

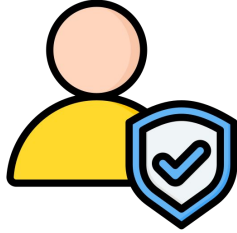
# SKILLPOV: Towards Accessible and Effective Privacy Notice for Amazon Alexa Skills

Jingwen Yan\*, Song Liao\*, Mohammed Aldeen  
Luyi Xing, Danfeng (Daphne) Yao, Long Cheng



# The Importance of Privacy Disclosure

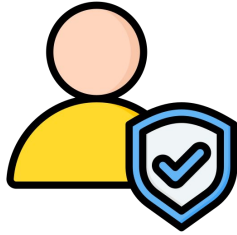
# The Importance of Privacy Disclosure



## Consumers

Privacy disclosure helps build and maintain users' trust. The modern users cares more about their privacy today than ever before.

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Privacy disclosure helps build and maintain users' trust. The modern users cares more about their privacy today than ever before.



## Laws

Businesses must have privacy disclosure (e.g., the General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA)).

# Limitations of Privacy Disclosure to VPA Users



Skills &  
Amazon Alexa Echo Dot

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Skills (voice application)  $\approx$  Apps on your phone.

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Amazon Alexa Echo Dot

Skills (voice application)  $\approx$  Apps on your phone.

**Each skill must have a privacy policy !!!**

**Accessibility** ✗: cannot access the privacy policy through voice interaction with Alexa.



# Limitations of Privacy Disclosure to VPA Users



**1. Open Amazon Alexa app**



2. Find “Skill & Game” section



3. Search for specific skill

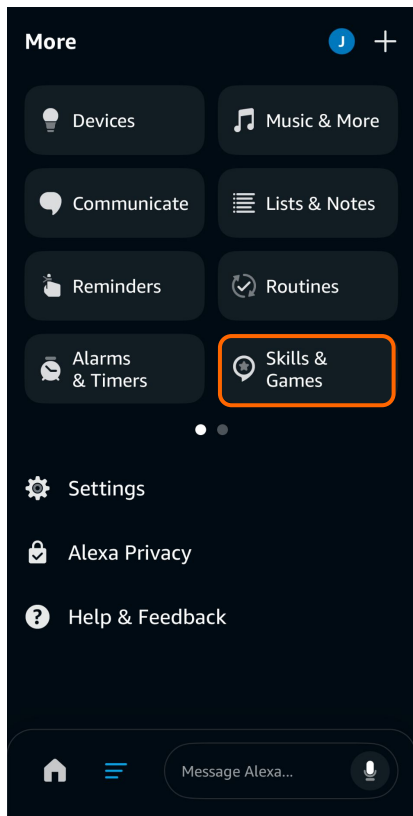


4. Find “Developer privacy policy”



5. Click and read privacy policy

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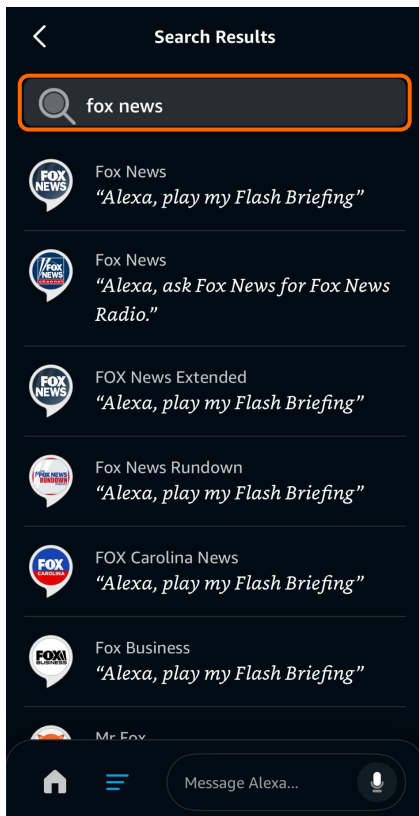


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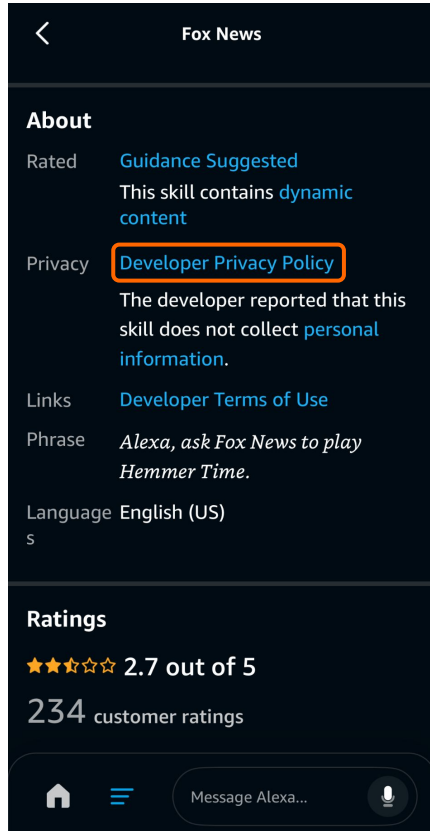


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# Limitations of Privacy Disclosure to VPA Users



# Limitations of Privacy Disclosure to VPA Users



## Privacy Policy

Last Updated/Effective Date: July 1, 2024

### Table of Contents:

#### 1. Scope and Application

What and who this Policy covers

#### 2. Collection of Information

The sources of and methods by which we, our service providers, and our advertisers collect information from and about you, including information about your interaction with the Fox News Services

#### 3. Use and Disclosure

How we use the information we collect from and about you, and who we might share it with and why

#### 4. Security

How we protect your information from loss or misuse

#### 5. User Access and Control

1. Open Amazon Alexa app



2. Find “Skill & Game” section



3. Search for specific skill



4. Find “Developer privacy policy”



5. Click and read privacy policy

# Limitations of Privacy Disclosure to VPA Users

User Study (N = 52) : 86.5% of users struggled with reading skills' privacy policies.

**Readability** ❌

1. Open Amazon Alexa app



2. Find "Skill & Game" section



3. Search for specific skill



4. Find "Developer privacy policy"



5. Click and read privacy policy

**Accessibility** ❌

# Objectives

## Privacy Notice over Voice (PNOV)

An accessible and inclusive mechanism to make users aware of the data practices of Alexa skills through the **conversational interface**.

Objectives



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## Objectives

### New tool development

To make Privacy Notice over Voice practical, we designed and developed the tool named **SKILLPOV** for **developers** to automatically generate Privacy Notice over Voice based on skill code and integrate it to skill code.



# Objectives

## Privacy Notice over Voice (PNOV)

An accessible and inclusive mechanism to make users aware of the data practices of Alexa skills through the **conversational interface**.



## Objectives

### Why for developer?

Skill code is black box - only developers have access to modify the skills' code.

