

A Crowd-Powered Conversational Assistant That Automates Itself Over Time

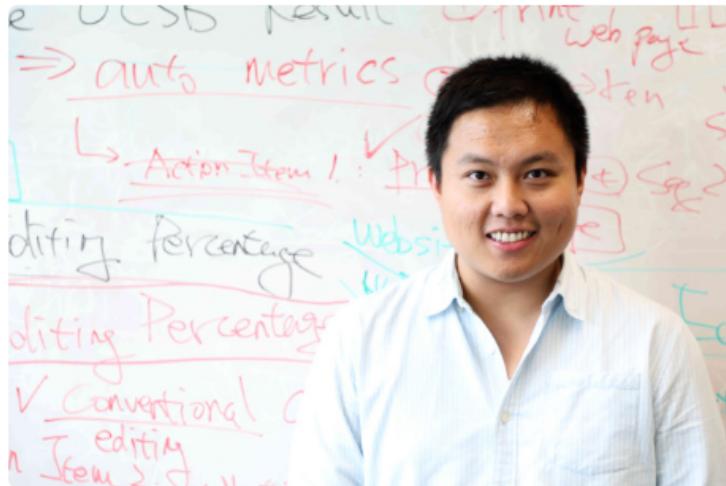


Lecturer: Kenneth Huang

Pennsylvania State University
`txh710@psu.edu`

Mar 26, 2019

About Me



Ting-Hao (Kenneth) Huang 黃挺豪

Tenure-Track Assistant Professor

College of Information Sciences and Technology (IST)

Pennsylvania State University (University Park)

Office: E357 Westgate Building

Email: txh710@psu.edu

We are hiring! Come work with us!

I combine AI with crowdsourcing to create systems that are more usable, robust, and intelligent.

- Curriculum Vitae (CV)
- Google Scholar
- Twitter: @windx0303
- Website: KennethHuang.cc



@windx0303

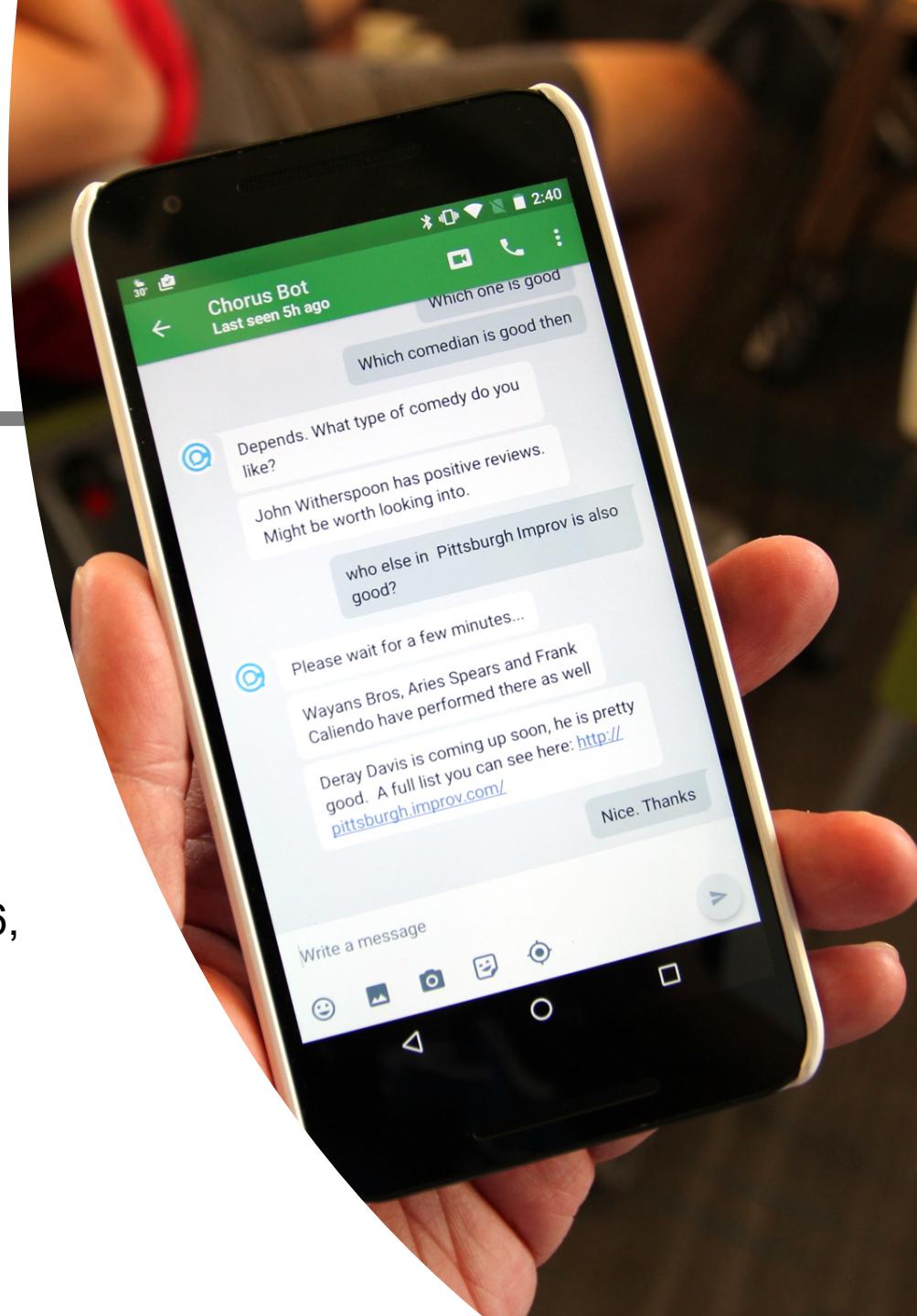


KennethHuang.cc



A Crowd-Powered Conversation Assistant

- CHI'18 🎫, CHI LBW'16 🎫
- UIST'17, UIST Poster'17
- HCOMP'17, '16, '15, HCOMP DC'16, HCOMP WIP'14
- CI'17
- CSCW Workshop'17





Chorus Bot

Active 2h ago



4 / 76

Hi



What can I help you with? I'll be able to chat in a few minutes.

Hi

What can I help you?

I'm moving to Penn State in summer

Mid July



What can I do for you?

What can I do in Penn State area?

like, during summer?

like, during summer?



I would love to help you.

Are you looking for summer events?

yeah, in Penn State area

Penn State University I mean



Remington Ryde Bluegrass Festival is held in July in that area.



Oh, wow

What is that?



There will be food and craft vendors and live music throughout the weekend.

What is that?



There will be food and craft vendors and live music throughout the weekend.

The 9th annual Remington Ryde Bluegrass Festival at the Grange Fair Grounds. 19 bands will be performing throughout the weekend.

Oh. Cool!



It's July 7-10th

Anything else?

Like, in State College particular, any concert or art festival?

Like, in State College particular,
any concert or art festival?



There is a “Best of the Best” car show on Allen Street in downtown State College. Families can enjoy strolling amongst remarkable vehicles from times past and enjoy free activities for children as well.

The screenshot shows the header of the "LAST CRUISE" website. The header features a blue classic car grille with the "LAST CRUISE" logo in the center. Below the grille are links for "REGISTRATION/BROCHURE", "SPONSORSHIP", "RESULTS", "CONTACT", and "EVENTS PAGE". A red arrow points from the text above to this header area.

Last Cruise Invitational Show, July 29, 2018.

A true “Best of the Best” car show on Allen Street in downtown State College, participants are invited based on their success in other competitions and the quality of their vehicles. This invitational car show is one of 4 major fundraising events YSB holds yearly to raise money for the programs that we serve. The day starts with a car show from 1-4PM, followed by an award ceremony at 4PM, and then the cruise around downtown from 4:30-6PM.

NEW THIS YEAR! YSB is selling tickets to win a 1964 Ford Galaxie 500 Coupe 390 V8 4 Speed! The winning ticket will be drawn at our show this year! For more information, please visit [click here](#).

Special thanks to Chuck Carroll Photography ([www.chuckcarrollphotography.com](#)) for taking great photos at the show!

It's also in July

Lemont Fest

Lemont Fest?

The screenshot shows the header of the "LEMONT FEST" website. The header features the word "LEMONT FEST" in large, bold, black letters. Below the header is a detailed description of the event:

Lemont has one of the most unique and historic exhibiting spaces in central Pennsylvania. 30+ vendors will have booths set up Inside and outside the Grain Elevator. Local food and beverage vendors will be located on the Village Green. Local bands will play throughout the afternoons on the Village Green stage, antique cars will be on display and other artistic activities for children and adults will also take place. Speeder rides will be hosted by the Bellefonte Historic Railroad Society. Art activities will be hosted by the Art Alliance of Central PA and other local artists.

Where: Lemont Village Green and historic Grain Elevator on Mt. Nittany Road, Lemont PA 16855

When: Friday, July 13th: 11 am - 6 pm, Saturday, July 14th: 10 am - 6 pm, Sunday, July 15th: 10 pm - 4 pm

CALL TO ARTISTS: If you are interested in exhibiting please download the documents at the bottom of this page. Please contact everything you need! This will be a juried event. Proceeds will be used for advertising both online and in print) and to benefit the Lemont Village Association's Granary Project.

For questions or to submit your application please contact Sean Bodley at lemonfestpa@gmail.com or (412) 334 - 1799



An art, music, and food festival
in July as well.

Cool! Do you know the semester
starting date of Penn State?



An art, music, and food festival
in July as well.

Cool! Do you know the semester
starting date of Penn State?

for Fall 2018



Which semester? Fall, Spring,
or summer?

Fall



Classes begin on August 20th

I see



What else can I help you with?

i will join Penn State as a new
professor in Fall haha



What else can I help you with?

i will join Penn State as a new professor in Fall haha

Just want to explore the area before class starts

I think that's it. Thanks!



You are welcome!

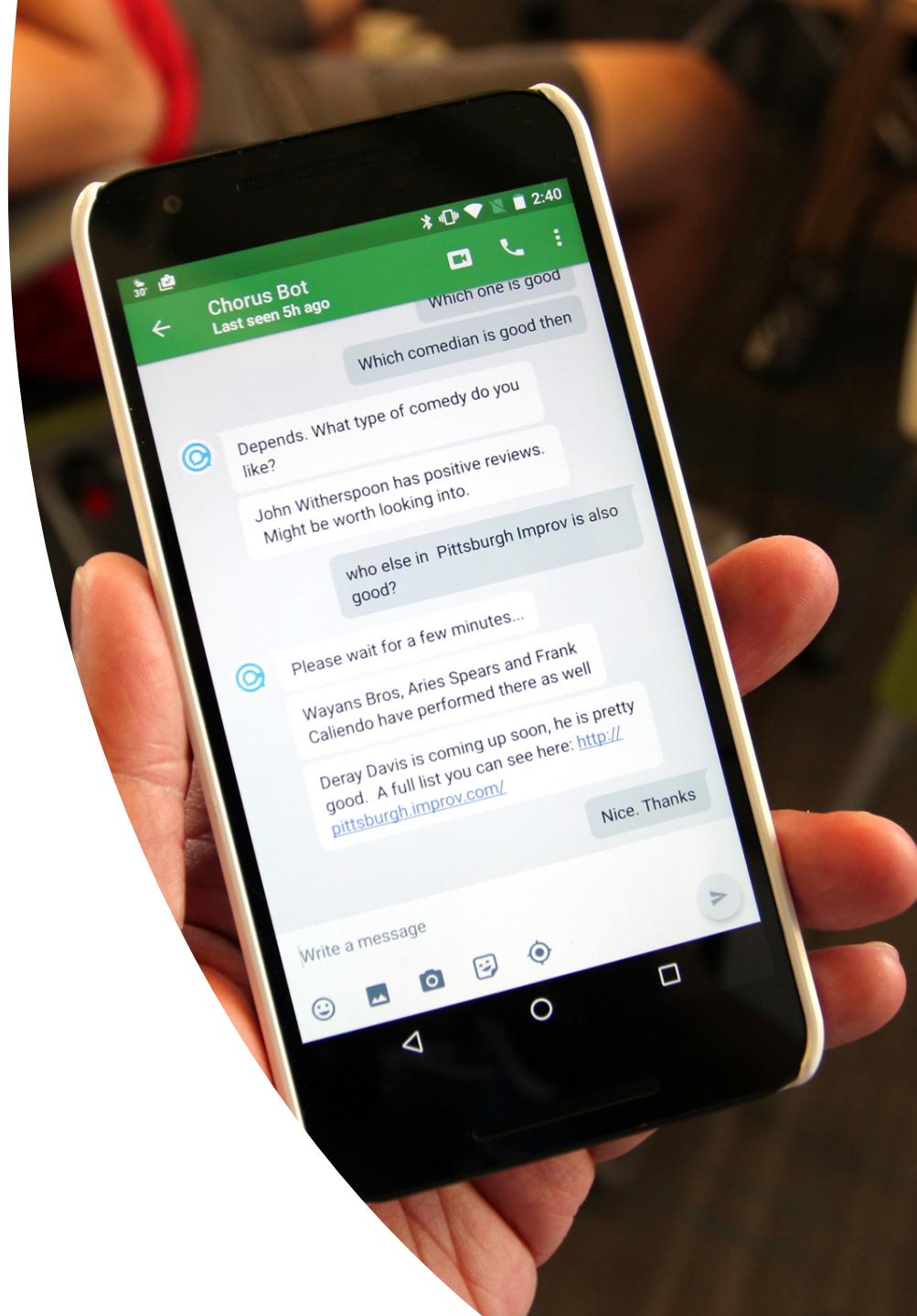
[How satisfied are you with this conversation?]

1. Very dissatisfied
2. Dissatisfied
3. Neither dissatisfied nor satisfied
4. Satisfied
5. Very satisfied

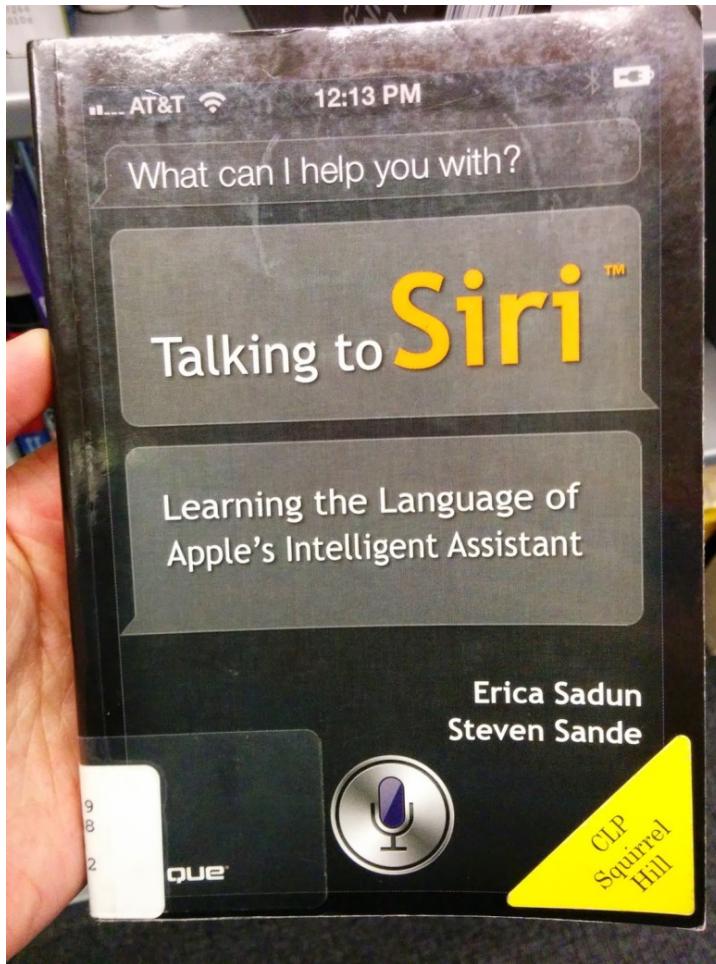
You have 10 minutes to answer this question

What just happened?

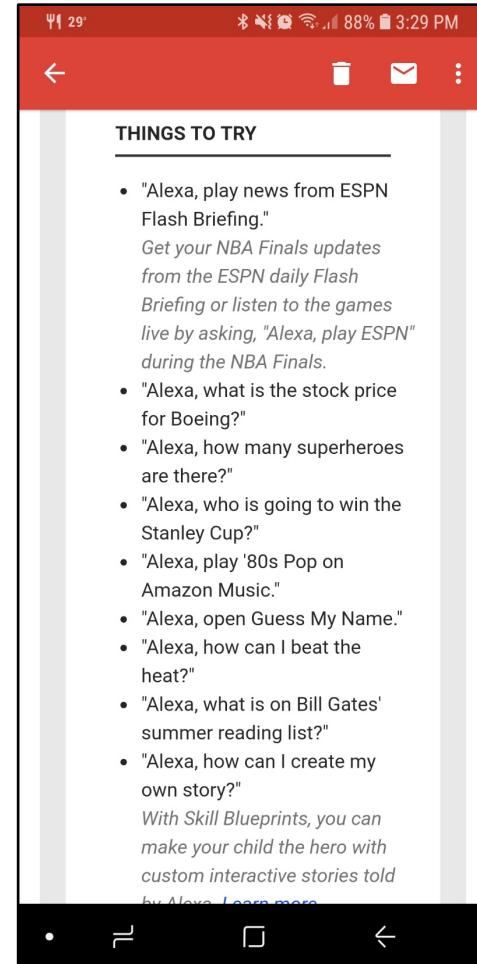
- Open Conversation
- Multi-turn interaction
- Multiple domains
- Personalized
- Coherent dialog
- Mix of task-oriented and social conversation



Today's Conversational Assistants...



“Talking to Siri”



“What’s new with Alexa?”

Automated



Personal
Assistants

Open Conversation

Existing Approaches to Open Conversation

- Combining **multiple automated dialog systems**
 - DialPort (Zhao, *et al.*, 2016)
- **End-to-end** framework for dialogue systems
 - Serban, *et al.* 2016; Li, *et al.* 2017
- **Adapting** a model to many other domains
 - Walker, *et al.*, 2007; Sun, *et al.*, 2016
- **Chit-chat** systems (social bot)
 - Hold social conversations (Banchs, *et al.*, 2012)
- **Still a very hard problem...**

The Alexa Prize

A \$500,000 prize will be awarded to the team selected for creating the best socialbot. The second- and third-place teams will receive prizes of \$100,000 and \$50,000, respectively. Additionally, a **\$1 million** research grant will be awarded to the winning team's university if their socialbot achieves the grand challenge of **conversing coherently and engagingly with humans for 20 minutes** with a 4.0 or higher rating.

Existing Approaches to

February 27, 2018

- C
- E
- A
- C



Amazon is trying to make Alexa more chatty—but it's very, very difficult

A \$500

place t The online retailer held a competition to have graduate students make its personal assistant into a grant w more conversational bot. Nobody won.

conversing coherently and engagingly with humans for 20 minutes with a

MIT Technology Review
Feb 27, 2018

Automated



Personal
Assistants



AI-Powered
Dialog Systems

Open Conversation

Automated



Personal
Assistants



AI-Powered
Dialog Systems

Open Conversation

Automated



Personal
Assistants

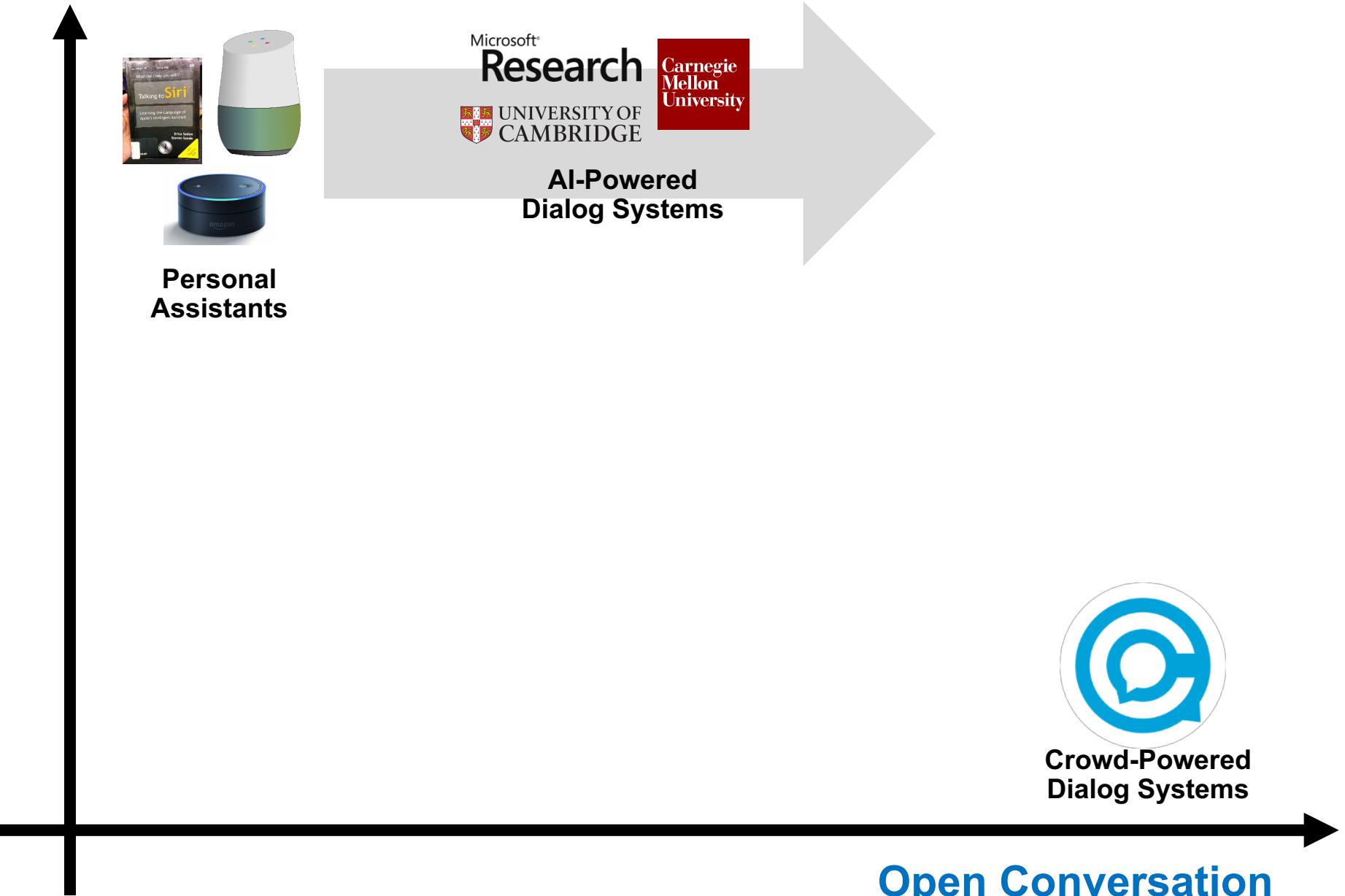


AI-Powered
Dialog Systems



Crowd-Powered
Dialog Systems

Open Conversation



Automated



Personal
Assistants



AI-Powered
Dialog Systems



Crowd-Powered
Dialog Systems

Open Conversation

Automated



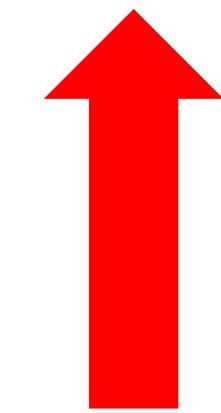
Personal
Assistants



AI-Powered
Dialog Systems

Kenneth's Thesis!

