

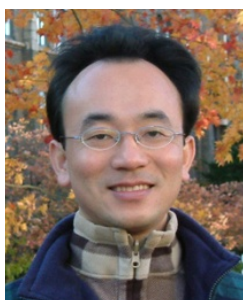
Practices of Business Intelligence

AI 交談機器人與對話式商務 (AI Chatbots and Conversational Commerce)

1071BI12

MI4 (M2084) (2888)

Wed, 7, 8 (14:10-16:00) (B217)



Min-Yuh Day

戴敏育

Assistant Professor

專任助理教授

Dept. of Information Management, Tamkang University

淡江大學 資訊管理學系

<http://mail.tku.edu.tw/myday/>

2018-12-19



課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
1	2018/09/12	商業智慧實務課程介紹 (Course Orientation for Practices of Business Intelligence)
2	2018/09/19	商業智慧、分析與資料科學 (Business Intelligence, Analytics, and Data Science)
3	2018/09/26	人工智慧、大數據與雲端運算 (ABC: AI, Big Data, and Cloud Computing)
4	2018/10/03	描述性分析I：數據的性質、統計模型與可視化 (Descriptive Analytics I: Nature of Data, Statistical Modeling, and Visualization)
5	2018/10/10	國慶紀念日 (放假一天) (National Day) (Day off)
6	2018/10/17	描述性分析II：商業智慧與資料倉儲 (Descriptive Analytics II: Business Intelligence and Data Warehousing)

課程大綱 (Syllabus)

週次 (Week) 日期 (Date) 內容 (Subject/Topics)

- 7 2018/10/24 預測性分析I：資料探勘流程、方法與演算法
(Predictive Analytics I: Data Mining Process,
Methods, and Algorithms)
- 8 2018/10/31 預測性分析II：文本、網路與社群媒體分析
(Predictive Analytics II: Text, Web, and
Social Media Analytics)
- 9 2018/11/07 期中報告 (Midterm Project Report)
- 10 2018/11/14 期中考試 (Midterm Exam)
- 11 2018/11/21 處方性分析：最佳化與模擬
(Prescriptive Analytics: Optimization and Simulation)
- 12 2018/11/28 社會網絡分析
(Social Network Analysis)

課程大綱 (Syllabus)

週次 (Week) 日期 (Date) 內容 (Subject/Topics)

13 2018/12/05 機器學習與深度學習
(Machine Learning and Deep Learning)

14 2018/12/12 自然語言處理
(Natural Language Processing)

15 2018/12/19 AI交談機器人與對話式商務
(AI Chatbots and Conversational Commerce)

16 2018/12/26 商業分析的未來趨勢、隱私與管理考量
(Future Trends, Privacy and
Managerial Considerations in Analytics)

17 2019/01/02 期末報告 (Final Project Presentation)

18 2019/01/09 期末考試 (Final Exam)

Business Intelligence (BI)

1 Introduction to BI and Data Science

2 Descriptive Analytics

3 Predictive Analytics

4 Prescriptive Analytics

⑤ Big Data Analytics

6 Future Trends

AI Chatbots and Conversational Commerce

Outline

- **AI Chatbots**
- **Conversational Commerce**
- **Bot Platform Ecosystem**

AI and Cognitive Computing

Artificial Intelligence (A.I.) Timeline

A.I. TIMELINE

SYZYG

1950

TURING TEST

Computer scientist Alan Turing proposes a test for machine intelligence. If a machine can trick humans into thinking it is human, then it has intelligence

1955

A.I. BORN

Term 'artificial intelligence' is coined by computer scientist, John McCarthy to describe "the science and engineering of making intelligent machines"

1961

UNIMATE

First industrial robot, Unimate, goes to work at GM replacing humans on the assembly line

1964

ELIZA

Pioneering chatbot developed by Joseph Weizenbaum at MIT holds conversations with humans

1966

SHAKY

The 'first electronic person' from Stanford, Shakey is a general-purpose mobile robot that reasons about its own actions

**A.I.
WINTER**

Many false starts and dead-ends leave A.I. out in the cold

1997

DEEP BLUE

Deep Blue, a chess-playing computer from IBM defeats world chess champion Garry Kasparov

1998

KISMET

Cynthia Breazeal at MIT introduces Kismet, an emotionally intelligent robot insofar as it detects and responds to people's feelings

1999

AIBO

Sony launches first consumer robot pet dog AiBO (AI robot) with skills and personality that develop over time

2002

ROOMBA

First mass produced autonomous robotic vacuum cleaner from iRobot learns to navigate and clean homes

2011

SIRI

Apple integrates Siri, an intelligent virtual assistant with a voice interface, into the iPhone 4S

2011

WATSON

IBM's question answering computer Watson wins first place on popular \$1M prize television quiz show Jeopardy

2014

EUGENE

Eugene Goostman, a chatbot passes the Turing Test with a third of judges believing Eugene is human

2014

ALEXA

Amazon launches Alexa, an intelligent virtual assistant with a voice interface that completes shopping tasks

2016

TAY

Microsoft's chatbot Tay goes rogue on social media making inflammatory and offensive racist comments

2017

ALPHAGO

Google's A.I. AlphaGo beats world champion Ke Jie in the complex board game of Go, notable for its vast number (2^{170}) of possible positions

Chatbots: Evolution of UI/UX

Paradigm	mid - 80s PC	mid - 90s Web	mid - 00s Smartphone	mid - 10s Messaging
Platform Examples	Desktop DOS, Windows, Mac OS	Browser Mosaic, Explorer, Chrome	Mobile OS iOS, Android	Messaging Apps WhatsApp, Messenger, Slack
Applications Examples	Clients Excel, PPT, Lotus	Website Yahoo, Amazon	Apps Angry Birds, Instagram	Bots Weather, Travel
UI/UX	Native Screens	Web Pages	Native Mobile Screens	Message
S/w Dev	Client-side	Server-side	Client-side	Server-side

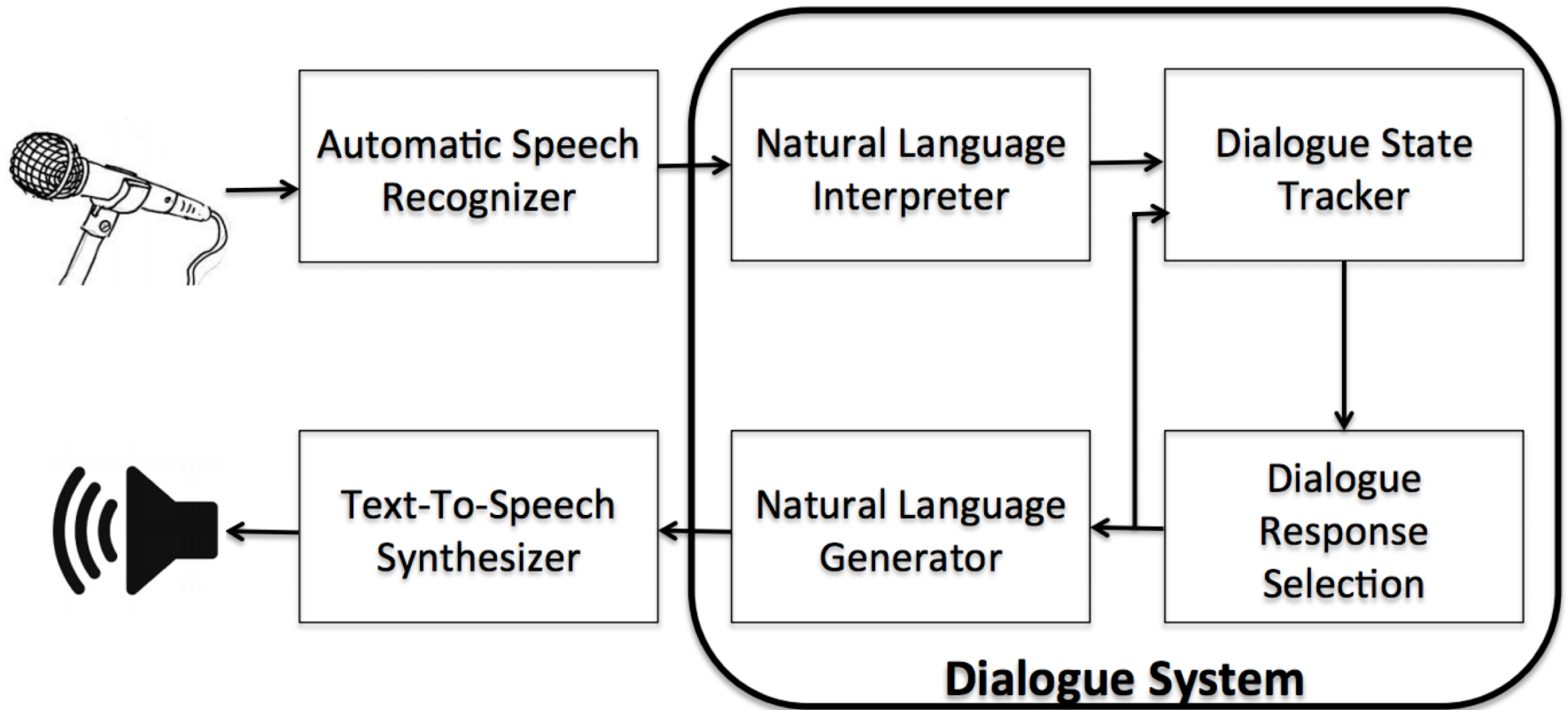
AI Chatbot for Conversational Commerce

Chatbot
Dialogue System
Intelligent Agent

Chatbot



Dialogue System



Can machines think?

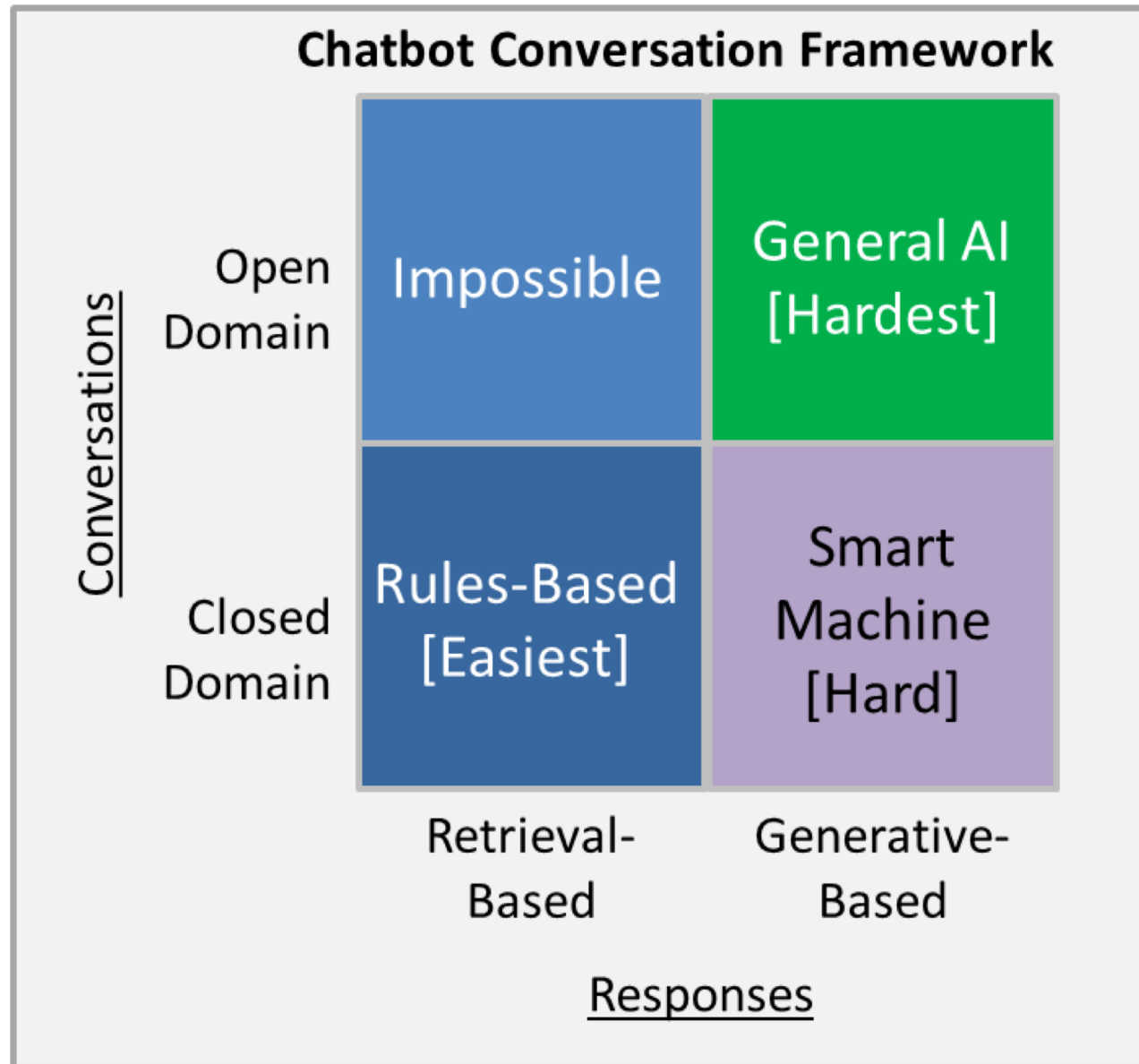
(Alan Turing ,1950)

Source: Cahn, Jack. "CHATBOT: Architecture, Design, & Development."
PhD diss., University of Pennsylvania, 2017.

Chatbot

**“online human-computer
dialog system
with
natural language.”**

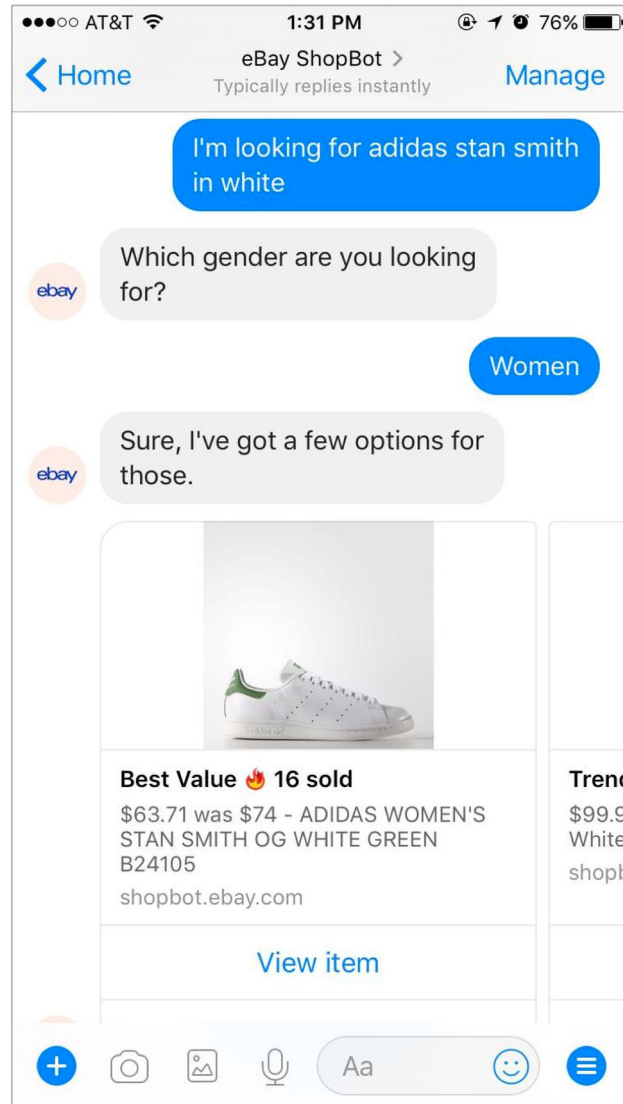
Chatbot Conversation Framework



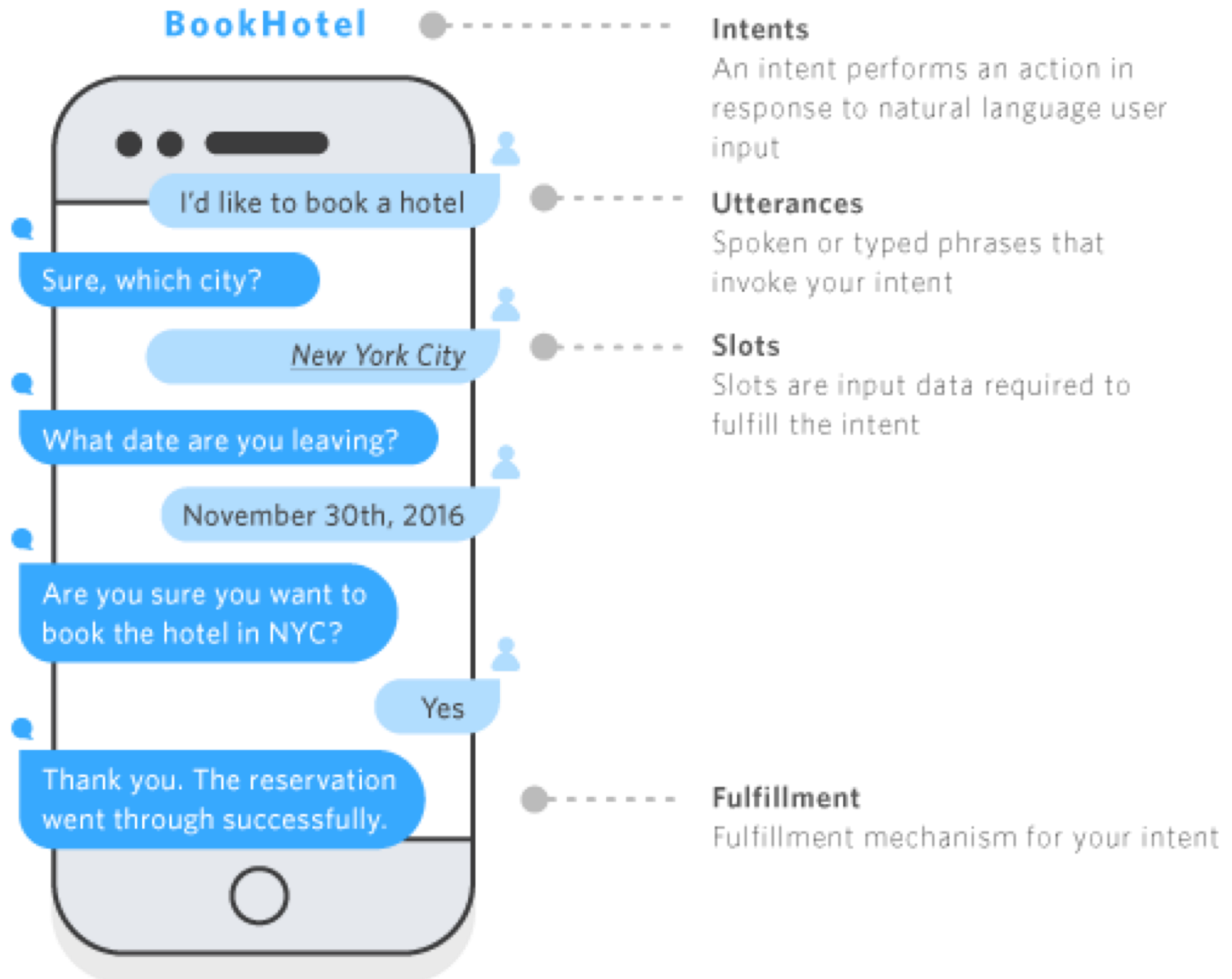
Conversational Commerce

**From
E-Commerce
to
Conversational Commerce:
Chatbots
and
Virtual Assistants**

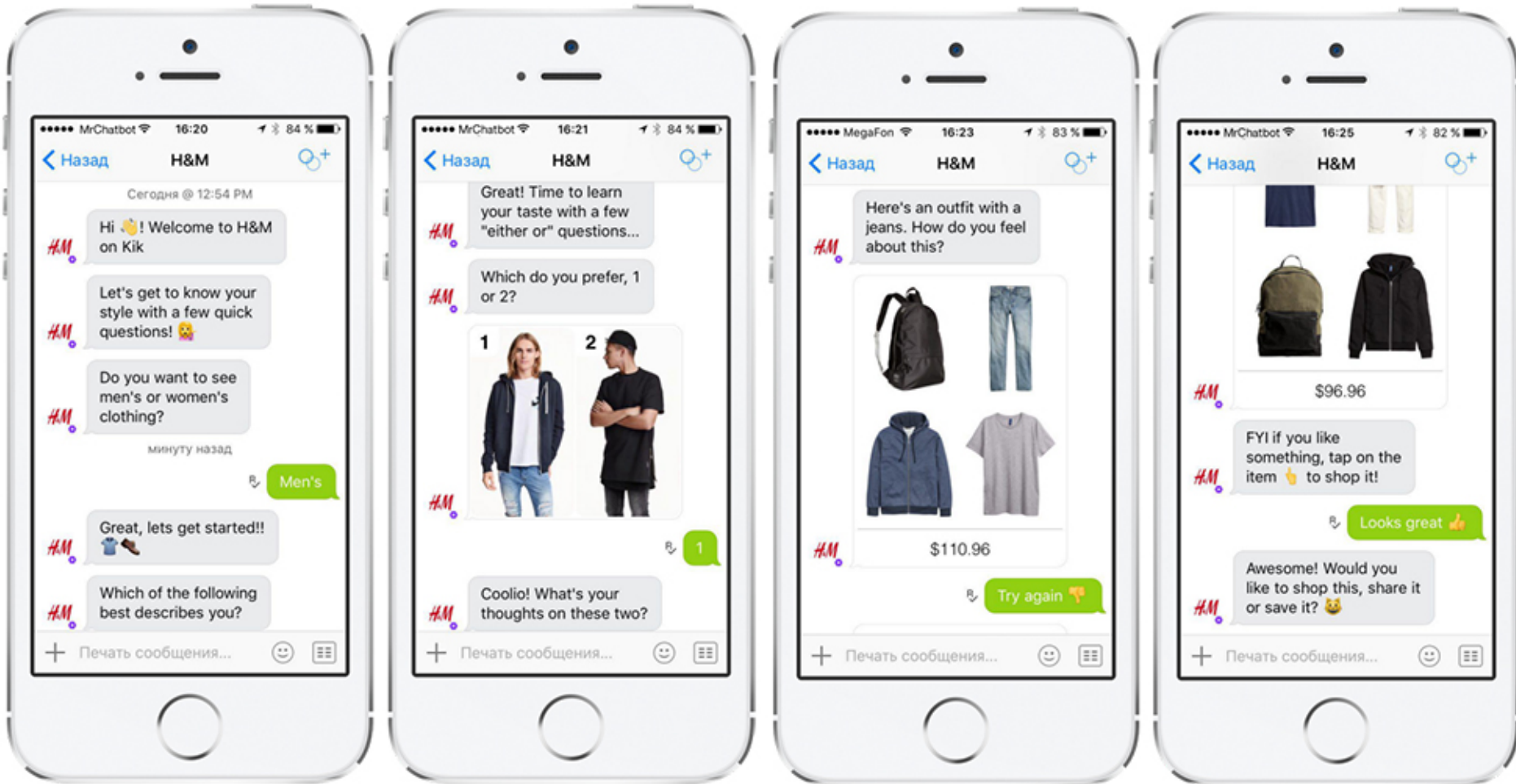
Conversational Commerce: eBay AI Chatbots



