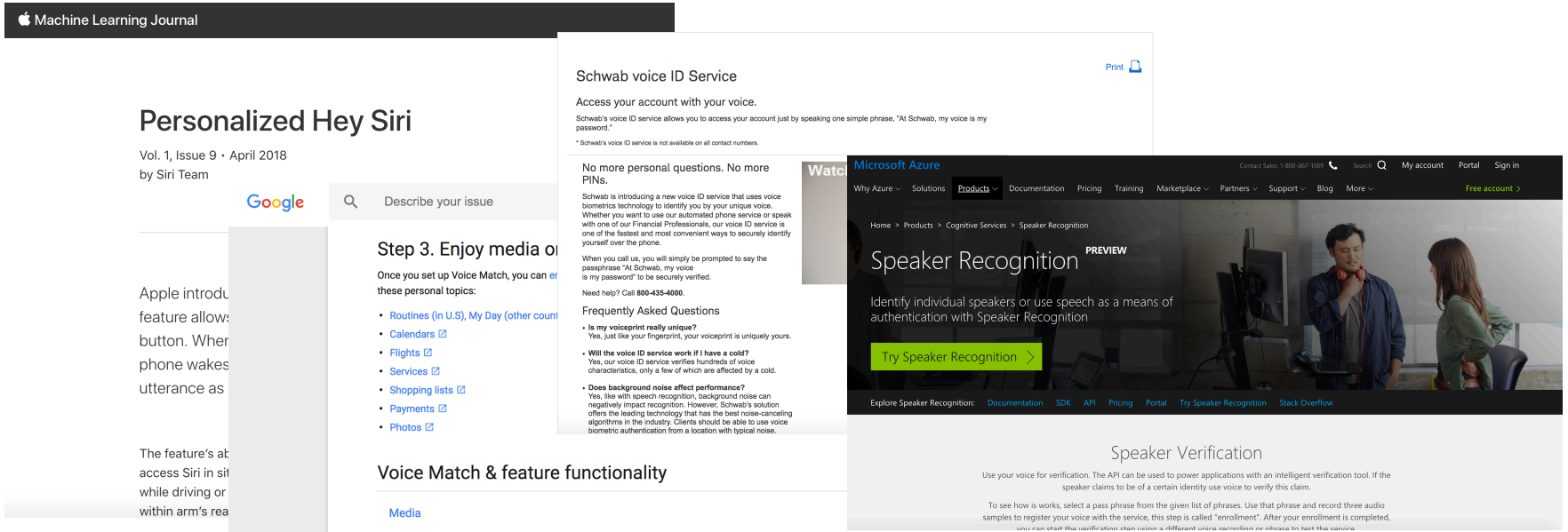


Goal:
Break Voice Authentication

(with minimal effort)

Obligatory Sneakers Reference

Obligatory Sneakers Reference

And here’s how you do it.

- In Sneakers, they social engineered the target in order to record the exact words they needed
- In practice, this is hard to do
- Luckily, text-to-speech exists