Open Conversation



Crowd-Powered
Dialog Systems

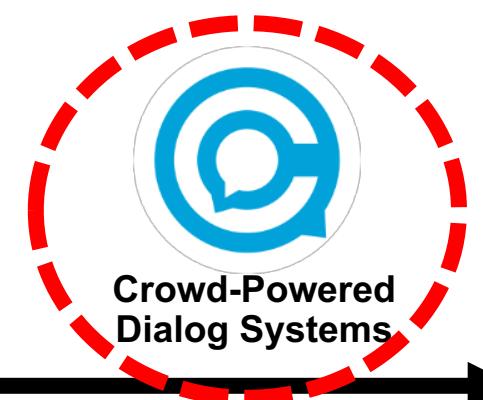
Automated



Personal
Assistants

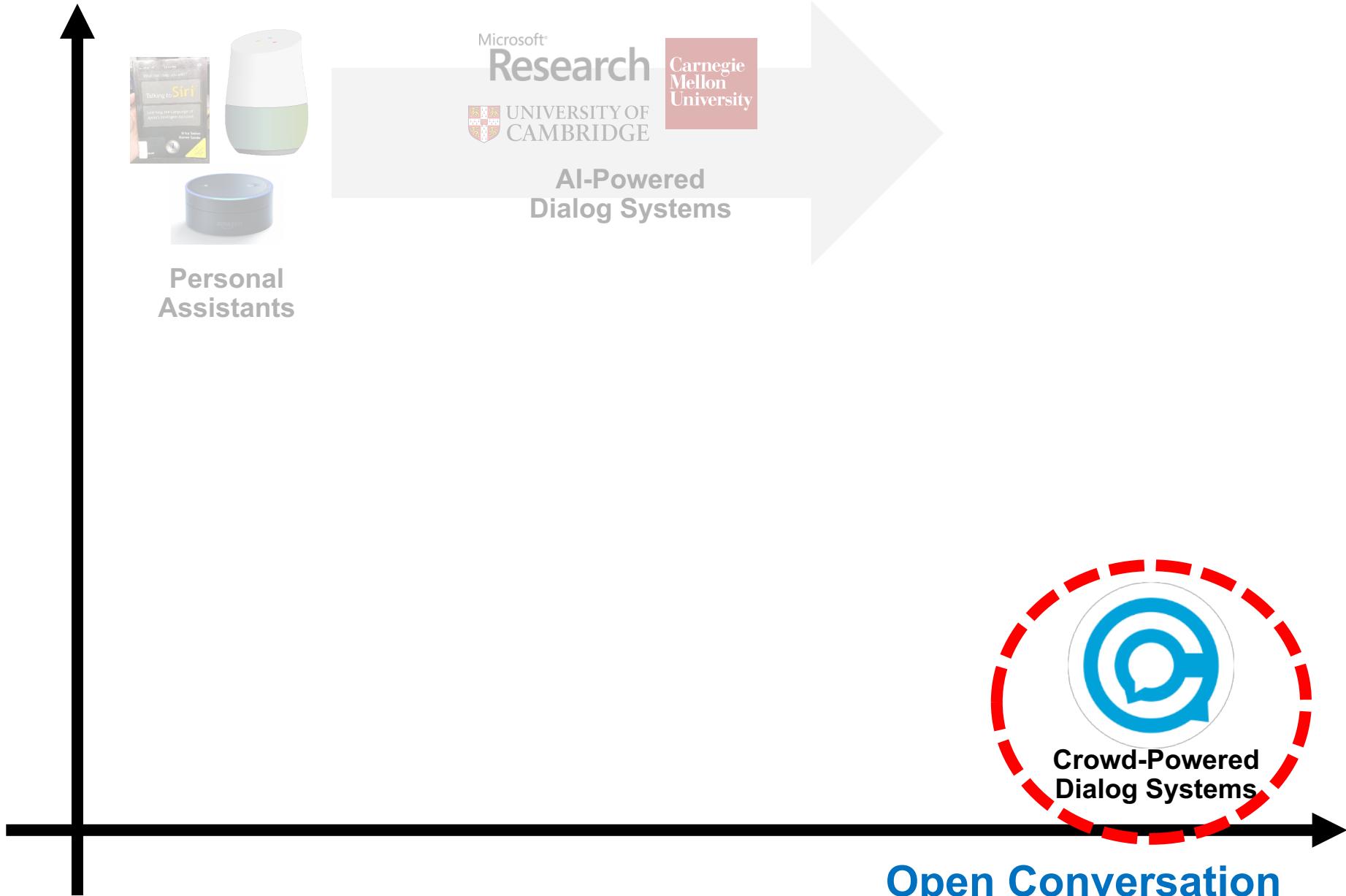


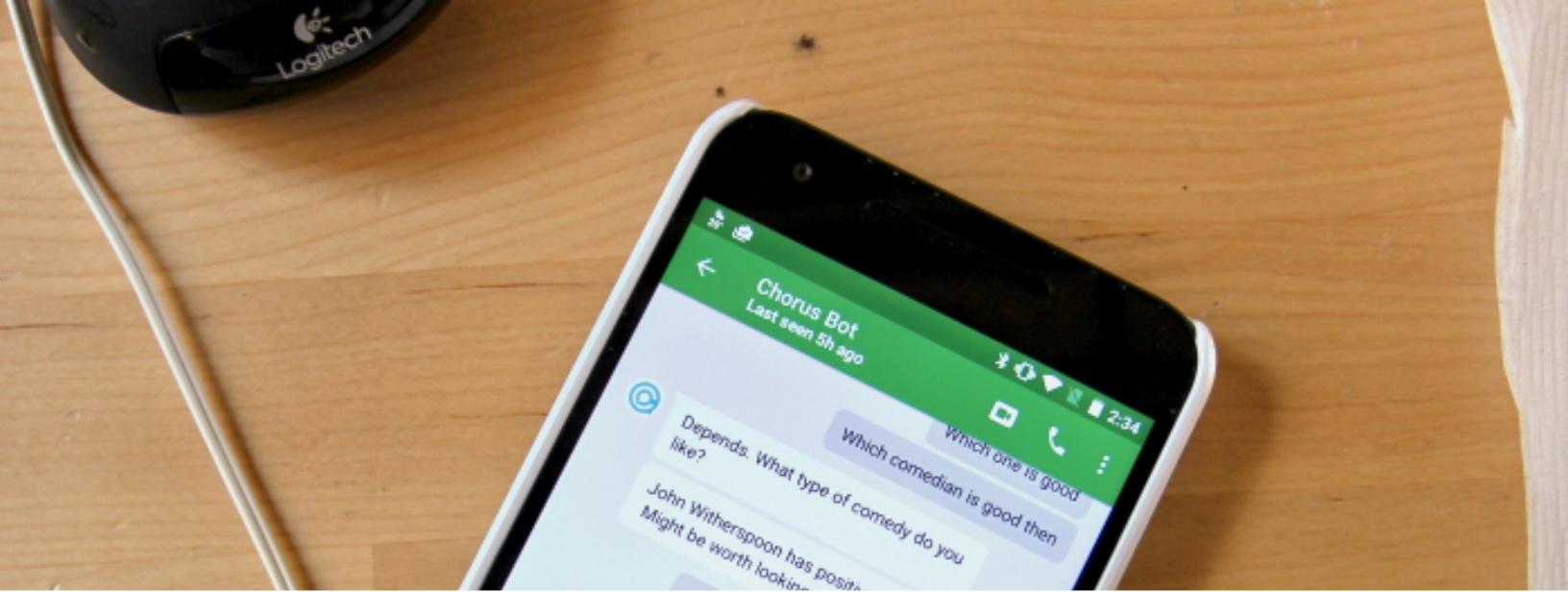
AI-Powered
Dialog Systems



Crowd-Powered
Dialog Systems

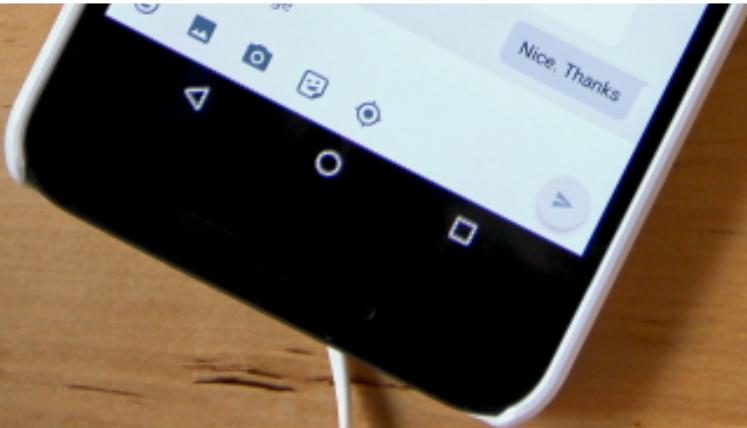
Open Conversation





Chorus: A Crowd-Powered Conversation Assistant

[HCOMP'16, HCOMP'17]

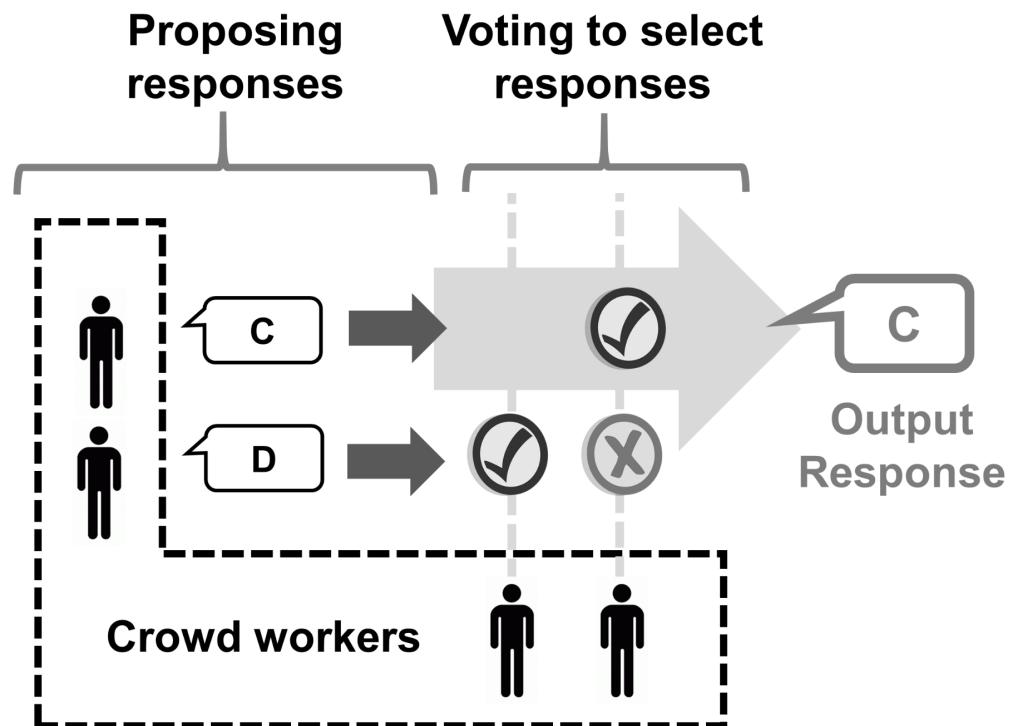


Chorus: A Crowd-Powered Conversation Assistant

- Crowd workers collectively hold a conversation by:

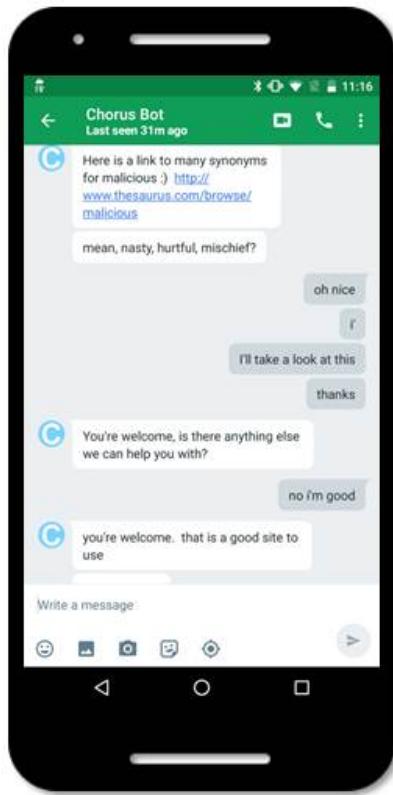
1. Propose Responses
2. Vote Responses
3. Take Notes

- Reward points for each action
- Agreement bonus



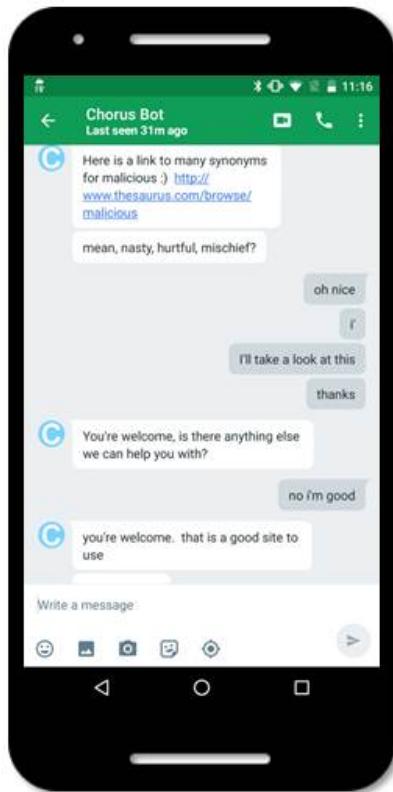
User Interface

User Client



User & Worker Interface

User Client



Worker Interface

This conversation is over. Submit the HIT now.

Submit although the conversation isn't over.

Hello, worker 30675 !

Workers on this Page: 3

4800

~ \$0.06 Bonus

You can submit now

Important Facts

Keep notes of important facts about this conversation.

E.g., located in Austin, Texas

Fact online video games (by worker 2390)

Fact Shutdown law (by worker 5916)

↑ Current conversation's facts

↓ Previous conversation's facts

Fact 515. are you from India? (by worker 248)

Fact Heh. I am just too worked up here.. :) (by worker 248)

To report any malicious or abnormal users or workers, send emails to the requester at windex0303@gmail.com

Every User is Different. Help to Solve His/Her Problems!

The user is talking via Google Hangouts. All the workers on this page please pretend you were a single conversational agent called "Chorus". Please collaborate with other workers to respond to this user.

User i'

User I'll take a look at this

User thanks

Crowd You're welcome, is there anything else we can help you with? (by worker 4073)

User no I'm good

Crowd you're welcome. that is a good site to use (by you) thumb up

Crowd Thank you. Have a great day! (by worker 19) checkmark cross

Crowd Hi (by worker 7) checkmark cross

Read the chat history. Do not say the same thing twice.

Don't say the same thing that have been said by others workers (E.g. "How can I help you?")

Downvote duplicate responses. bell icon

Send

Hangoutsbot

Web Server



Is this conversation over? Click here if the conversation is over.

Every User is Different. Help to Solve His/Her Problems!

The user is talking via **Google Hangouts**. All the workers on this page please **pretend you were a single conversational agent** called "**Chorus**". Please collaborate with other workers to respond to this user.

Hello, worker 144664 !

Workers on this Page: 2

Crowd Is there anything else I can answer for you?

(by worker 139809)



User That's it



User Thanks



Crowd Have a nice day!

(by worker 139809)



Crowd I hope you have a nice day as well!

(by worker 144680)



User Hi



↑ Previous conversation of this user.

↓ Current conversation starts here.

User Hi



Auto Reply hello

(by bot 131971)



Crowd Do you have any questions?

(by worker 139809)



Read the chat history. Do not say the same thing twice.

I

Send

Don't say the same thing that have been said by others workers (E.g. "How can I help you?").

Downvote duplicate responses.

Reach 4000 points to submit

1312

~ \$0.016 Bonus

Important Facts

Keep notes of important facts about this conversation.

E.g., located in Austin, Texas

↑ Current conversation's facts

↓ Previous conversation's facts

Fact User wants to know the weather in Pittsburgh. (by worker 139809)

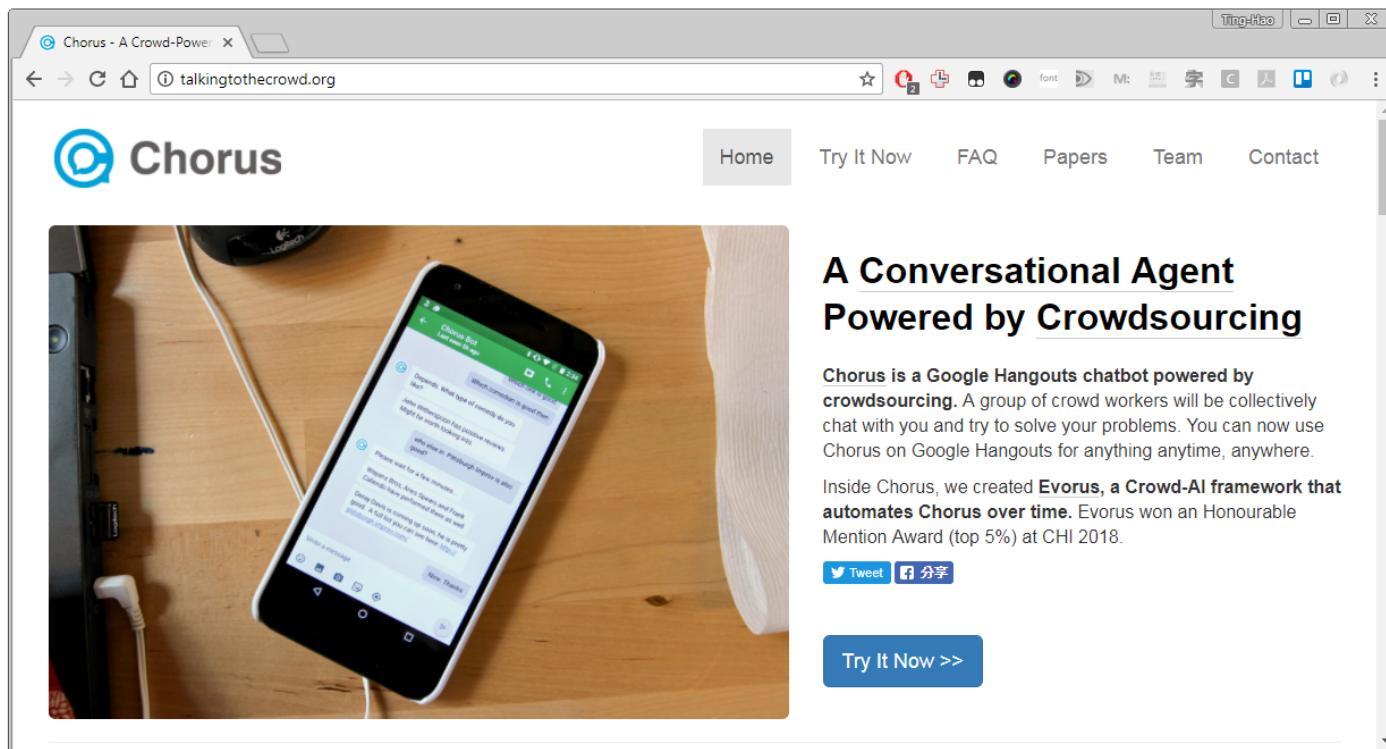
To report any malicious or abnormal users or workers, send emails to the requester at windex0303@gmail.com

Downvote bad chats. Upvote good chats. Only the chats with enough vote count will go through.

Pretend you are a **single chatbot** called Chorus.

We Deployed Chorus

- Launched on May 20th, 2016
 - On Google Hangouts
 - **2200+** conversations, **420+** users
- [TalkingToTheCrowd.org](http://talkingtothecrowd.org)



The screenshot shows a web browser window titled "Chorus - A Crowd-Powered Chatbot". The URL in the address bar is "talkingtothecrowd.org". The page content includes the Chorus logo, a navigation bar with links to Home, Try It Now, FAQ, Papers, Team, and Contact, and a main section titled "A Conversational Agent Powered by Crowdsourcing". This section contains text about Chorus being a Google Hangouts chatbot powered by crowdsourcing, and mentions Evorus, a Crowd-AI framework. Below this is a "Try It Now >>" button. To the left of the text is a photograph of a white smartphone lying on a wooden surface, displaying the Chorus mobile application's conversational interface.

Gift Suggestion

Can you suggest some birthday present for one of my friend?

U

female, computer science PhD student in Texas



Sure! What types of things does your friend like?

U

we're going to visit her this weekend from Pittsburgh

She's in Austin



Does she have any favorite TV shows, movies, or video games?

Gift Suggestion



Can you suggest some birthday present for one of my friend?

female, computer science PhD student in Texas



Sure! What types of things does your friend like?



we're going to visit her this weekend from Pittsburgh

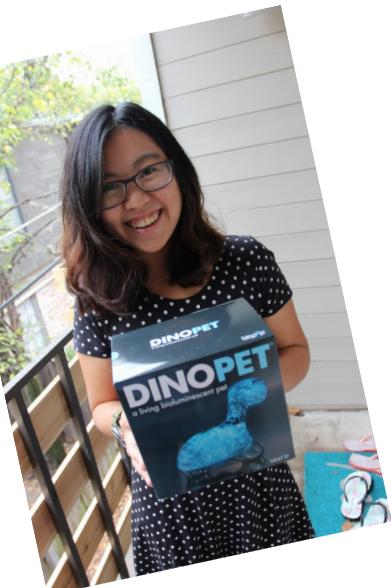


She's in Austin



Does she have any favorite TV shows, movies, or video games?

