



Chatbots Personal Assistants Conversational Agents

Swisscom AI Research
Claudiu Musat

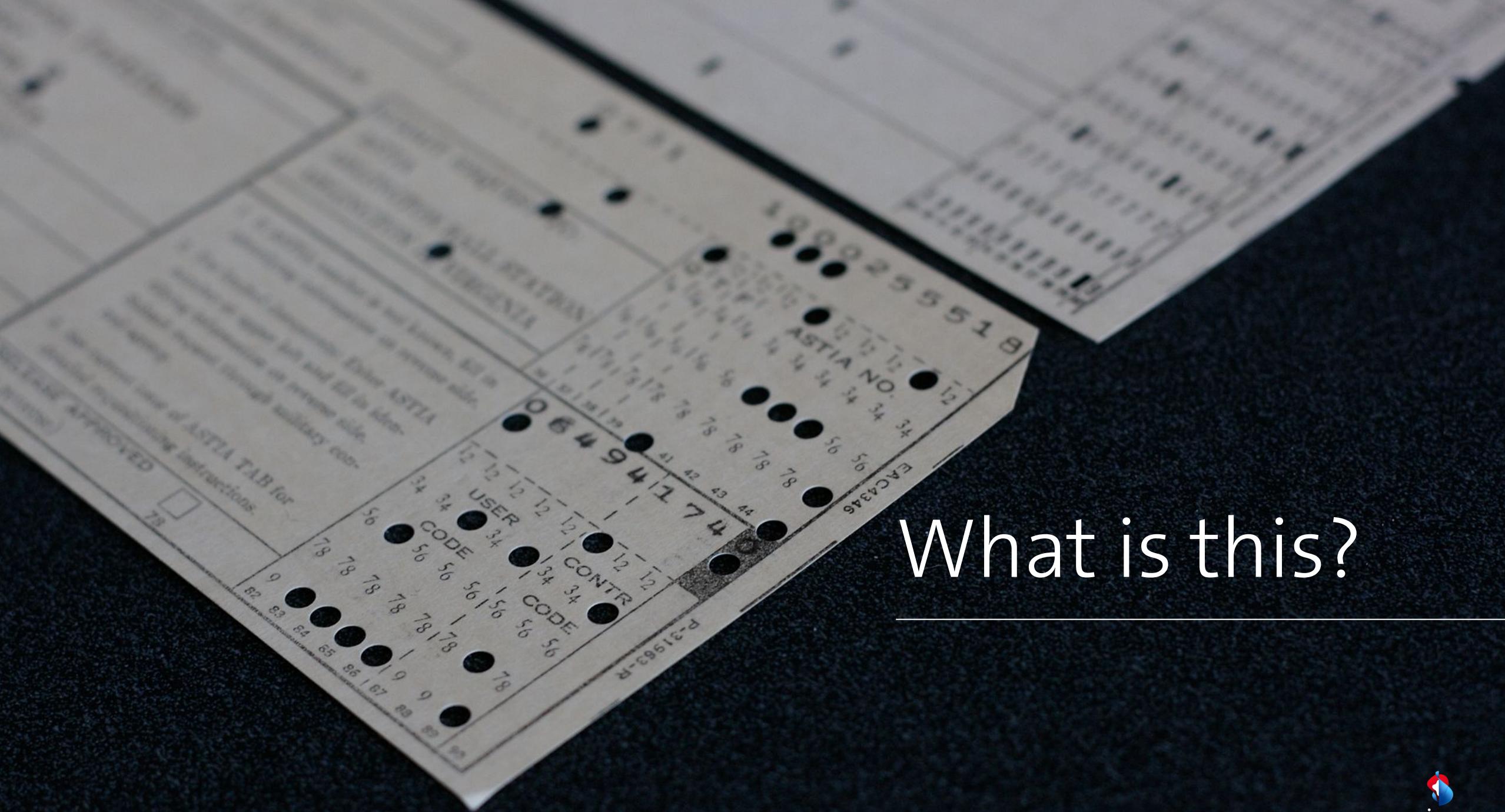


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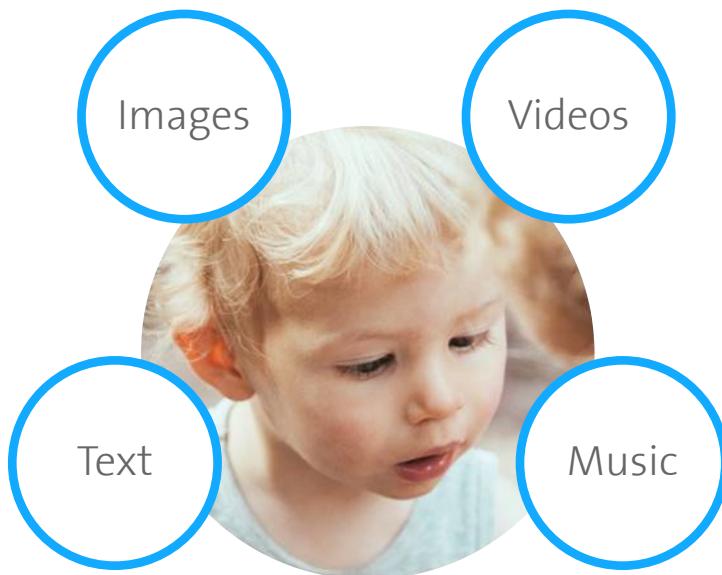
What is this?





The Past!