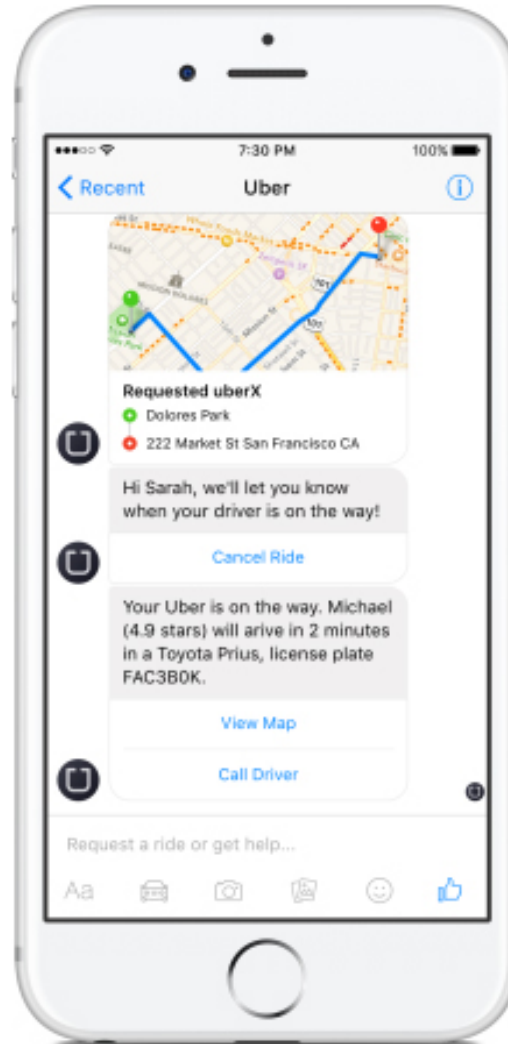
Hotel Chatbot



H&M's Chatbot on Kik



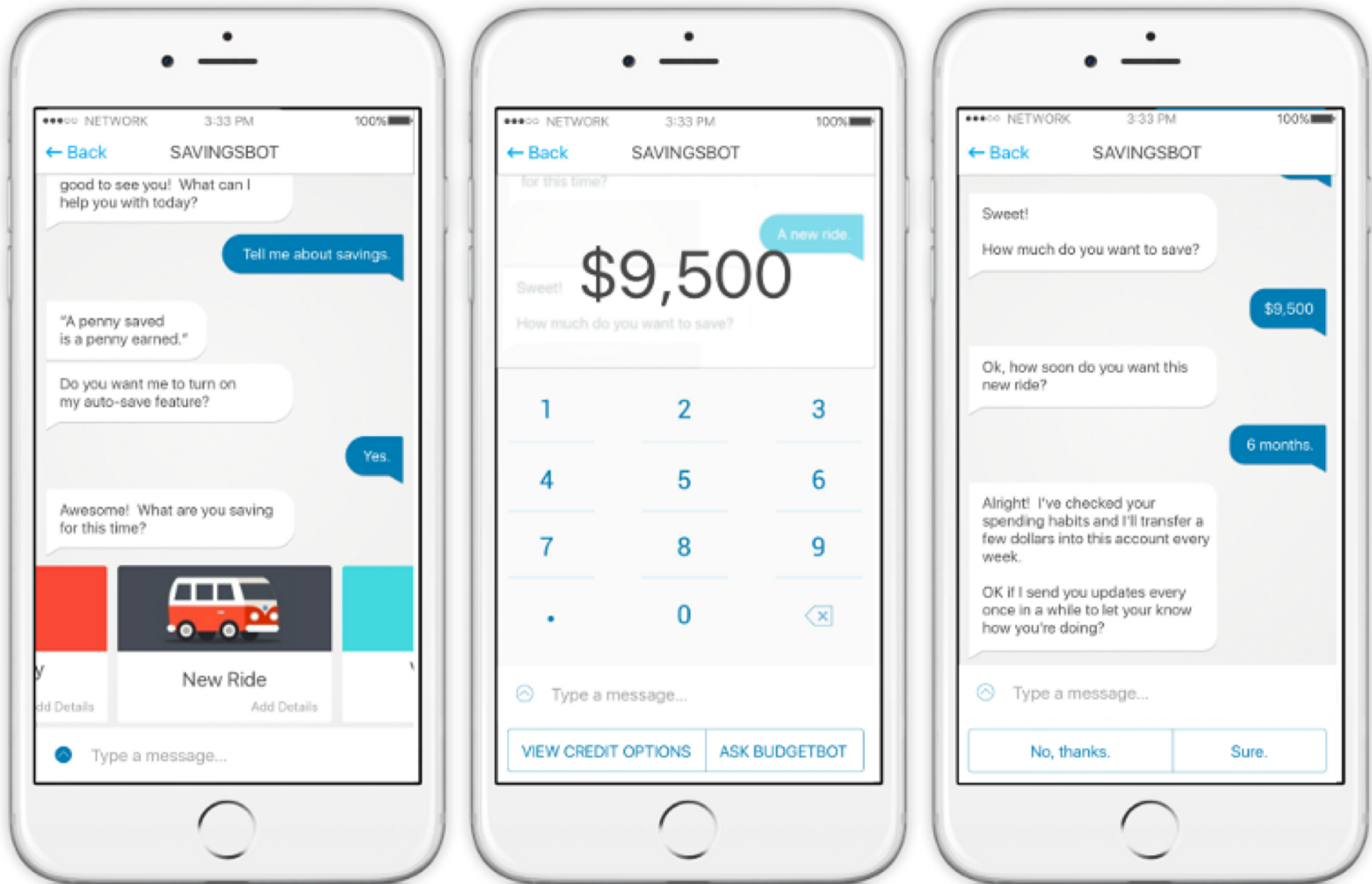
Uber's Chatbot on Facebook's Messenger



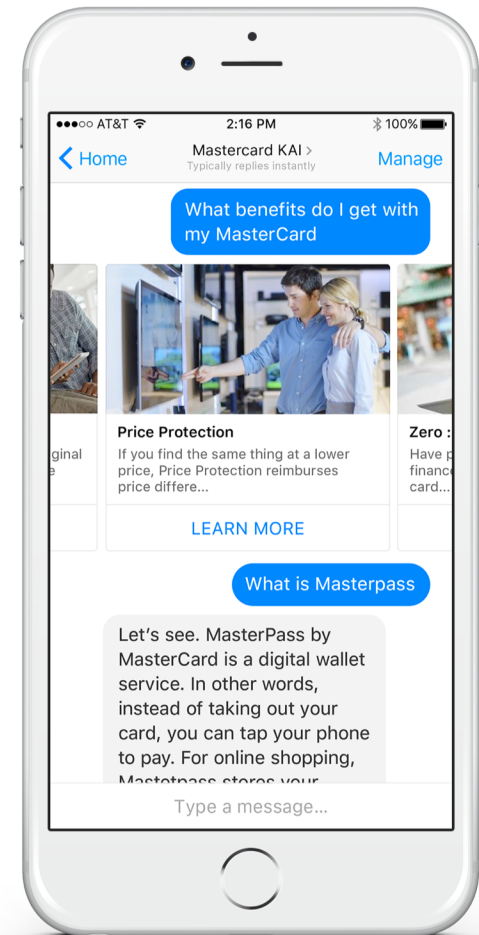
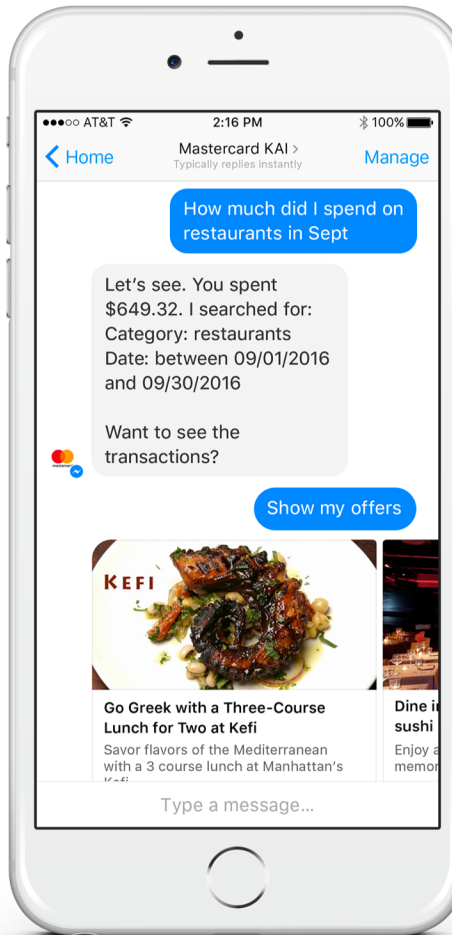
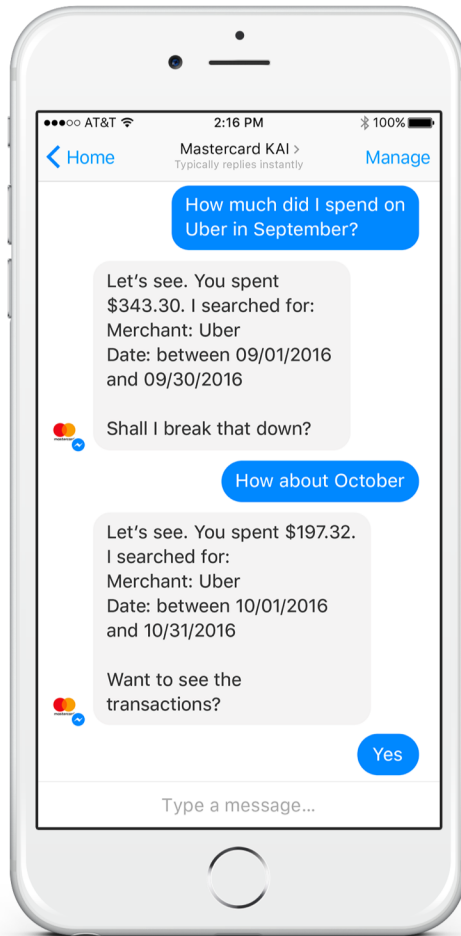
- Uber's chatbot on Facebook's messenger
- one main benefit: it loads much faster than the Uber app

Source: <http://www.guided-selling.org/from-e-commerce-to-conversational-commerce/>

Savings Bot



Mastercard Makes Commerce More Conversational



POWERED BY
Kasisto

Bot Platform Ecosystem

The bot platform ecosystem and the emerging giants

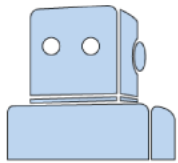
Nearly every large software company has announced some sort of bot strategy in the last year. Here's a look at a handful of leading platforms that developers might use to send messages, interpret natural language, and deploy bots, with the emerging bot-ecosystem giants highlighted.

General AI agents with platforms

Developer access available now or announced



Bot frameworks and deployment platforms



Wit.ai
Facebook



BotKit
Howdy



Chatfuel

Automat

Automat



Bot Framework
Microsoft



Api.ai
Google



Pandorabots



MindMeld



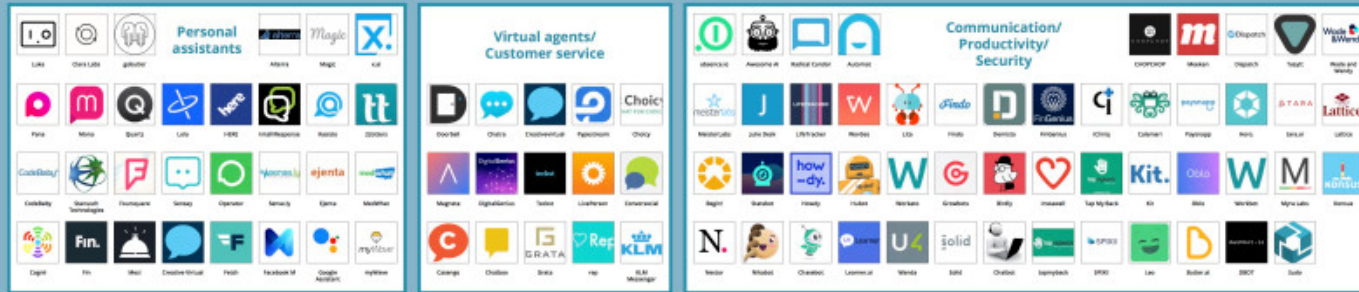
Gupshup



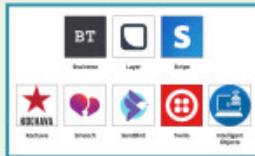
Sequel

Bots Landscape

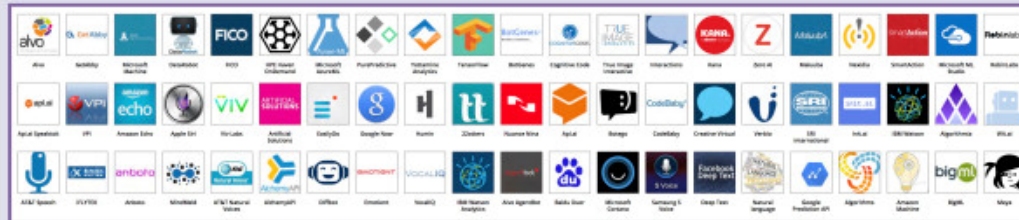
Bots with traction



Connectors/ Shared Services



AI Tools: Natural Language Processing, Machine Learning, Speech & Voice Recognition