Gift Suggestion



Can you suggest some birthday present for one of my friend?



female, computer science PhD student in Texas



Sure! What types of things does your friend like?



we're going to visit her this weekend from Pittsburgh

She's in Austin



Does she have any favorite TV shows, movies, or video games?

Travel Planning



How many suitcases can I take on a flight from the US to Israel?



Let me check

Can I ask you from where are you planning to board the flight?

Pittsburgh



with which company are you flying?

and which air services are you using?

What Did We Learn?

- **Challenges Identified**
 - **Malicious** workers & users
 - Identifying **the end of a conversation**
 - When workers' consensus is not enough...
- **Basic Statistics**
 - Avg session duration = 10.63 min (SD=8.38)
 - Avg #message per session = 25.87 (SD= 27.27)



Foundation for future automation!

Automated



Personal
Assistants



AI-Powered
Dialog Systems

Chorus Deployment

[HCOMP'16, HCOMP'17]



Crowd-Powered
Dialog Systems

Open Conversation

Automated



Personal
Assistants

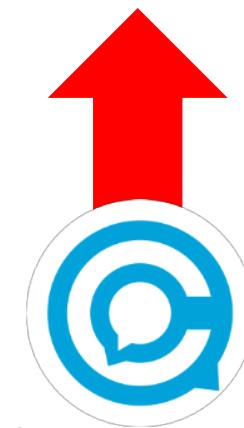


AI-Powered
Dialog Systems

Chorus Deployment

[HCOMP'16, HCOMP'17]

Open Conversation



Crowd-Powered
Dialog Systems

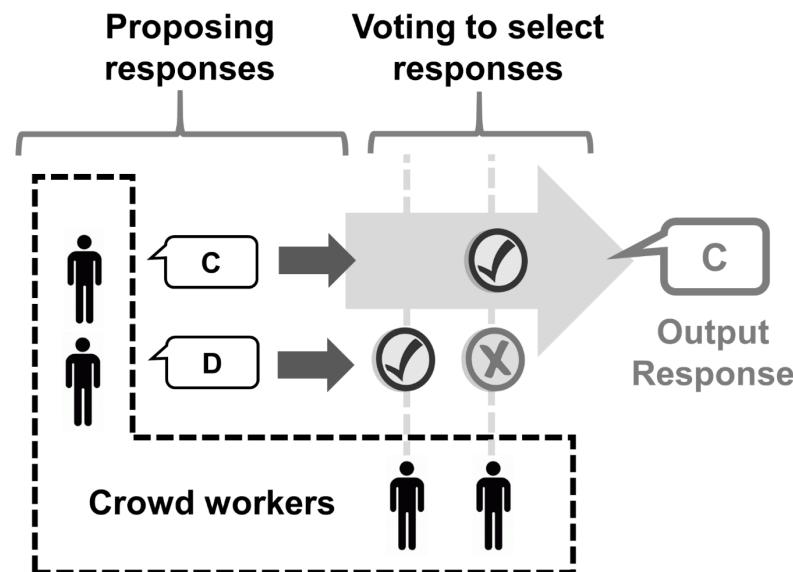


Evorus: A Crowd-Powered Conversational Assistant Built to Automate Itself Over Time

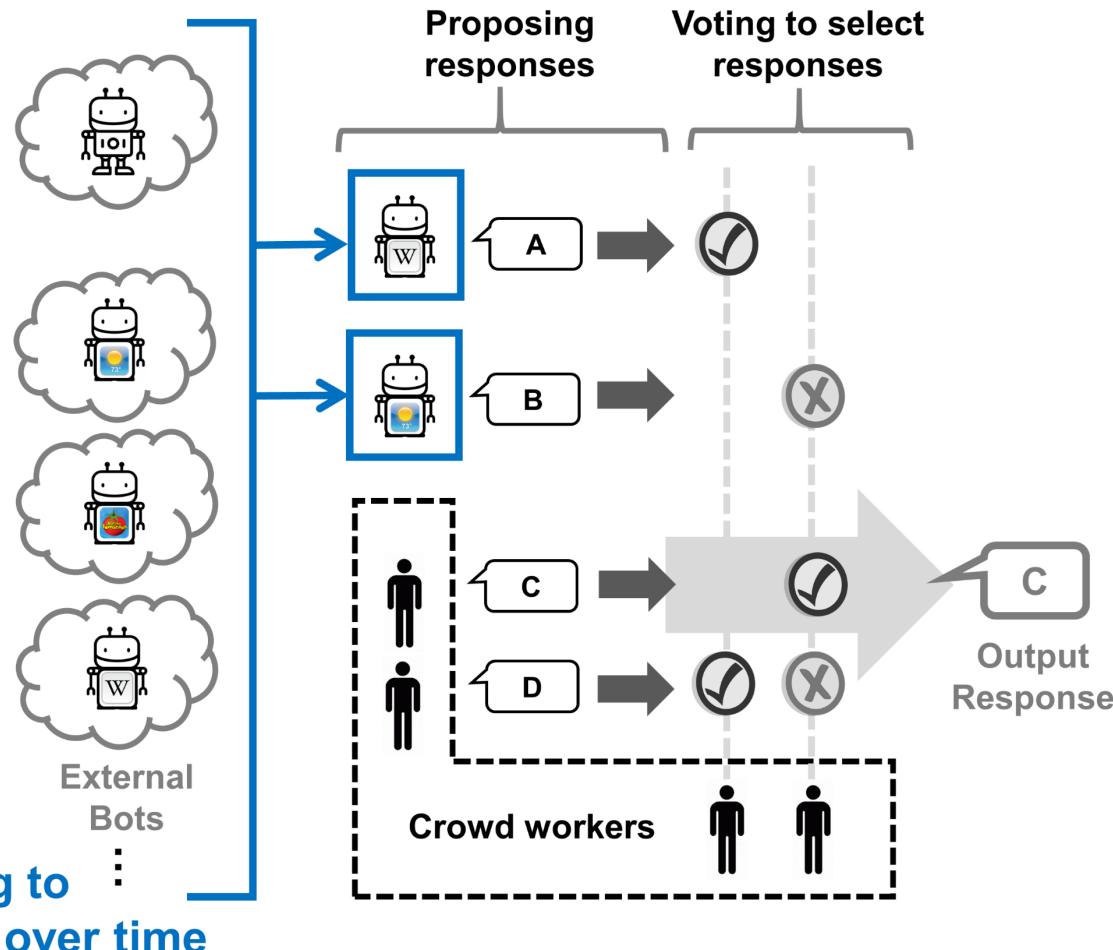
[UIST Poster'17, CHI'18 ]