What distinguishes our brain from a machine

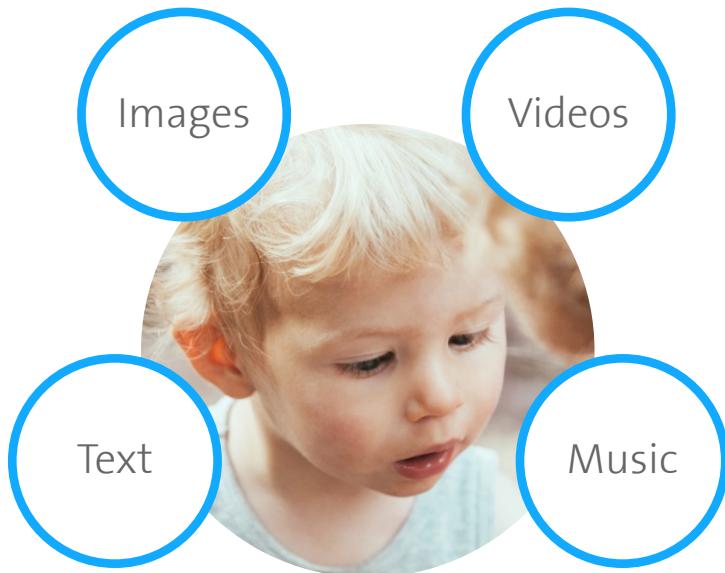


Understanding of **structured**
and **unstructured** data

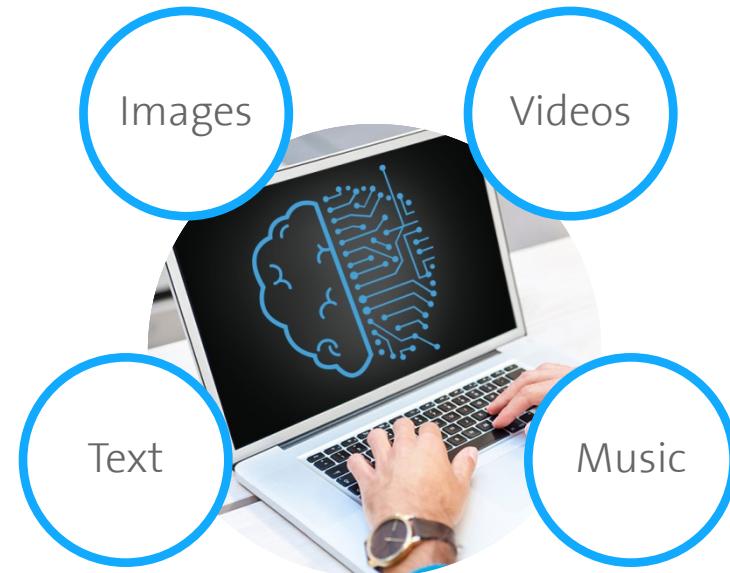


Understanding of
structured data only

Bots must speak our language

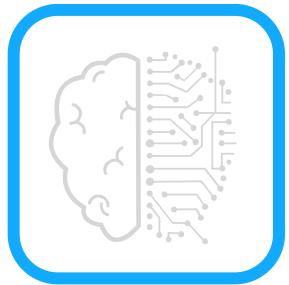


Understanding of **structured** and **unstructured** data