### New tool development

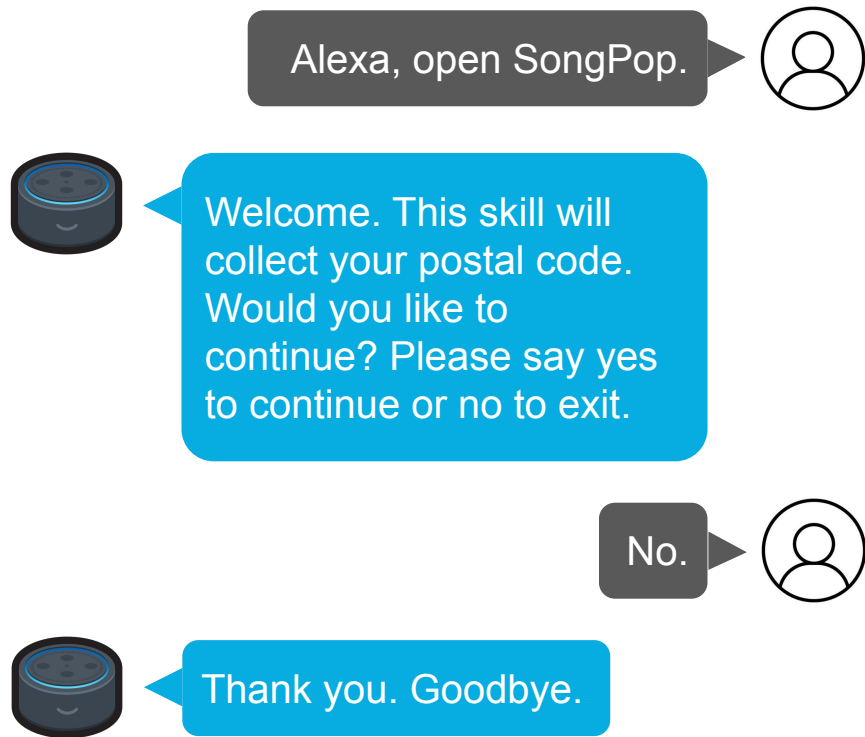
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# What is Privacy Notice Over Voice?

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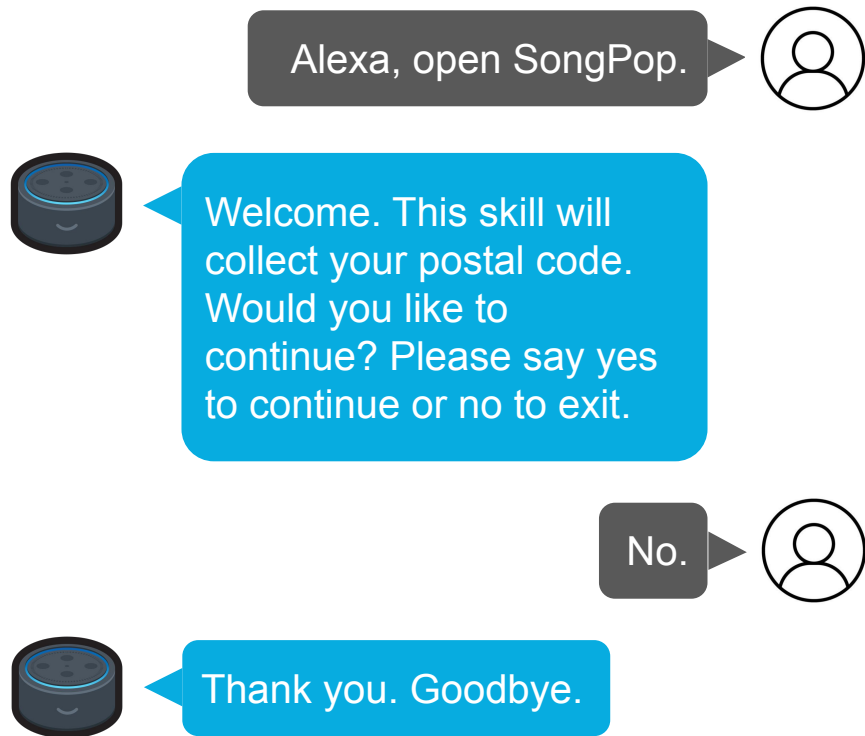
# What is Privacy Notice Over Voice?



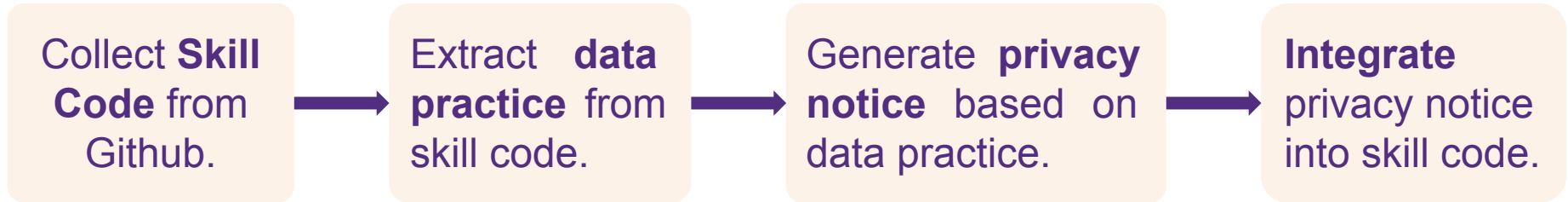
# What is Privacy Notice Over Voice?



**User Study (N = 52)** : 96.2% of users agreed that our proposed Privacy Notice over Voice provides a better way to notify users about their privacy.



# SKILLPOV's Task



# Data Collection in Alexa Skills



## Quotify

by Bluefin Technology Partners

Rated: [Guidance Suggested](#)

★★★★☆ 10

Free to Enable

"Alexa, open Quotify"



alexa open quotify



Thank you for using Quotify. Larry is going to help you out with your car shipping needs. What's your name?

### Manage this Skill

Disable Skill

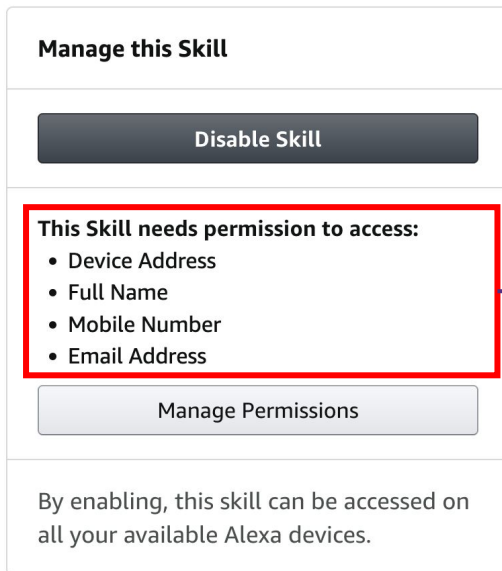
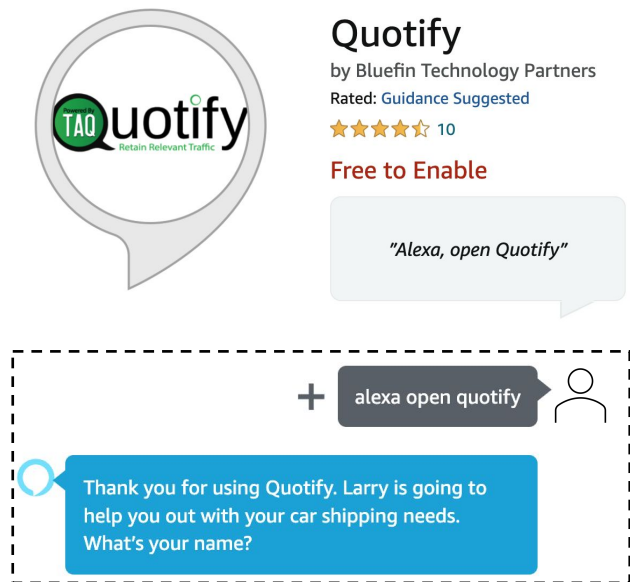
#### This Skill needs permission to access:

- Device Address
- Full Name
- Mobile Number
- Email Address

Manage Permissions

By enabling, this skill can be accessed on all your available Alexa devices.