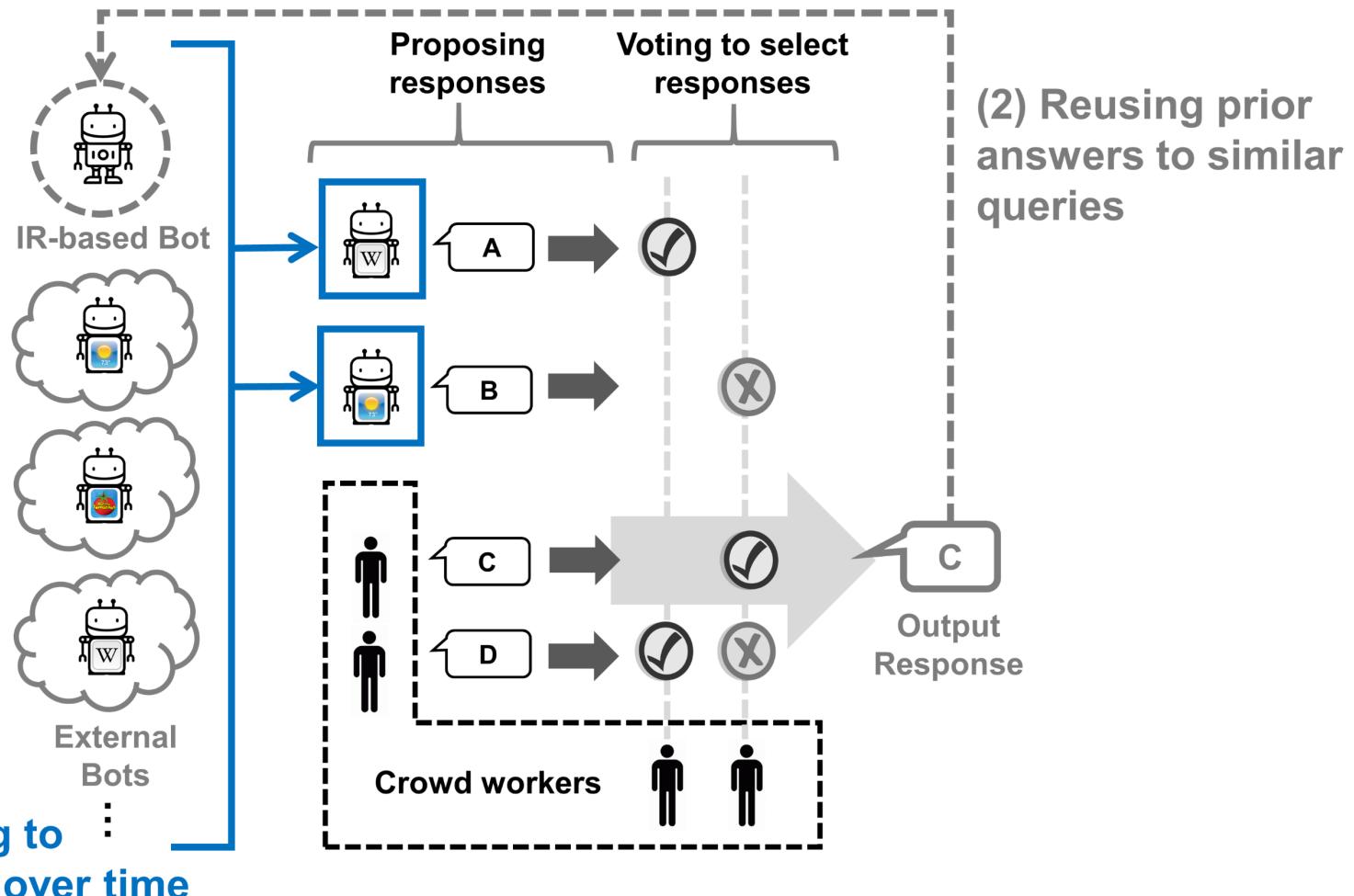
Automating Chorus Over Time



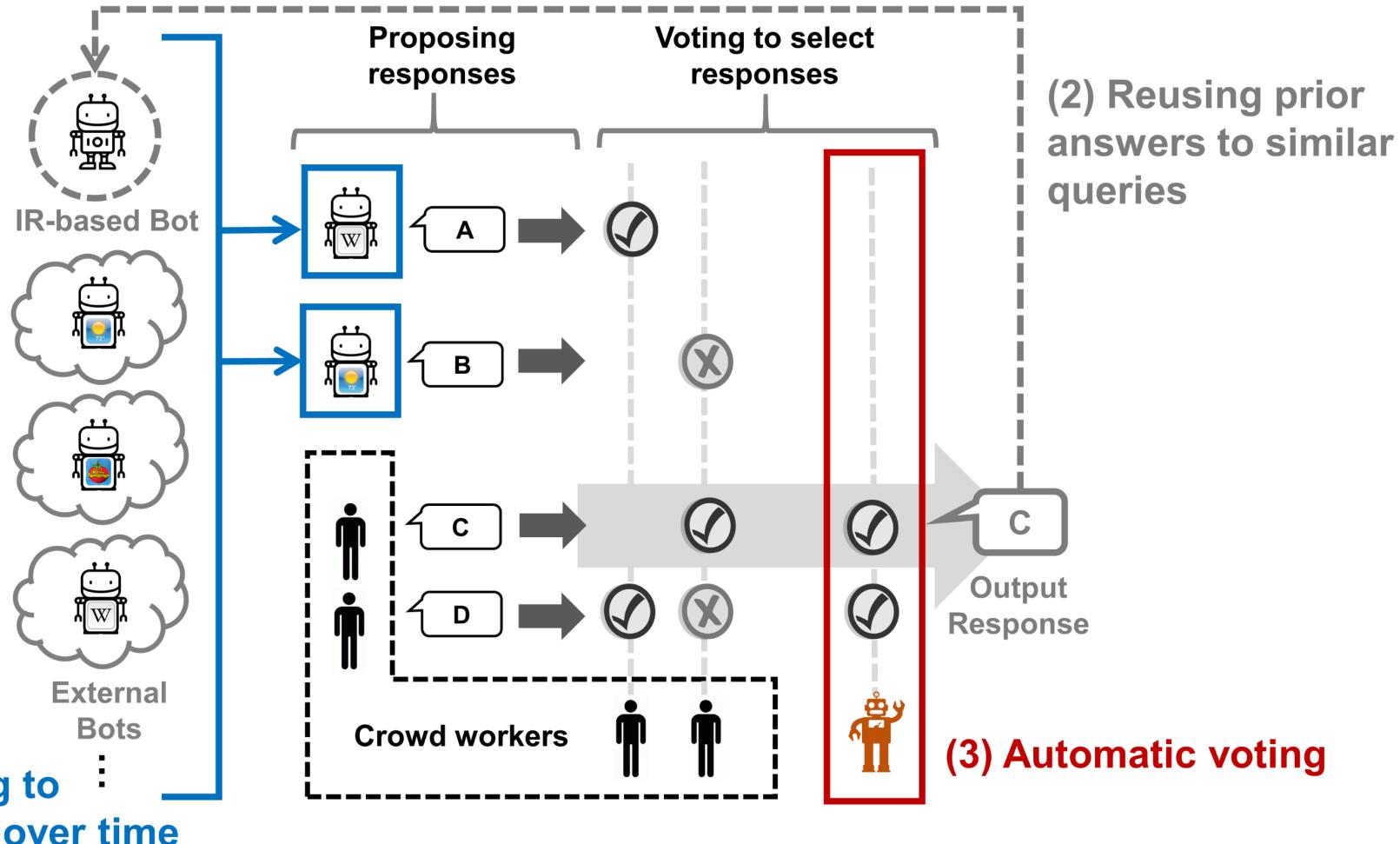
Automating Chorus Over Time



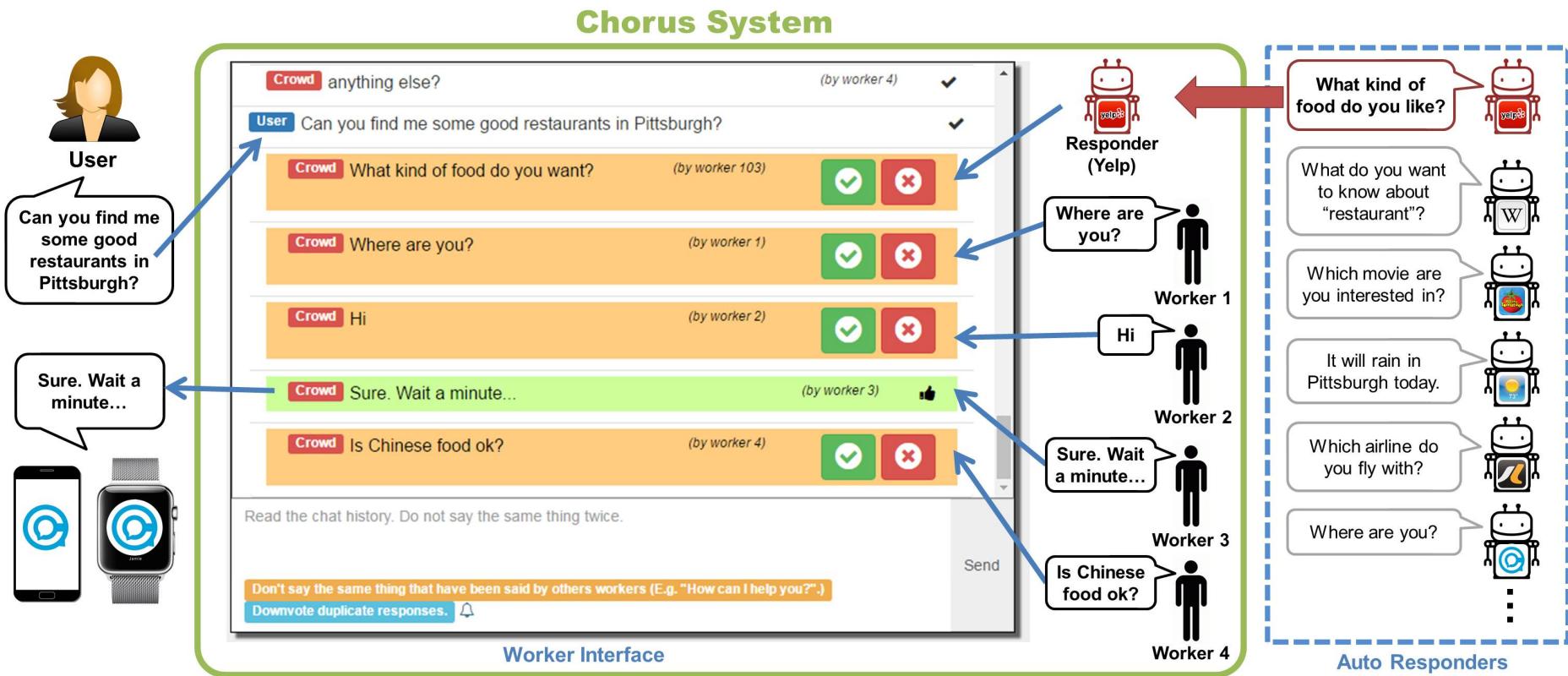
Automating Chorus Over Time



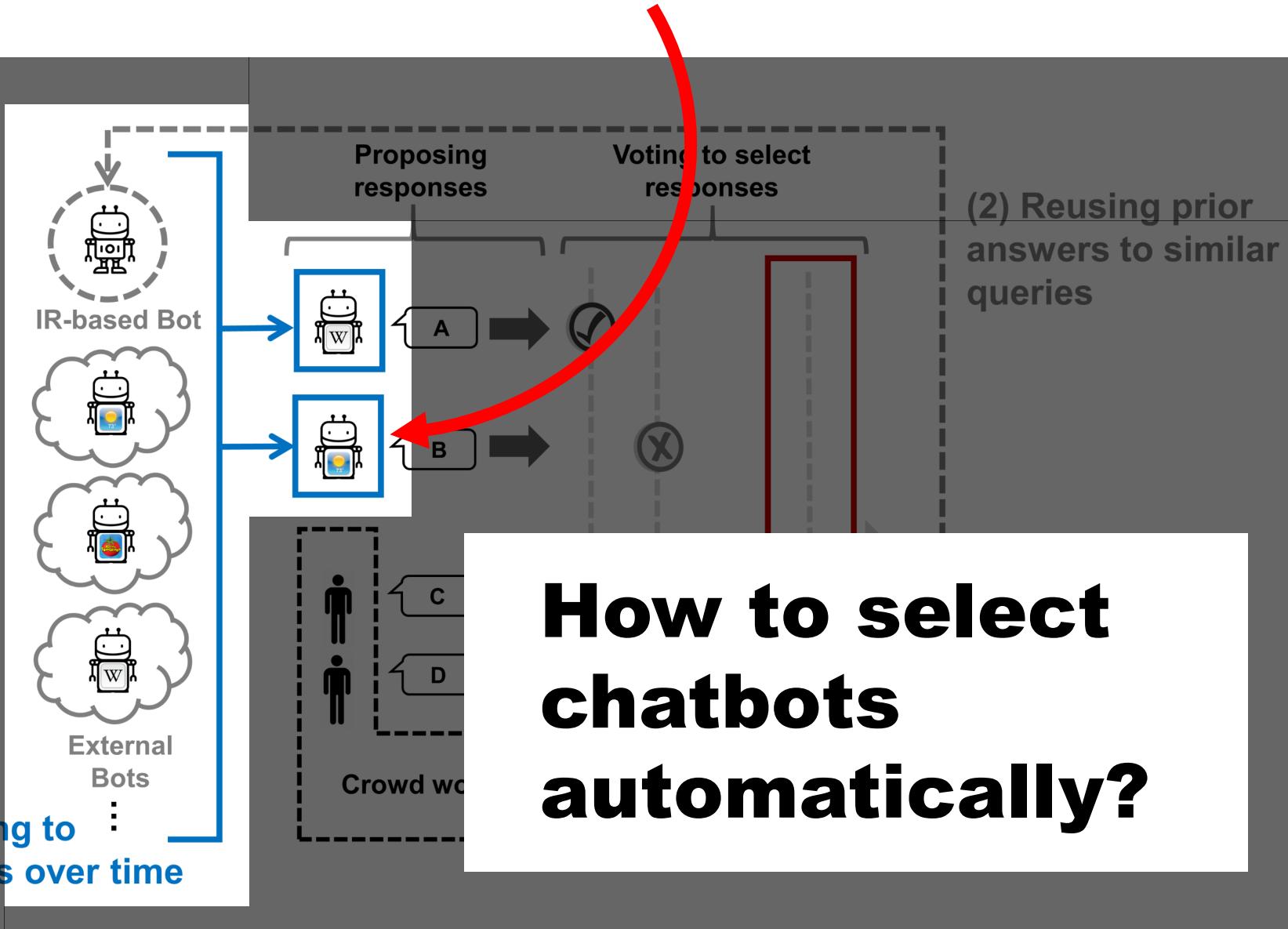
Automating Chorus Over Time



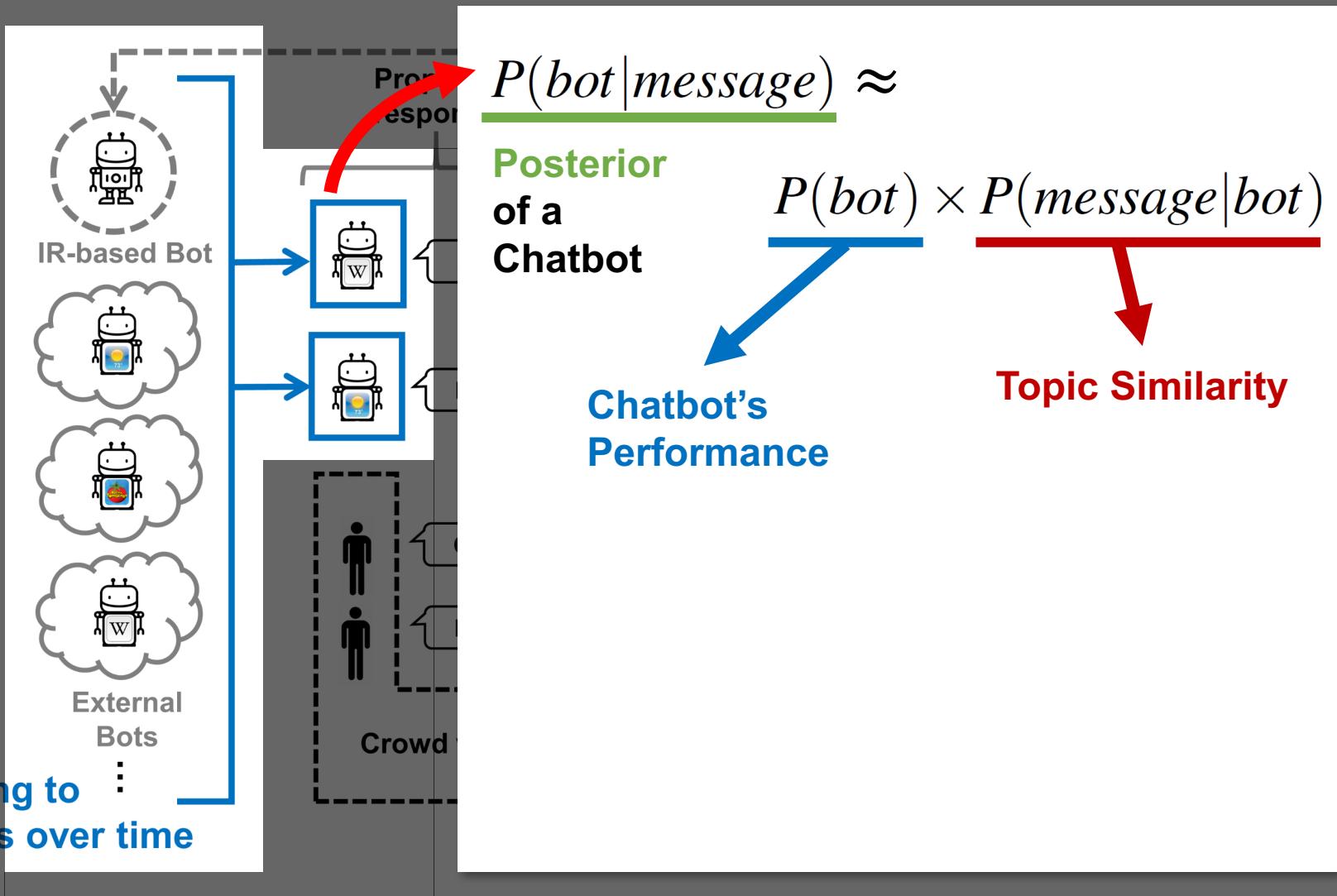
Empower Chorus with Multiple Chatbots



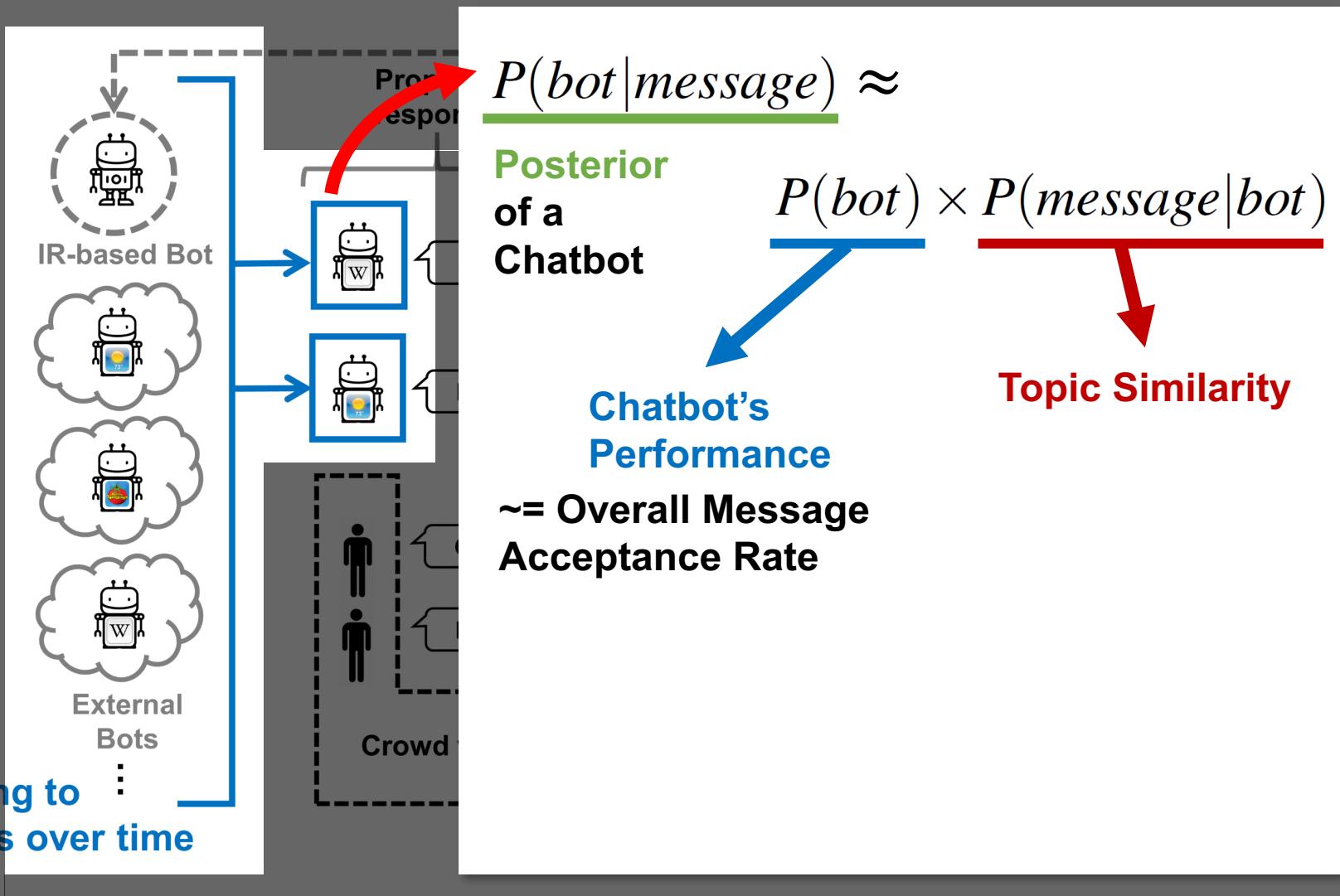
Chatbots



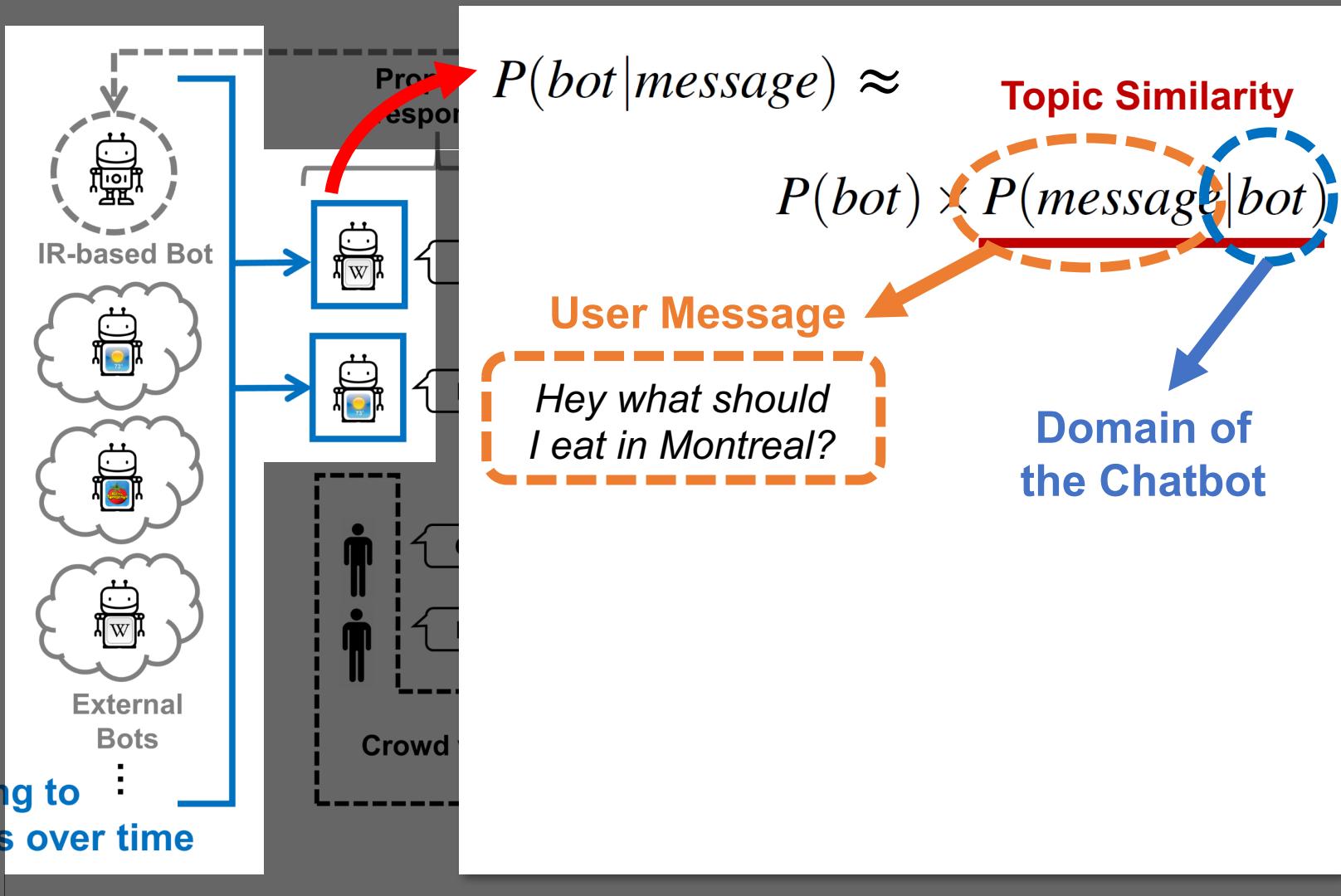
Ranking Chatbots: Performance & Topic



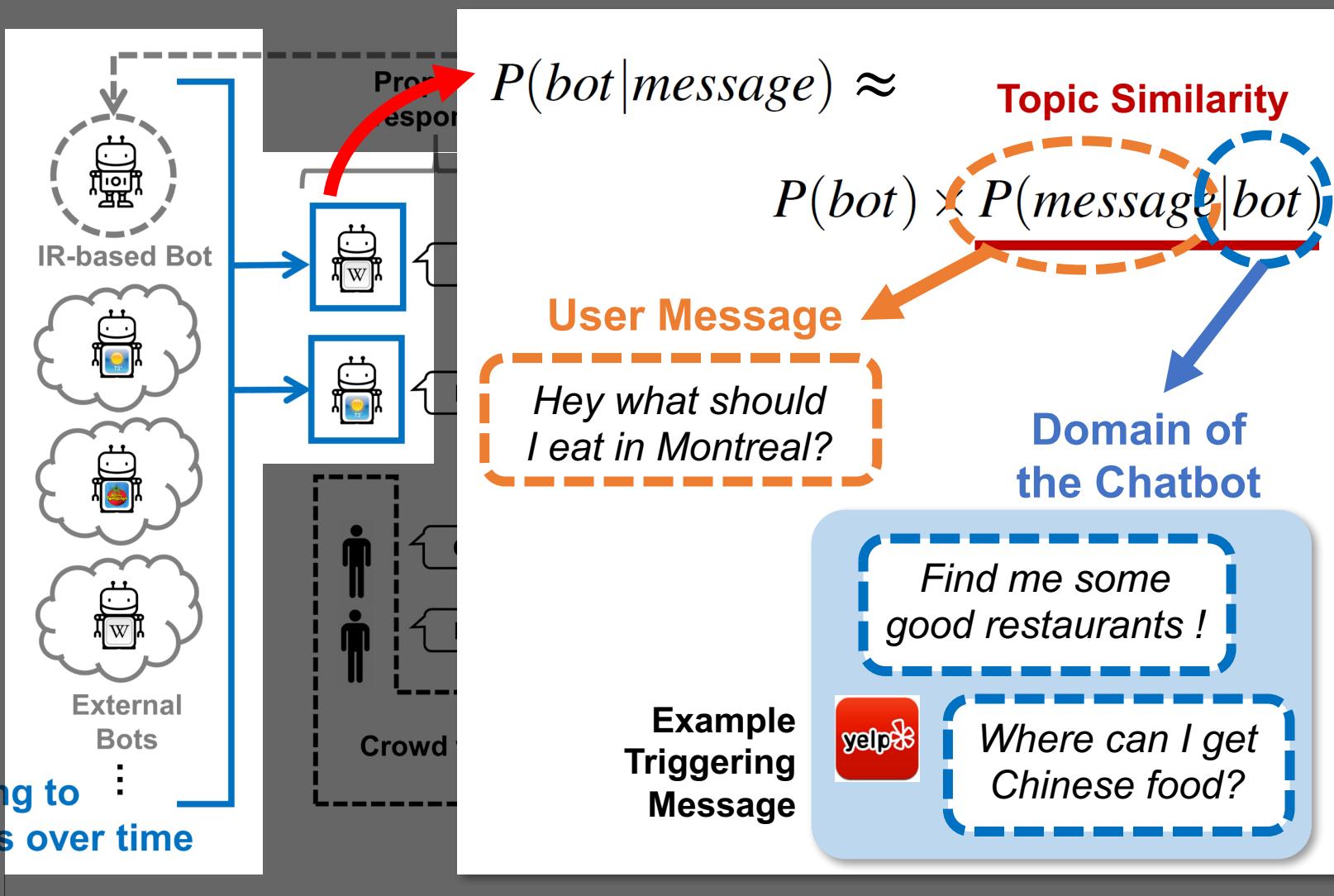
Ranking Chatbots: Performance & Topic



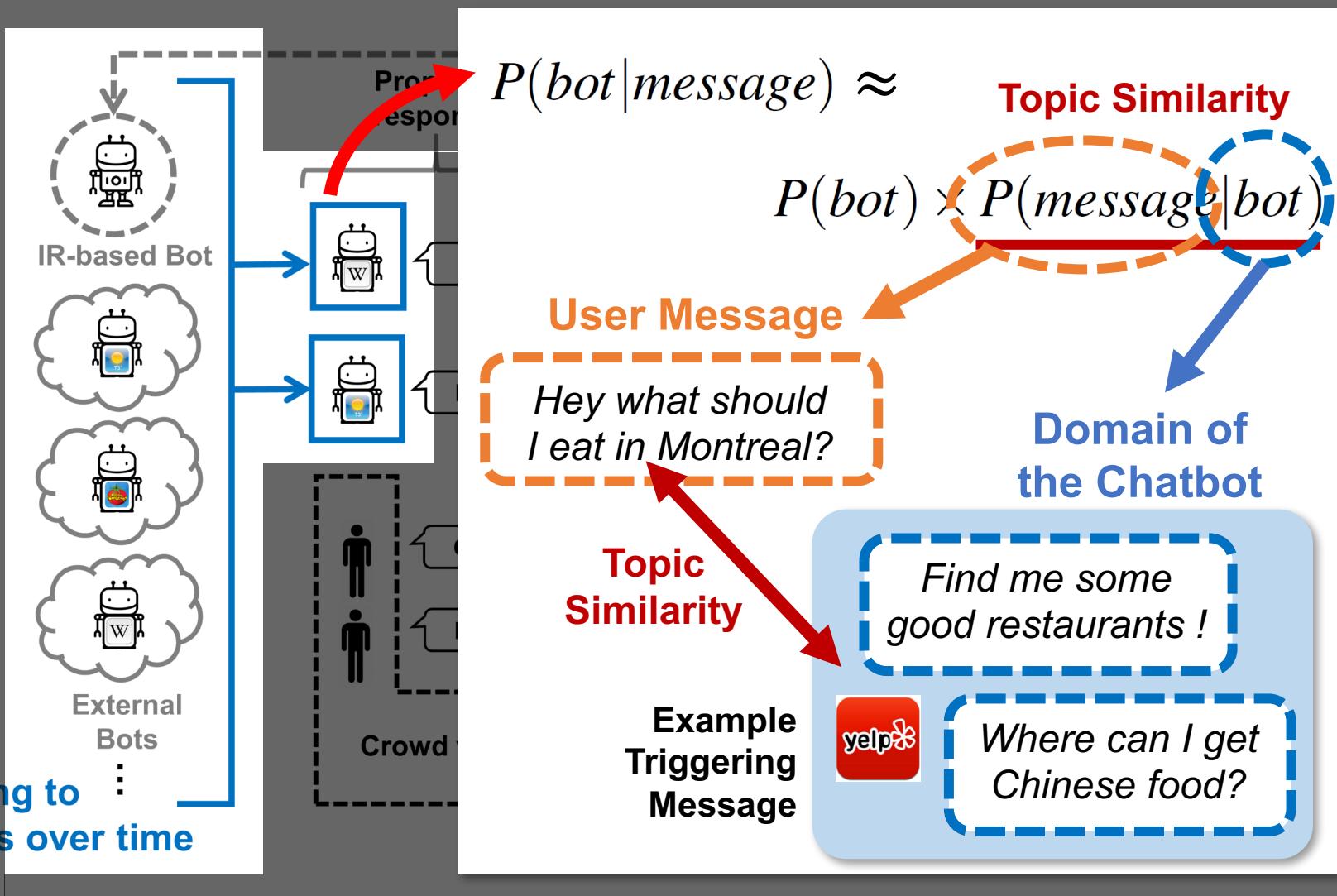
Ranking Chatbots: Performance & Topic



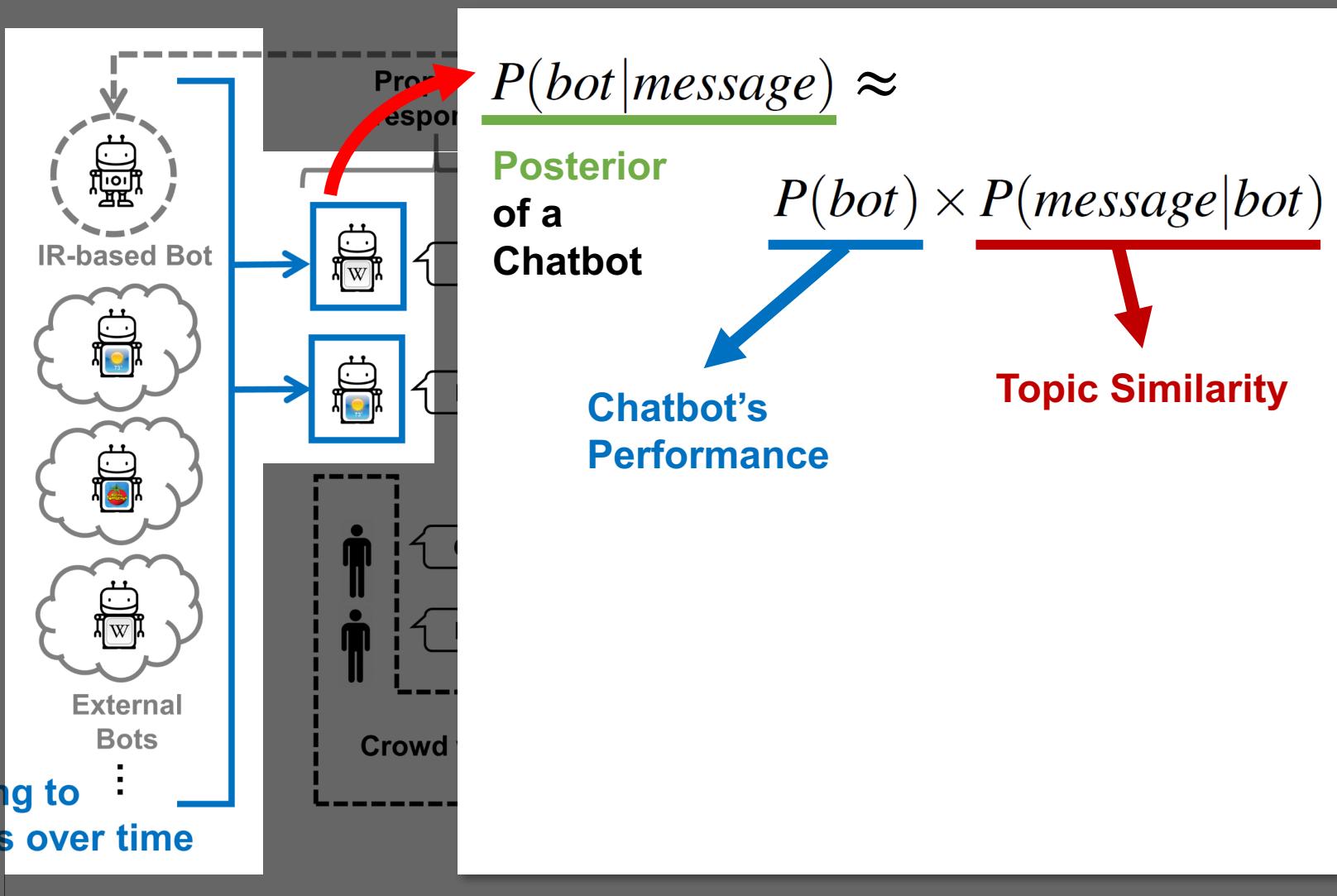
Ranking Chatbots: Performance & Topic



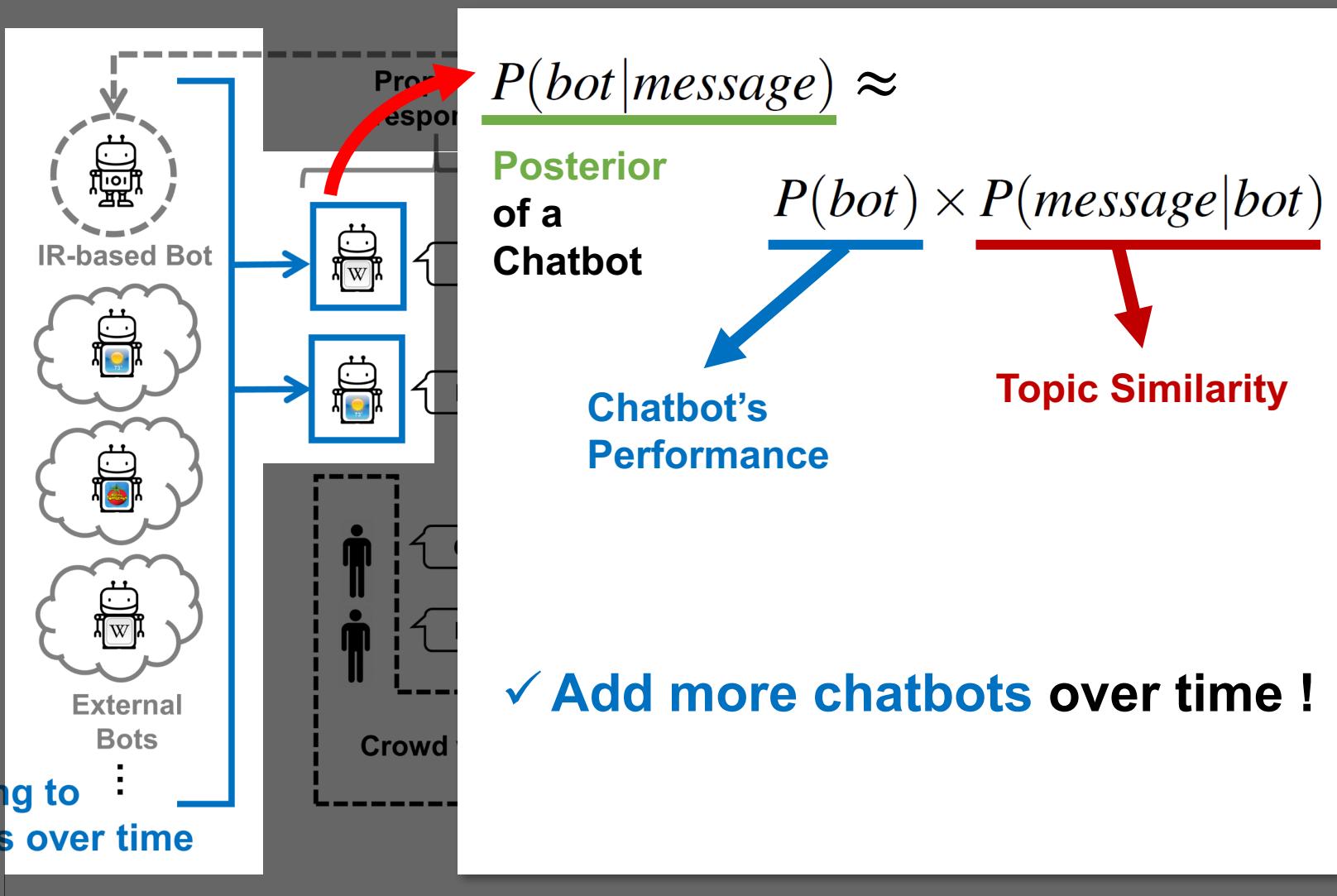
Ranking Chatbots: Performance & Topic



Ranking Chatbots: Performance & Topic



Ranking Chatbots: Performance & Topic



Is this conversation over? Click here if the conversation is over.

