SAMSUNG Research

Voice Presentation Attack Detection through Text-Converted Voice Command Analysis

Shape the Future with Innovation and Intelligence

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Motivation

Emergence of Voice assistants:

Samsung Bixby, Apple Siri, Amazon Alexa, etc

Security Critical Commands

Voice assistants now support security-critical commands, making them attractive target for adversaries to exploit

"Open Samsung Pay and show me the registered credit card"

"Take a picture with the front camera"

"Open Facebook and post a recent picture"

"Change unlock password"

Threat Model

TV anchor says live on-air 'Alexa, order me a dollhouse' – guess what happens next

Story on accidental order begets story on accidental order begets accidental order

By Shaun Nichols in San Francisco 7 Jan 2017 at 00:58 244 SHARE ▼

A San Diego TV station sparked complaints this week – after an on-air report about a girl who ordered a dollhouse via her parents' Amazon Echo caused Echoes in viewers' homes to also attempt to order dollhouses.

Mitigation Strategies

- Voice Biometric Authentication

- Voice Liveness Detection

- Voice-Command based Attack Detection

Bixby Dataset

English voice commands that were processed from a voice assistant, Bixby.

Attained 34.8 million voice commands collected from 2.6 million users in Nov and Dec, 2017

Security Critical Commands

Security critical command:
command that can be used in a voice presentation attack
to exploit one of the threats mentioned in
"I've Got 99 Problems" (Porter et al. 2012)

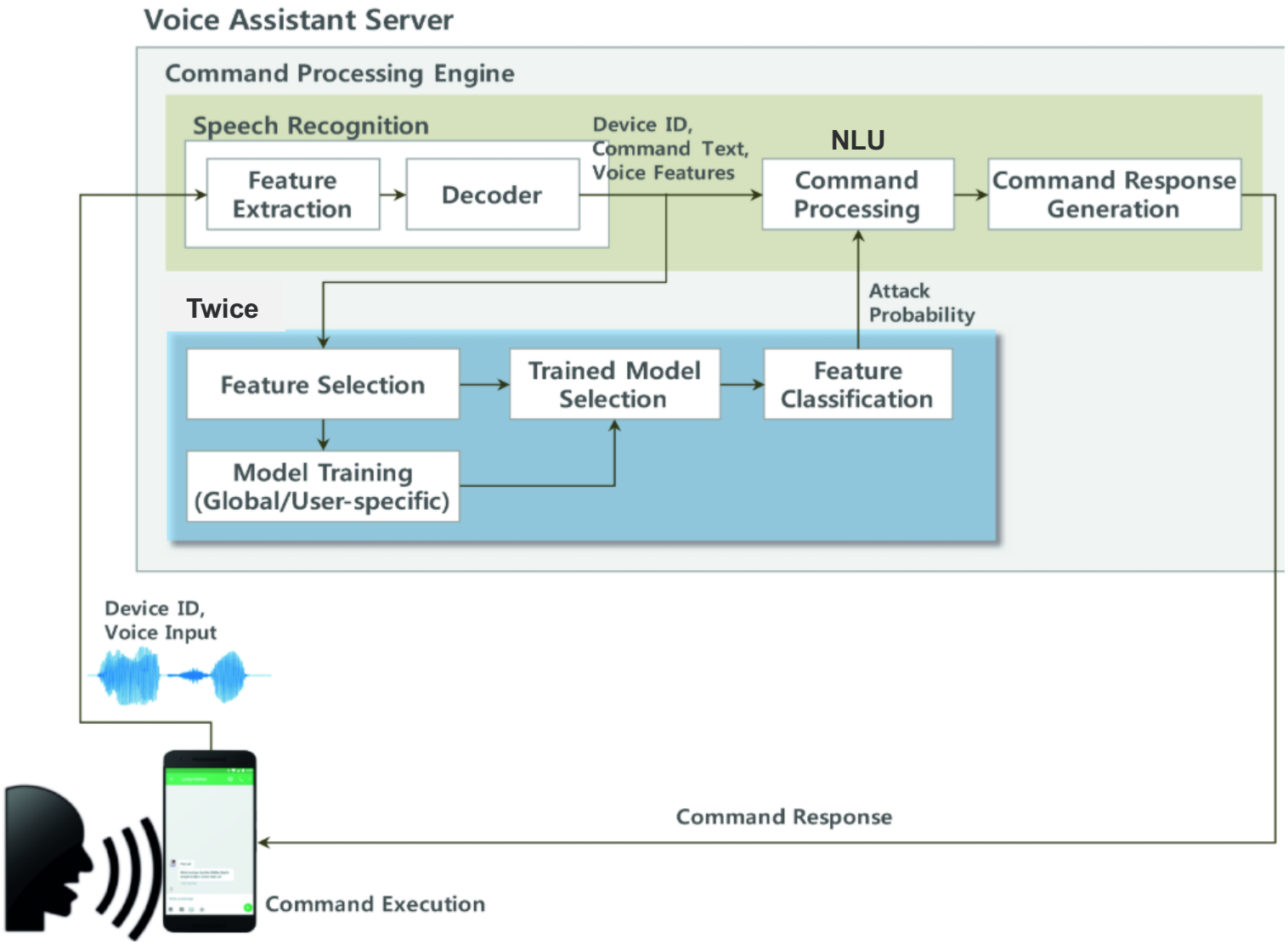
Synthetic attack set:
security-critical commands selected from
existing set of Bixby commands