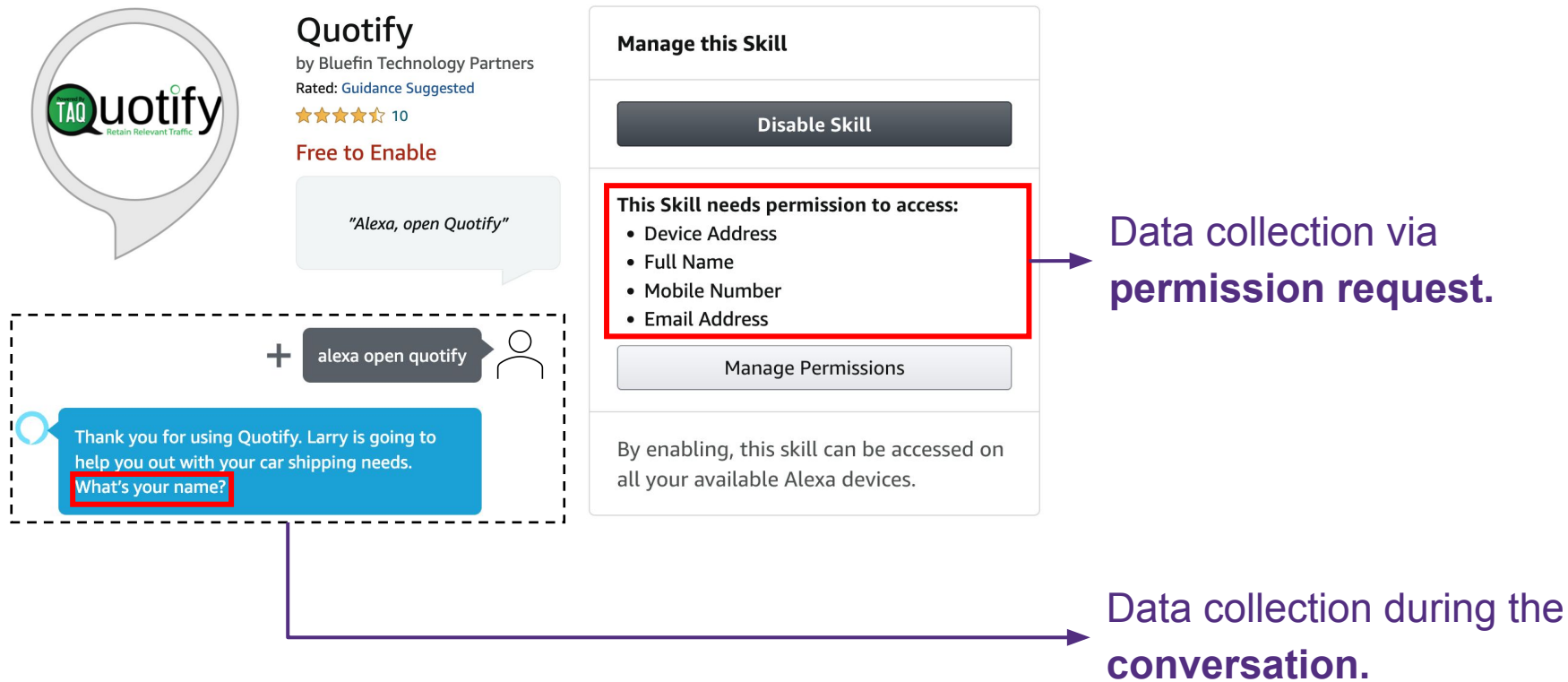
# Data Collection in Alexa Skills



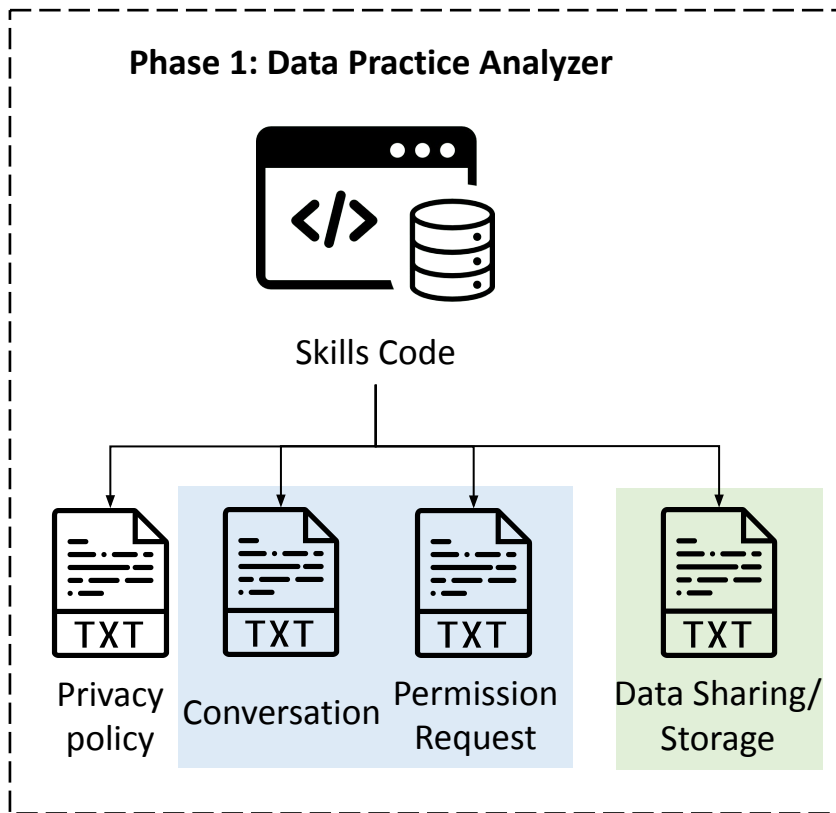
Data collection via  
permission request.



# Data Collection in Alexa Skills



# System Design



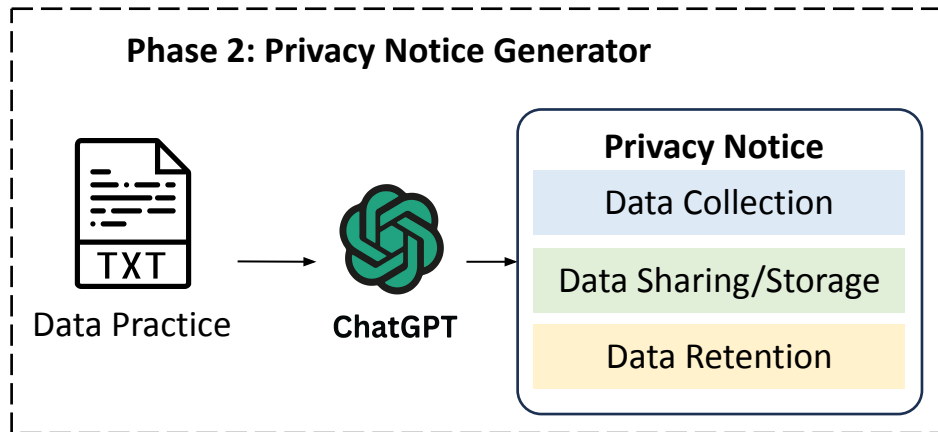
## Method

- Web crawler
- Regular expressions
- NLP-based method
- LLMs

## Result

- 1,459 open-source skill codes from GitHub
- 143 skills with data collection
  - 50 accessible skills' privacy policies
  - 44 skills with data sharing or storage behaviors