Every User is Different. Help to Solve His/Her Problems!

The user is talking via **Google Hangouts**. All the workers on this page please **pretend you were a single conversational agent** called "**Chorus**". Please collaborate with other workers to respond to this user.

Hello, worker 144664 !

Workers on this Page: 2

Crowd Is there anything else I can answer for you?

(by worker 139809)



User That's it



User Thanks



Crowd Have a nice day!

(by worker 139809)



Crowd I hope you have a nice day as well!

(by worker 144680)



User Hi



↑ Previous conversation of this user.

↓ Current conversation starts here.

User Hi



Auto Reply hello

(by bot 131971)



Crowd Do you have any questions?

(by worker 139809)



Read the chat history. Do not say the same thing twice.

I

Send

Don't say the same thing that have been said by others workers (E.g. "How can I help you?").

Downvote duplicate responses.

Reach 4000 points to submit

1312

~ \$0.016 Bonus

Important Facts

Keep notes of important facts about this conversation.

E.g., located in Austin, Texas

↑ Current conversation's facts

↓ Previous conversation's facts

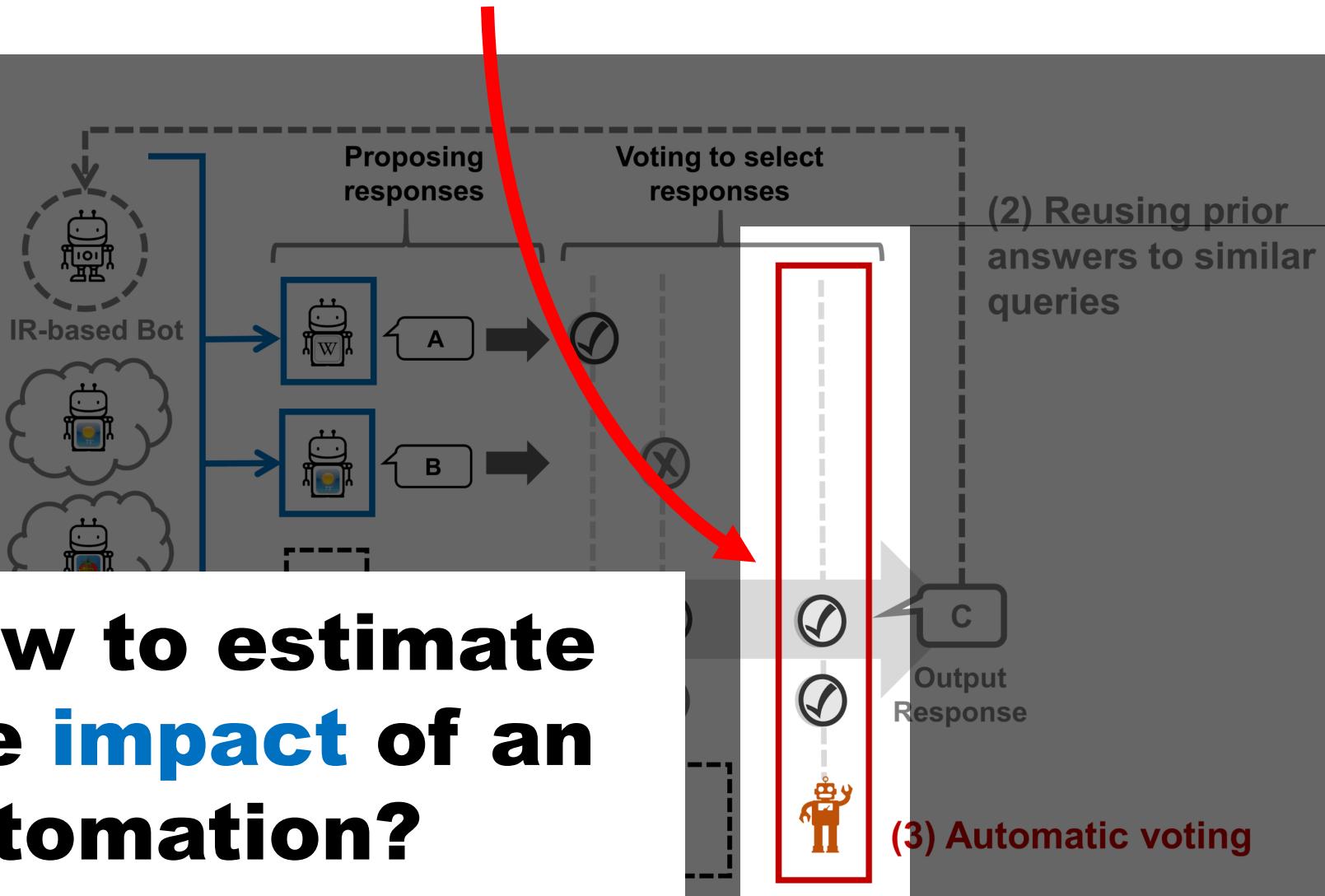
Fact User wants to know the weather in Pittsburgh. (by worker 139809)

To report any malicious or abnormal users or workers, send emails to the requester at windex0303@gmail.com

Downvote bad chats. Upvote good chats. Only the chats with enough vote count will go through.

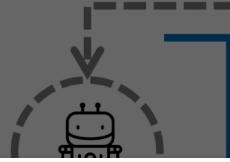
Pretend you are a **single chatbot** called Chorus.

Automatic Upvote



Select Bots over time

Find the Best Confidence Threshold



Proposing responses

Voting to select responses

(2) Reusing prior answers to similar queries

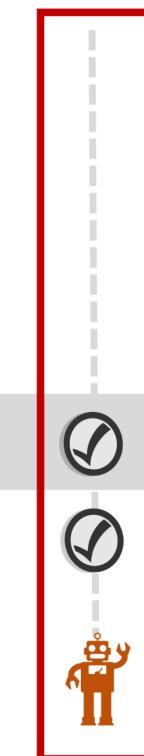
- **High Threshold**

- Only vote when pretty sure
- High precision, but **little benefit**

- **Low Threshold**

- Nearly always vote
- Grant agreement bonus by mistake
- Damage conversation quality

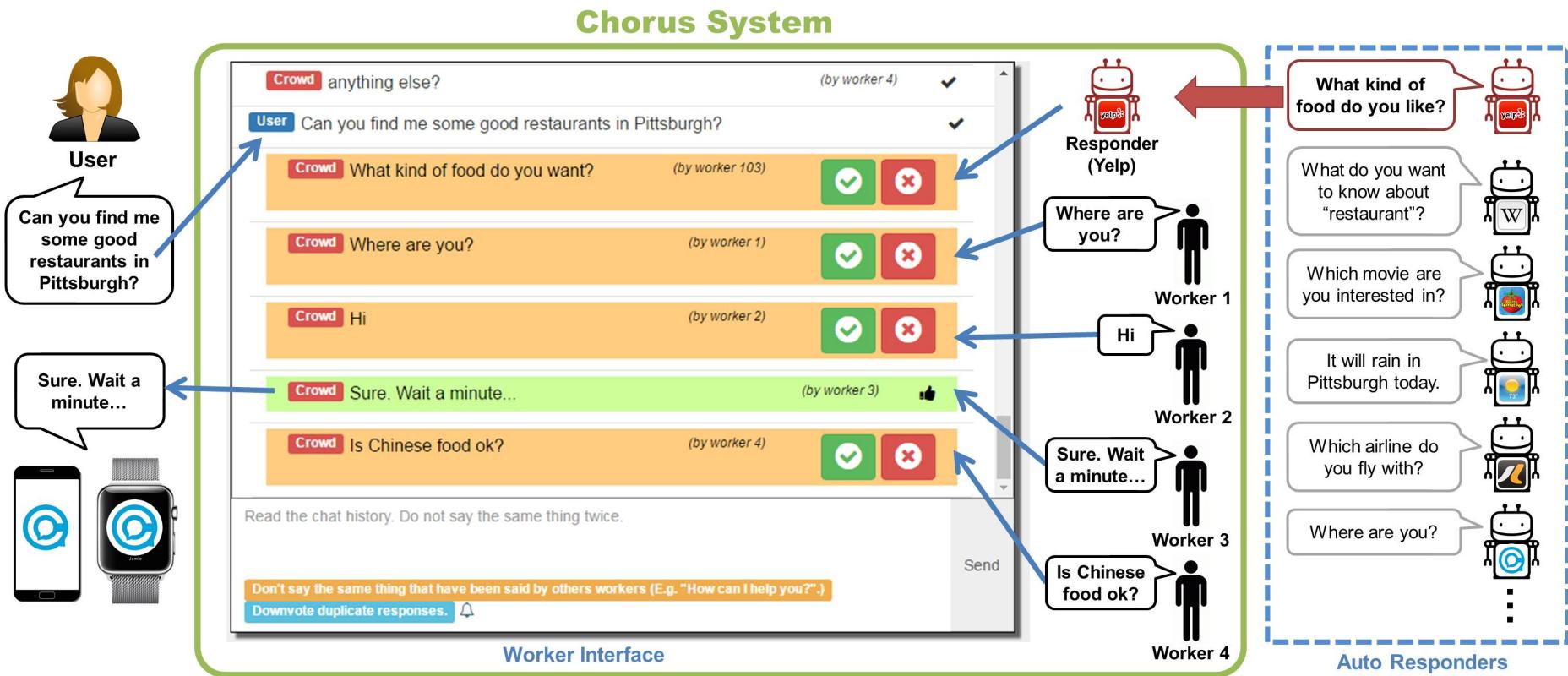
(1) Learning to select bots over time



Output Response

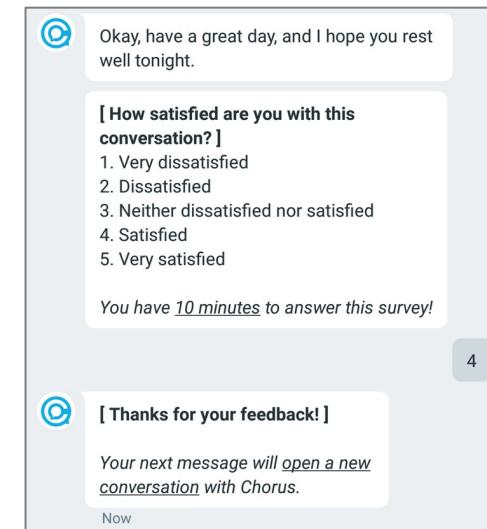
(3) Automatic voting

Automating Chorus Over Time



Automating Open Conversation

- **Setup**
 - A 5-month-long deployment, 80 Users
 - 4 chatbots + 1 voting bot
- **Result**
 - Automated responses were chosen **12.44%** of the time.
 - Human upvotes were reduced by **13.81%**.
 - The cost of each message is reduced by **32.76%**.
- **Conversation quality and user satisfaction level remains.**
 - Conversation Quality: Satisfaction, Clarity, Responsiveness, Comfort
(Liu, et al., 2010)



Automated



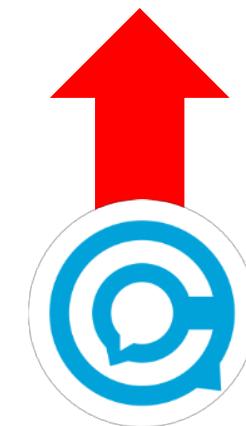
Personal
Assistants



AI-Powered
Dialog Systems

Evorus
[CHI'18 , UIST Poster'17]

Chorus Deployment
[HCOMP'16, HCOMP'17]



Crowd-Powered
Dialog Systems

Open Conversation

Automated



Personal
Assistants

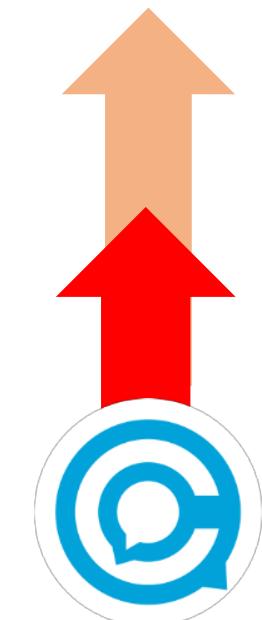


AI-Powered
Dialog Systems

Evorus
[CHI'18 , UIST Poster'17]

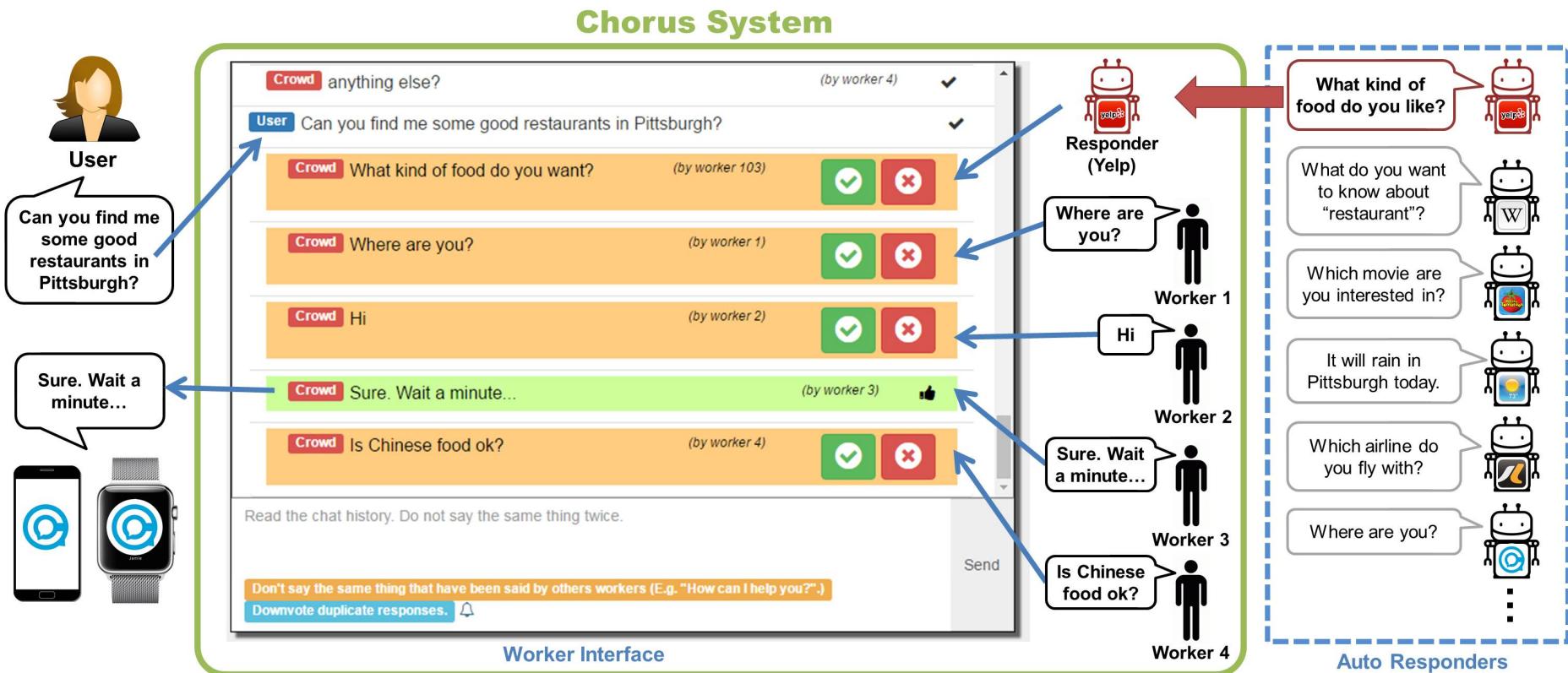
Chorus Deployment
[HCOMP'16, HCOMP'17]

Open Conversation

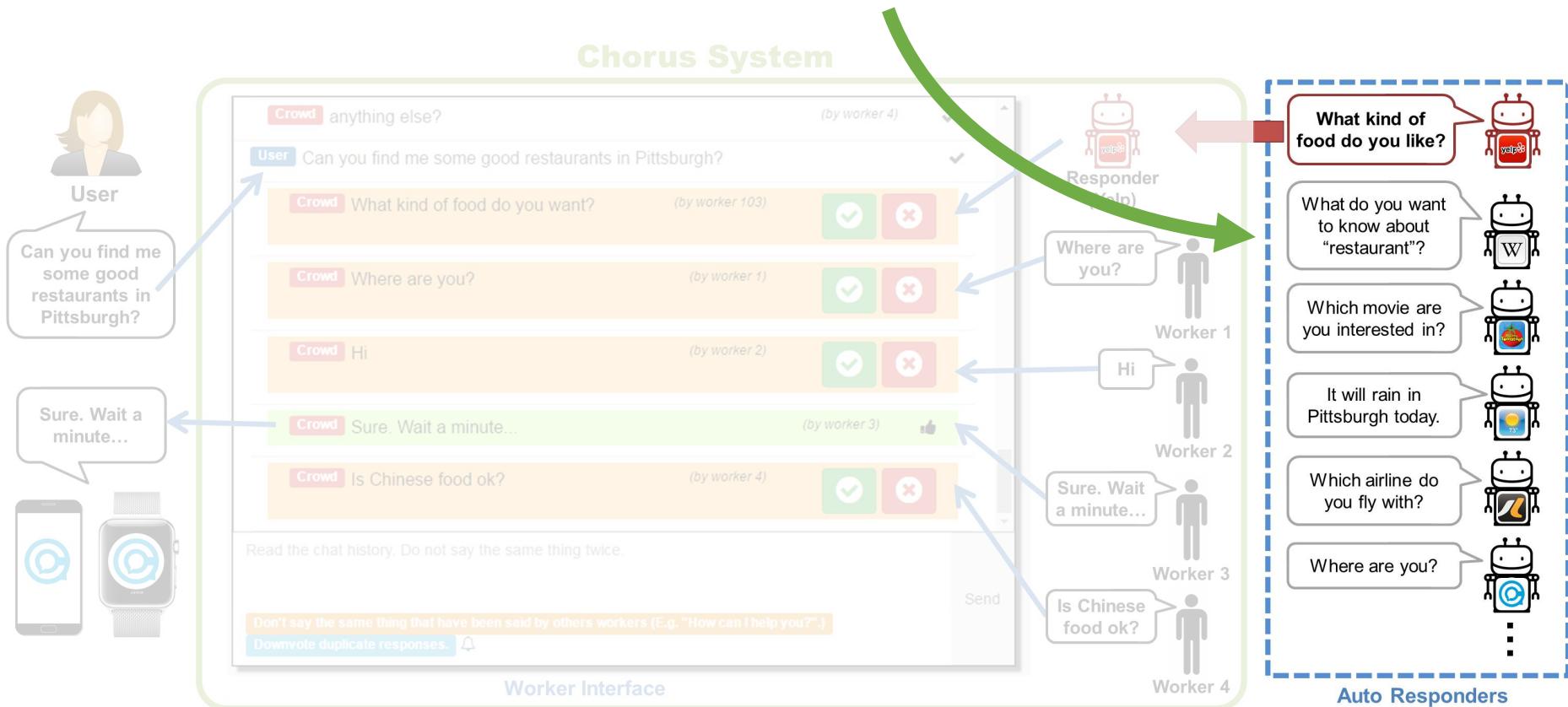


Crowd-Powered
Dialog Systems

Empower Chorus with Multiple Chatbots



How to build a set of chatbots quickly?