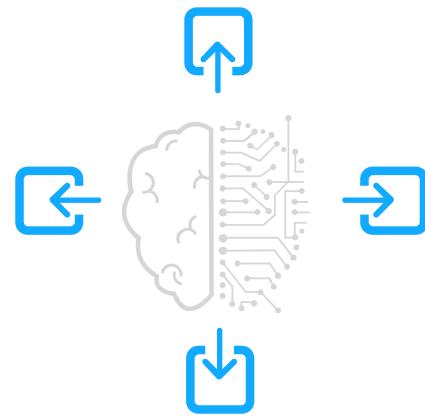


Understanding of **structured** and **unstructured** data

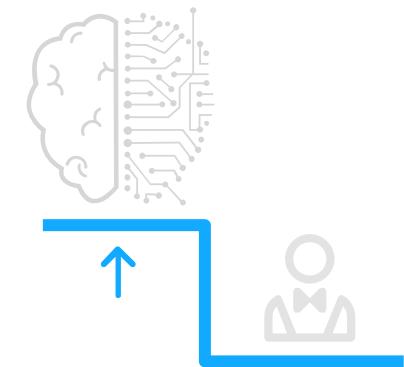
Three kinds of artificial intelligence



Artificial
Narrow Intelligence

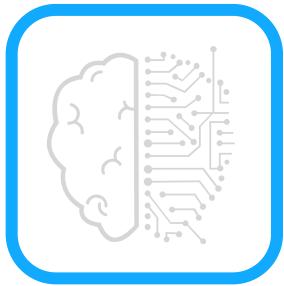


Artificial
General Intelligence

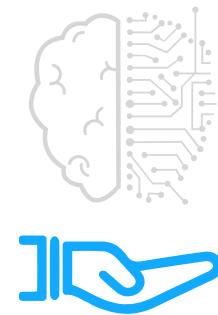