Voice-Command based Attack Detection

Starts from global model that detects security critical commands

And switches to user-tailored model that also considers users' genuine commands

System Overview



Modeling

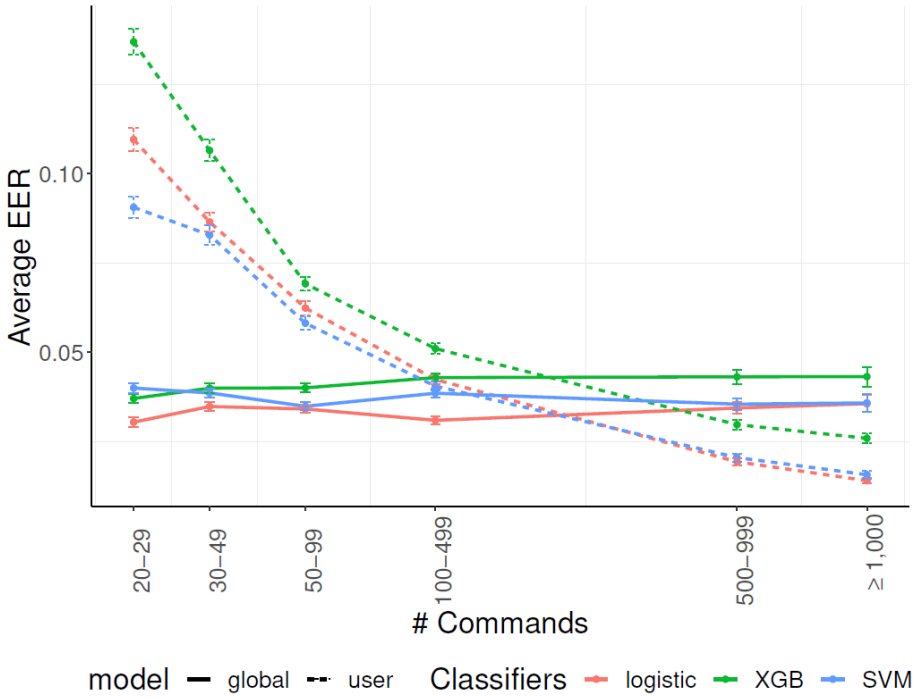
We used BoW (Back of Words) feature, and logistic regression model with LASSO penalty

Global model trained from **randomly selected commands from 700 users** vs **security critical commands**

User-tailored model trained from **user-specific commands** vs **security critical commands**

Evaluation

Starts with the global model for new users (available immediately), and switches to the user-tailored models when users use about 500 commands



Accuracy against Unseen Data (FAR)