# System Design



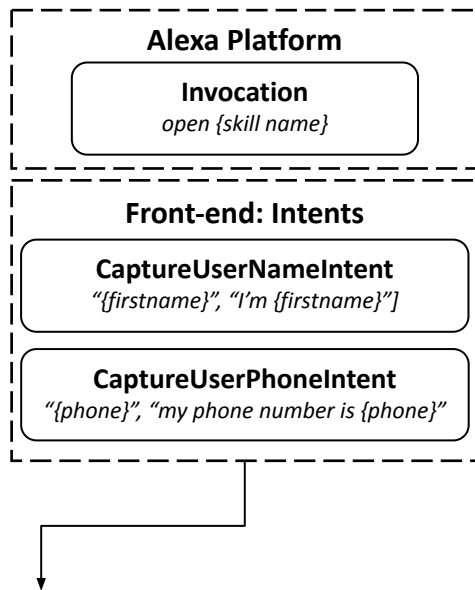
## Method

- Promoting Design

## Result

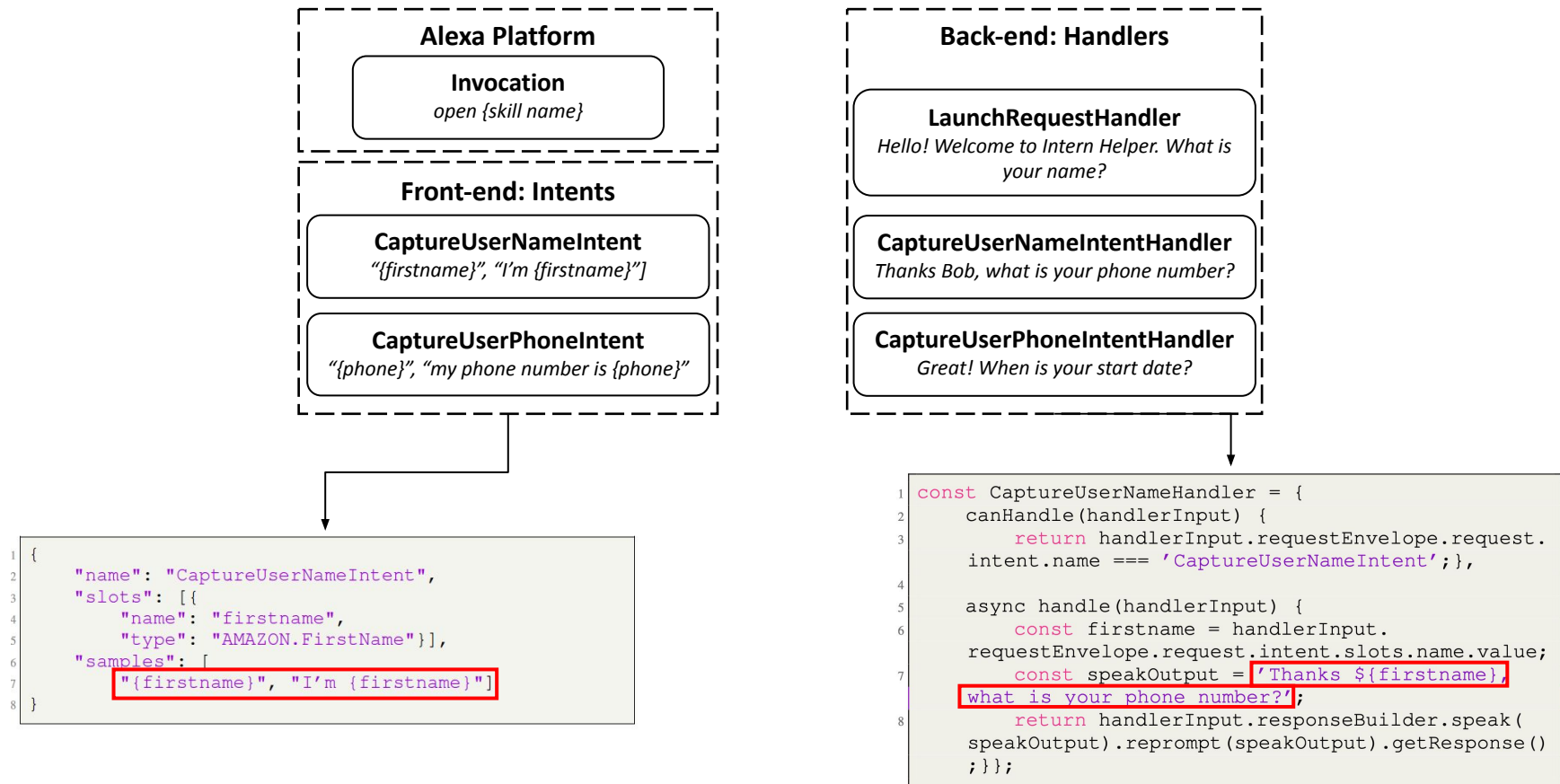
- 143 privacy notices

# Code Structure of Alexa Skills

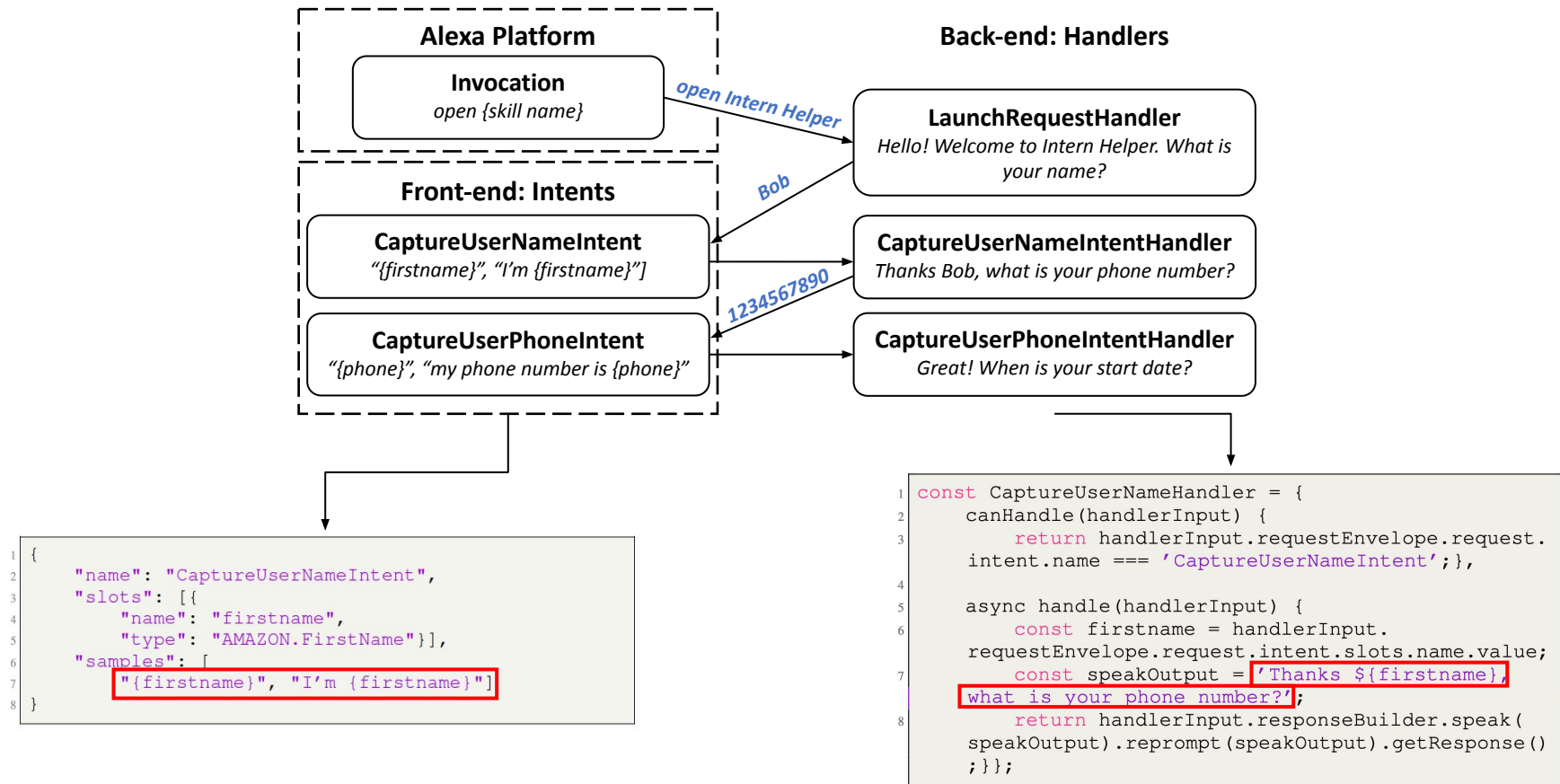


```
1 {
2   "name": "CaptureUserNameIntent",
3   "slots": [{
4     "name": "firstname",
5     "type": "AMAZON.FirstName"}],
6   "samples": [
7     "{firstname}", "I'm {firstname}"
8 ]
}
```