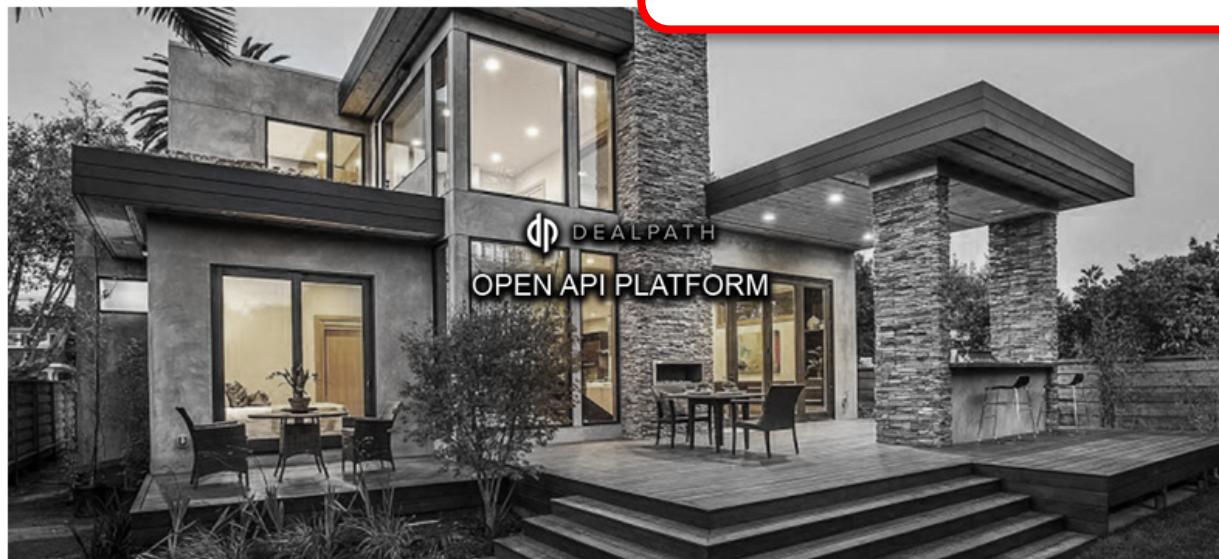
Use Web APIs to Empower Chorus


[API DIRECTORY](#) | [API NEWS](#)
[LEARN ABOUT APIs](#)
[WHAT IS AN API ?](#)
19,758+ APIs
[WRITE FOR US](#) | [BECOME MEMBER](#) | [LOGIN](#)

Search over 19,758 APIs and much more


[ADD APIs & MORE](#)


Advertisement



Dealpath Announces Open Platform API

[Announcement](#) . [Real Estate](#) . [ProgrammableWeb Staff](#)

Dealpath has opened its third party API providing customers and partners with convenient, real-time access to their data. Dealpath's platform is designed for interoperability with other leading software systems and provides unprecedented flexibility for institutional real estate investment teams.

[LATEST APIs](#)
[Add Your API](#)
[API NEWS](#)
[API TUTORIALS](#)

Today in APIs

Latest news about the API economy and newest APIs, delivered daily:

[SUBSCRIBE](#)


API UNIVERSITY

[FEATURED](#) [LATEST](#)

FOR API PROVIDERS

[What Are APIs and How Do They Work?](#)
[8 Real World API Strategies and the Keys to Their Success](#)
[Microservices 101: Understanding and Leveraging Microservices](#)

Use Web APIs to Empower Chorus


[API DIRECTORY](#) | [API NEWS](#)
[LEARN ABOUT APIs](#)
[WHAT IS AN API ?](#)

19,758+ APIs

[WRITE FOR US](#) | [BECOME MEMBER](#) | [LOGIN](#)

Search over 19,758 APIs and much more


[ADD APIs & MORE](#)


Advertisement



Today in APIs

Latest news about the API economy and newest APIs, delivered daily:

[SUBSCRIBE](#)


API UNIVERSITY

[FEATURED](#) [LATEST](#)

FOR API PROVIDERS

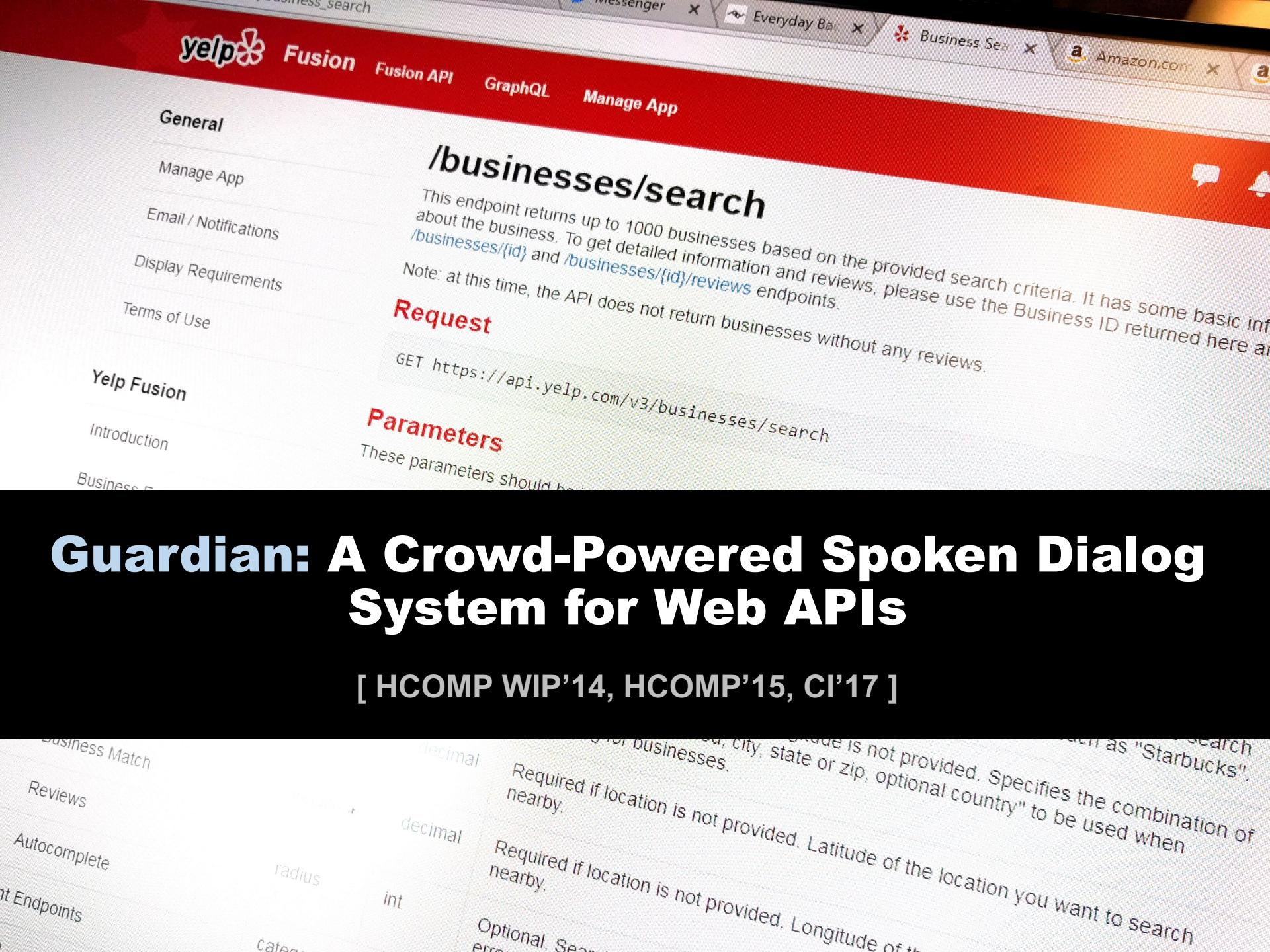
[What Are APIs and How Do They Work?](#)
[8 Real World API Strategies and the Keys to Their Success](#)
[Microservices 101: Understanding and Leveraging Microservices](#)


Dealpath API

[Announcement](#) . [Real Estate](#) . [Programs](#)

Dealpath has opened its third party API provider program, giving customers convenient, real-time access to their data. Dealpath's platform is designed for interoperability with other leading software systems and provides unprecedented flexibility for institutional real estate investments.

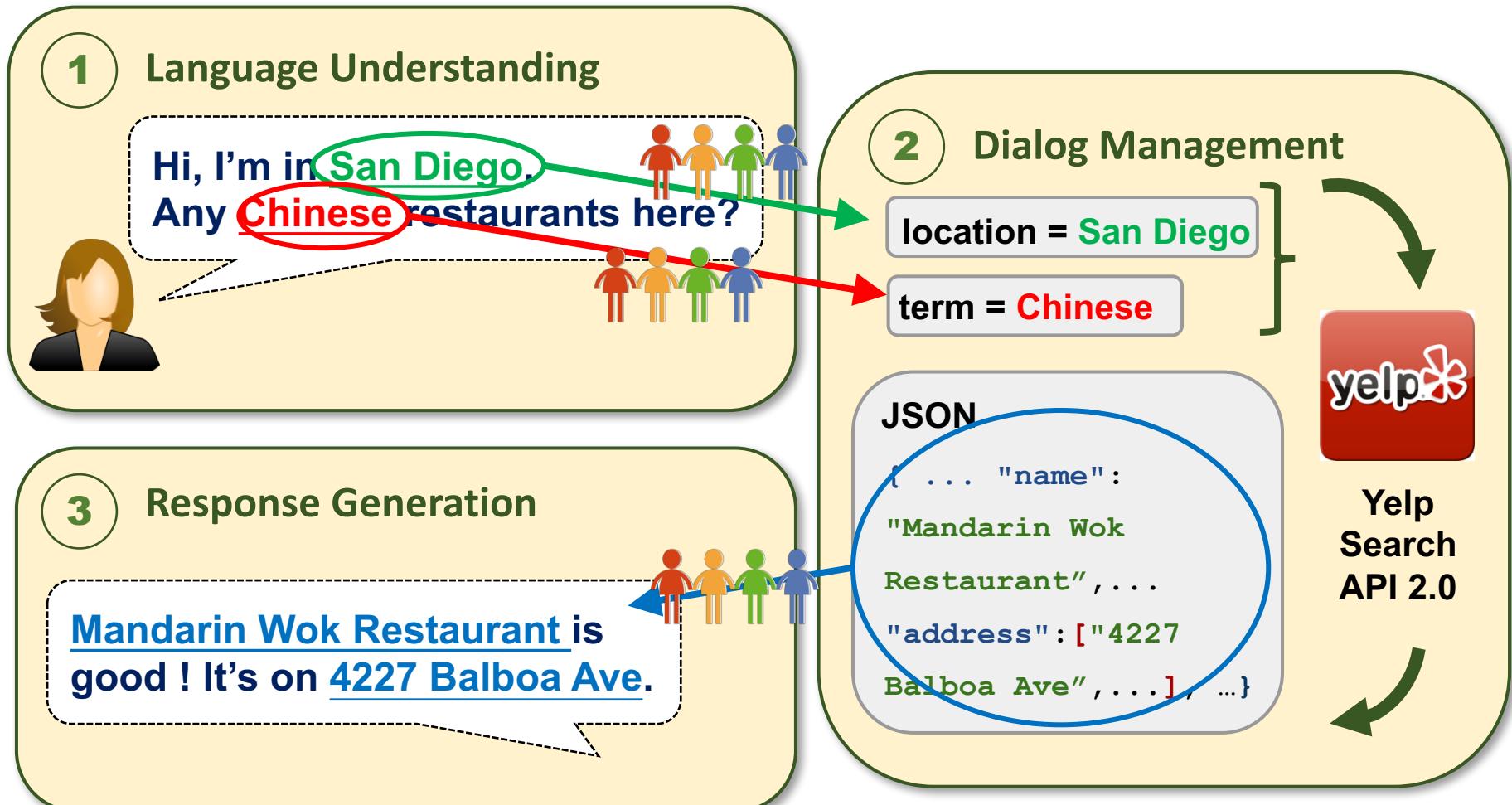
[LATEST APIs](#)
[Add Your API](#)
[API NEWS](#)
[API TUTORIALS](#)



Guardian: A Crowd-Powered Spoken Dialog System for Web APIs

[HCOMP WIP'14, HCOMP'15, CI'17]

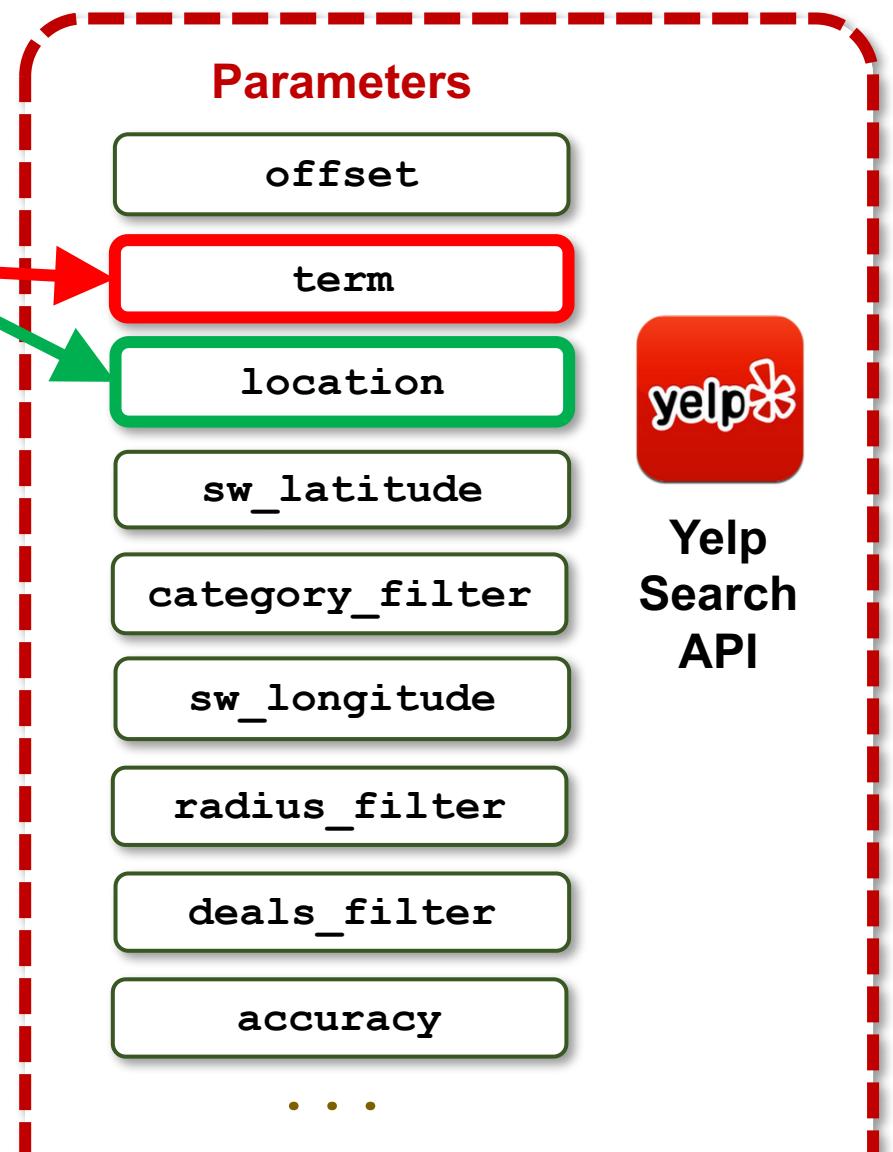
Guardian: A Crowd-Powered Dialog System for Web APIs



Parameter Extraction

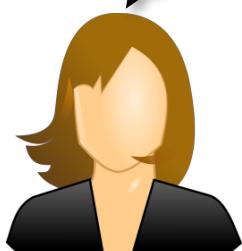


User



Parameter Extraction

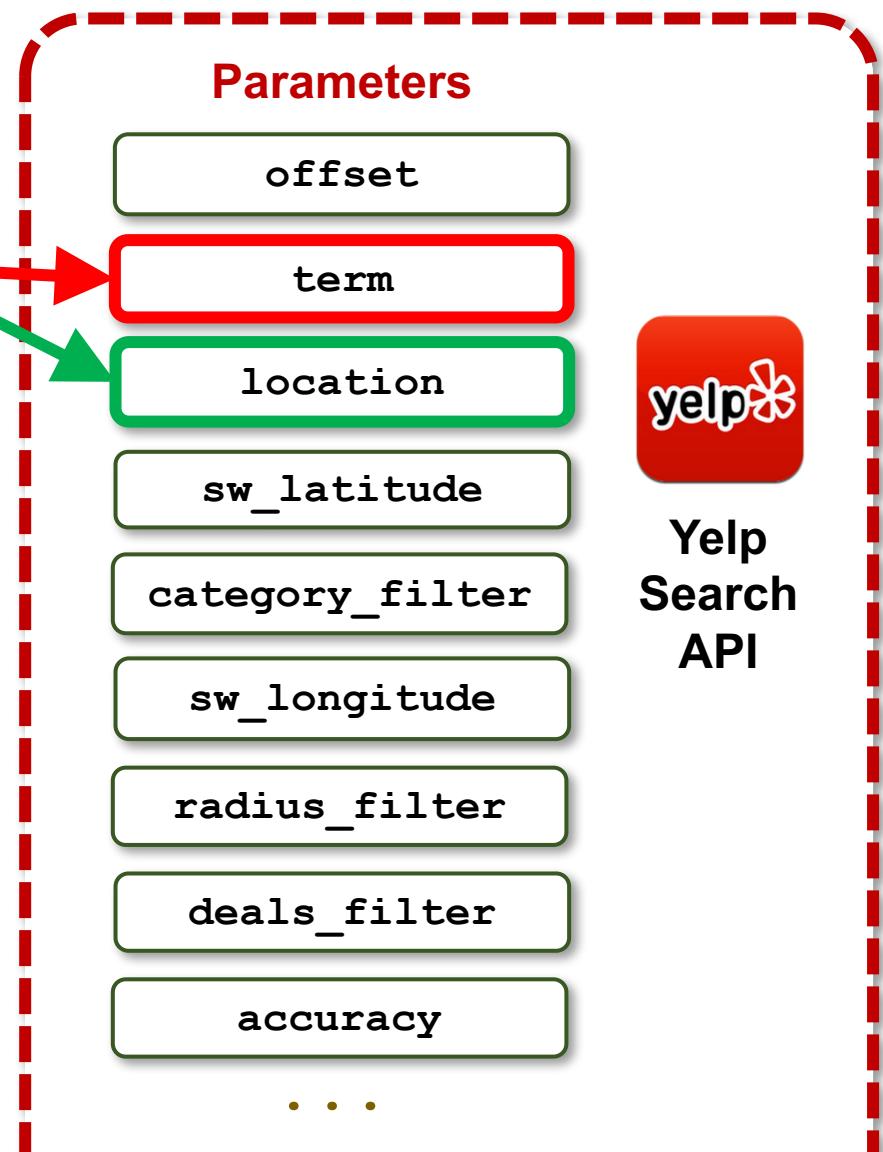
Hi, I'm in San Diego.
Any Chinese restaurants here?



User

1. How to extract parameters?

2. Which parameters to use?

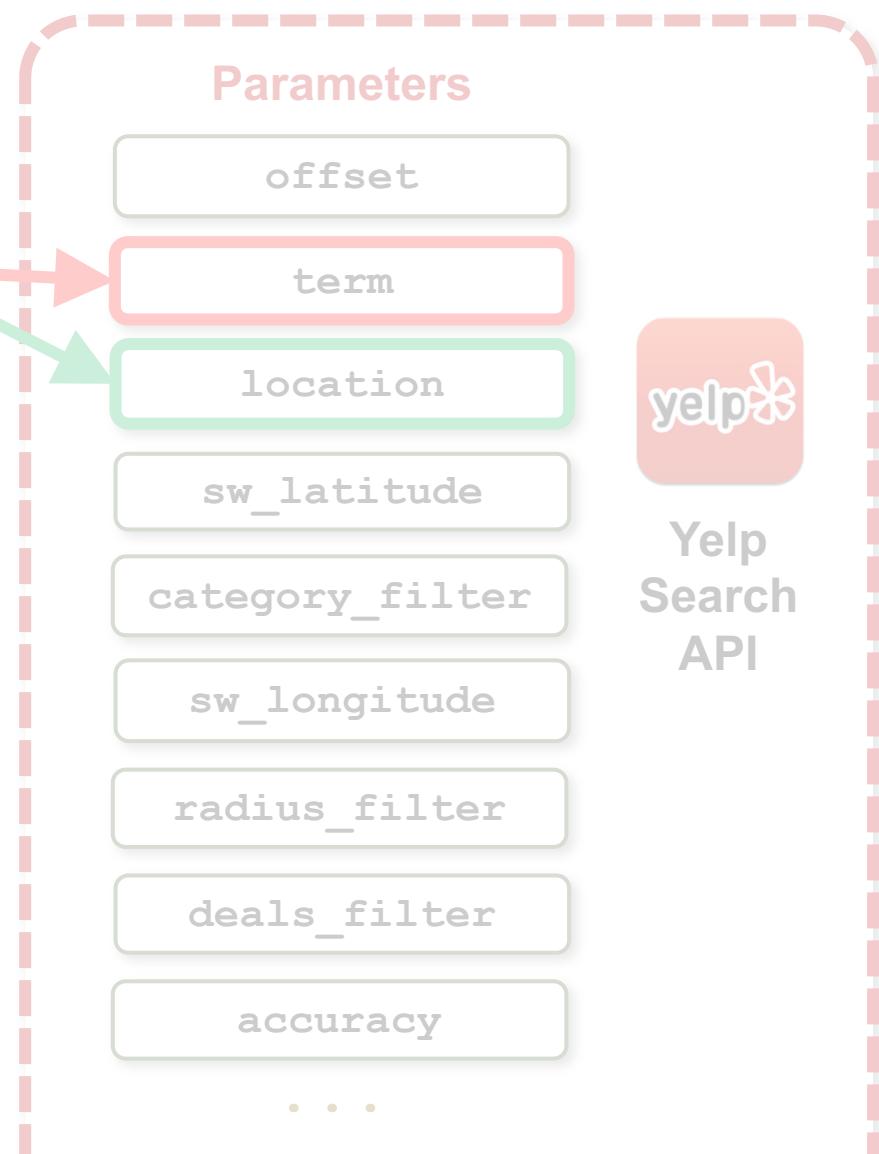


How to Extract Parameters?