Bot Discovery



Bot developer frameworks and tools



Analytics



Messaging



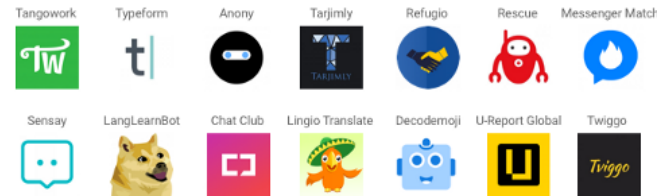
RECAST.AI Messenger Bot Landscape

May 2017

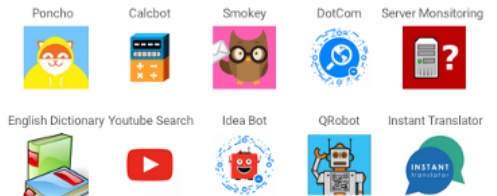
Food



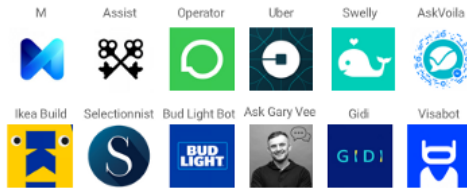
Communication



Utilities



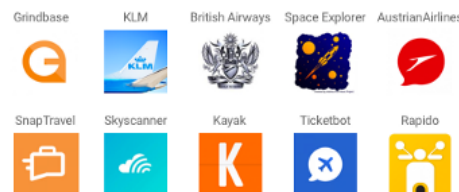
Personal



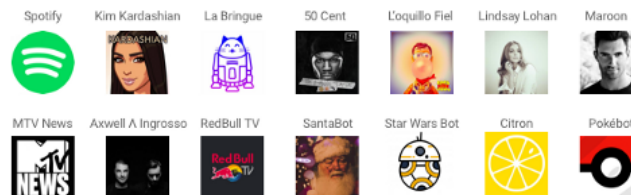
Analytics



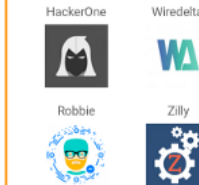
Travel



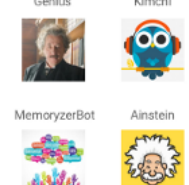
Entertainment



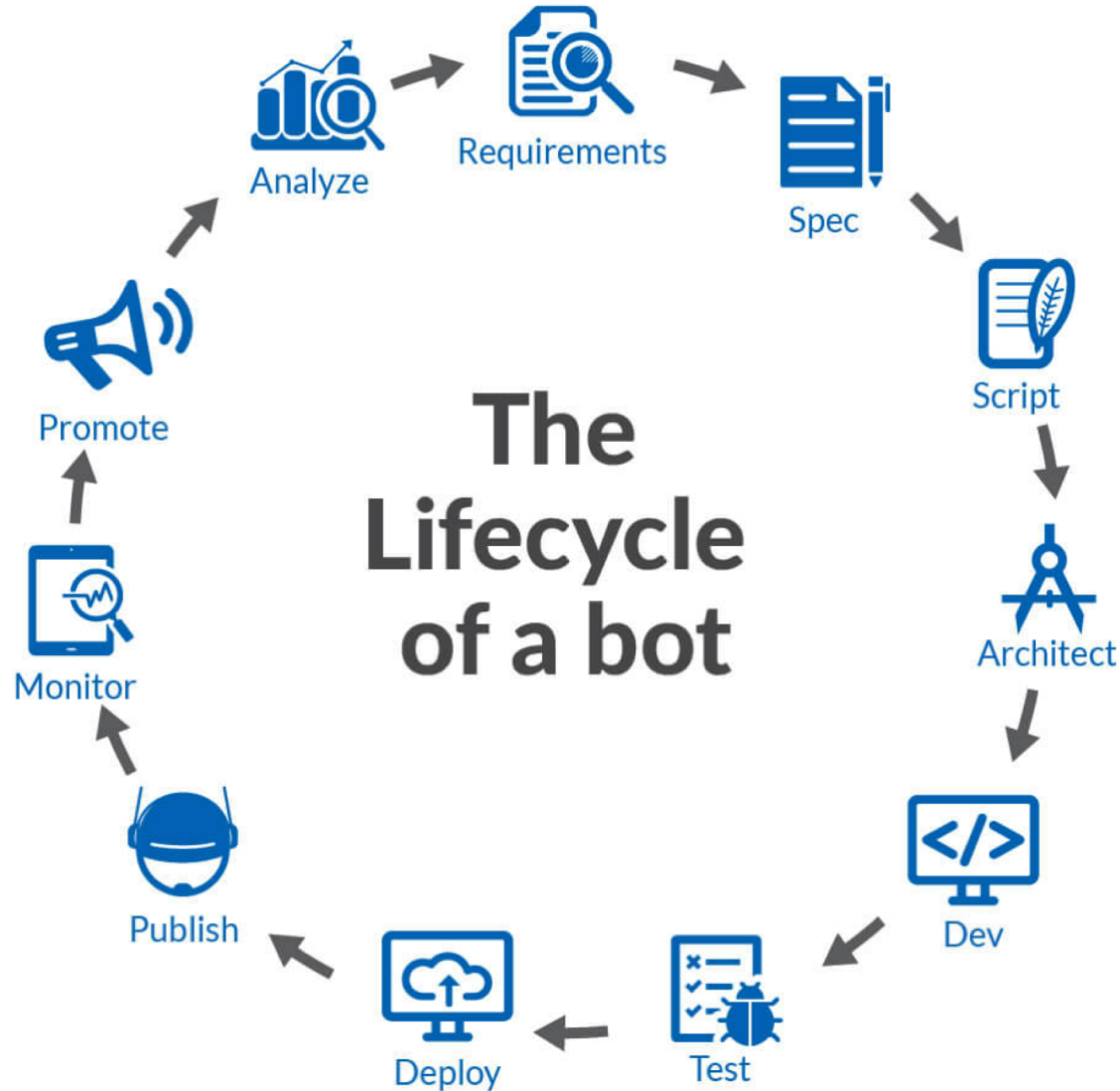
Developer Tools



Education



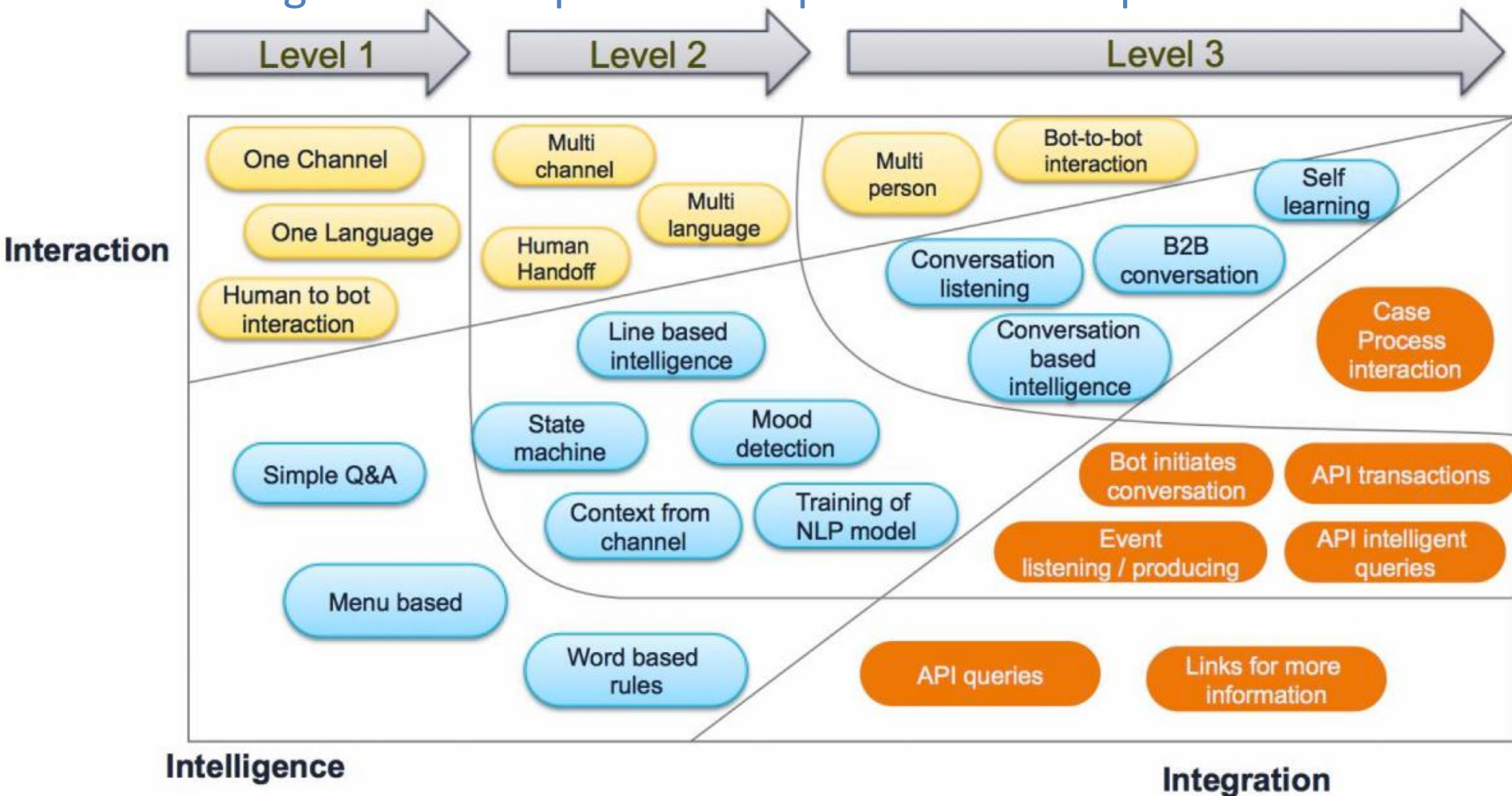
The Bot Lifecycle



Chatbots

Bot Maturity Model

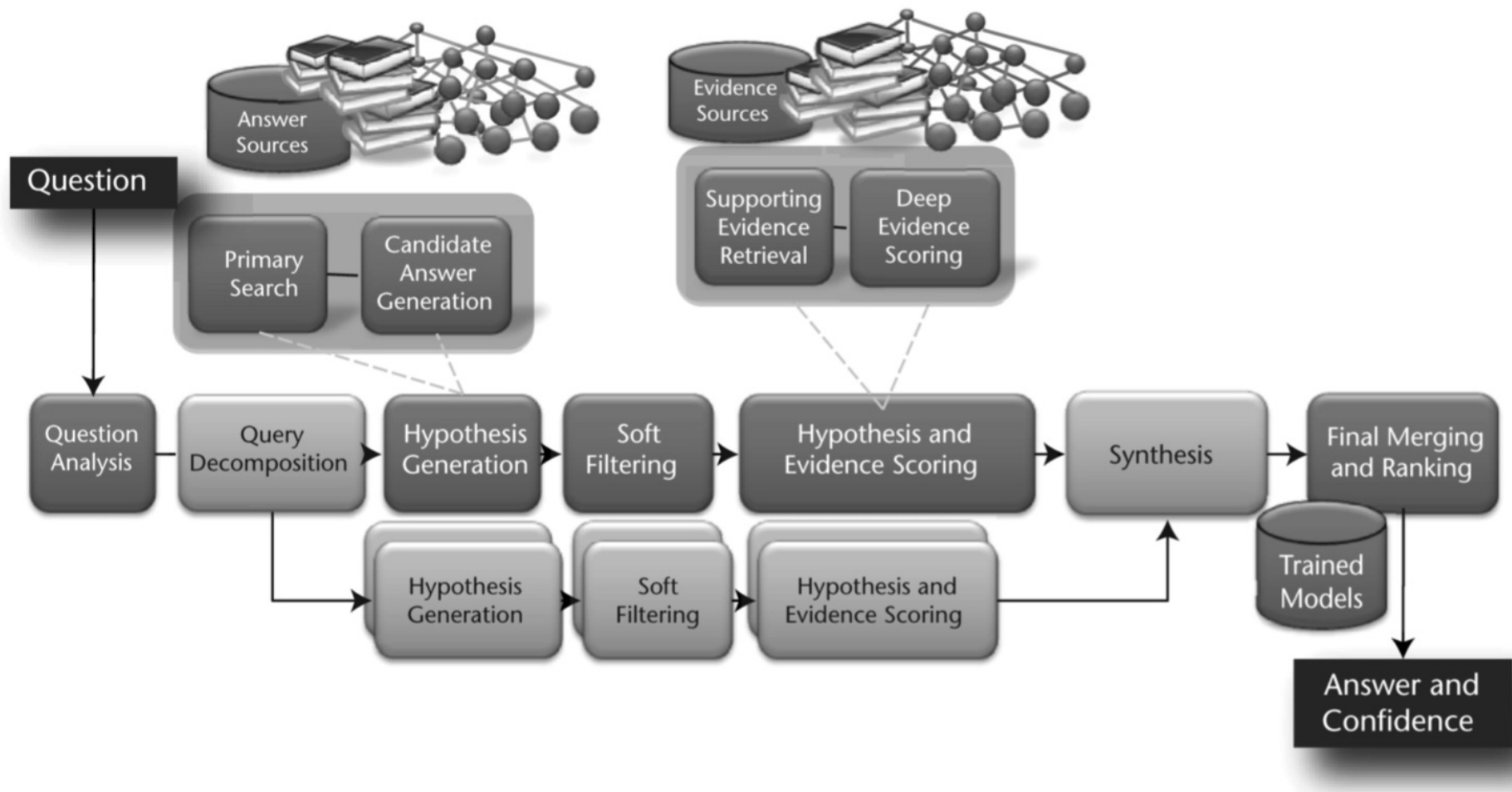
Customers want to have simpler means to interact with businesses and get faster response to a question or complaint.



Chatbot Architectures

- Information Retrieval based Bot (IR-Bot)
- Task Oriented Bot (Task-Bot)
- Chitchat-Bot (Chatbot)

Watson DeepQA Architecture



ALICE and AIML



A.L.I.C.E. Silver Edition

DAVE E.S.L. bot

C.L.A.U.D.I.O Personality Test

GET SITEPAL AVATARS

Free Live Chat with the award winning A. I. chat robot **A. L. I. C. E.**

Get Started

[Chat with A.L.I.C.E.](#)

[Chat with Fake Kirk](#)

[What is AIML?](#)
[Foundation Bot Directory](#)
[Bot Industry Survey](#)
[AIML Overview](#)

Software

[Downloads](#)
[Bot Hosting](#)
[AIML Sets](#)
[AIML 1.1 Specification](#)
[AIML 2.0 Working Draft](#)
[Documentation](#)
[Superbot - New!](#)

Links

[ESL](#)
[Books](#)
[Film and TV](#)
[Recent Press](#)
[Popular Culture](#)
[Web Ontologies](#)
[ALICE and A.I. History](#)
[Scholarly Research and Teaching](#)

Site Info

alicebot.org

Rank: 257,092

Links in: 638

AIML: Artificial Intelligence Markup Language

AIML (Artificial Intelligence Markup Language) is an XML-compliant language that's easy to learn, and makes it possible for you to begin customizing an Alicebot or creating one from scratch within minutes.

The most important units of AIML are:

- `<aiml>`: the tag that begins and ends an AIML document
- `<category>`: the tag that marks a "unit of knowledge" in an Alicebot's knowledge base
- `<pattern>`: used to contain a simple pattern that matches what a user may say or type to an Alicebot
- `<template>`: contains the response to a user input

There are also 20 or so additional more tags often found in AIML files, and it's possible to create your own so-called "custom predicates". Right now, a beginner's guide to AIML can be found in the [AIML Primer](#).

The free [A.L.I.C.E. AIML](#) includes a knowledge base of approximately 41,000 categories. Here's an example of one of them:

```
<category>
  <pattern>WHAT ARE YOU</pattern>
  <template>
    <think><set name="topic">Me</set></think>
    I am the latest result in artificial intelligence,
    which can reproduce the capabilities of the human brain
    with greater speed and accuracy.
  </template>
</category>
```

(The opening and closing `<aiml>` tags are not shown here, because this is an excerpt from the middle of a document.)

Everything between `<category>` and `</category>` is -- you guessed it -- a category. A category can have one pattern and one template. (It can also contain a `<that>` tag, but we won't get into that here.)

The pattern shown will match *only* the exact phrase "what are you" (capitalization is ignored).

But it's possible that this category may be invoked by another category, using the `<srai>` tag (not shown) and the principle of **reductionism**.

In any case, if this category is called, it will produce the response "I am the latest result in artificial intelligence..." shown above. In addition, it will do something else interesting. Using the `<think>` tag, which causes Alicebot to perform whatever it contains but hide the result from the user, the Alicebot engine will set the "topic" in its memory to "Me". This allows any categories elsewhere with an

Subscription Bots

[A.L.I.C.E. Silver Edition](#)
[DAVE E.S.L. Bot](#)
[CLAUDIO Personality Test](#)



Build native
iOS, Android,
and Windows
apps in C#



AIML

(Artificial Intelligence Markup Language)

<category>

<pattern>HELLO</pattern>

<template>Hi, I am a robot</template>

</category>

AIML

(Artificial Intelligence Markup Language)

- `<aiml>`
 - the tag that begins and ends an AIML document
- `<category>`
 - the tag that marks a "unit of knowledge" in an Alicebot's knowledge base
- `<pattern>`
 - used to contain a simple pattern that matches what a **user** may say or type to an Alicebot
- `<template>`
 - contains the **response** to a user input

AIML

(Artificial Intelligence Markup Language)

<category>

<pattern>WHAT ARE YOU</pattern>

<template>

<think><set name="topic">Me</set></think>

I am the latest result in artificial intelligence,
which can reproduce the capabilities of the human brain
with greater speed and accuracy.

</template>

</category>

Deep Learning for Dialogues

Intent Classification

Intent LSTM

LSTM (Long-Short Term Memory)

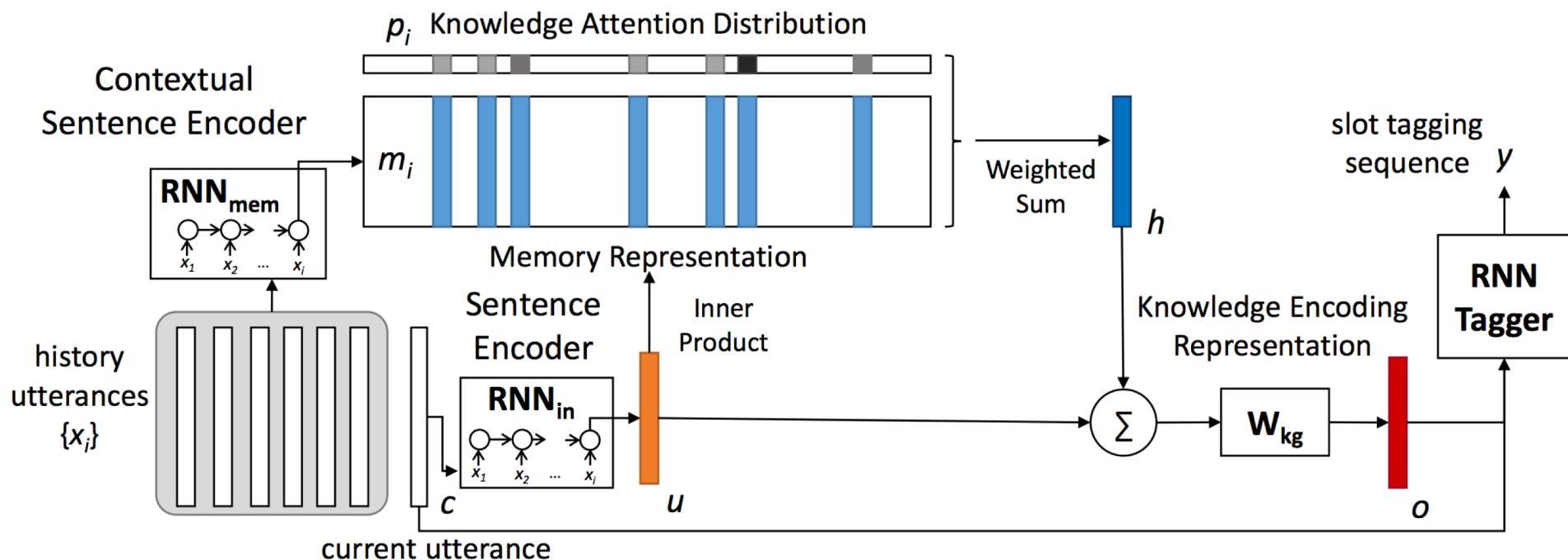
GRU (Gated Recurrent Unit)

Dialogue Utterance

W	find	recent	comedies	by	james	cameron
	↓	↓	↓	↓	↓	↓
S	O	B-date	B-genre	O	B-dir	I-dir
D	movies					
I	find_movie					

An example utterance with annotations of semantic slots in IOB format (S), domain (D), and intent (I),
B-dir and I-dir denote the director name.

End-to-end Memory Network Model for Multi-turn SLU



D communication

I send_email

U just sent email to bob about fishing this weekend

↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓

S O O O O ↓ O ↓ ↓ ↓

B-contact_name B-subject I-subject I-subject

→ send_email(contact_name="bob", subject="fishing this weekend")

U₁ send email to bob



S₁ B-contact_name

→ send_email(contact_name="bob")

U₂ are we going to fish this weekend

↓ ↓ ↓ ↓ ↓ ↓ ↓

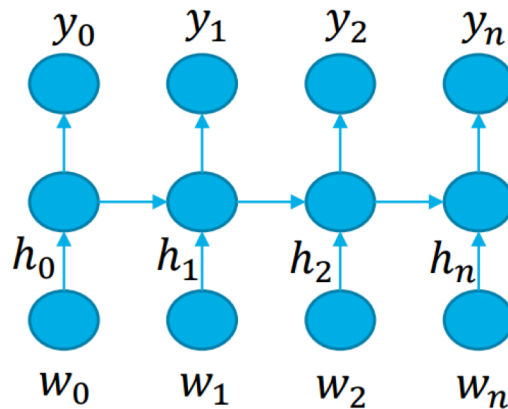
S₂ B-message I-message I-message I-message I-message

I-message I-message I-message

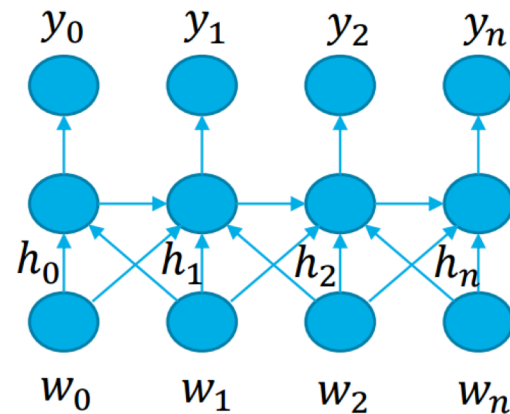
→ send_email(message="are we going to fish this weekend")

Deep Learning for SLU

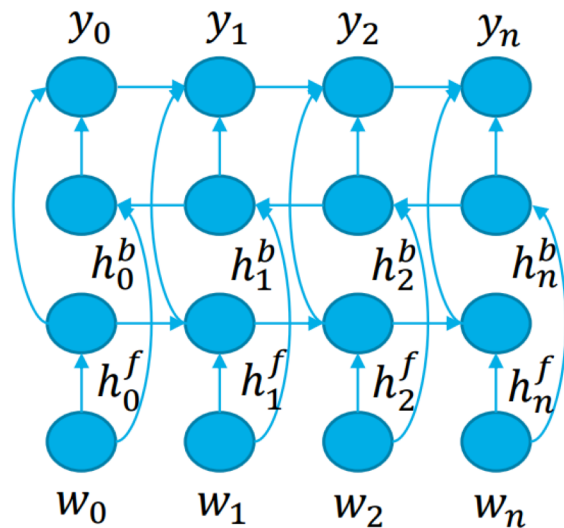
(Spoken Language Understanding)



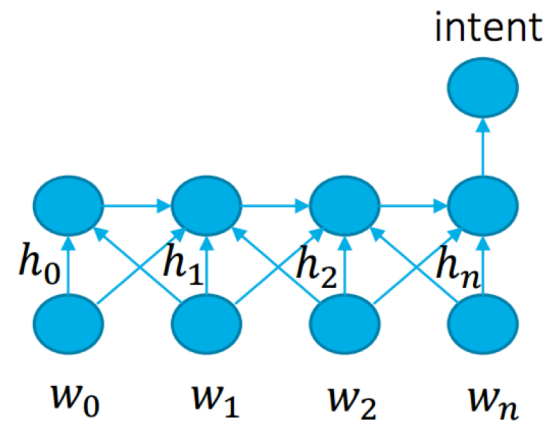
(a) LSTM



(b) LSTM-LA

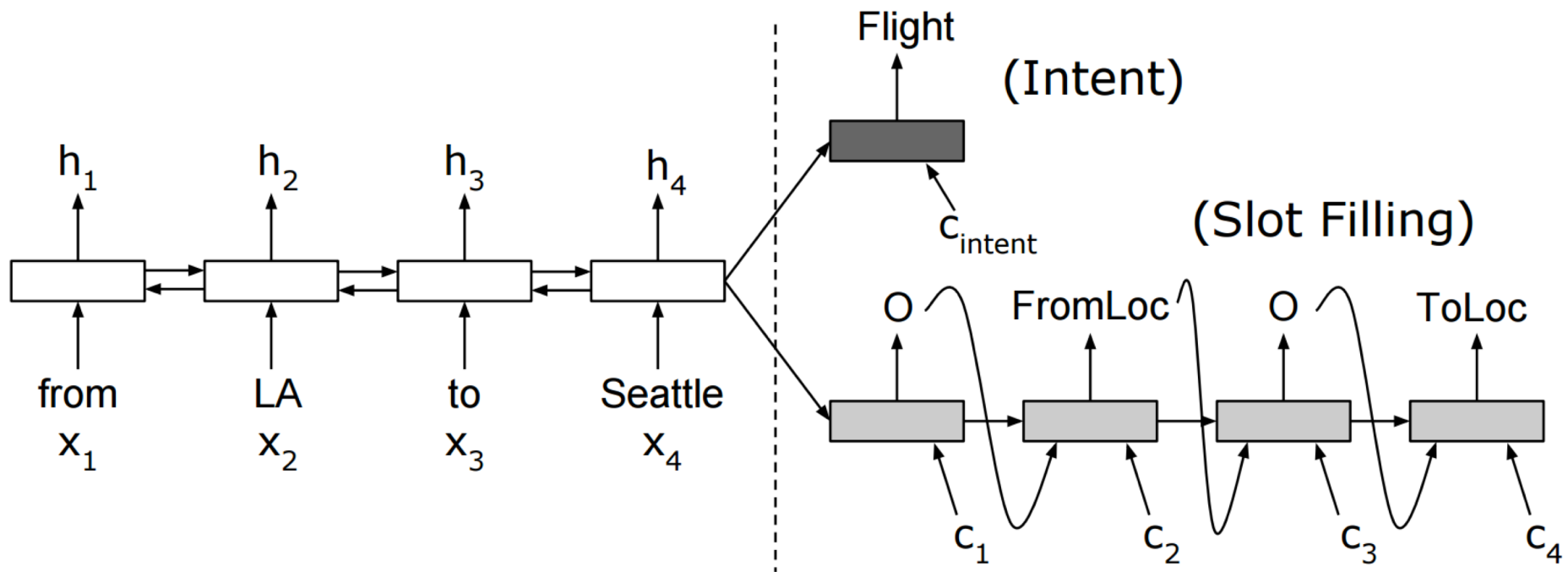


(c) bLSTM-LA



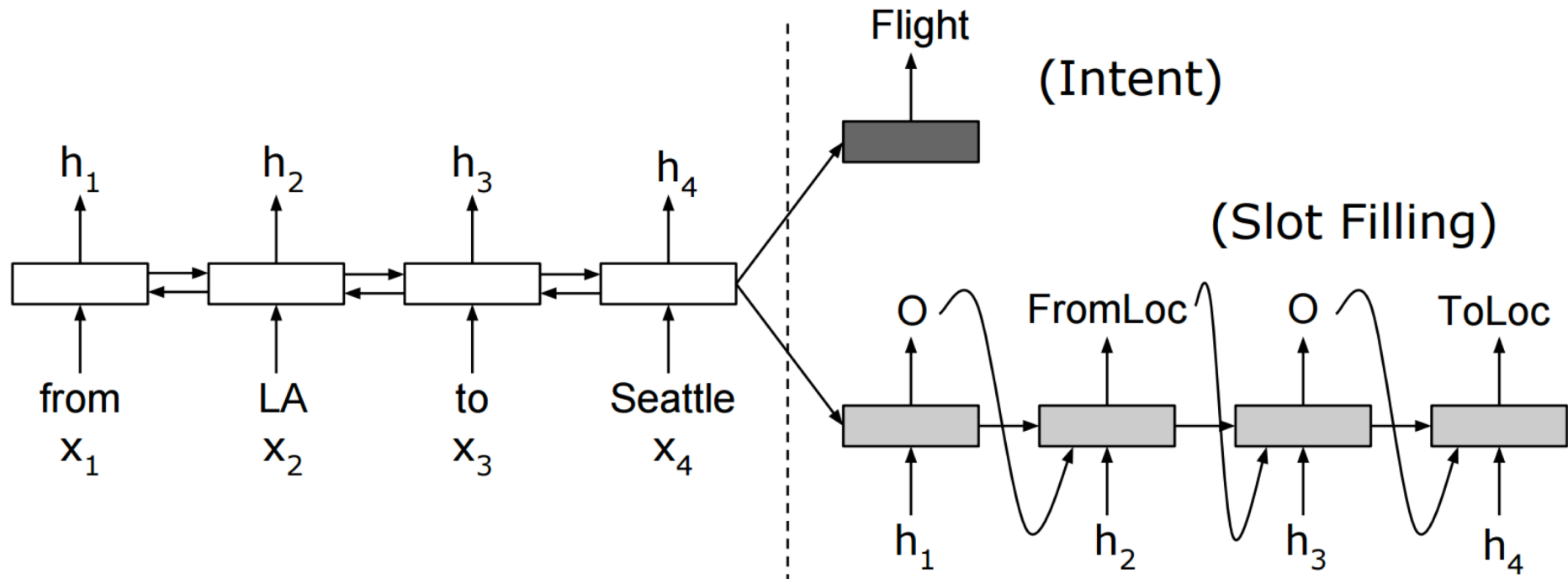
(b) Intent LSTM

Encoder-decoder model for joint intent detection and slot filling



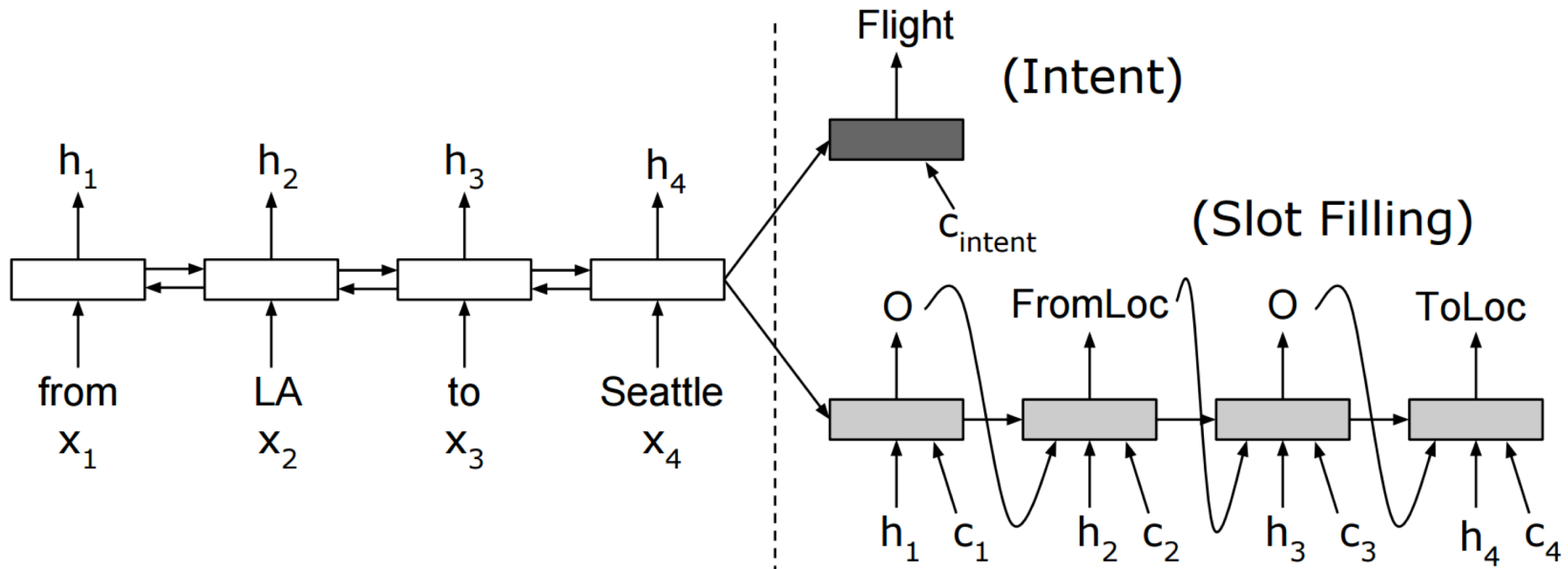
(a) with no aligned inputs.