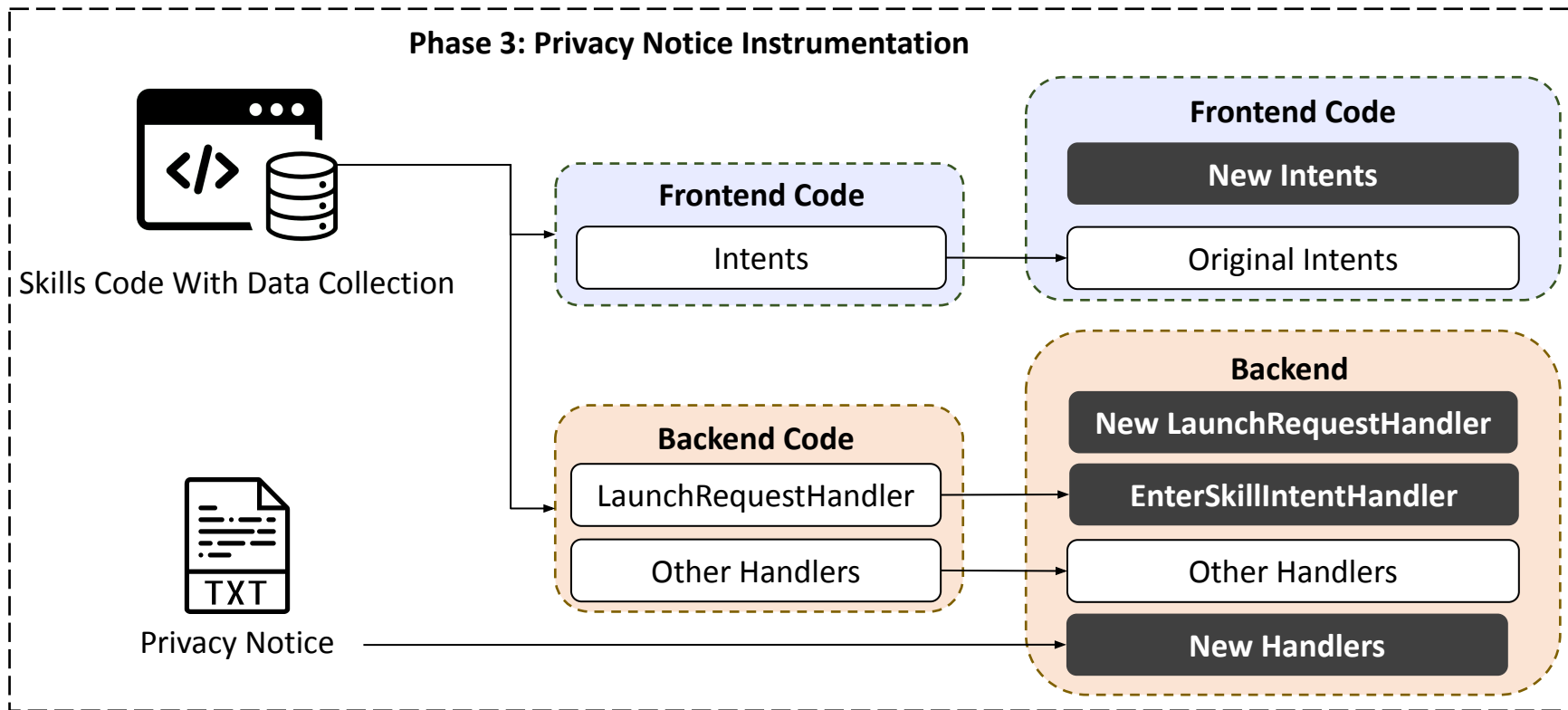
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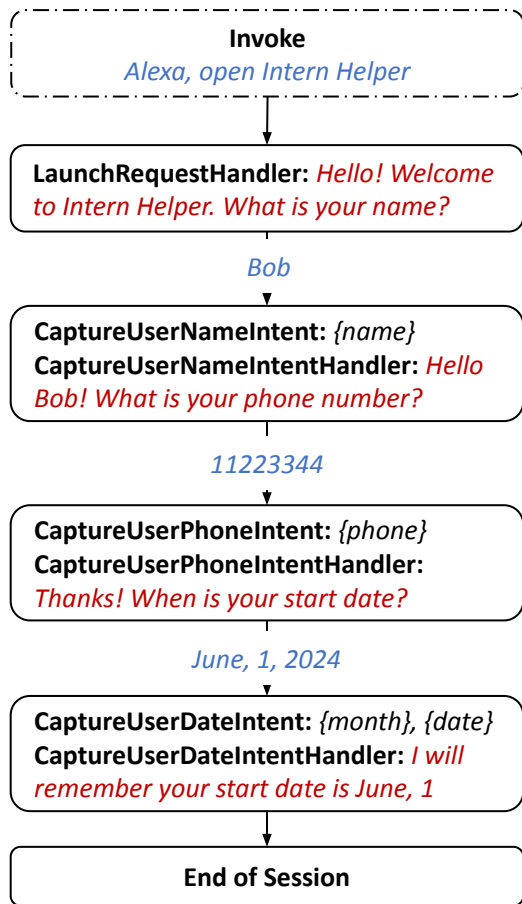
# Code Structure of Alexa Skills



# System Design



# System Design





# System Design

**LaunchRequestHandler:** *Hello! Welcome to Intern helper. This skill contains data practice. Which data practice do you want to learn about? Please say data collection, data usage, data retention or I don't want to know. Remember feel free to ask me anytime later as well.*