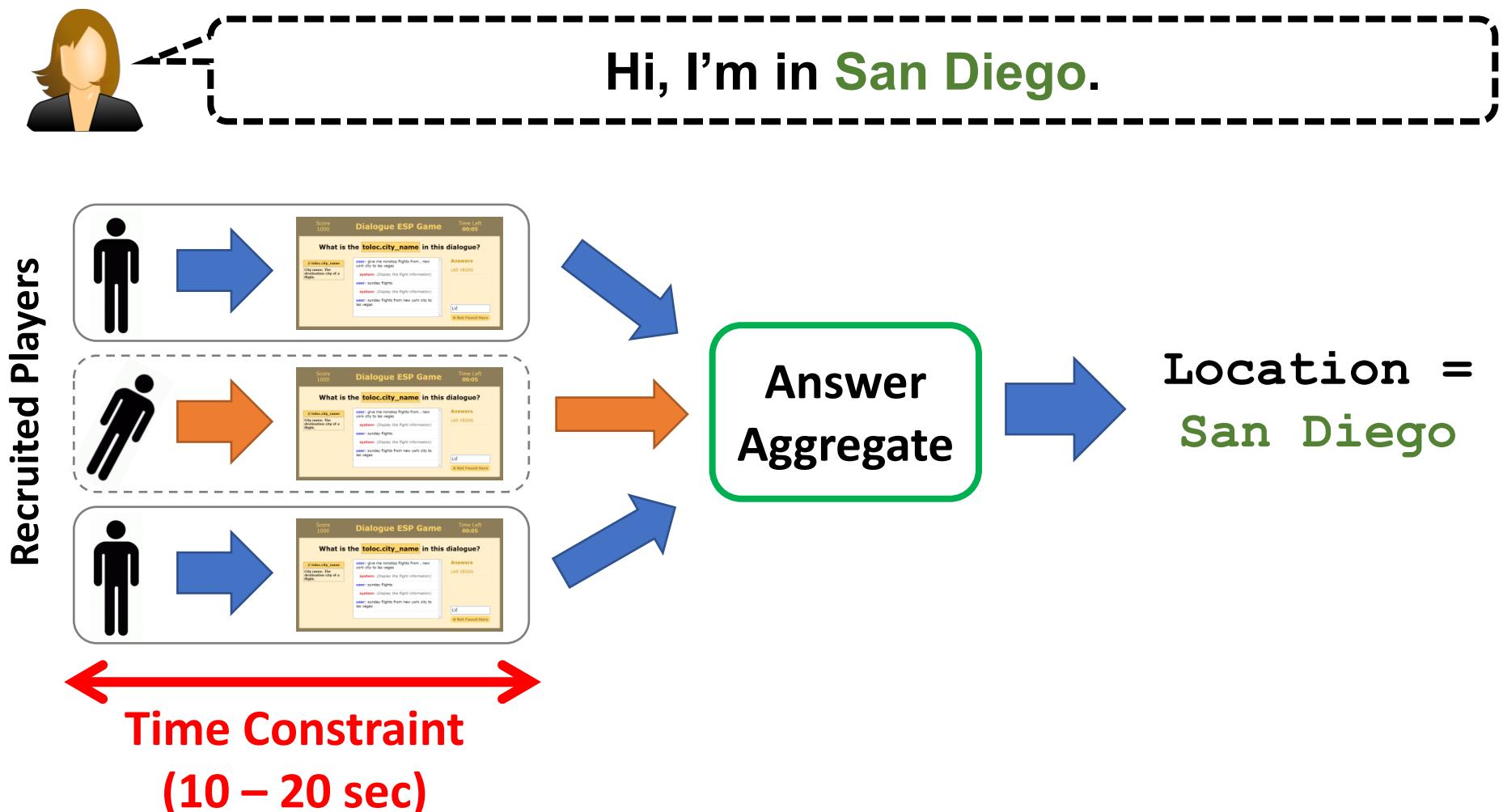


1. How to extract parameters?

2. Which parameters to use?



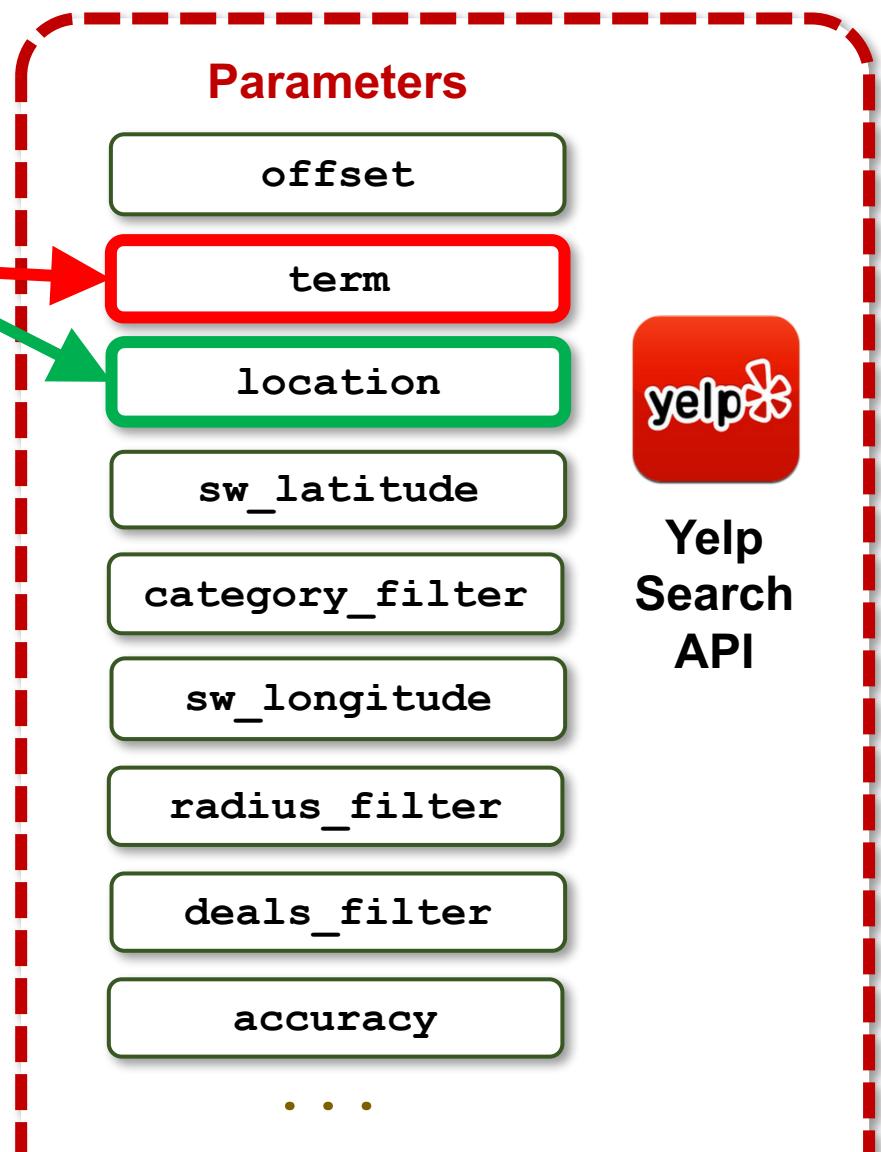
Crowd-Powered Parameter Extraction



Which Parameters to Use?

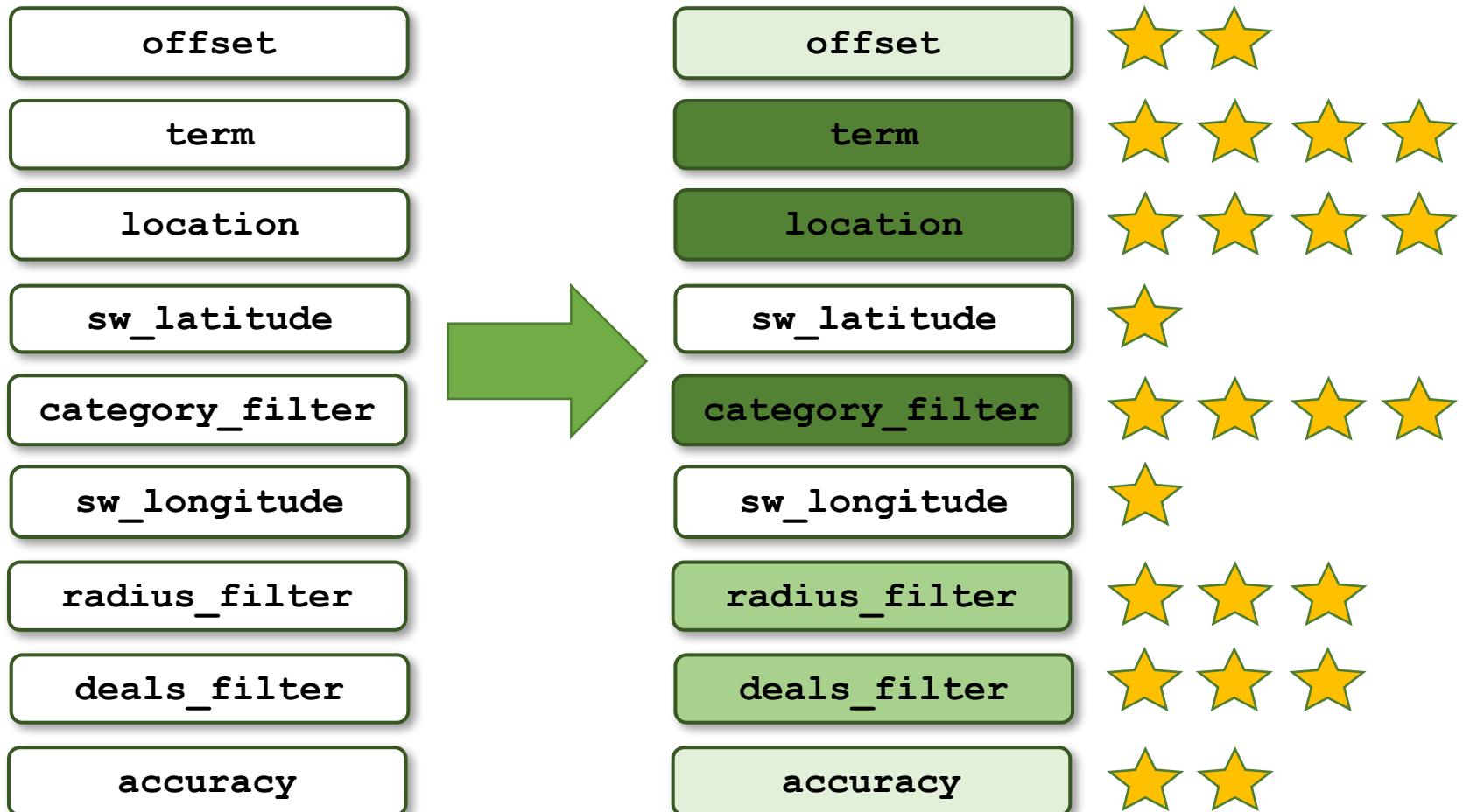


2. Which parameters to use?



Parameter Rating Problem

Pick **good parameters** for the dialog system.



How about just do a survey?

Will You Say This To Your Friend?

Instructions ▾

Overview

Now, you need some information -- like, good food nearby, the weather tomorrow, or a news article -- But you can NOT use the Internet right now. So you call a friend for help. In this phone call, you will tell your friend some information -- your requirements, your constraints, your preferences, and what do you want -- and then, this friend will check the Internet based on your information and tell you the answer.

In this phone call, how likely will you directly say this information to your friend?

Why do you call your friend: Find restaurants **Task**

Information Name: term

Information Description: Search term (e.g. "food", "restaurants"). If term isn't included we search everything.

Parameter Name / Desc

You can't use the Internet now. So you call a friend to check something online for you. How likely will you directly say this information to your friend?

1 2 3 4 5

Not likely

Very likely

i Do NOT provide ANY security code, permission key, password, or even user ID in your phone call. Please rate these kinds of information as "Not likely".

Why do you call your friend: Find restaurants

Information Name: limit

Information Description: Number of links you will accept

Match Questions with Parameters



The image shows the Yelp API logo on the left, which consists of a red square with the word "yelp" in white and a white starburst icon. To the right of the logo is a yellow rounded rectangle labeled "Question Collection". Inside this box are three rows of question and answer pairs. Each row contains two speech bubbles: one blue with a question mark and one colored (pink, red, or orange) with an exclamation mark. The first row asks "What do you want to eat?" and answers "I like Chinese food.". The second row asks "Which city are you in?" and answers "I'm in Pittsburgh.". The third row asks "Is it dinner or lunch?" and answers "Dinner.". Ellipses at the bottom indicate more items.

Question Collection

What do you want to eat?
I like Chinese food.

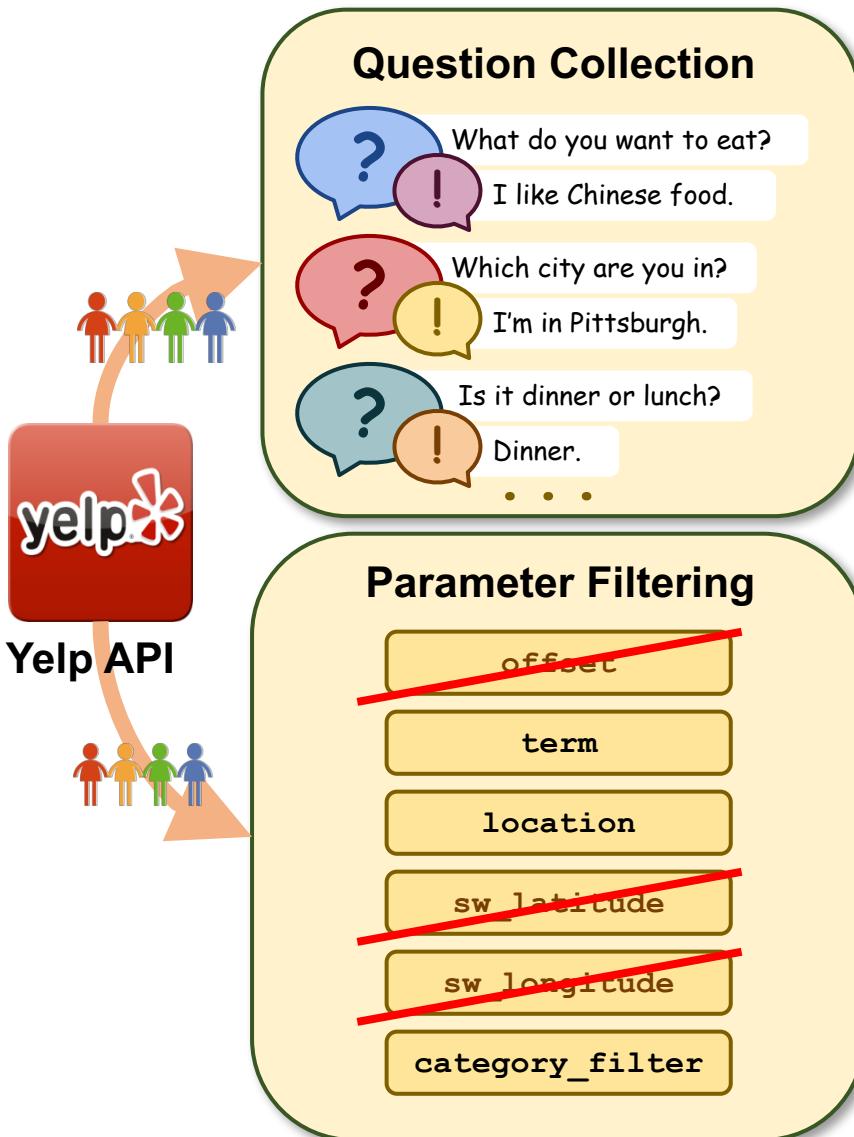
Which city are you in?
I'm in Pittsburgh.

Is it dinner or lunch?
Dinner.

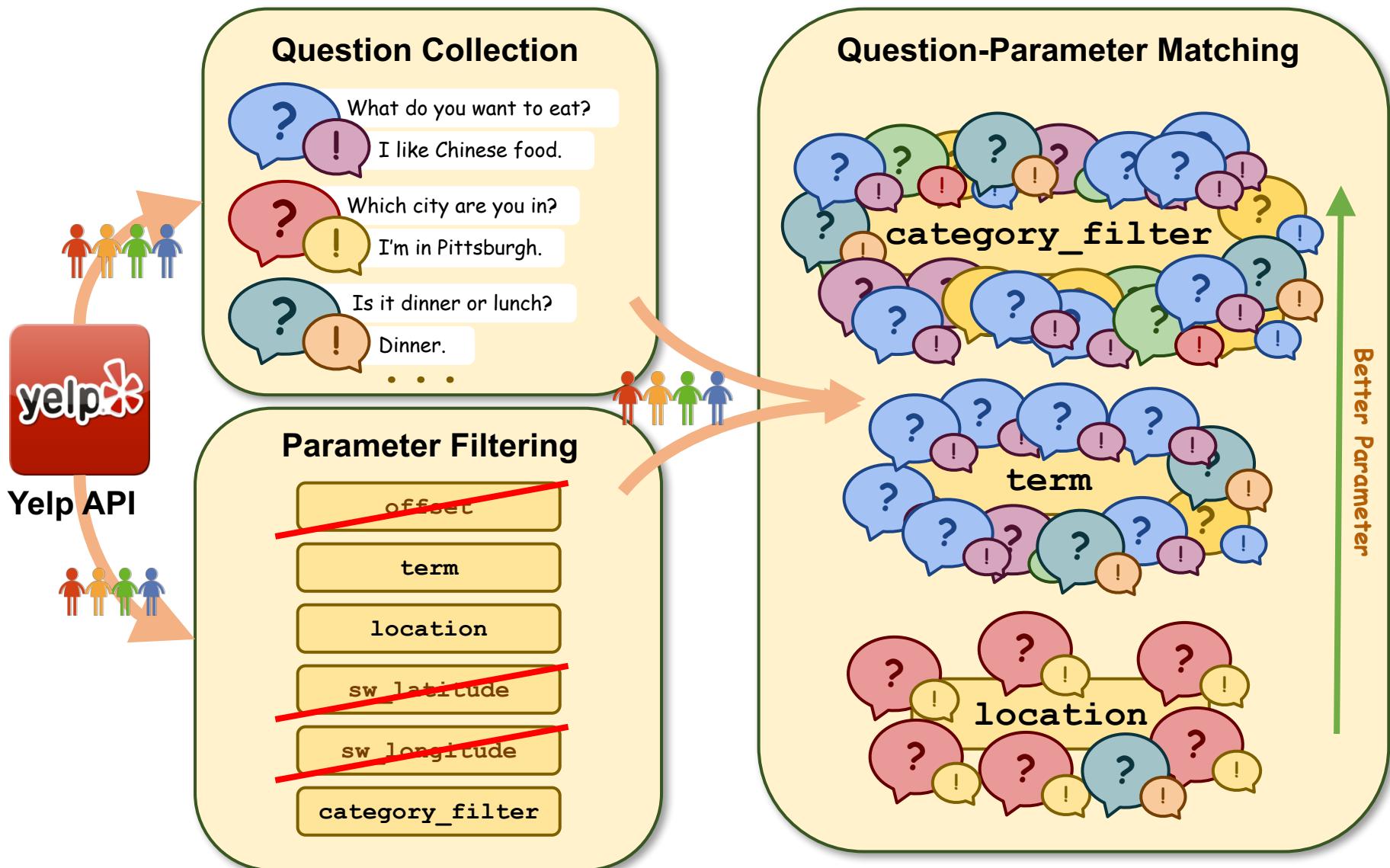
...