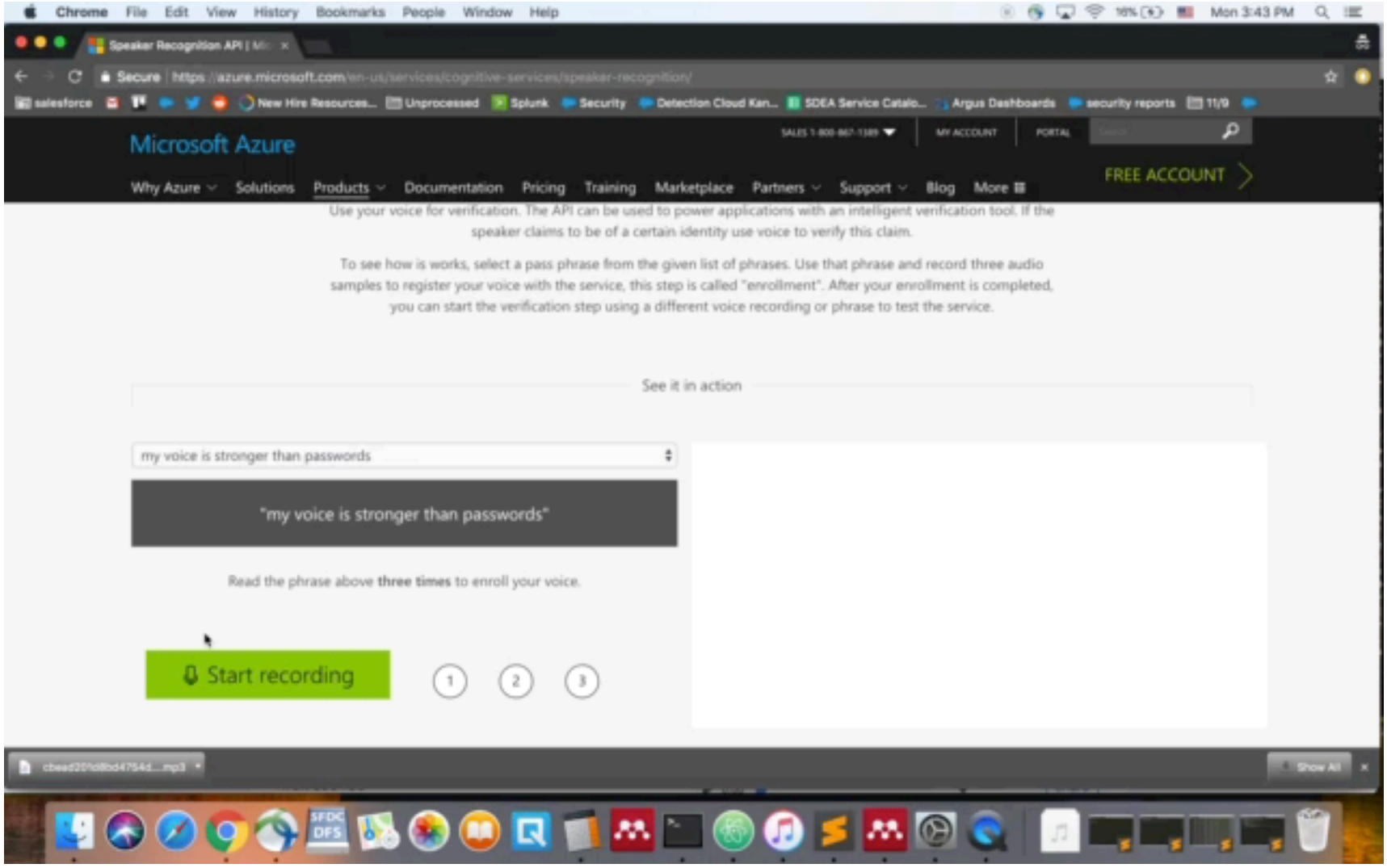
Overview of Text to Speech (TTS)

- Essential idea: you give the algorithm text, and it generates the equivalent audio representation of that text (e.g. Mel Spectrograms)
- Model learns the mapping between the transcript and audio
- The way it does this is you give it labeled (transcribed) audio and feed it into a deep neural network
  - Generally models are trained on a single person's voice
  - Generally deep learning models require a LARGE amount of labeled data
    - Open source datasets (e.g. Blizzard, LJ Speech)
    - >24 hours of labeled data to do well

Proof of concept

- Create an account
- Record >30 sentences
  - Chosen by Lyrebird, same for all users.
- Provide a target sentence that Lyrebird will generate.