Encoder-decoder model for joint intent detection and slot filling



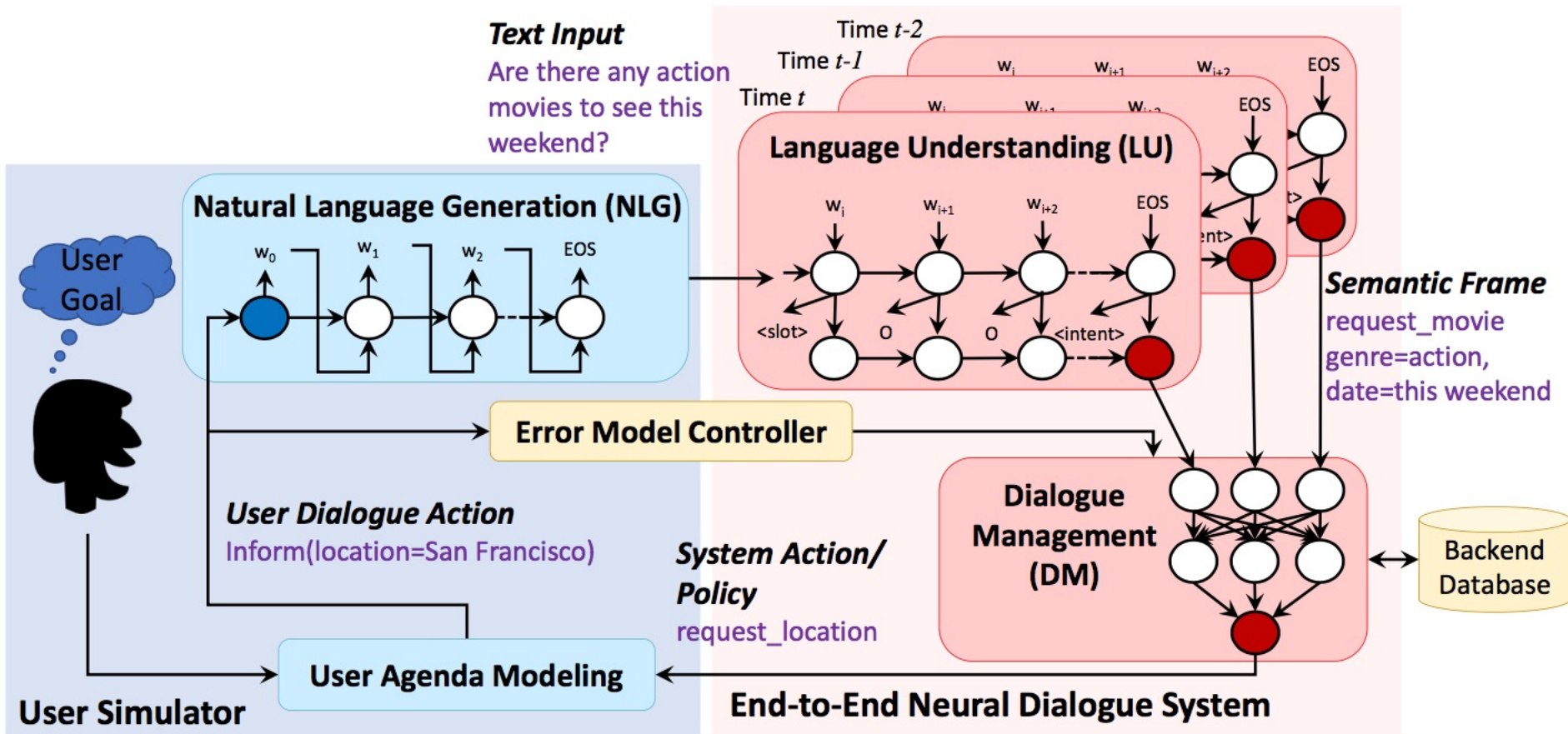
(b) with aligned inputs.

Encoder-decoder model for joint intent detection and slot filling



(c) with aligned inputs and attention

End-to-End Task-Completion Neural Dialogue Systems



Reinforcement learning is used to train all components in an end-to-end fashion

Slot Intent

W	find	action	movies	this	weekend
	↓	↓	↓	↓	↓
S	O	B-genre	O	B-date	I-date
I	find_movie				

Slot Intent

Annotations	
Intent	request, inform, deny, confirm_question, confirm_answer, greeting, closing, not_sure, multiple_choice, thanks, welcome
Slot	actor, actress, city, closing, critic_rating, date, description, distanceconstraints, greeting, implicit_value, movie_series, moviename, mpaa_rating, numberofpeople, numberofkids, taskcomplete, other, price, seating, starttime, state, theater, theater_chain, video_format, zip, result, ticket, mc_list

Sample dialogues generated by rule-based and RL agents

Rule-based agent

User: Can I get some tickets for zoolander 2?

Agent: What movie are you interested in?

User: I want to watch zoolander 2.

Agent: What time would you like to see it?

User: I want to watch at 9:25 pm.

Agent: What city you would like?

User: I want to watch at seattle.

Agent: What date would you like to watch it?

User: I want to set it up tomorrow.

Agent: Which theater would you like?

User: I want to watch at regal meridian 16.

Agent: How many tickets do you need?

User: I want 2 tickets please!

Agent: Great - I was able to purchase 2 tickets for you to see zoolander 2 tomorrow at regal meridian 16 theater in seattle at 9:25 pm.

User: Thank you.

Agent: Thank you.

Success

Sample dialogues generated by rule-based and RL agents

RL agent

User: Can I get tickets for zoolander 2 tomorrow?

Agent: Which city would you like?

User: I want to watch at seattle.

Agent: How many tickets do you need?

User: I want 2 tickets please!

Agent: 9:25 pm is available.

User: I want to watch at regal meridian 16.

Agent: Great - I was able to purchase 2 tickets for you to see zoolander 2 tomorrow at regal meridian 16 theater in seattle at 9:25 pm.

User: Thank you.

Agent: Thank you.

Success

Sample dialogues generated by rule-based and RL agents

New episode, user goal:

```
{
  "request_slots": {
    "ticket": "UNK"
  },
  "inform_slots": {
    "city": "seattle",
    "numberofpeople": "2",
    "theater": "regal meridian 16",
    "starttime": "9:25 pm",
    "date": "tomorrow",
    "moviename": "zoolander 2"
  }
}
```

A Deep Reinforcement Learning Chatbot

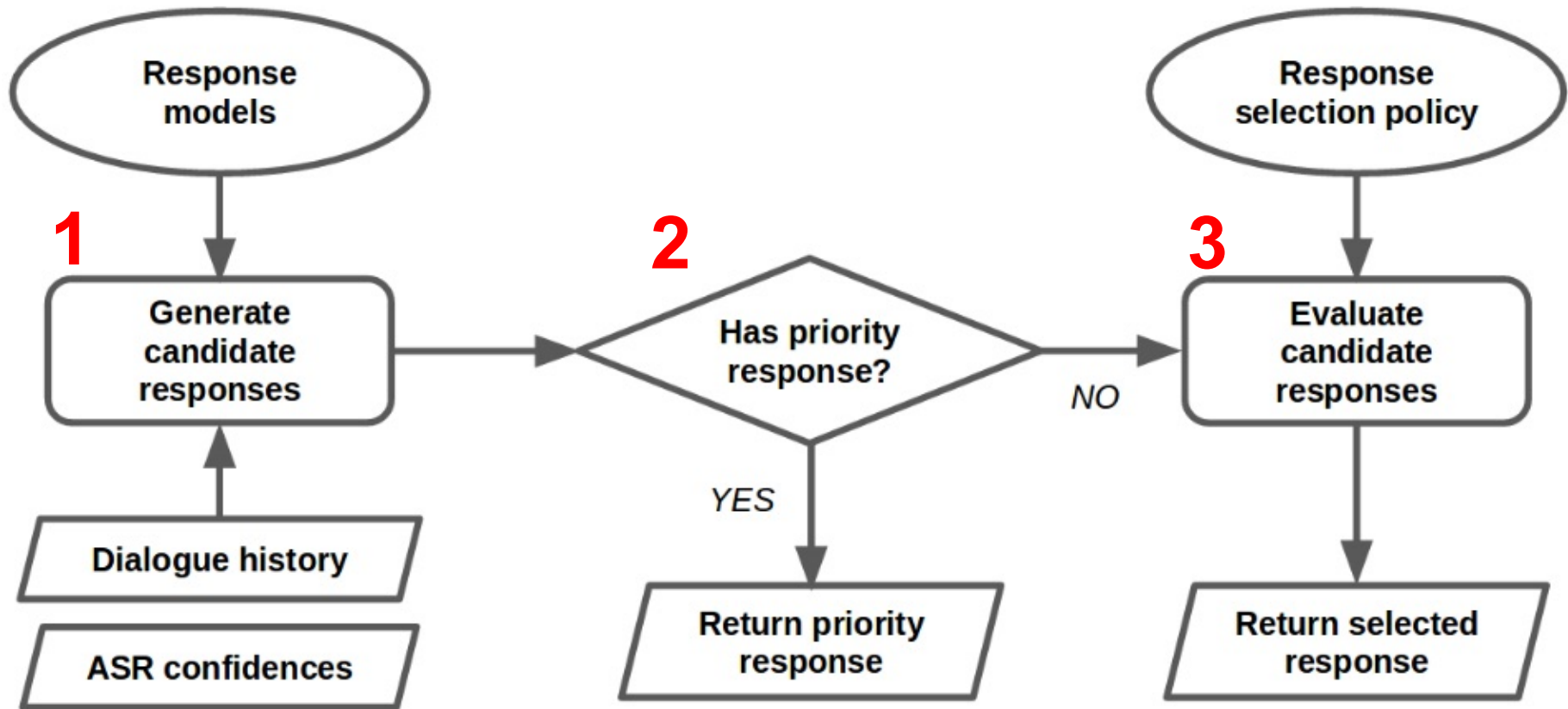
Iulian V. Serban, Chinnadhurai Sankar, Mathieu Germain, Saizheng Zhang, Zhouhan Lin, Sandeep Subramanian, Taesup Kim, Michael Pieper, Sarath Chandar, Nan Rosemary Ke, Sai Mudumba, Alexandre de Brebisson Jose M. R. Sotelo, Dendi Suhubdy, Vincent Michalski, Alexandre Nguyen, Joelle Pineau and Yoshua Bengio

**Montreal Institute for Learning Algorithms,
Montreal, Quebec, Canada**

**A Deep Reinforcement Learning
Chatbot
MILABOT:
Chatbot developed by the
Montreal Institute for Learning
Algorithms (MILA)
for the
Amazon Alexa Prize competition**

MILABOT

Dialogue manager control flow



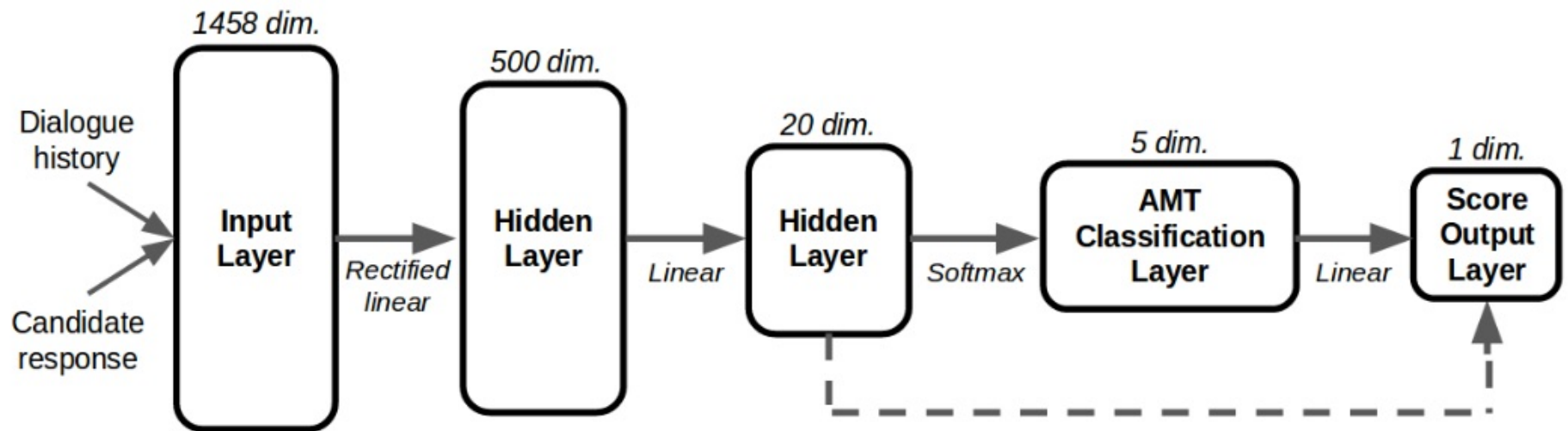
Q: "What is your name?"

R: "I am an Alexa Prize Socialbo"

Dialogue	Dialogue
SYSTEM: Hi. This is an Alexa Prize socialbot. USER: Hi SYSTEM: Do you have pets? USER: Yes, I have two rabbits.	... USER: Let's talk about movies. SYSTEM: What's your favorite movie? USER: star wars movie
Candidate Responses	Candidate Responses
BoWEscapePlan: I don't have an answer for this. BoWFactGenerator: Did you know that male rabbits are called bucks, females are does? GRUQuestionGenerator: How about the American family of it? Initiatorbot: Do you believe in love at first sight? LSTMClassifierMSMarco: Mar 23, 2017 Two Parts: Learning What to Feed Your Rabbit Learning How to ... DualEncoderRedditNews: bye doggie DualEncoderRedditPolitics: Who's edger u shboys? Alicebot: Hurrah! Two is a good number of rabbits. Elizabot: OK, but can you elaborate a bit? VHREDRedditMovies: Hmm. Nope, never heard of it. VHREDSubtitles: Would you like to see them? HelpResponse: I would really like to talk about news, politics or movies.	BoWEscapePlan: I don't have an answer for this. BoWFactGenerator: Here's an interesting fact. The international telephone dialing code for Antarctica is 672. GRUQuestionGenerator: how about your New York City? Initiatorbot: How was your day? LSTMClassifierMSMarco: A third Anthology film will be released in 2020. DualEncoderRedditNews: Now whisper it to me , one more time bby. DualEncoderRedditPolitics: hahaha on mobile this ain't even close. I wish I could show you but this looks awful I'm sorry man. Alicebot: What did you like about the robots in that movie? Elizabot: How does that make you feel? Evi: Star Wars movie a movie in the Star Wars series. VHREDRedditMovies: Oh please. Please. Pleecease. Let this happen. VHREDSubtitles: What? HelpResponse: I would really like to talk about news, politics or movies.

MILABOT

Computational graph for scoring model



model selection policies based on
both action-value function and stochastic policy parametrizations

Facebook AI Research :

bAbI Project

- The (20) QA bAbI tasks
- The (6) dialog bAbI tasks
- The Children's Book Test
- The Movie Dialog dataset
- The WikiMovies dataset
- The Dialog-based Language Learning dataset
- The SimpleQuestions dataset

Facebook bAbI QA Datasets

- 1 Mary moved to the bathroom.
- 2 John went to the hallway.
- 3 Where is Mary? bathroom 1
- 4 Daniel went back to the hallway.
- 5 Sandra moved to the garden.
- 6 Where is Daniel? hallway 4
- 7 John moved to the office.
- 8 Sandra journeyed to the bathroom.
- 9 Where is Daniel? hallway 4
- 10 Mary moved to the hallway.
- 11 Daniel travelled to the office.
- 12 Where is Daniel? office 11
- 13 John went back to the garden.
- 14 John moved to the bedroom.
- 15 Where is Sandra? bathroom 8
- 1 Sandra travelled to the office.
- 2 Sandra went to the bathroom.
- 3 Where is Sandra? bathroom 2

Facebook bAbI QA Datasets

Task 1: Single Supporting Fact

Mary went to the bathroom.
John moved to the hallway.
Mary travelled to the office.
Where is Mary? A: office

Task 2: Two Supporting Facts

John is in the playground.
John picked up the football.
Bob went to the kitchen.
Where is the football? A: playground

Task 3: Three Supporting Facts

John picked up the apple.
John went to the office.
John went to the kitchen.
John dropped the apple.
Where was the apple before the kitchen? A: office

Task 4: Two Argument Relations

The office is north of the bedroom.
The bedroom is north of the bathroom.
The kitchen is west of the garden.
What is north of the bedroom? A: office
What is the bedroom north of? A: bathroom

Task 5: Three Argument Relations

Mary gave the cake to Fred.
Fred gave the cake to Bill.
Jeff was given the milk by Bill.
Who gave the cake to Fred? A: Mary
Who did Fred give the cake to? A: Bill

Task 6: Yes/No Questions

John moved to the playground.
Daniel went to the bathroom.
John went back to the hallway.
Is John in the playground? A: no
Is Daniel in the bathroom? A: yes

Facebook bAbI QA Datasets

Task 7: Counting

Daniel picked up the football.
Daniel dropped the football.
Daniel got the milk.
Daniel took the apple.
How many objects is Daniel holding? **A: two**

Task 8: Lists/Sets

Daniel picks up the football.
Daniel drops the newspaper.
Daniel picks up the milk.
John took the apple.
What is Daniel holding? **milk, football**

Task 9: Simple Negation

Sandra travelled to the office.
Fred is no longer in the office.
Is Fred in the office? **A:no**
Is Sandra in the office? **A:yes**

Task 10: Indefinite Knowledge

John is either in the classroom or the playground.
Sandra is in the garden.
Is John in the classroom? **A:maybe**
Is John in the office? **A:no**

Task 11: Basic Coreference

Daniel was in the kitchen.
Then he went to the studio.
Sandra was in the office.
Where is Daniel? **A:studio**

Task 12: Conjunction

Mary and Jeff went to the kitchen.
Then Jeff went to the park.
Where is Mary? **A: kitchen**
Where is Jeff? **A: park**

Task 13: Compound Coreference

Daniel and Sandra journeyed to the office.
Then they went to the garden.
Sandra and John travelled to the kitchen.
After that they moved to the hallway.
Where is Daniel? **A: garden**

Task 14: Time Reasoning

In the afternoon Julie went to the park.
Yesterday Julie was at school.
Julie went to the cinema this evening.
Where did Julie go after the park? **A:cinema**
Where was Julie before the park? **A:school**

Facebook bAbI QA Datasets

Task 15: Basic Deduction

Sheep are afraid of wolves.

Cats are afraid of dogs.

Mice are afraid of cats.

Gertrude is a sheep.

What is Gertrude afraid of? **A:wolves**

Task 16: Basic Induction

Lily is a swan.

Lily is white.

Bernhard is green.

Greg is a swan.

What color is Greg? **A:white**

Task 17: Positional Reasoning

The triangle is to the right of the blue square.

The red square is on top of the blue square.

The red sphere is to the right of the blue square.

Is the red sphere to the right of the blue square? **A:yes**

Is the red square to the left of the triangle? **A:yes**

Task 18: Size Reasoning

The football fits in the suitcase.

The suitcase fits in the cupboard.

The box is smaller than the football.

Will the box fit in the suitcase? **A:yes**

Will the cupboard fit in the box? **A:no**

Task 19: Path Finding

The kitchen is north of the hallway.

The bathroom is west of the bedroom.

The den is east of the hallway.

The office is south of the bedroom.

How do you go from den to kitchen? **A: west, north**

How do you go from office to bathroom? **A: north, west**

Task 20: Agent's Motivations

John is hungry.

John goes to the kitchen.

John grabbed the apple there.

Daniel is hungry.

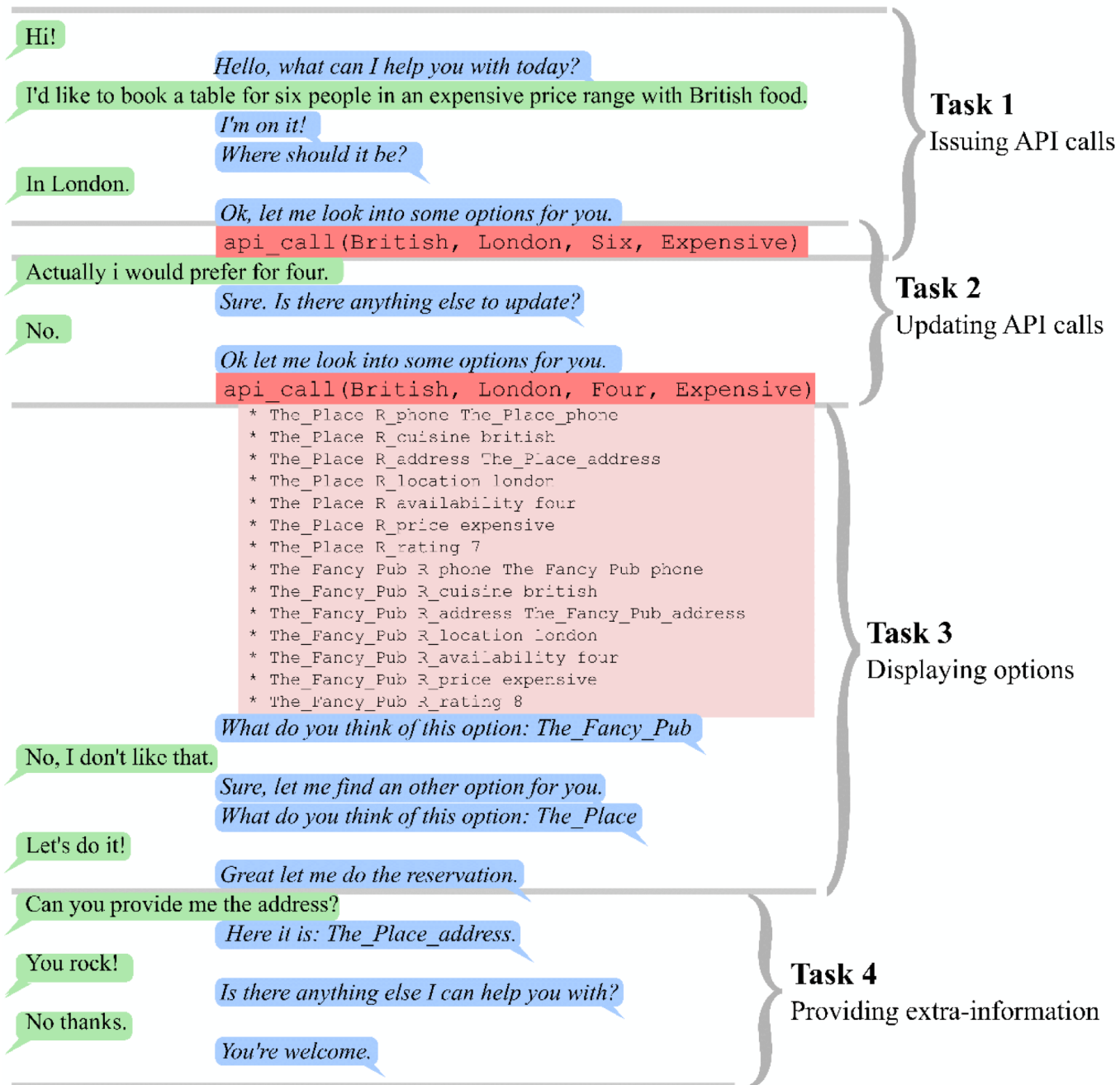
Where does Daniel go? **A:kitchen**

Why did John go to the kitchen? **A:hungry**

Learning End-to-End Goal-Oriented Dialog

Facebook bAbI Dialogue Datasets

1 hi hello what can i help you with today
2 can you make a restaurant reservation with italian cuisine for six people in a
cheap price range i'm on it
3 <SILENCE> where should it be
4 rome please ok let me look into some options for you
5 <SILENCE> api_call italian rome six cheap



The Dialog bAbI Tasks

Hi!