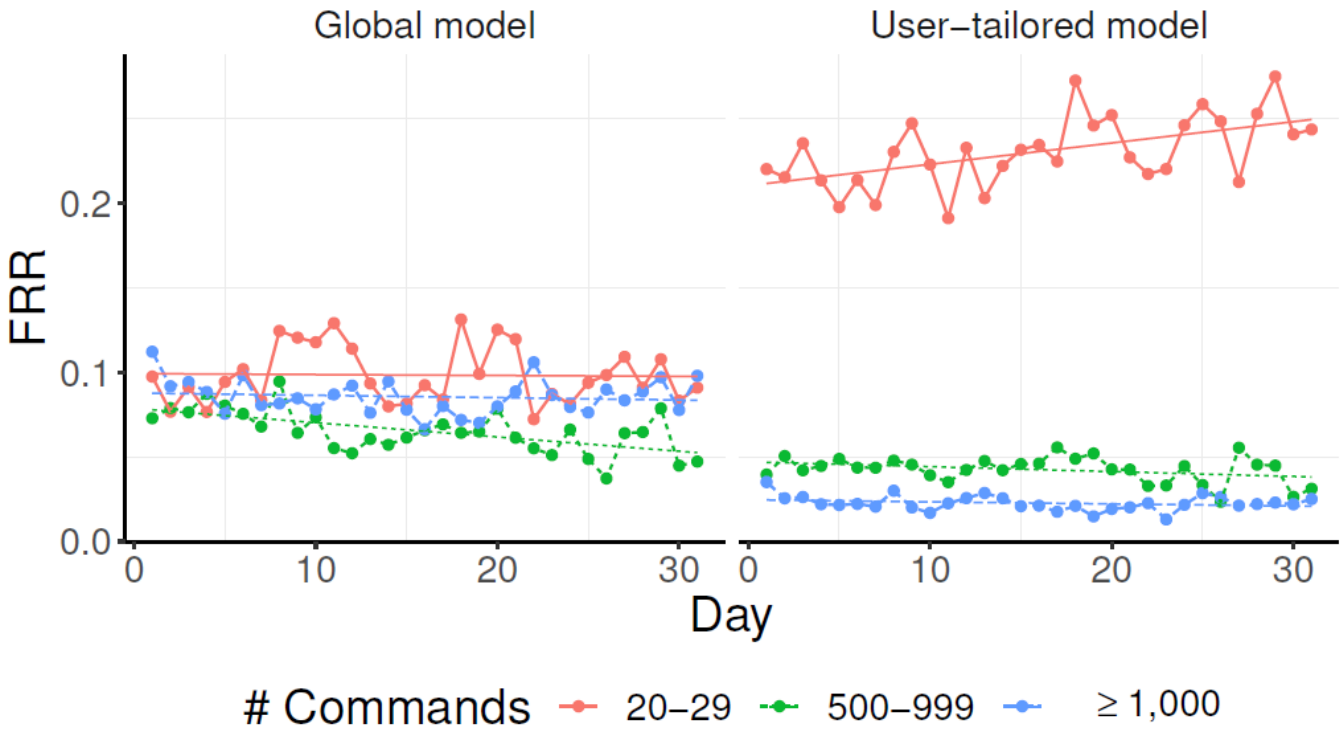
Global model achieves low average FAR at 4.3%

For those who have used 100 or more commands, the user-tailored models achieve lower FARs between 1.7–4.3%

	Global model	User-tailored model					
# Commands		20–30	30–50	50–100	100–500	500–1,000	>1,000
FAR	4.3% (0.03)	10.1% (0.10)	8.34% (0.08)	5.9% (0.06)	4.3% (0.04)	2.3% (0.02)	1.7% (0.02)