Invoke

*Alexa, open Intern Helper*

**LaunchRequestHandler:** *Hello! Welcome to Intern Helper. What is your name?*

*Bob*

**CaptureUserNameIntent:** {name}  
**CaptureUserNameIntentHandler:** *Hello Bob! What is your phone number?*

*11223344*

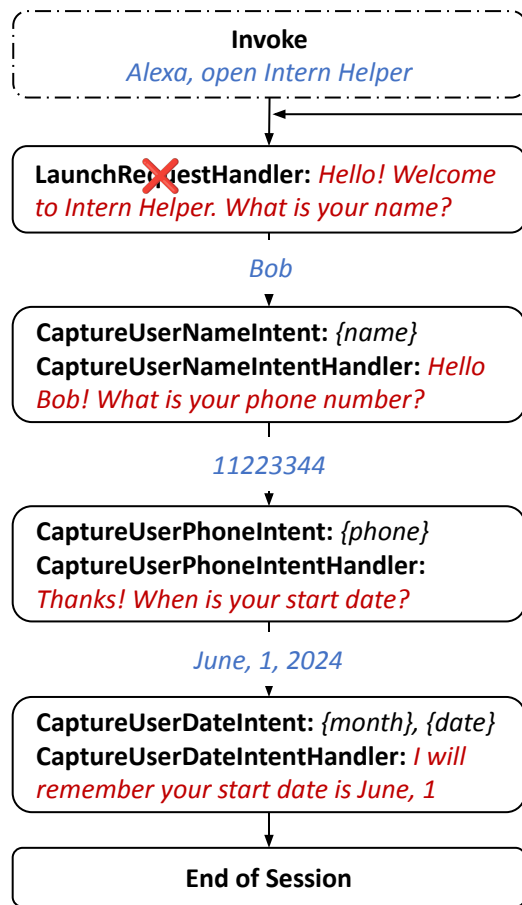
**CaptureUserPhoneIntent:** {phone}  
**CaptureUserPhoneIntentHandler:** *Thanks! When is your start date?*

*June, 1, 2024*

**CaptureUserDataIntent:** {month}, {date}  
**CaptureUserDataIntentHandler:** *I will remember your start date is June, 1*

End of Session

# System Design



**LaunchRequestHandler:** *Hello! Welcome to Intern helper. This skill contains data practice. Which data practice do you want to learn about? Please say data collection, data usage, data retention or I don't want to know. Remember feel free to ask me anytime later as well.*

**CollectionIntent:** *data collection*  
**CollectionIntentHandler:** *This skill will collect your name ..... Would you like to continue?*

**UsageIntent:** *data usage*  
**UsageIntentHandler:** *Your name is stored in DynamoDB ..... Would you like to continue?*

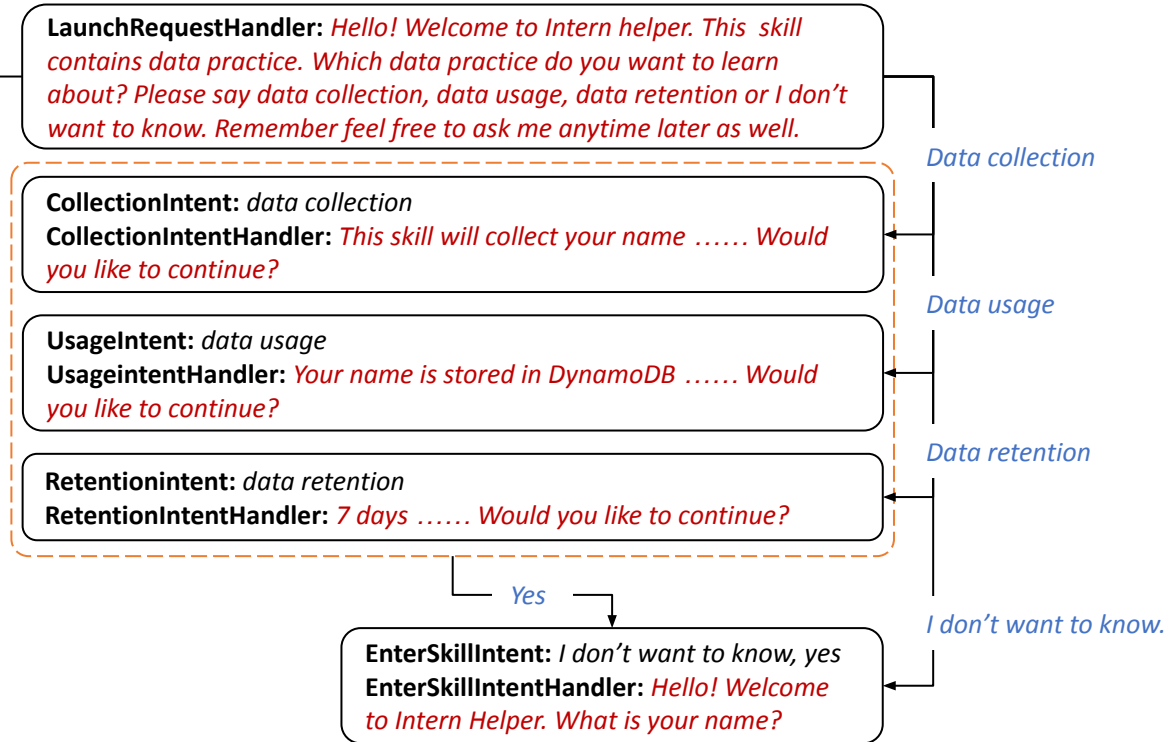
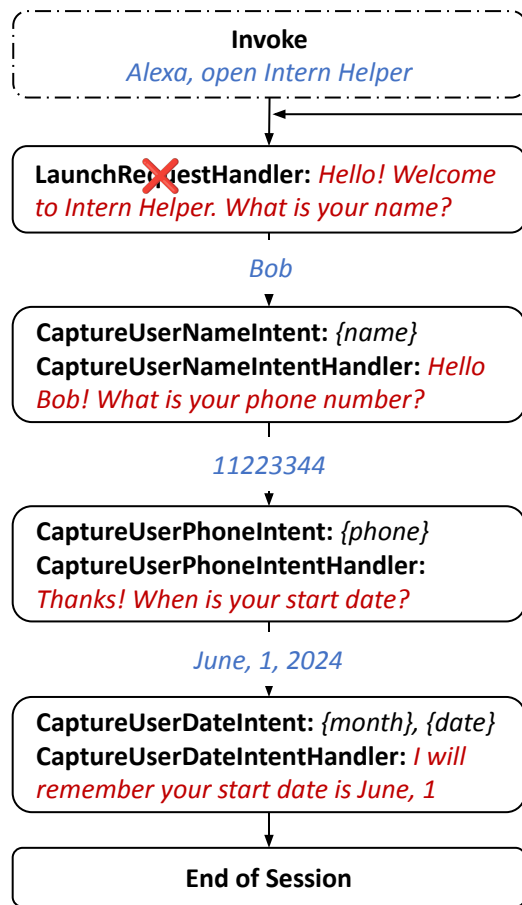
**Retentionintent:** *data retention*  
**RetentionIntentHandler:** *7 days ..... Would you like to continue?*