Hello, what can I help you with today?

I'd like to book a table for six people in an expensive price range with British food.

I'm on it!

Where should it be?

In London.

Ok, let me look into some options for you.

`api_call(British, London, Six, Expensive)`

Actually i would prefer for four.

Sure. Is there anything else to update?

No.

Ok let me look into some options for you.

`api_call(British, London, Four, Expensive)`

Task 1

Issuing API calls

Task 2

Updating API calls

The Dialog bAbI Tasks

```
* The_Place R_phone The_Place_phone
* The_Place R_cuisine british
* The_Place R_address The_Place_address
* The_Place R_location london
* The_Place R_availability four
* The_Place R_price expensive
* The_Place R_rating 7
* The_Fancy_Pub R_phone The_Fancy_Pub_phone
* The_Fancy_Pub R_cuisine british
* The_Fancy_Pub R_address The_Fancy_Pub_address
* The_Fancy_Pub R_location london
* The_Fancy_Pub R_availability four
* The_Fancy_Pub R_price expensive
* The_Fancy_Pub R_rating 8
```

Task 3 Displaying options

What do you think of this option: The_Fancy_Pub

No, I don't like that.

Sure, let me find an other option for you.

What do you think of this option: The_Place

Let's do it!

Great let me do the reservation.

The Dialog bAbI Tasks

What do you think of this option: The_Fancy_Pub

No, I don't like that.

Sure, let me find an other option for you.

What do you think of this option: The_Place

Let's do it!

Great let me do the reservation.

Can you provide me the address?

Here it is: The_Place_address.

You rock!

Is there anything else I can help you with?

No thanks.

You're welcome.

Task 4
Providing extra-information

Task 5 Conducting full dialogs

Short Text Conversation (STC)



Short Text Conversation Task (STC-3)

Chinese Emotional Conversation Generation (CECG) Subtask

NTCIR Short Text Conversation

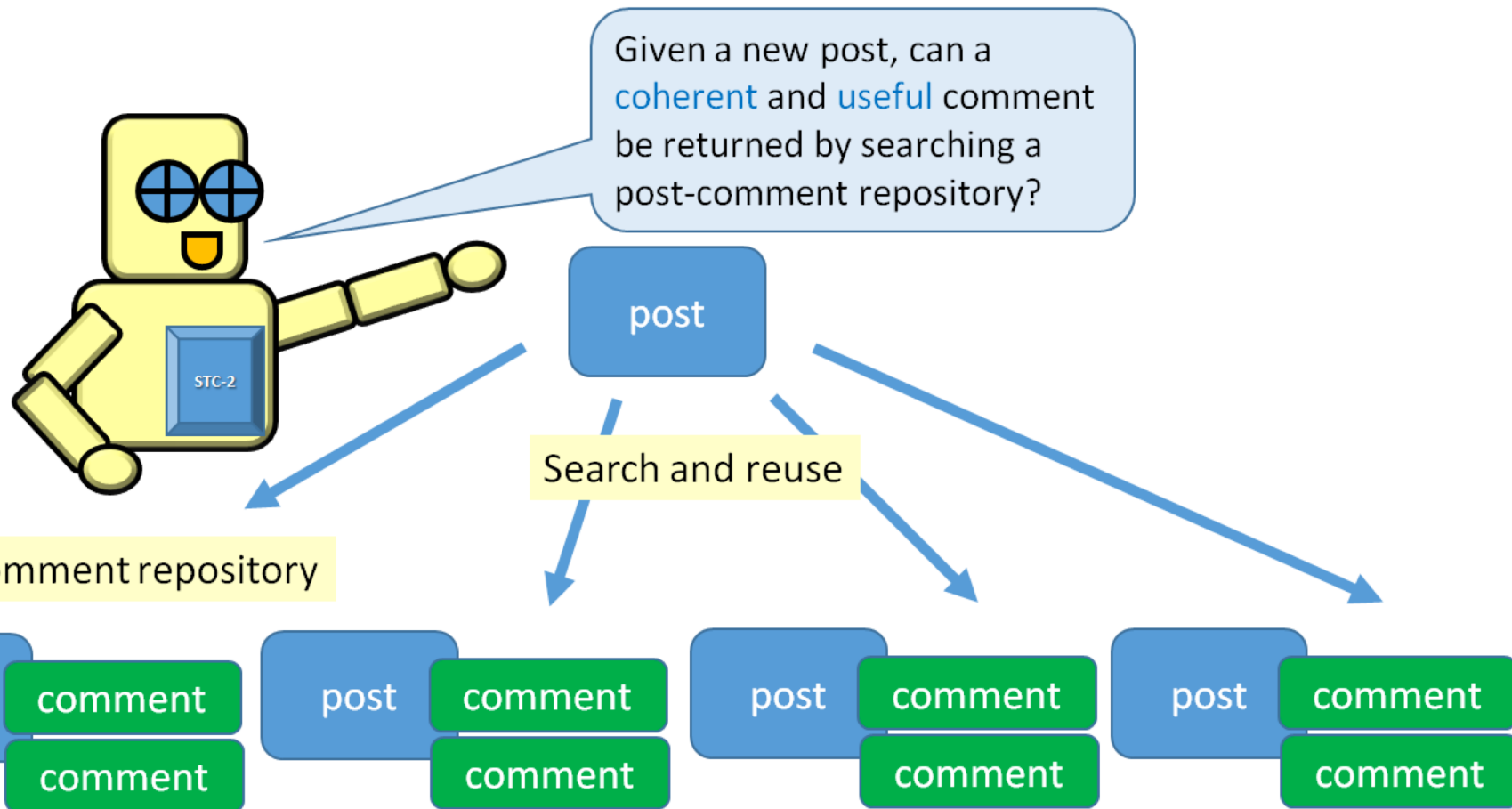
STC-1, STC-2, STC-3

	Japanese	Chinese	English	
NTCIR-12 STC-1 22 active participants	Twitter, Retrieval	Weibo, Retrieval		Single-turn, Non task-oriented
NTCIR-13 STC-2 27 active participants	Yahoo! News, Retrieval+ Generation	Weibo, Retrieval+ Generation		
NTCIR-14 STC-3		Weibo, Generation for given emotion categories		Multi-turn, task-oriented (helpdesk)
Chinese Emotional Conversation Generation (CECG) subtask				
Dialogue Quality (DQ) and Nugget Detection (ND) subtasks		Weibo+English translations, distribution estimation for subjective annotations		

Source: <https://waseda.app.box.com/v/STC3atNTCIR-14>

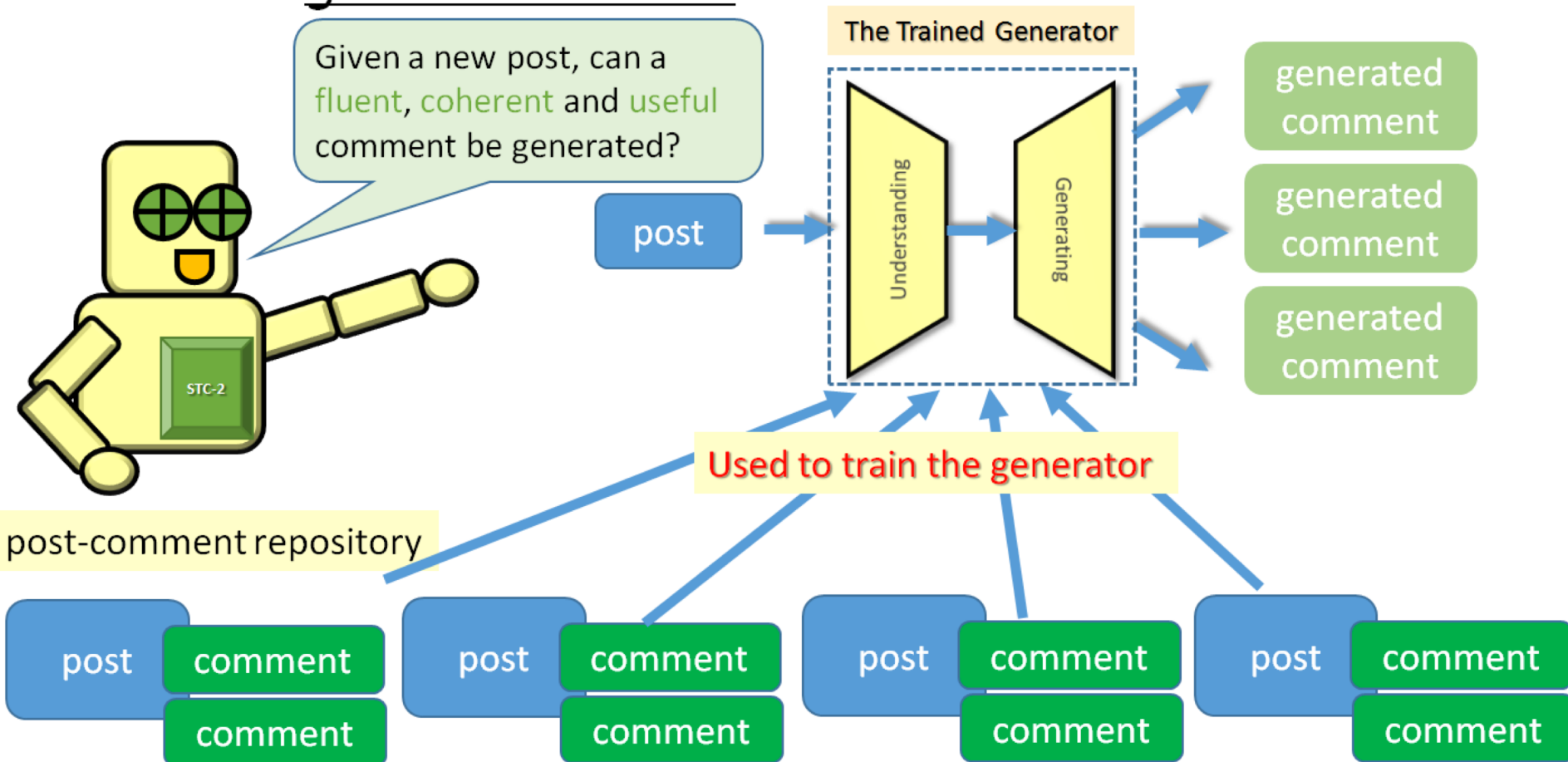
Short Text Conversation (NTCIR-13 STC2) Retrieval-based

retrieval-based method



Short Text Conversation (NTCIR-13 STC2) Generation-based

generation-based method



Short Text Conversation (STC-3)

- Emotional Conversation Generation
- Dialogue Quality
- Nugget Detection subtasks
using Chinese and English dialogue data

NTCIR-14

Short Text Conversation Task (STC-3)

- Three new subtasks
 - Chinese Emotional Conversation Generation (CECG)
 - Dialogue Quality (DQ)
(for Chinese and English)
 - Nugget Detection (ND)
(for Chinese and English)

Given post:

爱狗还会做饭的男人，最帅了！

The man who cooks and loves dogs is very handsome!

Response	Chinese / Translated English	Emotion Class	Coherence and Fluency	Emotion Consistency	Label
Response 1	会做饭的男人是很帅的啊。 The man who cooks is handsome.	喜欢 Like	Yes	Yes	2
Response 2	哈哈，我也觉得。 Haha, I feel the same way.	喜欢 Like	Yes	No	1
Response 3	这是哪部电影里的？ Which movie is this from?	厌恶 Disgust	No	Yes	0
Response 4	哈哈,你也是。 Haha, the same to you.	喜欢 Like	No	No	0
Response 5	我爱你会。 I love you, will you.	厌恶 Disgust	No	Yes	0
Response 6	这是同主义同的道！ This is the same way of the same doctrine!	厌恶 Disgust	No	No	0

NLPCC

Emotion Classification Challenge

6 classes (64%)

- 0: Other
- 1: Like
- 2: Sadness
- 3: Disgust
- 4: Anger
- 5: Happiness

Chinese Emotional Conversation Generation (CECG)

Post (Given)	Emotion Category (Given)	Response (to be generated)
爱狗还会做饭的男人，最帅了！ The man who cooks and loves dogs is very handsome!	喜欢 Like	会做饭的男人是很帅的啊。 The man who cooks is handsome.
爸爸，明天是六一啦，带我出去玩吧！ Daddy, tomorrow is June 1th Children's Day. Please take me out to play!	喜欢 Like	好，一定带。 Yes, of course.
被特别在乎的人忽略，会很难过，而装做不在乎，会更难过。 It's sad to be ignored by someone that you really care, and it's harder to pretend that you don't care.	悲伤 Sadness	因为在乎，所以在乎。 I am concerned with it, because I care about it.
冰天雪地的哈尔滨！你要冻死我咋地？！？！ Harbin is in the snow! Are you going to freeze me to death?!?!?	喜欢 Like	注意保暖，小心别感冒！ Keep warm. Watch out for getting cold!
本来想学一把沧桑，结果令我更忧伤。 I wanted to learn the vicissitudes of life, but I became sadder.	悲伤 Sadness	这是一个悲伤的故事。 It a sad story.
今天一整天都在海边训练。虽然很累，但还是很开心的！ I have been training at the seaside all day. Though very tired, I still very happy!	快乐 Happiness	是的呢，开心！ Yeah, happy!

Chinese Emotional Conversation Generation (CECG) Dataset

- 1,110,000 Weibo post-response pairs
 - $[[[post, post_label], [response, response_label]], [post, post_label], [response, response_label]], \dots]$.

Fluency judgement on responses with repetitive words

Response	Fluency
悲哀，悲哀，悲哀。	Yes
飘逸，飘逸，飘逸！	Yes
好可爱，好可爱！	Yes
哈哈，当然啦	Yes
疯了。疯了。全疯了	Yes
对的的对的的对的的对的的对的的对的	No
我骗骗骗骗我骗你信不信不信不信我反正信了	No
中国的教育教育教育教育教育教育教育教育教育教育教育 教育教育教育教育教育教育教育教育教育教育教育	No
矮贱贱贱贱贱贱贱，你爱你，我也不爱你了	No
不关我事不关我事不关我事不关我事不关我事！	No

Source: Huang, Minlie, Zuoxian Ye, and Hao Zhou. "Overview of the NLPCC 2017 Shared Task: Emotion Generation Challenge." In *National CCF Conference on Natural Language Processing and Chinese Computing (NLPCC)*, pp. 926-936. Springer, Cham, 2017.

Sample responses generated by Seq2Seq and ECM (Emotional Chatting Machine)

Post	Model		Response(Original)	Response(Translated)
承诺，就是一个骗子说给一个傻子听的。 A promise is what a cheater says to a fool.	Seq2Seq		承诺，就是一个骗子说给一个傻子听的。	A promise is what a cheater says to a fool.
	ECM	Like	承诺是一个 专一 的傻子	Promise is a single-minded fool
		Happy	我就是个 开心 的傻子	I'm just a happy fool
		Sad	我就是个 悲伤 的傻子	I am a sad fool
		Disgust	一个 骗子 说给一个 傻子 听	A cheater says to a fool
		Angry	不管你信不信，反正我信了！	Whatever you believe or not, I trust in it!
知道真相的我眼泪笑下来 Knowing the truth, I laughed myself to tears	Seq2Seq		知道真相的我眼泪掉下来。	After knowing the truth, I burst into tears.
	ECM	Like	太 可爱 了，太 可爱 了！	Too lovely , it's too lovely .
		Happy	笑得我眼泪都出来了。	I can't help laugh myself to tears.
		Sad	知道真相的我 眼泪 掉下来。	After knowing the truth, I burst into tears .
		Disgust	这是真的还是假的？	Is this true?
		Angry	什么意思？没看懂。	What do you mean? I don't understand.

Sample responses generated by Seq2Seq and ECM (Emotional Chatting Machine)

Post	Model		Response(Original)
承诺，就是一个骗子说给一个傻子听的。 A promise is what a cheater says to a fool.	Seq2Seq		承诺，就是一个骗子说给一个傻子听的。
	ECM	Like	承诺是一个 专一 的傻子
		Happy	我就是个 开心 的傻子
		Sad	我就是个 悲伤 的傻子
		Disgust	一个 骗子 说给一个 傻子 听
		Angry	不管你信不信，反正我信了！

Emotional Short Text Conversation (ESTC) Dataset

Training	Posts	217,905	
	Responses	Angry	234,635
		Disgust	689,295
		Happy	306,364
		Like	1,226,954
		Sad	537,028
		Other	1,365,371
Validation	Posts	1,000	
Test	Posts	1,000	

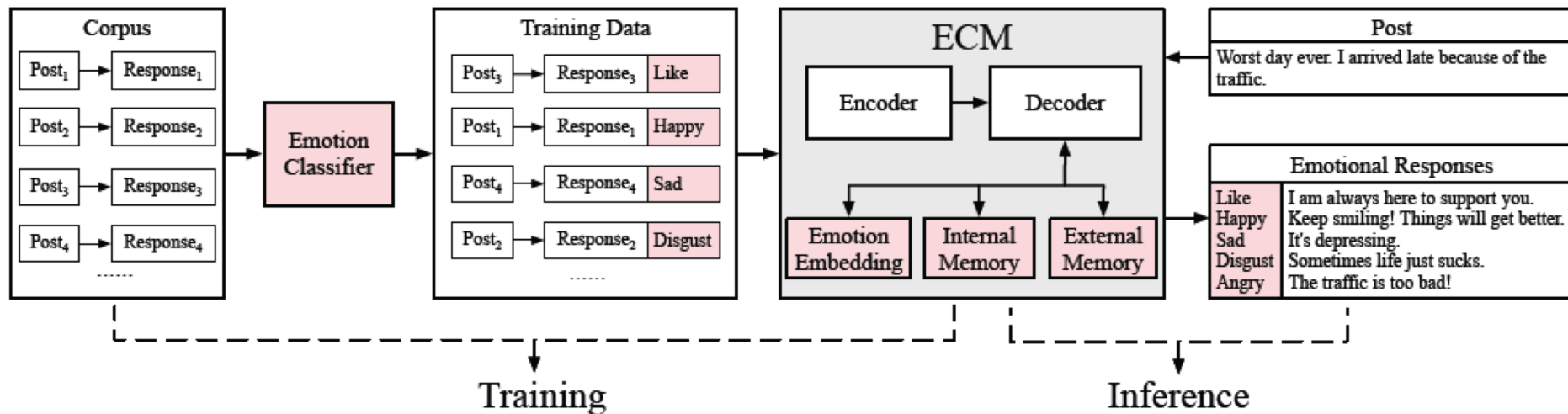
Source: Zhou, Hao, Minlie Huang, Tianyang Zhang, Xiaoyan Zhu, and Bing Liu. "Emotional chatting machine: emotional conversation generation with internal and external memory." *arXiv preprint arXiv:1704.01074* (2017).

Conversations with/without considering emotion

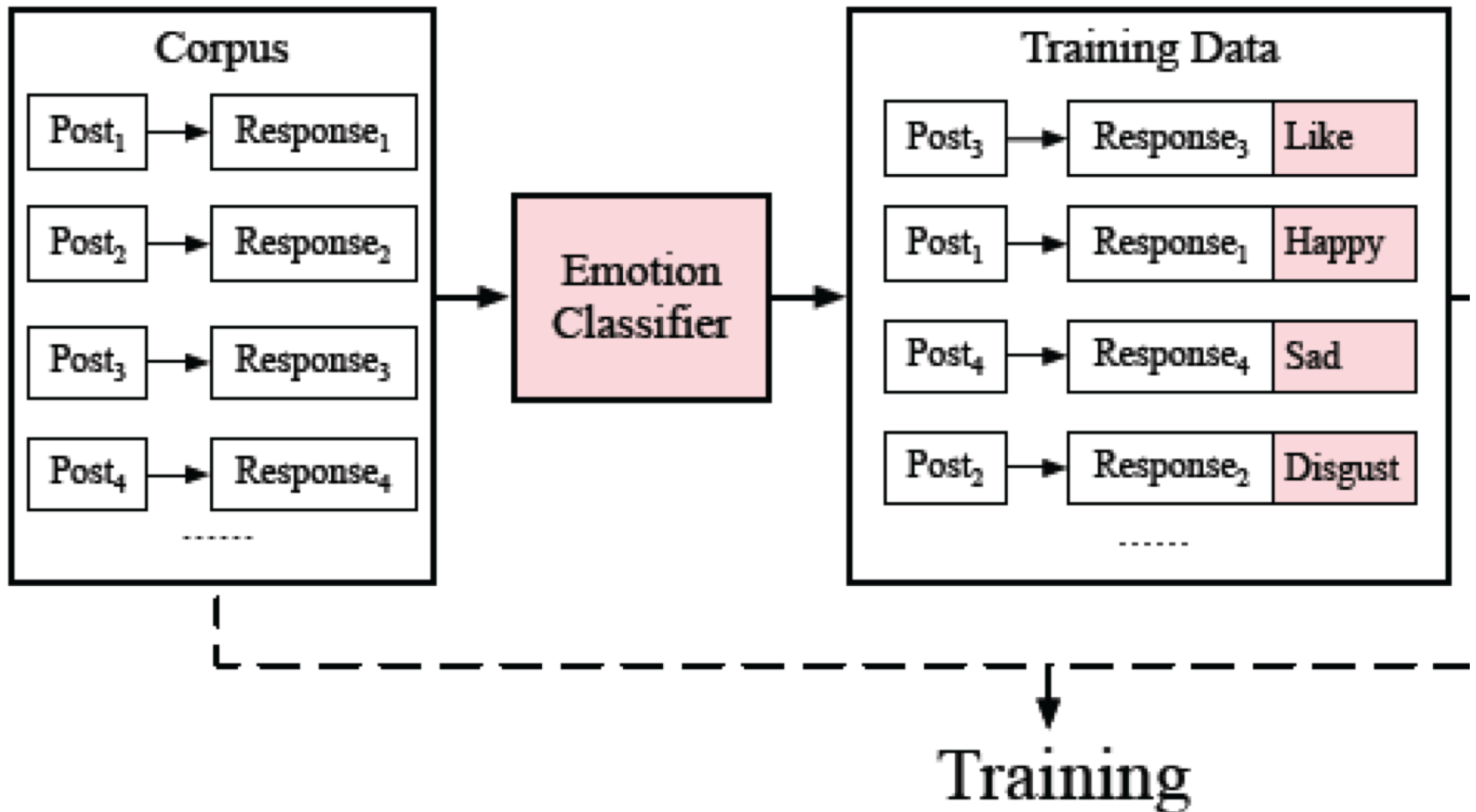
Emotional Chatting Machine (ECM)

- User: Worst day ever. I arrived late because of the traffic.
 1. Basic Seq2Seq: You were late.
 2. ECM (Like): I am always here to support you.
 3. ECM (Happy): Keep smiling! Things will get better.
 4. ECM (Sad): It's depressing.
 5. ECM (Disgust): Sometimes life just sucks.
 6. ECM (Angry): The traffic is too bad!