- Apple Siri and Microsoft Speaker Recognition API (Public Beta)
- Proof of concept is of limited value from a security standpoint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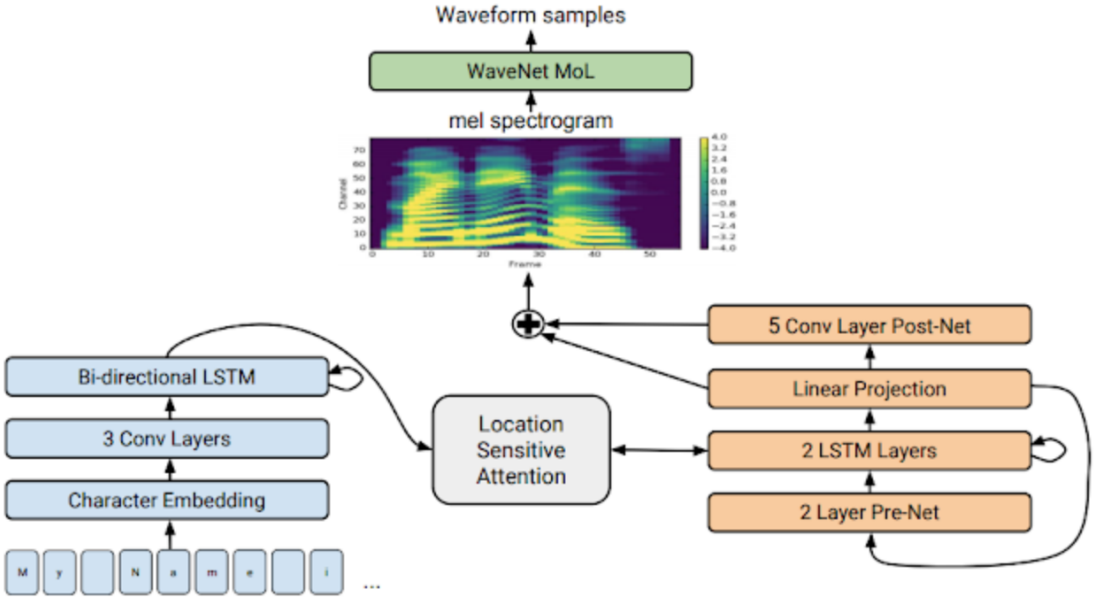
Speaker Recognition API
Secure https://azure.microsoft.com/en-us/services/cognitive-services/speaker-recognition/
Microsoft Azure
Why Azure Solutions Products Documentation Pricing Training Marketplace Partners Support Blog More
FREE ACCOUNT
Use your voice for verification. The API can be used to power applications with an intelligent verification tool. If the speaker claims to be of a certain identity use voice to verify this claim.
To see how is works, select a pass phrase from the given list of phrases. Use that phrase and record three audio samples to register your voice with the service, this step is called "enrollment". After your enrollment is completed, you can start the verification step using a different voice recording or phrase to test the service.
See it in action
my voice is stronger than passwords
"my voice is stronger than passwords"
Read the phrase above three times to enroll your voice.
Start recording
1
2
3

Open source TTS models

- Several open source models (Tacotron, Wavenet are best known)
  - WaveNet generates realistic human sounding output, however, needs to be ‘tuned’ significantly.
- Tacotron simplifies this process greatly
  - The production of the feature set (which needs tuning in WaveNet) is replaced by another NN that works directly off data
- We use Tacotron

Model overview



A detailed look at Tacotron 2's model architecture. The lower half of the image describes the sequence-to-sequence model that maps a sequence of letters to a spectrogram. For technical details, please refer to the paper.

Tacotron v1/v2 and WaveNet

Collecting Data

- That's all well and good, but in order to train a model, we need to feed it data
  - Can grab audio from e.g. YouTube, but quality/quantity are both important
- Need to transcribe this data
  - Youtube/Google Speech API not good enough
  - We also had to cut pieces with poor quality or with "um"
  - We had to manually transcribe the data we used for training
- Most open source models require short (<10 second) snippets of audio
  - Use ffmpeg to split the file into chunks

Data Augmentation

- Publicly available data for a specific target is probably limited
- Transcribing is time intensive since it must be done manually

- Need LARGE amount of high quality training data
- Solution: Augment Data

Data Augmentation: Shifting Pitch

- Slow down and speed up audio to generate new examples
- Libraries (pydub) available for this
- Measured how far pitch can be raised/lowered by recording “Hey Siri” and testing how much speed up/slowdown would be accepted
  - 0.88x to 1.21x for our tests
  - YMMV for exact parameter (probably different for every person)

Adding Transfer Learning

1. Initially train on large open source dataset (Blizzard, LJSpeech)
2. Get a good model, stop training
3. Replace open source dataset with the target data
4. Continue to train