Yelp API

Match Questions with Parameters

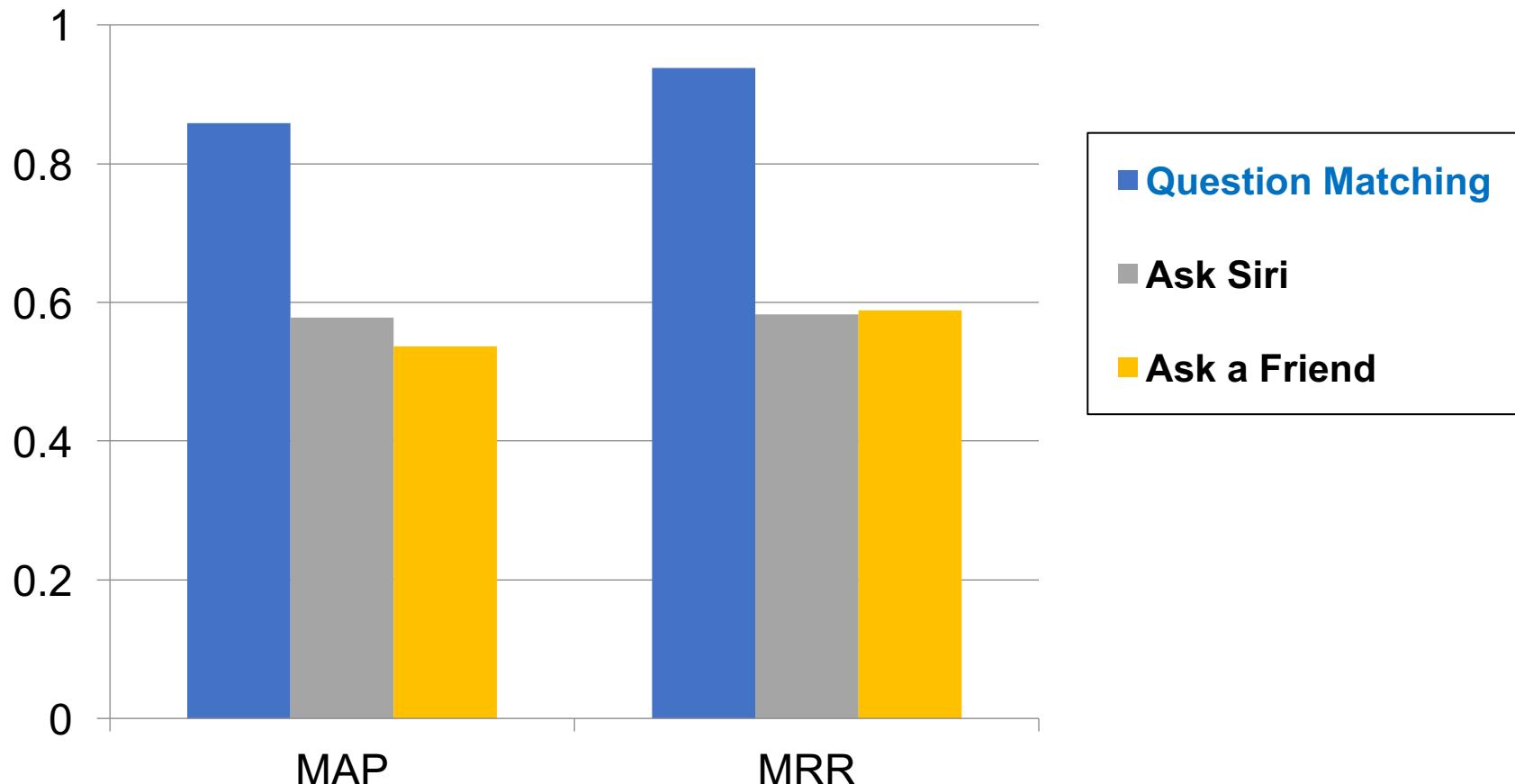


Match Questions with Parameters

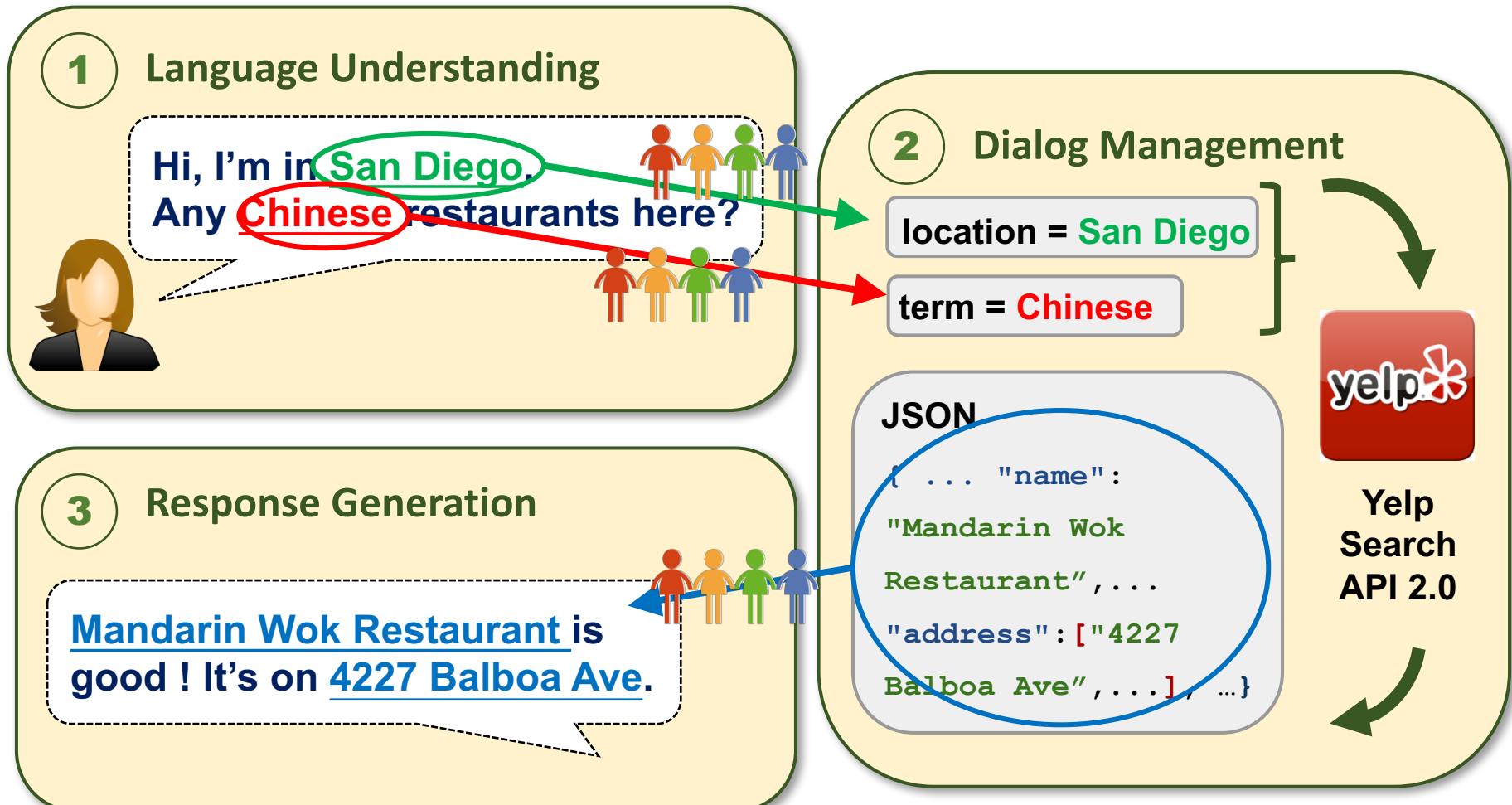


Evaluation on Parameter Ranking

- Average results of 8 Web APIs' parameters



Guardian: A Crowd-Powered Dialog System for Web APIs



Evaluation: Task Completion Rate



Task	Find Chinese restaurants in Pittsburgh.	Check current weather by using a zip code.	Find information of "Titanic".
2 API Result	9 out of 10 Crowd Recover Errors	9 out of 10	6 out of 10 Crowd Recover Errors
3 Final Response	10 out of 10	9 out of 10	10 out of 10

Automated



Personal
Assistants



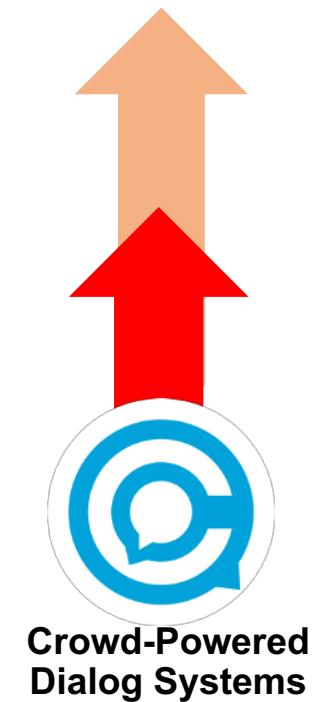
AI-Powered
Dialog Systems

Guardian
[HCOMP'15, CI'17]

Evorus
[CHI'18 , UIST Poster'17]

Chorus Deployment
[HCOMP'16, HCOMP'17]

Open Conversation



Crowd Research is Critical For Building Future Computer Systems.



- **Collect data to guide AI models**
- **Accomplish tasks that are not yet fully automated**
- **Pave the way for future AI systems**

A Crowd-Powered Conversational Assistant That Automates Itself Over Time



Lecturer: Kenneth Huang

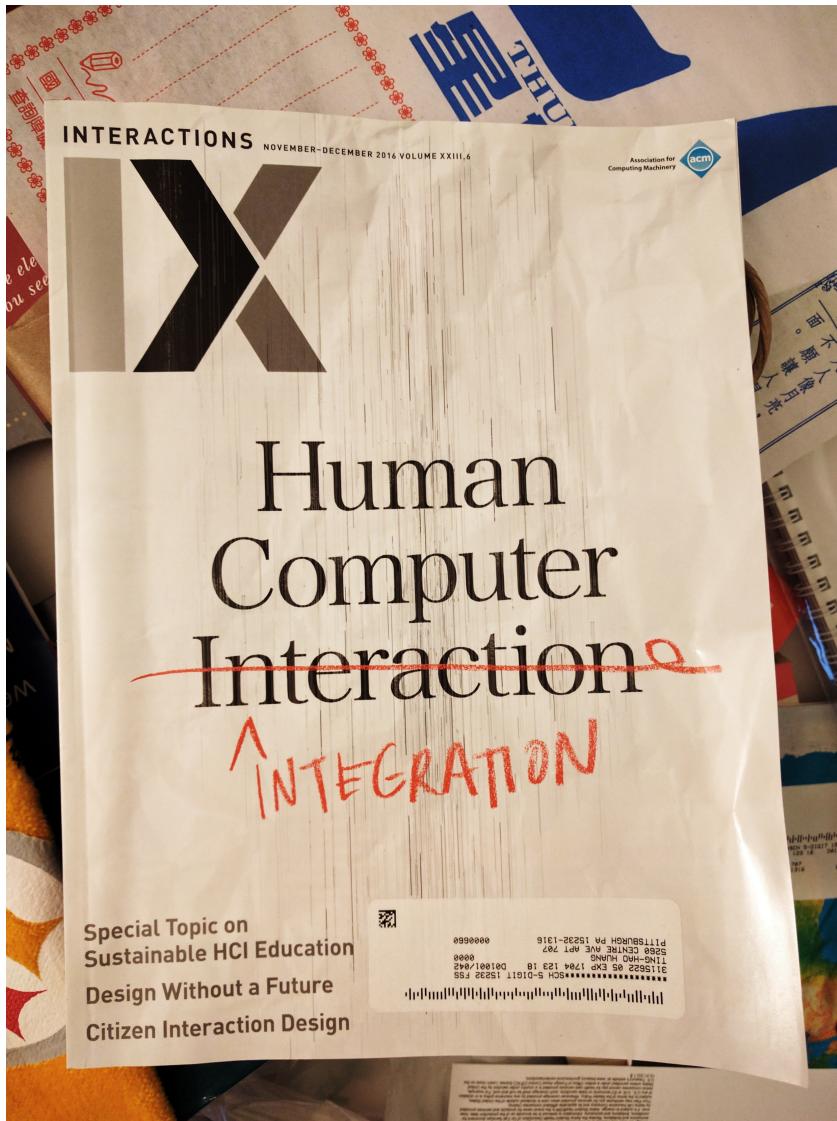
Pennsylvania State University

`txh710@psu.edu`

Mar 26, 2019

Backup Slides

Thank you!



Ting-Hao (Kenneth) Huang

Pennsylvania State University
txh710@psu.edu



 [@windx0303](https://twitter.com/windx0303)

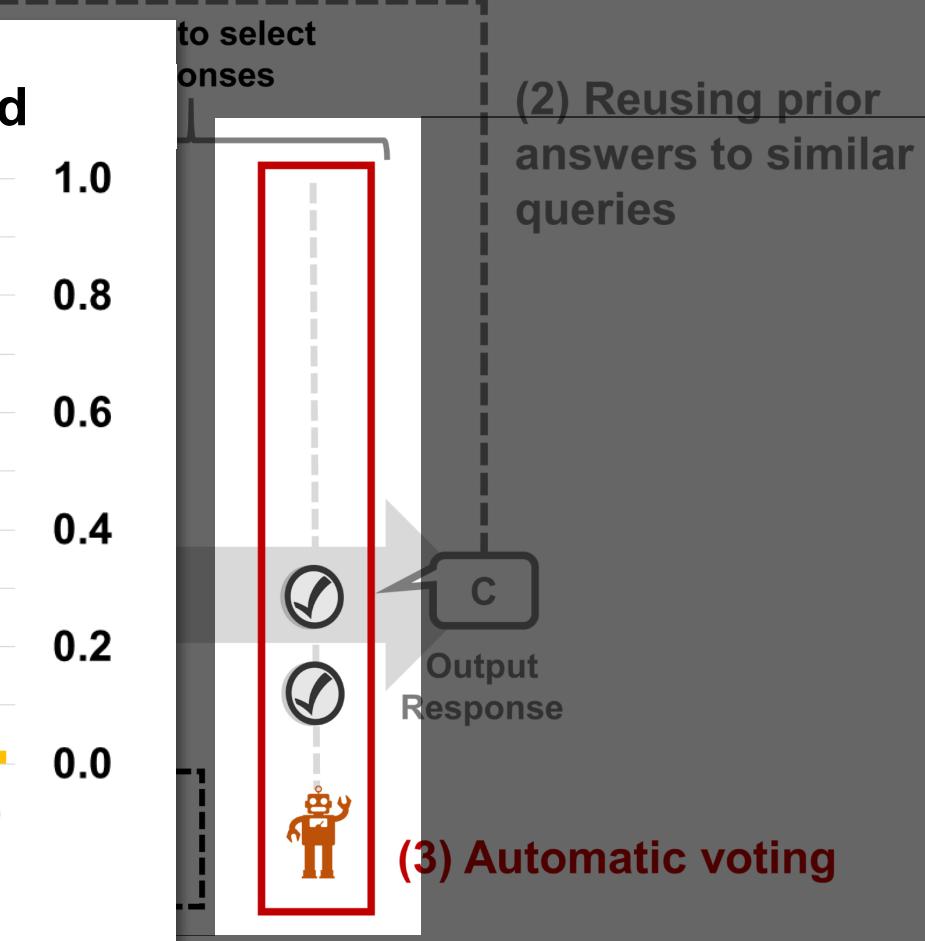
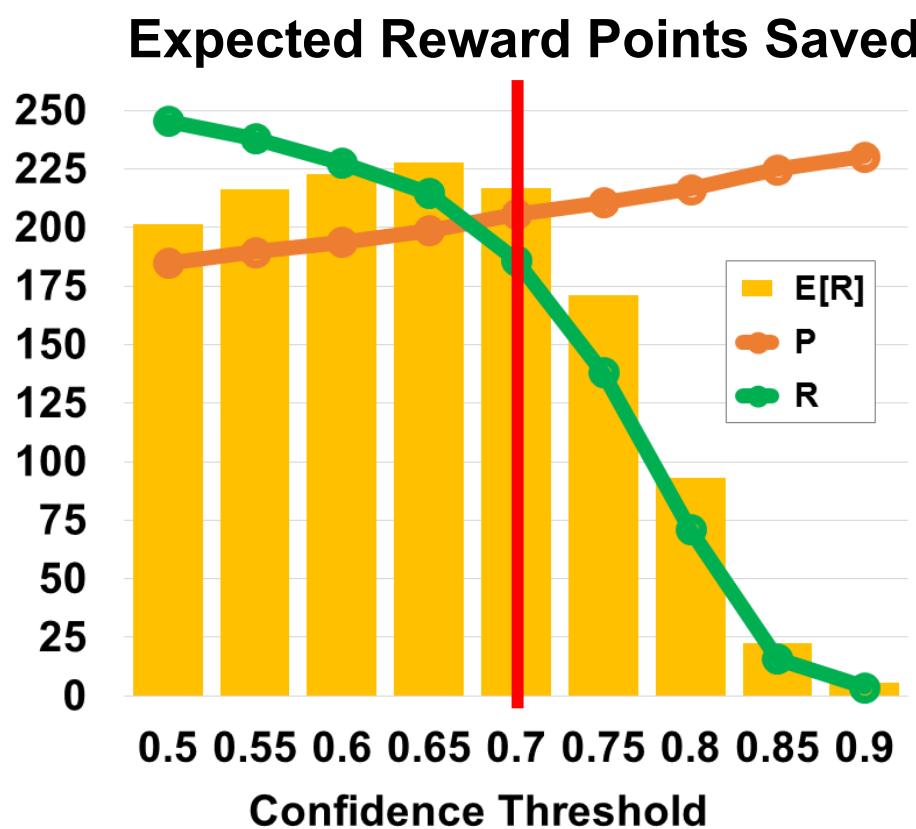
 KennethHuang.cc

Backend**Messages that are Visible to the User**

Type	ID	Feature Description
Message Level	1	Vocabulary size of this message
	2	String length of this message
	3	Worker ID of proposer of this message
Turn Level	4	#Already-accepted crowd message in this turn
	5	Duration from the latest user message (sec)
	6	#Already-accepted (and Not-accepted) crowd message of this worker in this turn
	7	Word vector of accepted (and non-accepted) crowd messages in this turn
Conv. Level	8	# Accepted (and Not-accepted) messages of this worker in this conversation
	9	Duration from the first accepted crowd message in this conversation
	10	Duration from the latest crowd message of this worker in this conversation (sec)
	11	# Already-accepted messages in this conversation
Word Vector (GloVe)	12	Message's acceptance rate of this worker in this conversation
	13	# Turns in this conversation
	14	Average word vector of this message
Word Vector (GloVe)	15	Average word vector of all accepted crowd messages in this turn
	16	Average word vector of all not-accepted crowd messages in this turn
	17	Average word vector of all the user messages in this turn
	18	Difference vectors between any two vectors in {14, 15, 16, 17}
Word Vector (GloVe)	19	Element-wise product vectors between any two vectors in {14, 15, 16, 17}

Automatic Voting

Find the Best Confidence Threshold



Thesis Statement

By allowing new **chatbots** to be easily integrated, **reusing prior crowd answers**, and gradually **reducing the crowd's role** in choosing high-quality responses,

a **deployed crowd-powered dialog system** can be **automated over time** to support real-world open conversations.

Thesis Statement

By allowing new **chatbots** to be easily integrated, **reusing prior crowd answers**, and gradually **reducing the crowd's role** in choosing high-quality responses,

a **deployed crowd-powered dialog system** can be **automated over time** to support real-world open conversations.



Chorus Deployment

[HCOMP'16, HCOMP'17]

Thesis Statement

By allowing new **chatbots** to be easily integrated, **reusing prior crowd answers**, and gradually **reducing the crowd's role** in choosing high-quality responses,

a **deployed crowd-powered dialog system** can be **automated over time** to support real-world open conversations.

Chorus Deployment
[HCOMP'16, HCOMP'17]

Evorus
[CHI'18  , UIST Poster'17]

Thesis Statement

Guardian
[HCOMP'15, CI'17]

By allowing new **chatbots** to be easily integrated, **reusing prior crowd answers**, and gradually **reducing the crowd's role** in choosing high-quality responses,

a **deployed crowd-powered dialog system** can be **automated over time** to support real-world open conversations.

Chorus Deployment
[HCOMP'16, HCOMP'17]

Evorus
[CHI'18  , UIST Poster'17]

Thesis Statement

By allowing new **chatbots** to be easily integrated, **reusing prior crowd answers**, and gradually **reducing the crowd's role** in choosing high-quality responses,

a **deployed crowd-powered dialog system** can be **automated over time** to support real-world open conversations.

Thesis Statement

Guardian
[HCOMP'15, CI'17]

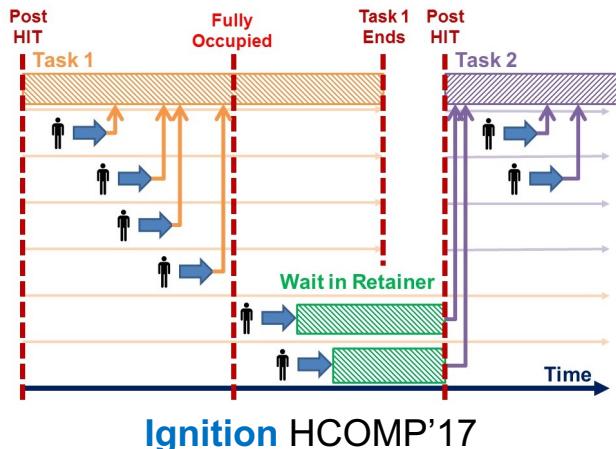
By allowing new **chatbots** to be easily integrated, **reusing prior crowd answers**, and gradually **reducing the crowd's role** in choosing high-quality responses,

a **deployed crowd-powered dialog system** can be **automated over time** to support real-world open conversations.

Chorus Deployment
[HCOMP'16, HCOMP'17]

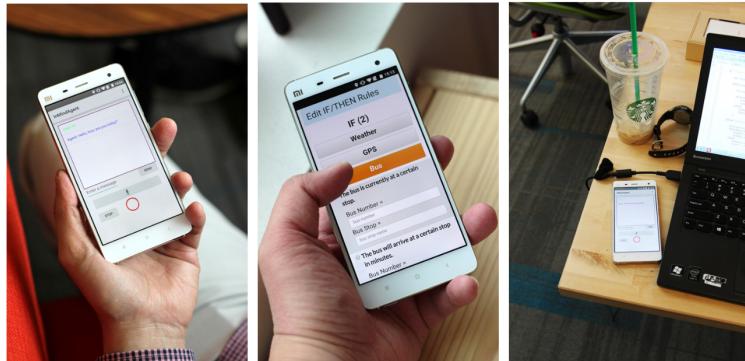
Evorus
[CHI'18  , UIST Poster'17]

Some More Projects...



Chandler	Matthew Perry talking about signs in Las Vegas. (Neutral)
Chandler	I guess it must've been some movie I saw. (Neutral)
Chandler	What do you say? (Neutral)
Monica	<i>Okay! (Joy)</i>
Chandler	Okay! Come on! Let's go! All right! (Joy)
Rachel	Oh okay, I'll fix that to. What's her e-mail address? (Neutral)
Ross	Rachel! (Anger)
Rachel	All right, I promise. I'll fix this. I swear. I'll-I'll-I'll talk to her. (Non-neutral)
Ross	<i>Okay! (Anger)</i>
Rachel	Okay. (Neutral)

EmotionLines
Chen et al., LREC'18



InstructableCrowd

CHI LBW'16, TOCHI (Under Review)



the halloween party was a lot of fun . there were a ton of people dressed up . i had a great time . the costumes was very good . afterward everyone went back home .

Visual Storytelling (VIST)
NAACL'16, Ferraro et al. EMNLP'15,

Future Work

- **Deployed Chorus as An Open Research Platform**
 - ✓ Chorus API
 - ✓ 1000+ chatbots
- **Chorus on Smart Devices**
 - ✓ Echo, Google Home...
- **Future Crowd-AI Systems!**
 - ✓ Object Recognition
 - ✓ Speech Recognition
 - ✓ Programming Tools
 - ✓ ... And More!

Future Work

- **Deployed Chorus as An Open Research Platform**
 - ✓ Chorus API
 - ✓ 1000+ chatbots
- **Chorus on Smart Devices**
 - ✓ Echo, Google Home...
- **Future Crowd-AI Systems!**
 - ✓ Object Recognition
 - ✓ Speech Recognition
 - ✓ Programming Tools
 - ✓ ... And More!



Acknowledgment

- **Family, Yan-Zhu (Lavender) Chen**
- **Jeffrey P. Bigham**
- Walter S. Lasecki, Chris Callison-Burch, Alex Rudnicky, Margaret Mitchell, Lun-Wei Ku, Hsin-Hsi Chen, Saiph Savage, Jane Hsu...
- Shou-I Yu, Joseph Chee Chang, Chih-Yi (Jessica) Lin, Shihyun Lo, Chu-Cheng Lin, Yun-Nung (Vivian) Chen, Lingpeng Kong, Luan Yi, William Wang, Zi Yang, Yen-Chia Hsu, Kuen-Bang Hou (Favonia), Kerry Shih-Ping Chang, Janet Huang, Yi-Chia Wang, Kai-min Kevin Chang...
- Anhong Guo, Sai Ganesh, Kotaro Hara, Yashesh Gaur, Gierad Laput, Robert Xiao, Yang Zhang, Patrick Carrington, Luz Rello, Cole Gleason, Kristin Williams, Alex Chen, Susumu Saito...
- Amos Azaria, Oscar Romero Lopez...
- Stacey Young