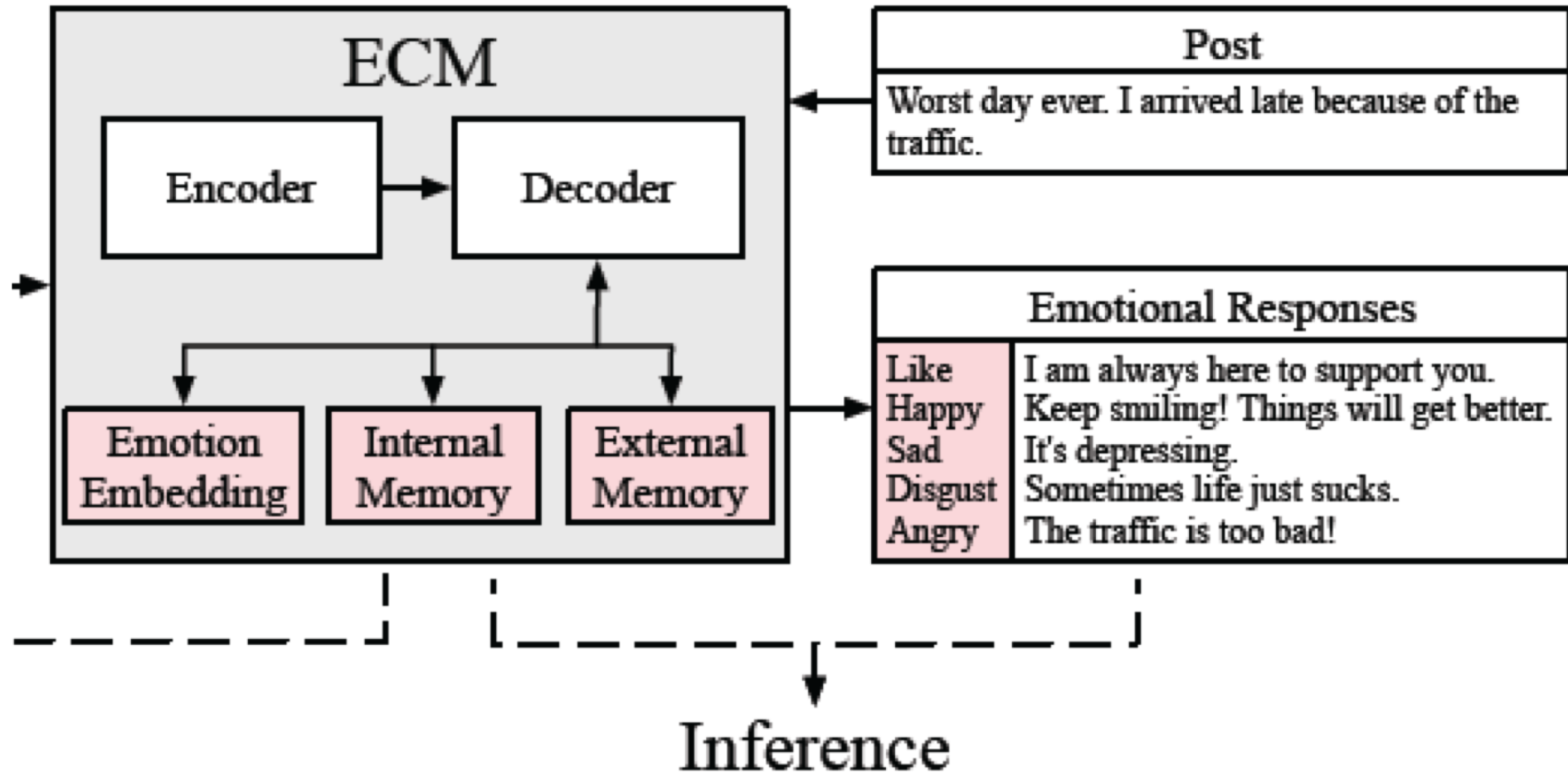
Overview of Emotional Chatting Machine (ECM)



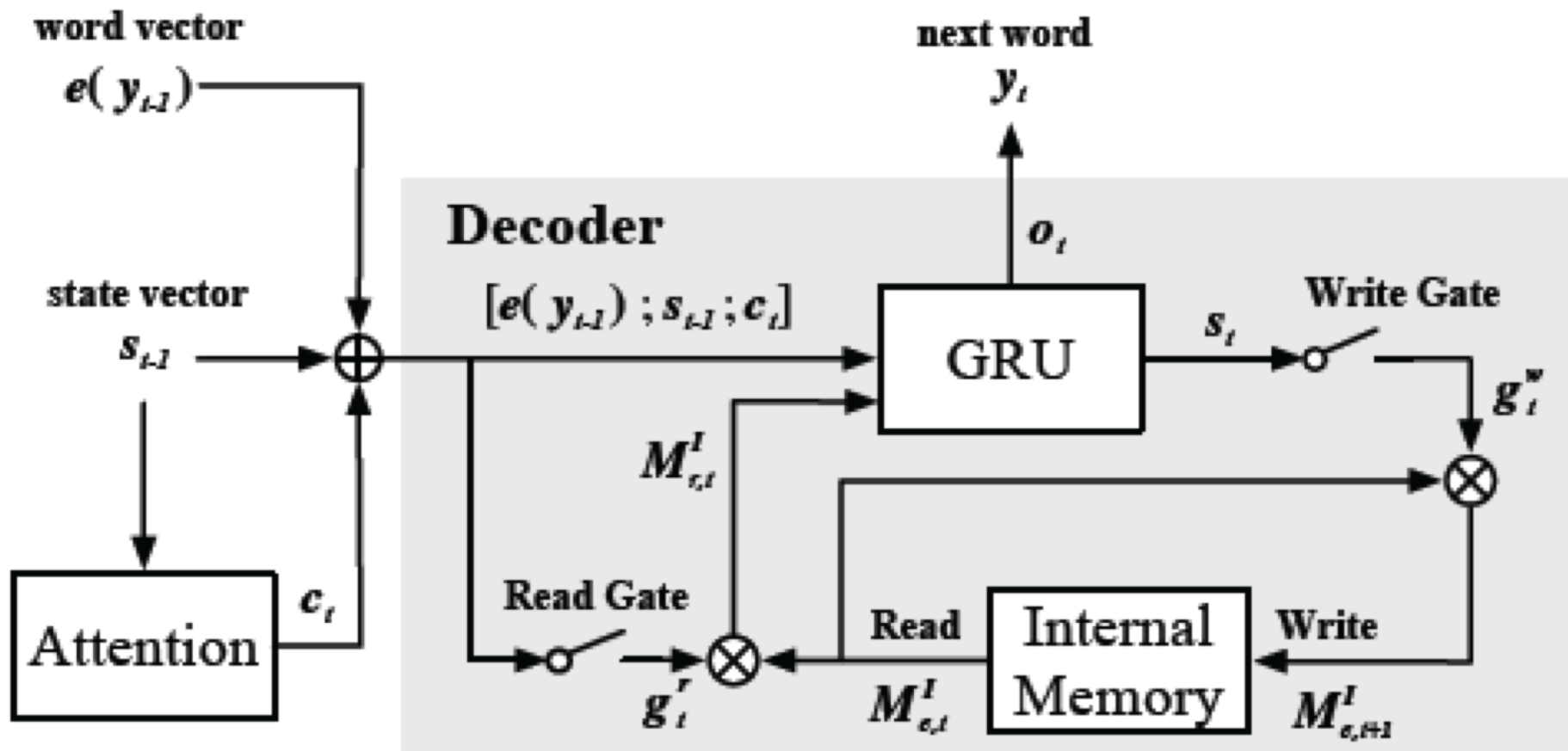
Overview of Emotional Chatting Machine (ECM)



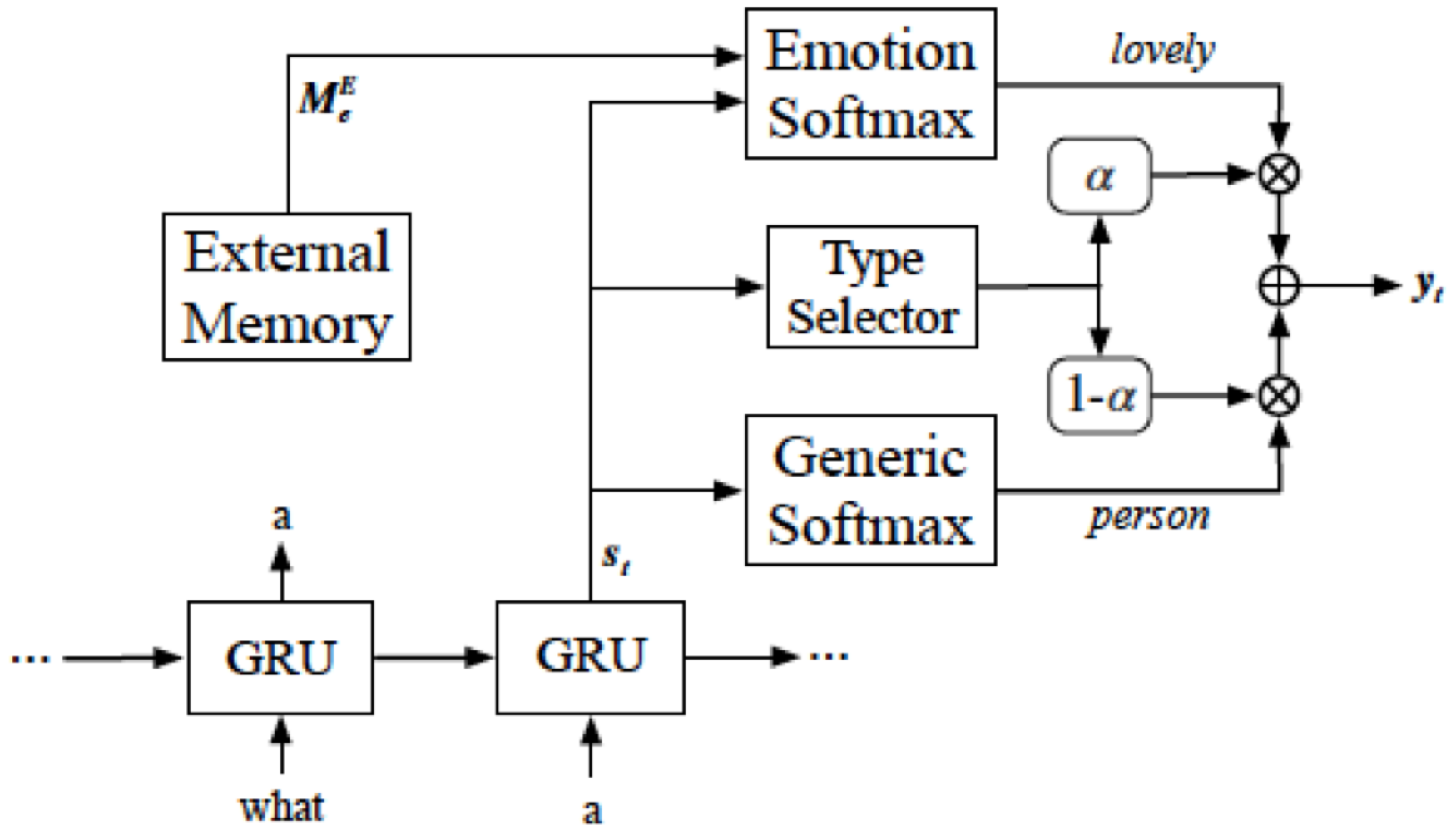
Overview of Emotional Chatting Machine (ECM)



Data flow of the decoder with an internal memory



Data flow of the decoder with an external memory



Source: Zhou, Hao, Minlie Huang, Tianyang Zhang, Xiaoyan Zhu, and Bing Liu. "Emotional chatting machine: emotional conversation generation with internal and external memory." *arXiv preprint arXiv:1704.01074* (2017).

Sample responses generated by Seq2Seq and ECM (Emotional Chatting Machine)

Post	Model		Response(Original)
知道真相的我眼泪笑下来 Knowing the truth, I laughed myself to tears	Seq2Seq		知道真相的我眼泪掉下来。
	ECM	Like	太可爱了, 太可爱了!
		Happy	笑得我眼泪都出来了。
		Sad	知道真相的我眼泪掉下来。
		Disgust	这是真的还是假的?
		Angry	什么意思? 没看懂。

Chinese Emotional Conversation Generation (CECG)

Evaluation Metric

- Emotion Consistency
 - whether the emotion class of a generated response is the same as the pre-specified class.
- Coherence
 - whether the response is appropriate in terms of both logically coherent and topic relevant content.
- Fluency
 - whether the response is fluent in grammar and acceptable as a natural language response.

Chinese Emotional Conversation Generation (CECG) Evaluation Metric

IF Coherence and Fluency

IF Emotion Consistency

LABEL 2

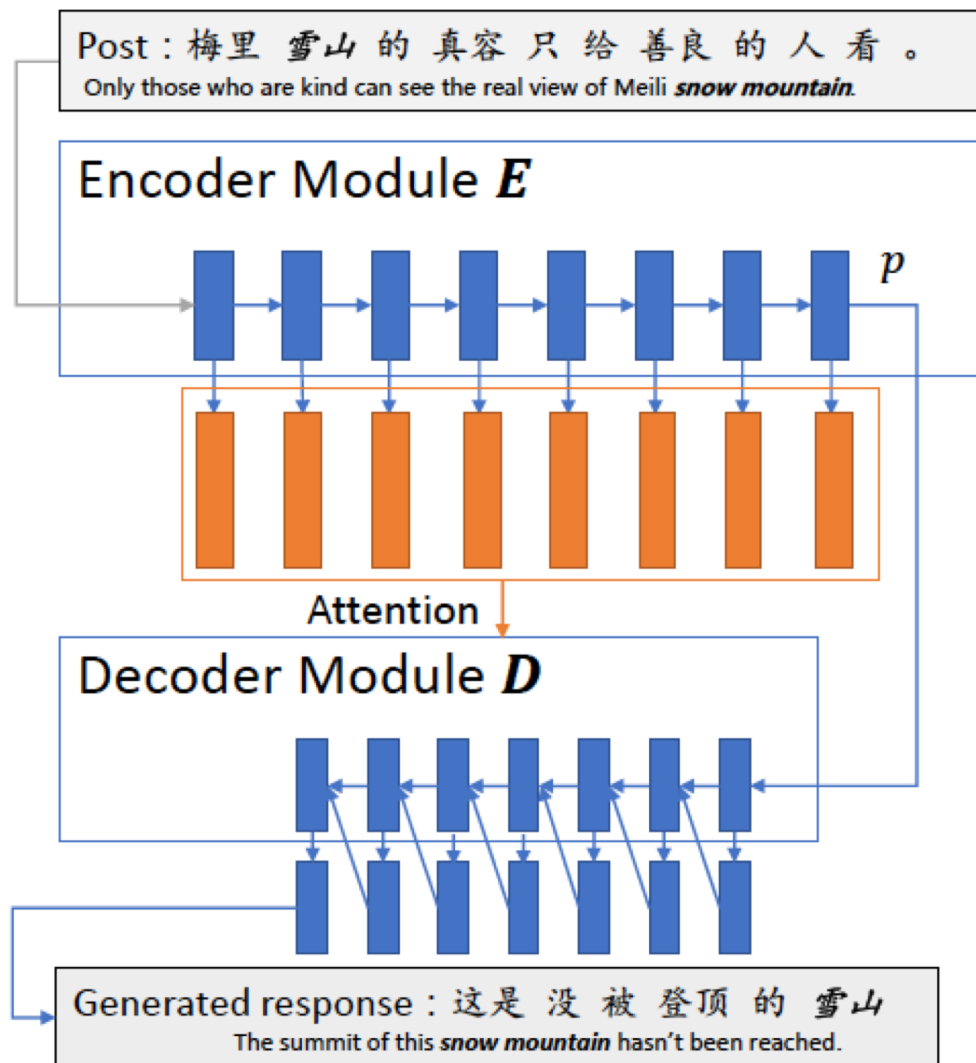
ELSE

LABEL 1

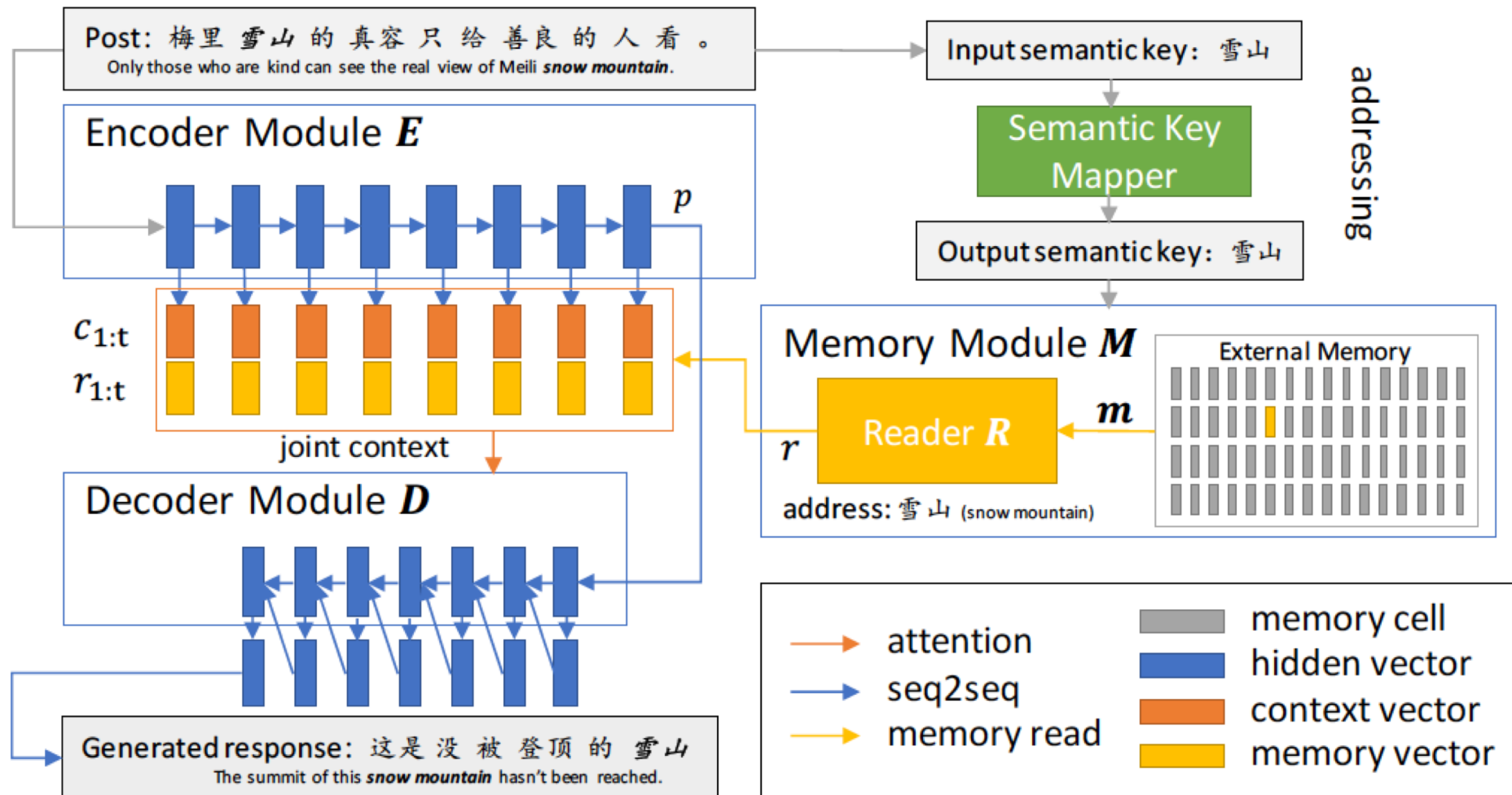
ELSE

LABEL 0

Sequence-to-sequence Learning with Attention for Generation-based STC



General Framework of Controllable Short-Text-Conversation Generation with External Memory



Controllable Short Text Conversation Examples

Post	李娜太牛了!中国第一个世界网球大满贯冠军! Li Na is great! China's first World Tennis Grand Slam champion!	
NRM	李娜是世界冠军! Li Na is the world champion!	
MrRNN	李娜加油,加油! Come on, Li Na. Come on!	
ESED	Key-Word	Response
	世界 world	李娜是世界上最棒的! Li Na is the best in the world!
	中国 China	李娜是中国的骄傲! Li Na is the pride of China!
	网球 tennis	中国网球公开赛,加油! China Tennis Open, come on!
Post	感人器官捐献广告,请感谢那些给你第二次生命的人。 A touching organ donation advertisement, please thank those who gave you a second life.	
NRM	给我第二次生命的人。 A man who gives me a second life.	
MrRNN	感谢每一个人! Thanks for everyone!	
ESED	Key-Word	Response
	生命 life	感谢生命给予的一切! Thanks for everything given by life!
	器官 organ	感谢那些器官捐赠者。 Thanks for those organ donors.
	广告 advertisement	很感人的广告! A very touching advertisement!

Source: Yu, Kai, Zijian Zhao, Xueyang Wu, Hongtao Lin, and Xuan Liu. "Rich Short Text Conversation Using Semantic Key Controlled Sequence Generation." *IEEE/ACM Transactions on Audio, Speech, and Language Processing* (2018).