*Data collection*

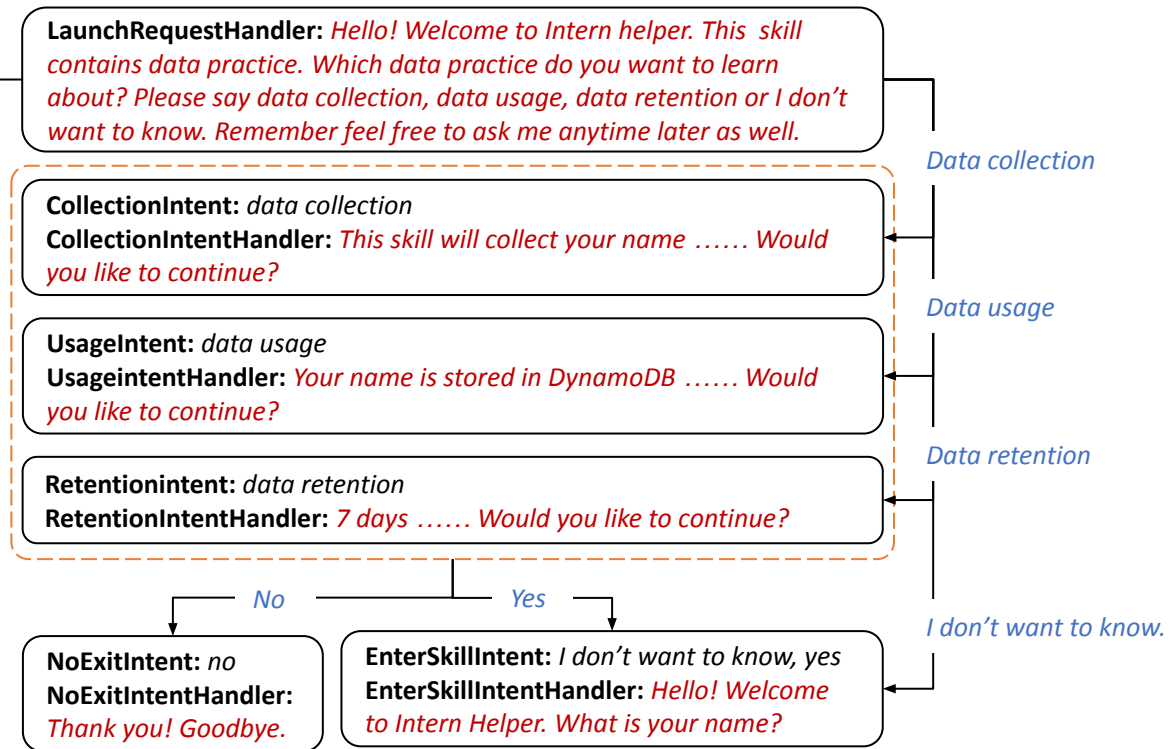
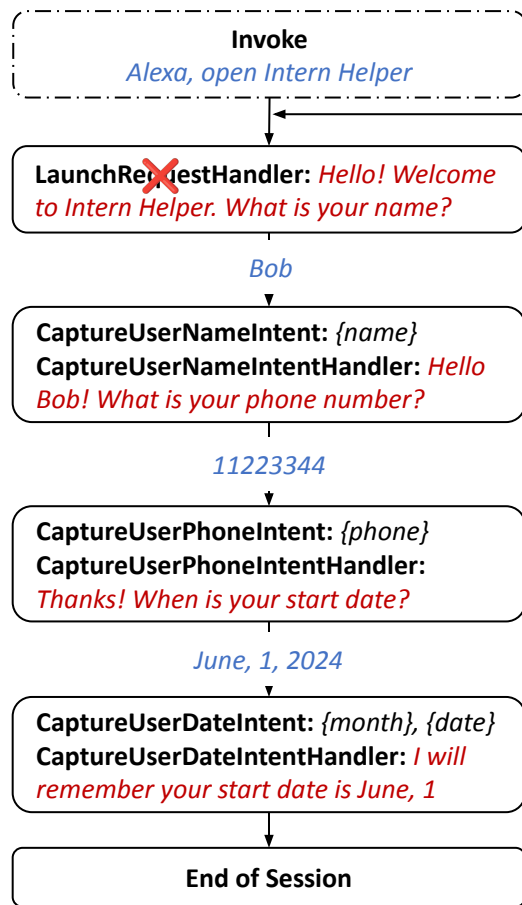
*Data usage*