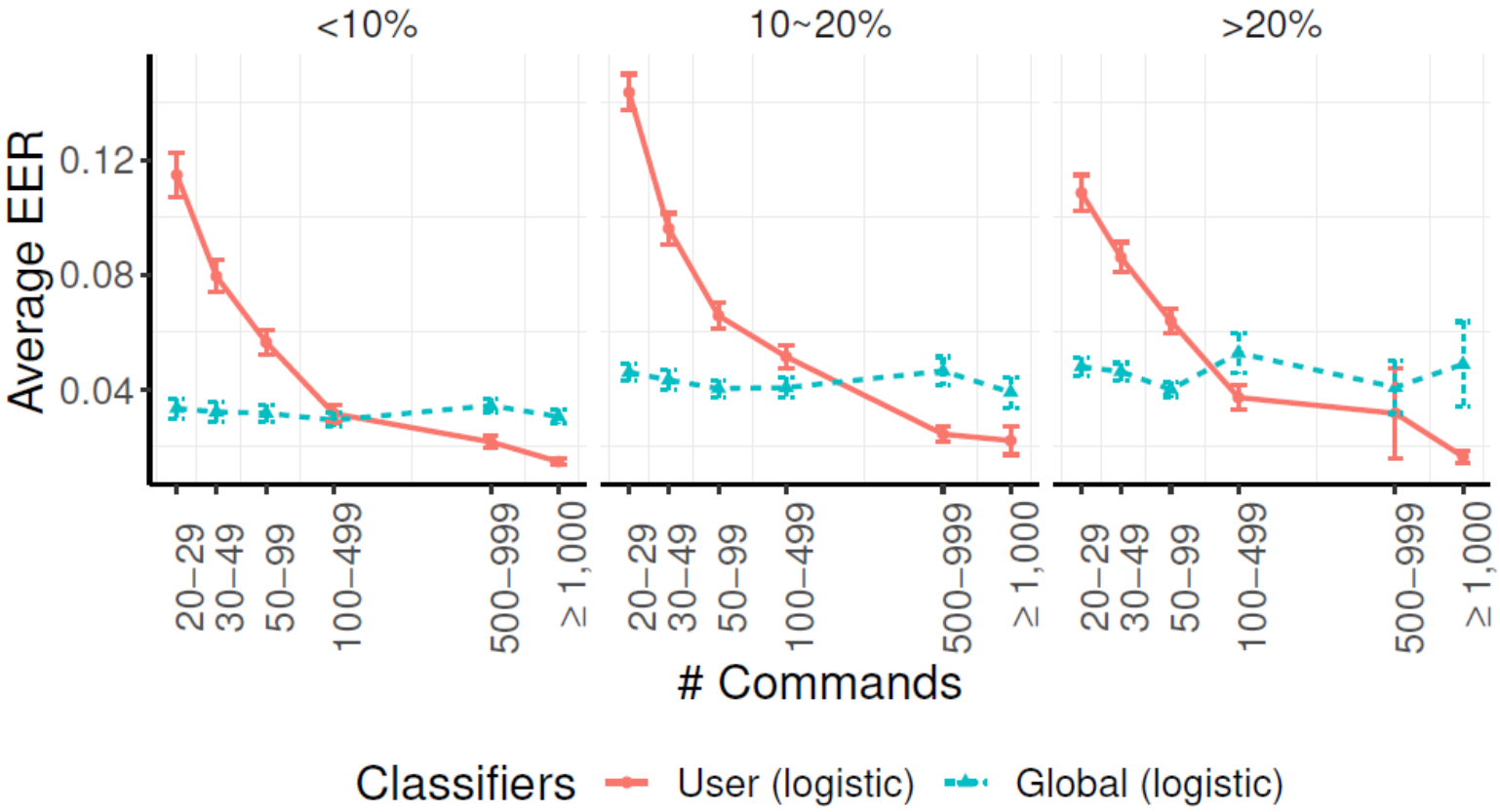
Accuracy against Unseen Data (FRR)

Global model should be used initially to maintain consistent FRRs below 10%, and eventually the user-tailored models would have to be used to achieve FRRs below 5%



Security-Critical Command Users

Twice will maintain average EERs below 5% even for those who frequently use security-critical commands.



Conclusion & Future Work

Can be used as an effective complementary technology to further enhance voice attack detection accuracy

Combined use of the global model and user-tailored models are integral in maintaining low and consistent EERs at around 3.4% for all users

Even for those users who frequently use security-critical commands, we achieve EERs below 5%.

Working toward an adaptive model based solution: user-tailored models are updated periodically

Thank you

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