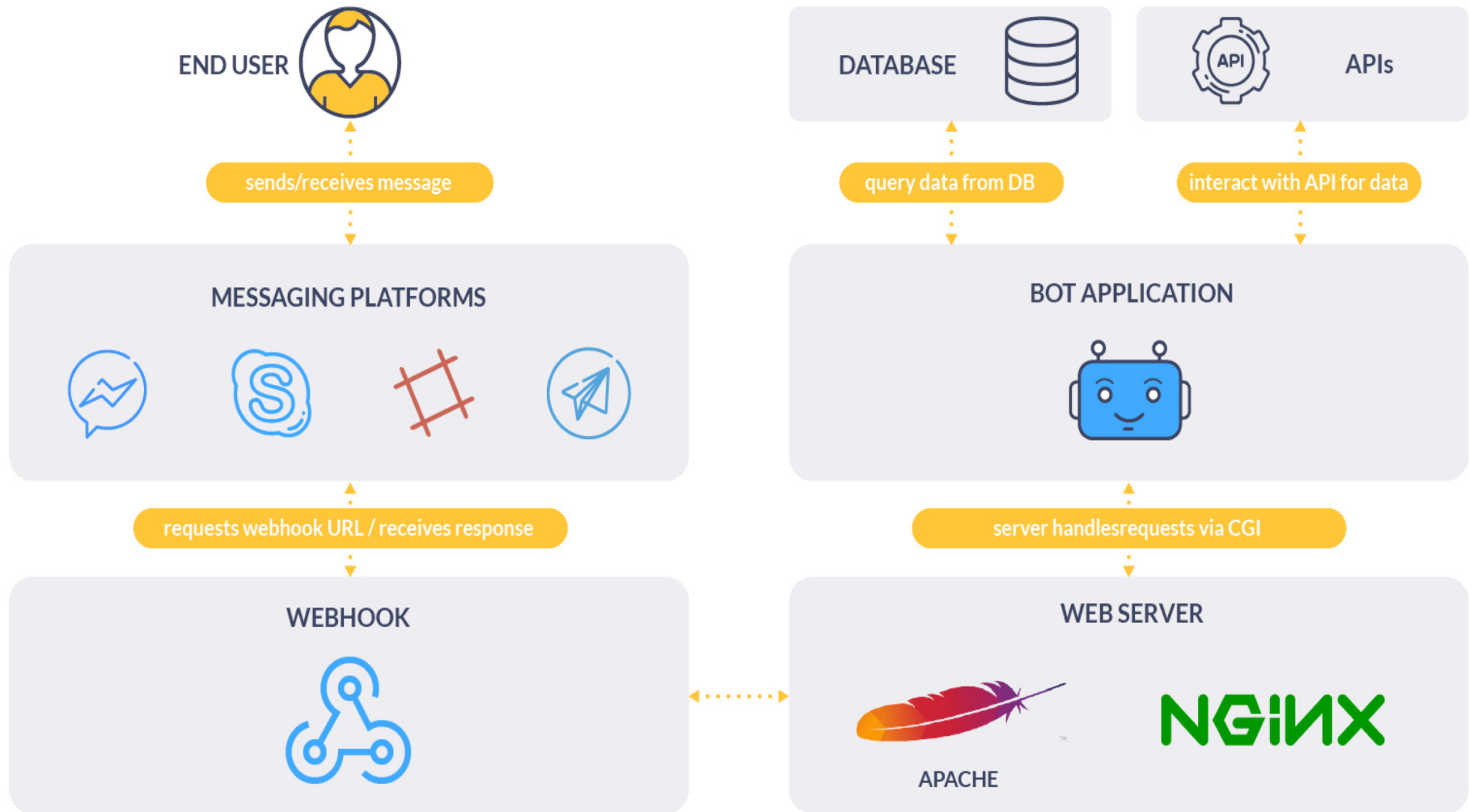
Comments Generated Using Different Semantic key Mapping Methods

Post	美好的社会应该由善良的人组成。 A good society should be composed of people of kindness.	
Mapping-Method	Key-Word	Response
Identity Mapper	善良 kindness	善良是一种信仰。 Kindness is a belief.
Synonym	友善 friendliness	善良是一种美德。 Kindness is a virtue.
Antonym	丑恶 evil	没有丑恶的社会,更可怕。 A society without evils is more terrifying.
Embedding	乐观 optimism	乐观是一种生活态度。 Optimism is an attitude of life.
Common-Reply	真 really	真的吗? Really?
	对 right	对的,对的。 Right, right.
Random	人 person	每个人都有善良的一面。 Every person has a side of kindness.
	中国 China	中国的贫富差距太大了。 The gap between the wealthy and the poor in China is too big.

Generated Responses of Knowledge Introduction by External Memory

Post	你最喜欢那个星座? What is your favorite constellation?	
Semantic-Key	Key-Word	Response
	摩羯座 Capricorn	我最喜欢摩羯座。 I love Capricorn.
	射手座 Sagittarius	我是射手座,我喜欢。 I am a Sagittarius and I like it.
Post	今天周杰伦的电影,太好看了。 Jay Chou's movie is so nice today.	
Semantic-Key	Key-Word	Response
	歌 song	杰伦的歌也很好听。 Jay Chou's songs are nice too.
Post	梵高的画,很漂亮。 Van Gogh's paintings are very beautiful.	
Semantic-Key	Key-Word	Response
	向日葵 sunflower	梵高笔下的向日葵。 The Sunflower by Van Gogh.
	荷兰 Holland	梵高的画,很漂亮。 Van Gogh's paintings are very beautiful.

How to Build Chatbots



Chatbot Frameworks and AI Services

- Bot Frameworks
 - Botkit
 - Microsoft Bot Framework
 - Rasa NLU
- AI Services
 - Wit.ai
 - api.ai
 - LUIS.ai
 - IBM Watson

Chatbot Frameworks

Comparison Table of Most Prominent Bot Frameworks



Botkit



Microsoft Bot Framework



Built-In Integration with messaging platforms	✓	✓	✗
NLP support	✗ but possible to integrate with middlewares	✗ but have close bonds with LUIS.ai	✓
Out-of-box bots ready to be deployed	✓	✗	✗
Programming Language	JavaScript (Node)	JavaScript (Node), C#	Python

Created by  ActiveWizards

Comparison of Most Prominent AI Services

	wit.ai	api.ai	LUIS.ai	IBM Watson
Free of charge	✓	✓ but has paid enterprise version	✓ it is in beta and has transaction limits	30 days trial then priced for enterprise use
Text and Speech processing	✓	✓	✓ with use of Cortana	✓
Machine Learning Modeling	✓	✓	✓	✓
Support for Intents, Entities, Actions	✓ Intents used as trait entities, actions are combined operations	✓ Intents is the main prediction mechanism. Domains of entities, intents and actions	✓	✓
Pre-build entities for easy parsing of numbers, temperature, date, etc.	✓	✓	✓	✓
Integration to messaging platforms	✗ web service API	✓ also has facility for deploying to heroku. Paid environment	✓ integrated to Azure	✓ possible via API
Support of SDKs	✓ includes SDKs for Python, Node.js, Rust, C, Ruby, iOS, Android, Windows Phone	✓ C#, Xamarin, Python, Node.js, iOS, Android, Windows Phone	✓ enables building with Web Service API, Microsoft Bot Framework integration	Proprietary language "AlchemyLanguage"

Created by **ActiveWizards**

Rasa

Conversational AI

Rasa: Conversational AI

[Products](#)[Customers](#)[Solutions](#)[Community](#)[Docs](#)[Talk to Us](#)[Get Started](#)

Open source tools to build contextual AI assistants

The Rasa Stack is a set of open source machine learning tools for developers to create contextual chatbots and assistants. Supported by thousands of community members.

[Explore the Rasa Stack](#)

ACME: Where should we send the confirmation to?

Please send it to amy@example.com

👍

ACME: Should we make that your primary email?

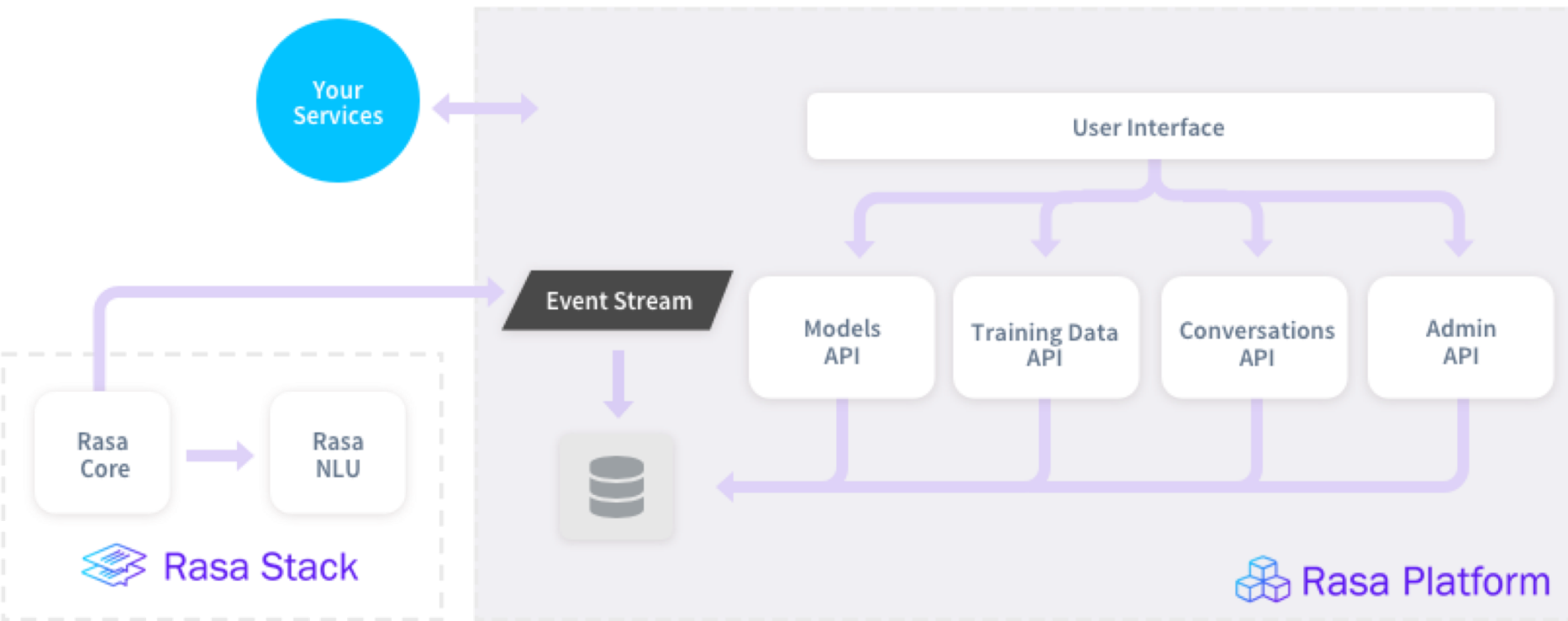
Oh, what is it right now?

Next best action:

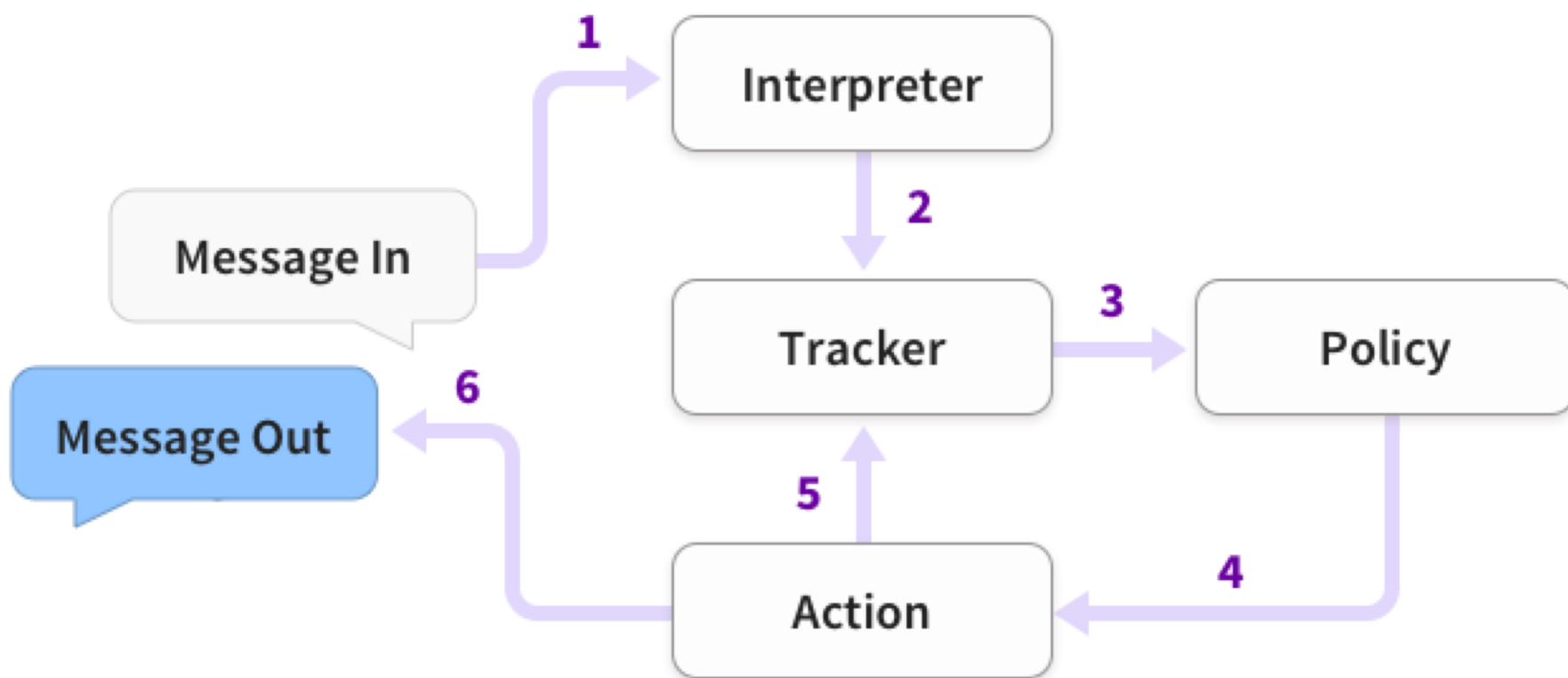
- | | | |
|-------------------------------------|---------------------|-----|
| <input checked="" type="checkbox"/> | fetch_primary_email | 88% |
| <input type="checkbox"/> | hand_off_to_human | 8% |
| <input type="checkbox"/> | fetch_primary_phone | 4% |

Rasa Platform

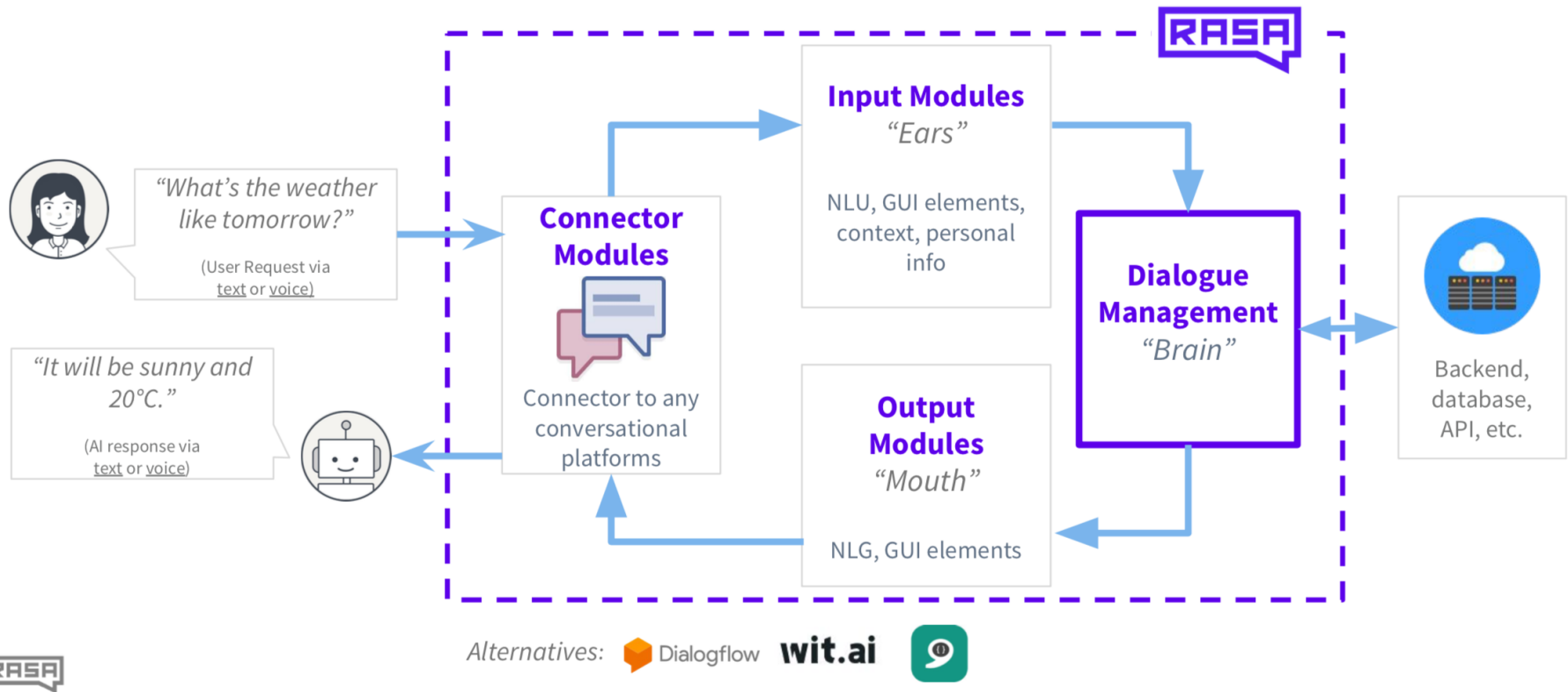
Rasa Stack



Rasa Core High-Level Architecture



Rasa the OSS to build conversational software with ML



<https://github.com/RasaHQ/rasa-workshop-pydata-berlin>

Rasa NLU:

Natural Language Understanding



What's the weather like tomorrow?

Natural Language Understanding

Example Intent Classification Pipeline

"What's the weather like tomorrow?" { "intent": "request_weather" }

Vectorization

Intent Classification

Example Entity Extraction Pipeline

"What's the weather like tomorrow?"