*Data retention*

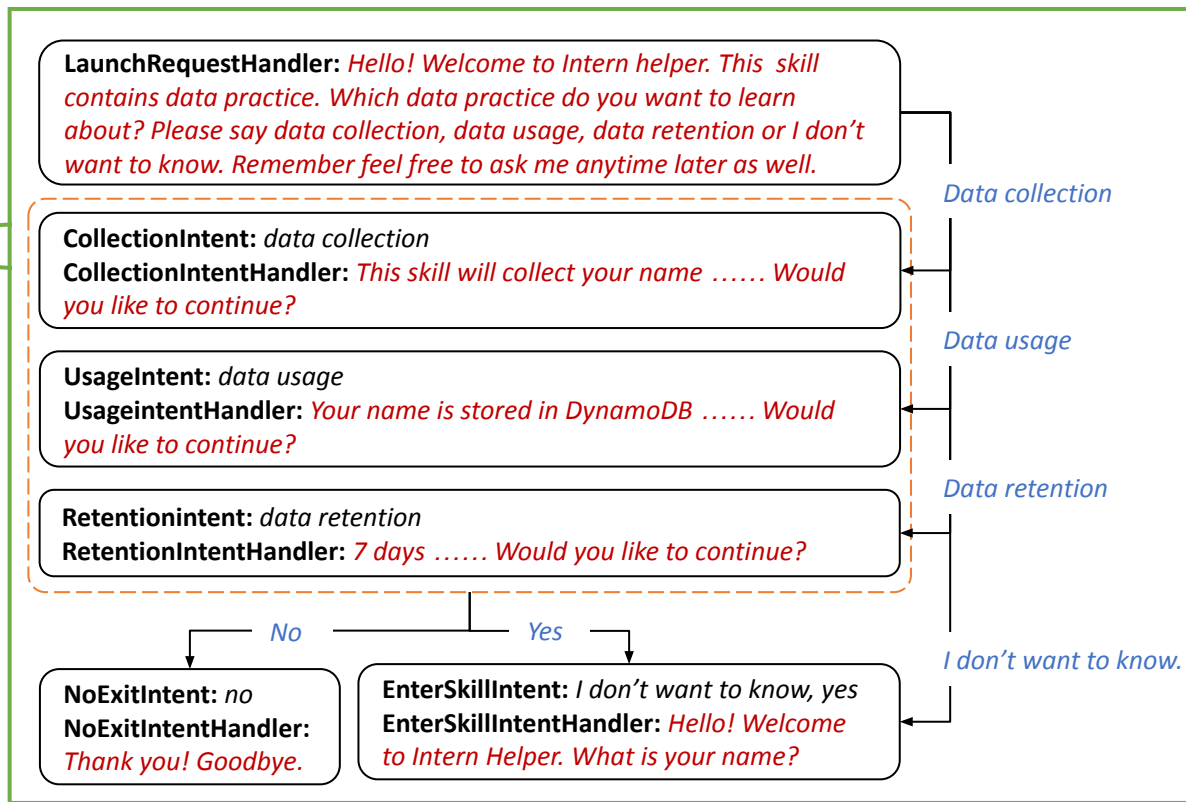
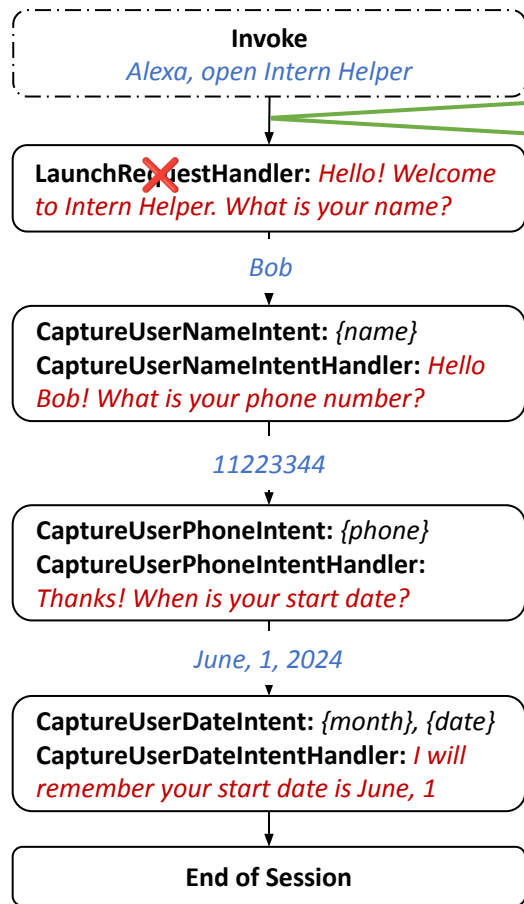
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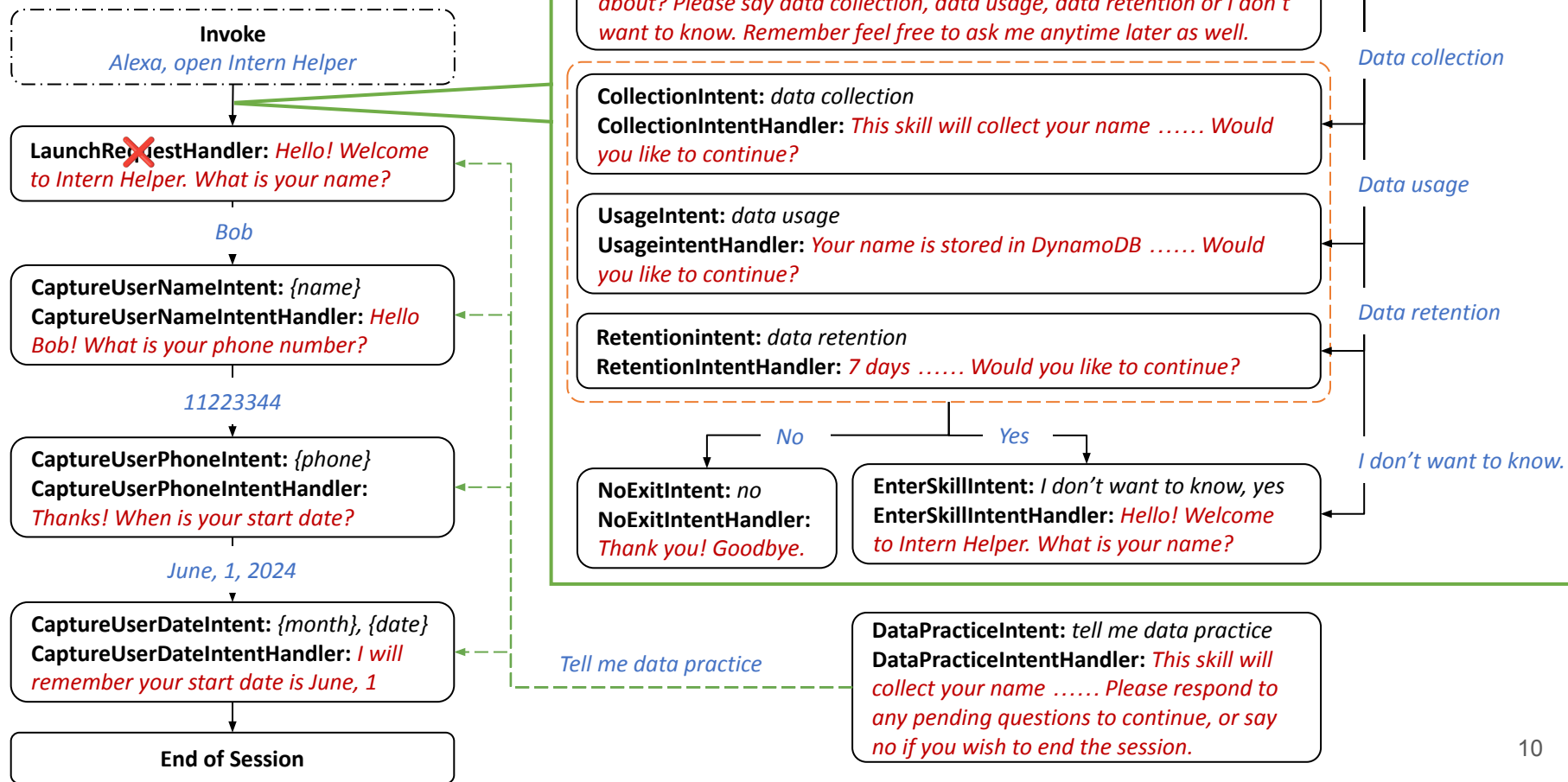
# System Design



# System Design



# System Design



## Original Skill

Alexa, open Intern helper



Hello! Welcome to Amazon Intern Helper. What is your name?

Emma



Hello Emma! What is your phone number?

1234567890



Great! When is your start date?

June, 1, 2024



Thanks, I'll remeber that you will start on June 1 2024.

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Data collection

This skill will collect your name and phone number during the conversation. Also, this skill will seek your email permission. Please say yes to continue or no to exit.

Yes

Hello! Welcome to Amazon Intern Helper. What is your name?

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Data collection

I don't want to know

This skill will collect your name and phone number during the conversation. Also, this skill will seek your email permission. Please say yes to continue or no to exit.

Hello! Welcome to Amazon Intern Helper. What is your name?

Tell me data practice

This skill will collect your name and phone number during the conversation. Also, this skill will seek your email permission. The name is stored in AWS S3. The data retention period is 7 days. Please respond to any questions to continue, or say no to exit.

Yes

Hello! Welcome to Amazon Intern Helper. What is your name?

Emma

Emma

Hello Emma! What is your phone number?

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# Evaluation



## ① **Functionality - 100%**

Whether SKILLPOV can successfully generate privacy notices and integrate them into skill code.

# Evaluation



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- Manually upload and deploy the skill's code in the Alexa Developer Console then execute.
- 17 developers verified SKILLPOV could execute successfully using their skill code.

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Whether the privacy notice content generated by SKILLPOV using our designed prompts always follows the expected sentence pattern.

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## ③ Readability, Accuracy and Completeness

When comparing the privacy notice content generated by SKILLPOV against the traditional *privacy policies* and *online generators*, how about their performance?

# Evaluation - Accuracy & Completeness

Skill Name	Privacy Policy	SKILLPOV	Ground Truth
Polar Cast	-	name	name
Reddit Deals	name	name	name
Feed Me Now	location, address, phone number, <b>email</b>	<b>name</b> , location, address, phone number	<b>name</b> , location, address, phone number
Megafood's Wellness Assistant	Age and 12 other data	age	age
<b>Average Accuracy</b>	<b>35.3%</b>	<b>91.3%</b>	-
<b>Average Completeness</b>	<b>50%</b>	<b>96.4%</b>	-

# Takeaways

## Privacy Notice over Voice

- An accessible and inclusive mechanism to make users aware of the data practices of Alexa skills through the conversational interface.

## New insight from user study

- 92.3% of participants liked the design of Privacy Notice over Voice and 70.2% of participants agreed that such mechanism provides better accessibility and readability than traditional privacy policies.

## SKILLPOV

- A tool for developers to analyze data practice, generate privacy notices and integrate privacy notices into skill code.

## Evaluation

- 91.3% accuracy and 96.4% completeness.



# Thank you!

## Q&A



Source code & Paper &  
User study result



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