Transfer Learning Demo

Putting it all together

1. Scrape data from target (e.g. Youtube)
2. Select high-quality samples
3. Transcribe and chunk audio
4. Augment audio by shifting pitch
5. Train general TTS model on open source dataset
6. Replace general model training data with target data; finish training
7. Synthesize voice from model

Our work in perspective (ML for offense)

- Attacks on ML systems
  - Adversarial Attacks
    - Most prior work attacking voice systems utilize GANs
    - Pro: hiding commands within benign-sounding audio
    - Con: method is currently brittle
    - (We use the simpler approach of generating speech for a given user)
  - Poisoning the Well
  - Privacy/Differential Privacy
- Attacks using ML systems
  - Phishing
  - DeepFakes
  - Robotics/Social Engineering

Mitigation: MFA

- Defense in Depth
- Potential issue: Speaker Recognition with unknown vocabulary is hard
- Potential issue: Passphrases may not be kept secret

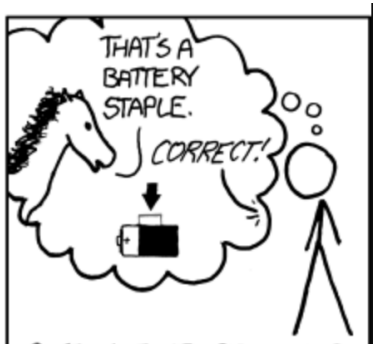
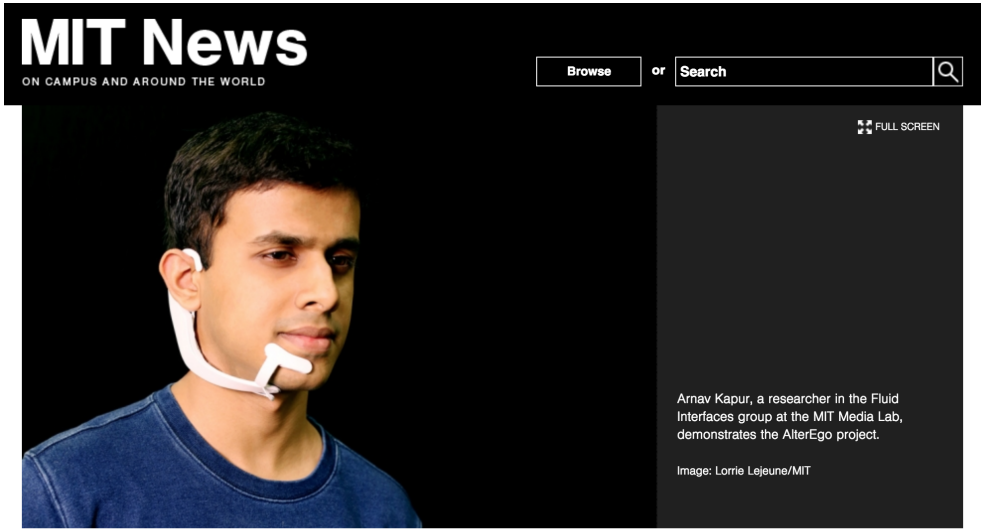


Image credit: XKCD.com

Mitigation: Detect CGA



Computer system transcribes words users "speak silently"

Electrodes on the face and jaw pick up otherwise undetectable neuromuscular signals triggered by internal verbalizations.

Black Hat Sound Bytes

- Speaker authentication and speaker recognition are different problems. Recognition is only a [weak] signal for “authenticating”.
- Speaker authentication can be broken if the attacker has speech data of the target and knows the authentication prompt.
- Although most TTS systems require 24 hours of speech to train, transfer learning is an effective way to reduce that time to an amount realistic for an attacker to abuse. Transfer learning is effective for reducing data requirements generally.
- In conclusion, it’s relatively easy to spoof someone’s voice
    - Will only get easier over time

Final note

Transfer Learning from Speaker Verification to Multispeaker Text-To-Speech Synthesis

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Be afraid. Be very afraid.

John Seymour and Azeem Aqil