{ "date": "tomorrow" }

Tokenizer

Entity Extraction

Part of Speech
Tagger

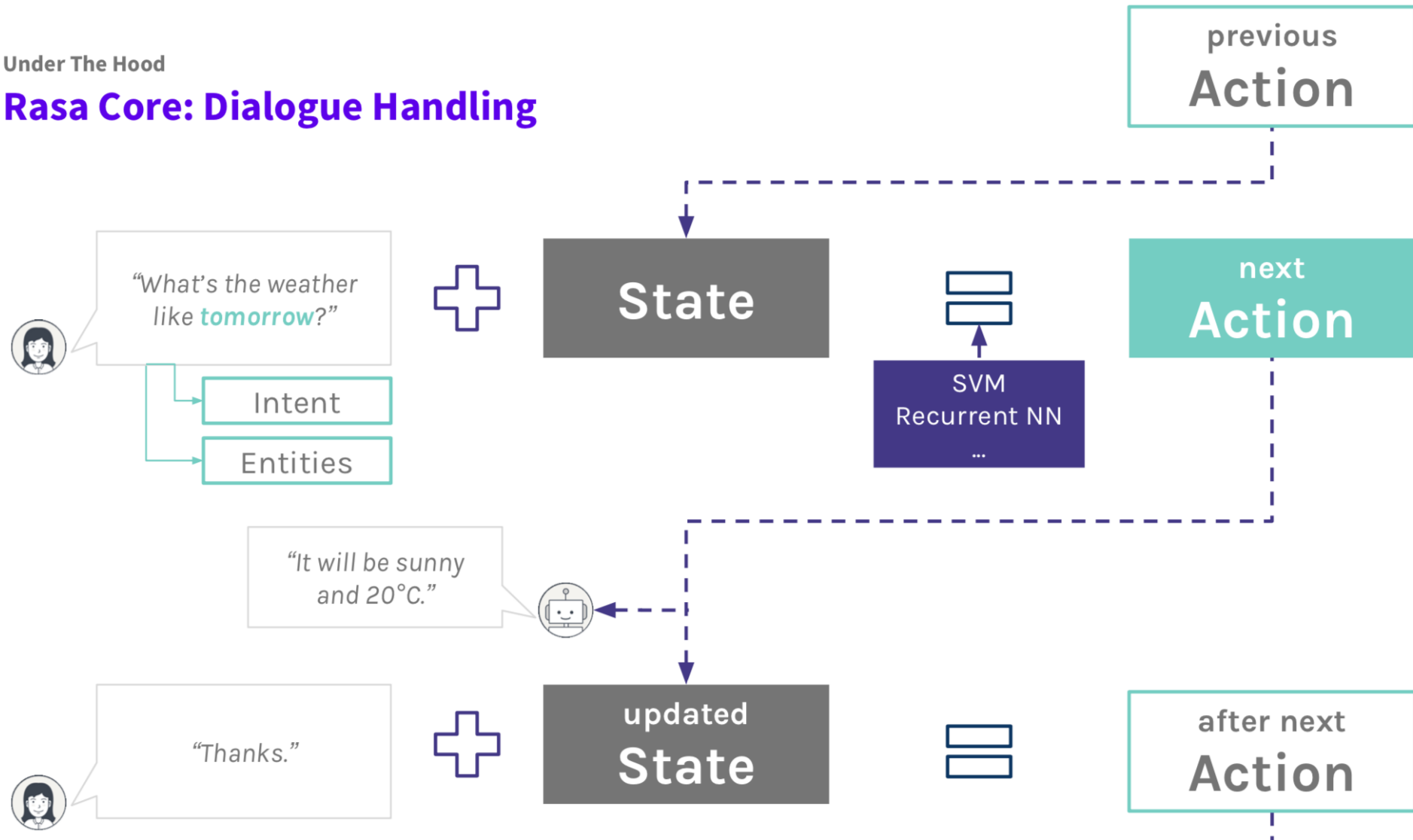
Chunker

Named Entity
Recognition

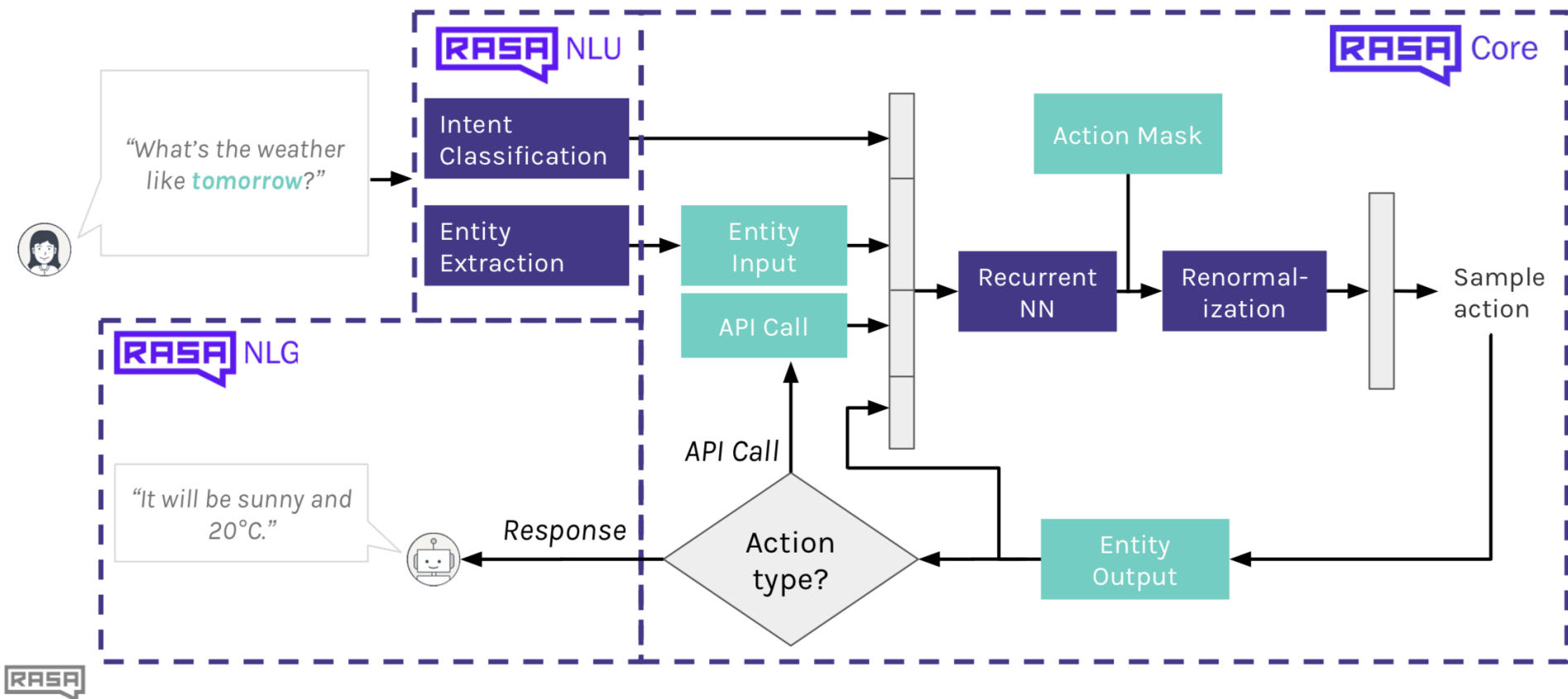
Rasa Core: Dialogue Handling

Under The Hood

Rasa Core: Dialogue Handling



Rasa Core: Dialogue Handling

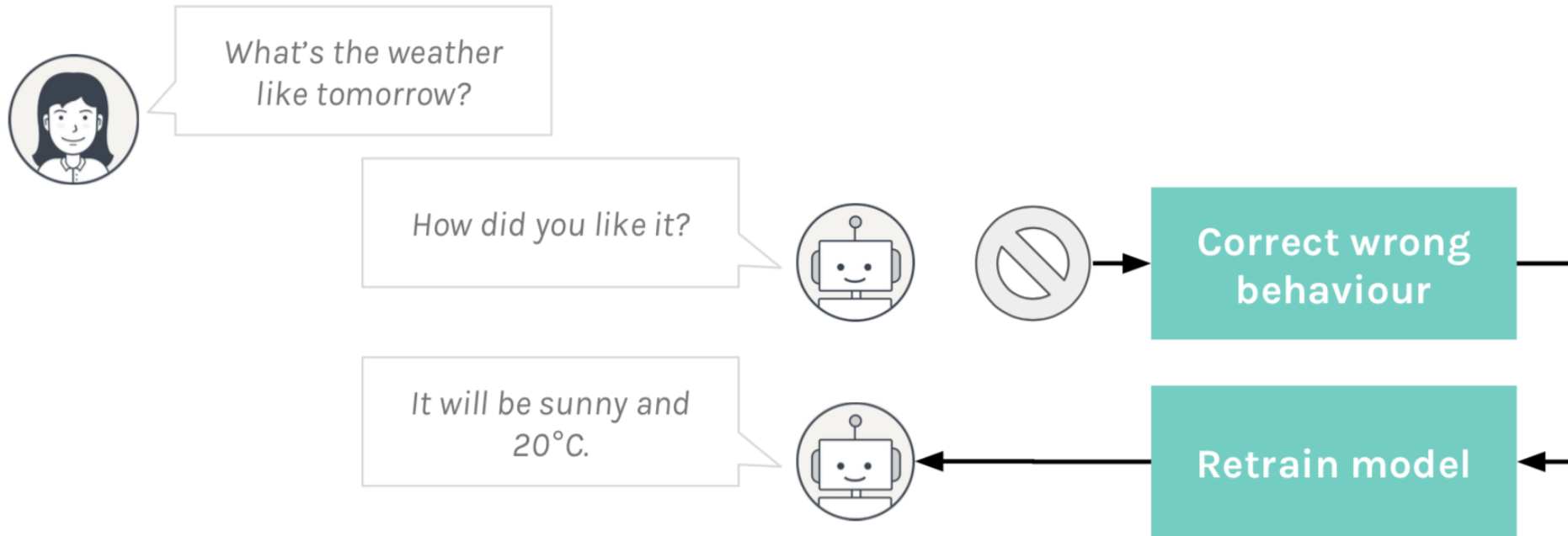


Rasa Core: Dialogue Training

Issue: How to get started?



Online Learning



Dialogflow

[Overview](#)[Case studies](#)[Docs](#)[Blog](#)[Pricing](#)[Support](#)[Go to console](#)

Build natural and rich conversational experiences

Give users new ways to interact with your product by building engaging voice and text-based conversational interfaces, such as voice apps and chatbots, powered by AI. Connect with users on your website, mobile app, the Google Assistant, Amazon Alexa, Facebook Messenger, and other popular platforms and devices.

[Sign up for free](#)

Powered by Google's machine learning

Dialogflow incorporates Google's machine learning expertise and products such as Google Cloud Speech-to-Text.

Built on Google infrastructure

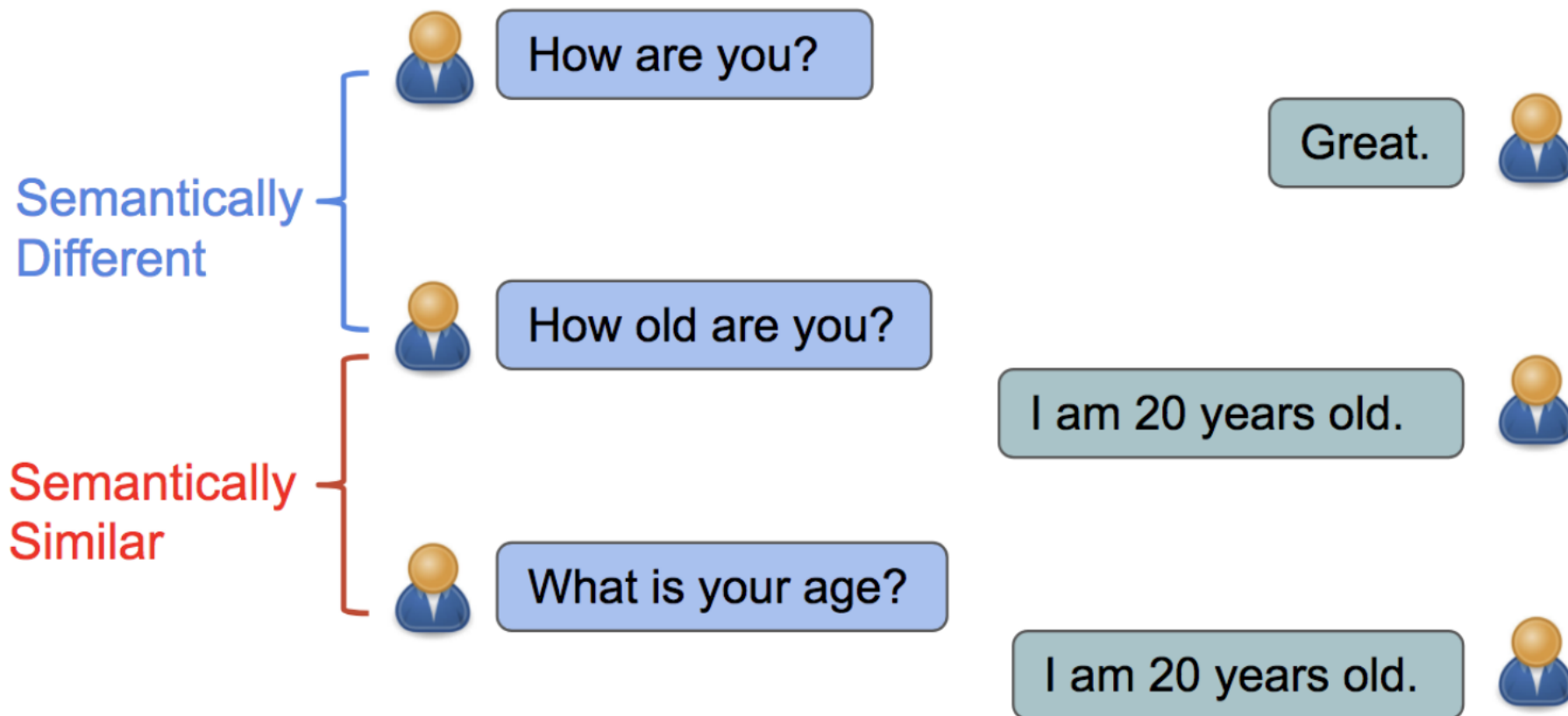
Dialogflow is backed by Google and runs on Google Cloud Platform, letting you scale to hundreds of millions of users.

Optimized for the Google Assistant

Dialogflow is the most widely used tool to build Actions for more than 400M+ Google Assistant devices.



Learning Semantic Textual Similarity from Conversations



TF-Hub Modules

Sentence Embedding

Universal Sentence Encoder

TensorFlow Hub



USER GUIDE

Text

Embedding

Image

Classification

Feature Vector

Generator

Other

Video

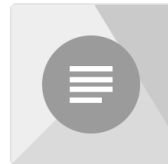
Classification

Publishers

Google

DeepMind

Text embedding



universal-sentence-encoder By Google

Text embedding DAN English

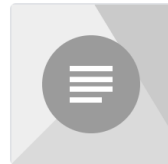
Encoder of greater-than-word length text trained on a variety of data.



universal-sentence-encoder-large By Google

Text embedding Transformer English

Encoder of greater-than-word length text trained on a variety of data.



elmo By Google

Text embedding 1 Billion Word Benchmark ELMo English

Embeddings from a language model trained on the 1 Billion Word Benchmark.

[View more text embeddings](#)

Image feature vectors





imagenet/inception_v3/feature_vector By Google

Image feature vector ImageNet (ILSVRC-2012-CLS) Inception V3

Feature vectors of images with Inception V3 trained on ImageNet (ILSVRC-2012-CLS).

<https://tfhub.dev/>

Semantic Similarity with TF-Hub University Sentence Encoder

 Semantic Similarity with TF-Hub Universal Encoder 



File Edit View Insert Runtime Tools Help

+ CODE + TEXT ↑ CELL ↓ CELL COPY TO DRIVE

CONNECT EDITING

▶ Copyright 2018 The TensorFlow Hub Authors.
Licensed under the Apache License, Version 2.0 (the "License");
↳ 1 cells hidden

▼ Universal Sentence Encoder


 [Run in Google Colab](#)  [View source on GitHub](#)

This notebook illustrates how to access the Universal Sentence Encoder and use it for sentence similarity and sentence classification tasks.

The Universal Sentence Encoder makes getting sentence level embeddings as easy as it has historically been to lookup the embeddings for individual words. The sentence embeddings can then be trivially used to compute sentence level meaning similarity as well as to enable better performance on downstream classification tasks using less supervised training data.

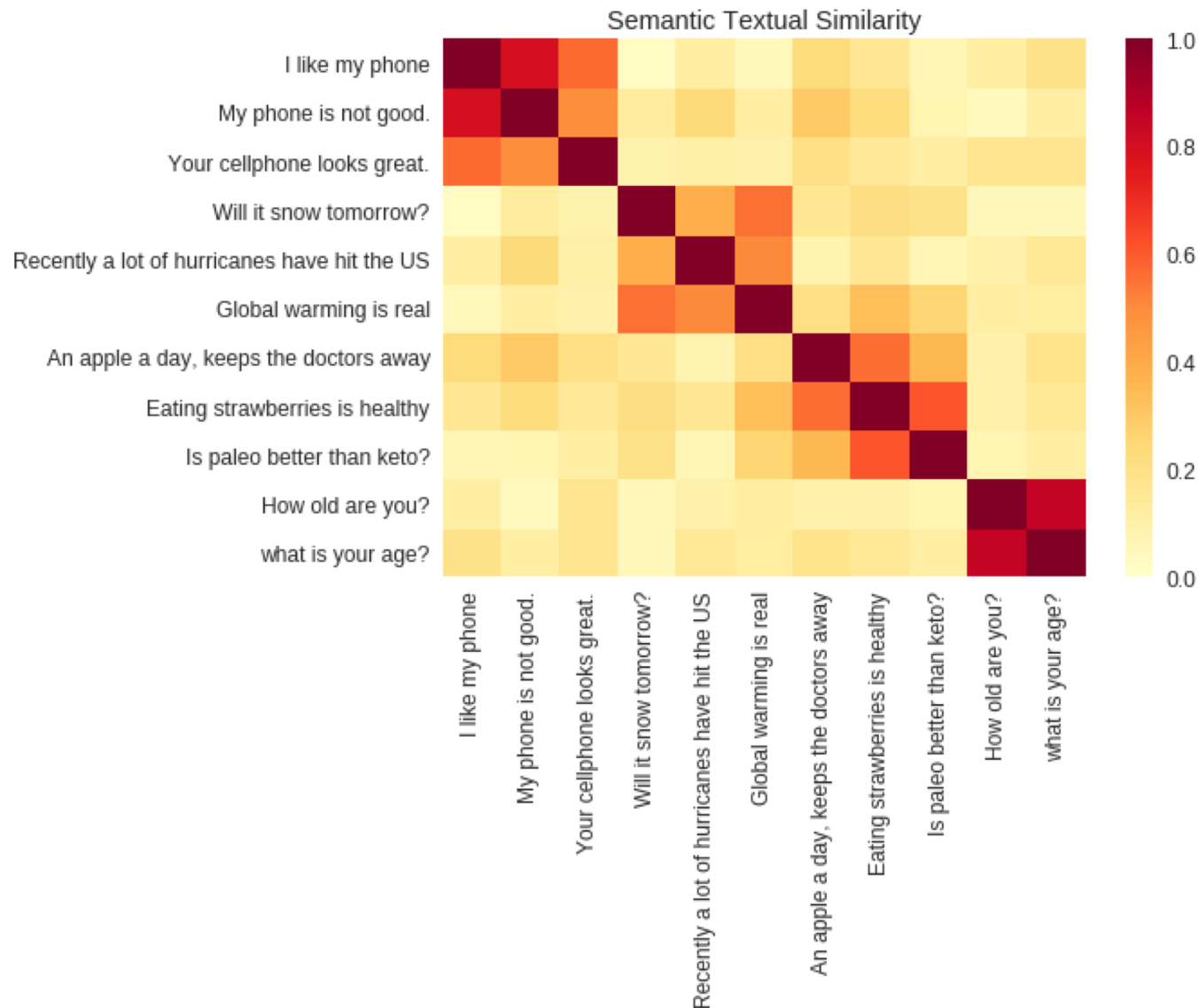
▼ Getting Started

This section sets up the environment for access to the Universal Sentence Encoder on TF Hub and provides examples of applying the encoder to words, sentences, and paragraphs.



```
1 # Install the latest Tensorflow version.
2 !pip3 install --quiet "tensorflow>=1.7"
3 # Install TF-Hub.
4 !pip3 install --quiet tensorflow-hub
5 !pip3 install --quiet seaborn
```


Semantic Textual Similarity



anaGo

Sequence Labeling (NER)

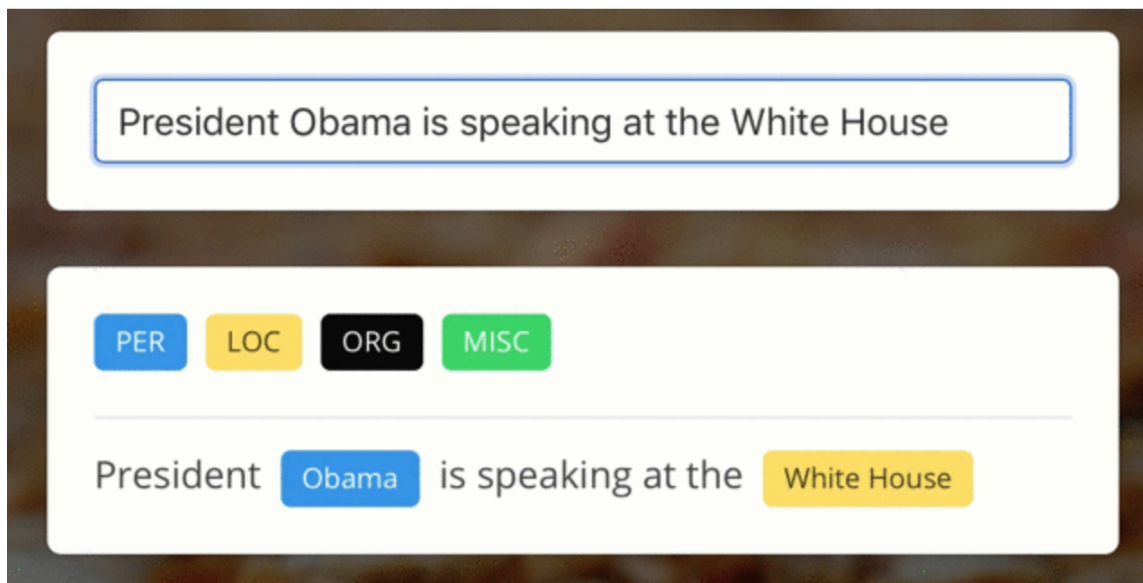
anaGo

anaGo is a Python library for sequence labeling(NER, PoS Tagging,...), implemented in Keras.

anaGo can solve sequence labeling tasks such as named entity recognition (NER), part-of-speech tagging (POS tagging), semantic role labeling (SRL) and so on. Unlike traditional sequence labeling solver, anaGo don't need to define any language dependent features. Thus, we can easily use anaGo for any languages.

As an example of anaGo, the following image shows named entity recognition in English:

[anaGo Demo](#)



GRAM-CNN

BioNER

- GRAM-CNN is a novel end-to-end approach for biomedical NER tasks. To automatically label a word, this method uses the local information around the word. Therefore, the GRAM-CNN method doesn't require any specific knowledge or feature engineering and can be theoretically applied to all existing NER problems.
- The GRAM-CNN approach was evaluated on three well-known biomedical datasets containing different BioNER entities. It obtained an F1-score of 87.38% on the Biocreative II dataset, 86.65% on the NCBI dataset, and 72.57% on the JNLPBA dataset. Those results put GRAM-CNN in the lead of the biological NER methods.
- Pre-trained embedding are from:
 - <https://github.com/cambridgeltl/BioNLP-2016>

Summary

- **AI Chatbots**
- **Conversational Commerce**
- **Bot Platform Ecosystem**

References

- Yun-Nung Chen, Dilek Hakkani-Tür, Gokhan Tur, Jianfeng Gao, and Li Deng (2016), "End-to-end memory networks with knowledge carryover for multi-turn spoken language understanding." In Proceedings of Interspeech.
- Hakkani-Tür, Dilek, Gokhan Tur, Asli Celikyilmaz, Yun-Nung Chen, Jianfeng Gao, Li Deng, and Ye-Yi Wang. "Multi-domain joint semantic frame parsing using bi-directional RNN-LSTM." In Proceedings of The 17th Annual Meeting of the International Speech Communication Association. 2016.
- Jeongkyu Shin (2016), Building AI Chat bot with Python 3 and TensorFlow, PyCon APAC 2016.
- Ankit Kumar, Ozan Irsoy, Jonathan Su, James Bradbury, Robert English, Brian Pierce, Peter Ondruska, Ishaan Gulrajani, and Richard Socher (2015). "Ask me anything: Dynamic memory networks for natural language processing." arXiv preprint arXiv:1506.07285.
- Antoine Bordes and Jason Weston (2016), "Learning End-to-End Goal-Oriented Dialog." arXiv preprint arXiv:1605.07683.
- Jason Weston, Antoine Bordes, Sumit Chopra, Alexander M. Rush, Bart van Merriënboer, Armand Joulin, and Tomas Mikolov (2015), "Towards AI-complete question answering: A set of prerequisite toy tasks." arXiv preprint arXiv:1502.05698.
- Iulian V. Serban, Chinnadhurai Sankar, Mathieu Germain, Saizheng Zhang, Zhouhan Lin, Sandeep Subramanian, Taesup Kim et al (2017). "A Deep Reinforcement Learning Chatbot." arXiv preprint arXiv:1709.02349.
- Xuijun Li, Yun-Nung Chen, Lihong Li, and Jianfeng Gao (2017), "End-to-end task-completion neural dialogue systems." arXiv preprint arXiv:1703.01008.
- Jack Cahn (2017), "CHATBOT: Architecture, Design, & Development." PhD diss., University of Pennsylvania.
- Ferrucci, David, Eric Brown, Jennifer Chu-Carroll, James Fan, David Gondek, Aditya A. Kalyanpur, Adam Lally et al.(2010) ". Building Watson: An overview of the DeepQA project" AI magazine 31, no. 3 (2010): 59-79.
- Kato, Makoto P., and Yiqun Liu (2017), "Overview of NTCIR-13." In Proceedings of the 13th NTCIR Conference. 2017.
- Huang, Minlie, Zuoxian Ye, and Hao Zhou (2017). "Overview of the NLPCC 2017 Shared Task: Emotion Generation Challenge." In National CCF Conference on Natural Language Processing and Chinese Computing (NLPCC), pp. 926-936. Springer, Cham, 2017.
- Zhou, Hao, Minlie Huang, Tianyang Zhang, Xiaoyan Zhu, and Bing Liu. (2017) "Emotional chatting machine: emotional conversation generation with internal and external memory." arXiv preprint arXiv:1704.01074.
- Yu, Kai, Zijian Zhao, Xueyang Wu, Hongtao Lin, and Xuan Liu. (2018)"Rich Short Text Conversation Using Semantic Key Controlled Sequence Generation." IEEE/ACM Transactions on Audio, Speech, and Language Processing.
- Justina Petraitytė (2018), Deprecating the state machine: building conversational AI with the Rasa stack, PyData Berlin 2018.
- Yinfei Yang, Steve Yuan, Daniel Cer, Sheng-yi Kong, Noah Constant, Petr Pilar, Heming Ge, Yun-Hsuan Sung, Brian Strope, and Ray Kurzweil (2018). "Learning Semantic Textual Similarity from Conversations." arXiv preprint arXiv:1804.07754.