Artificial
Superintelligence

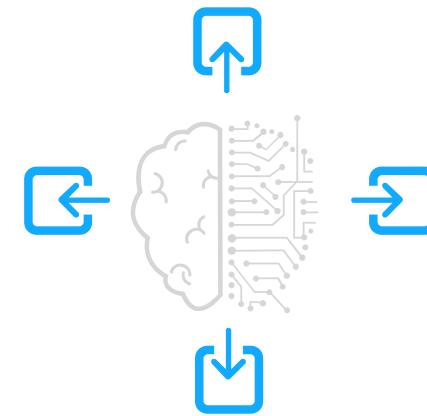
Four kinds of artificial intelligence



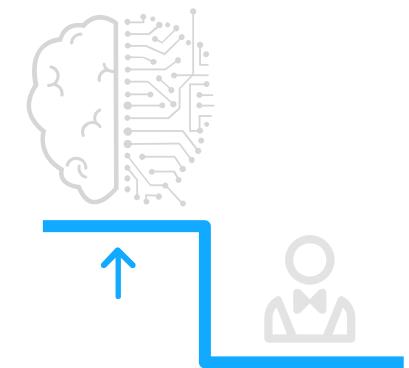
Artificial
Narrow Intelligence



Artificial
Useful Intelligence

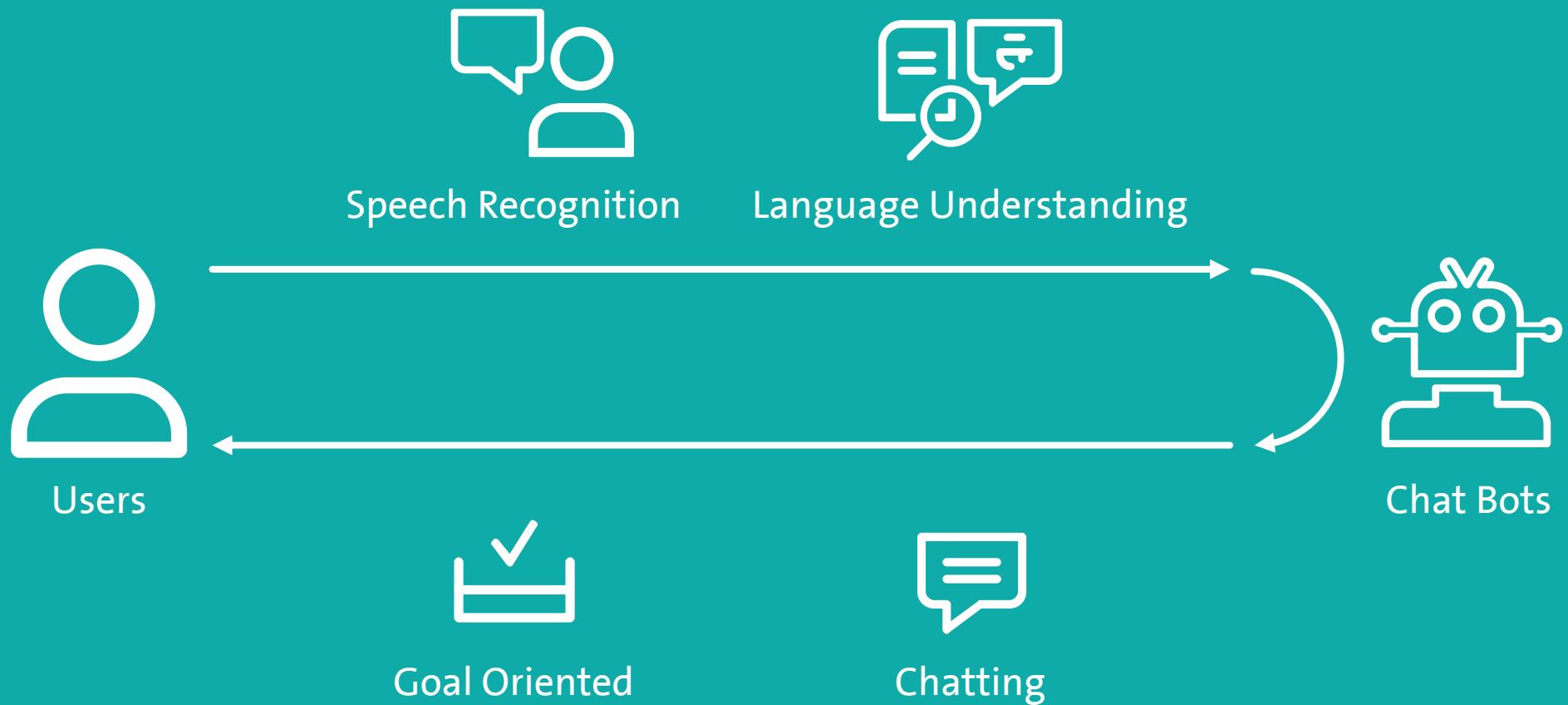


Artificial
General Intelligence



Artificial
Superintelligence

Useful Bots



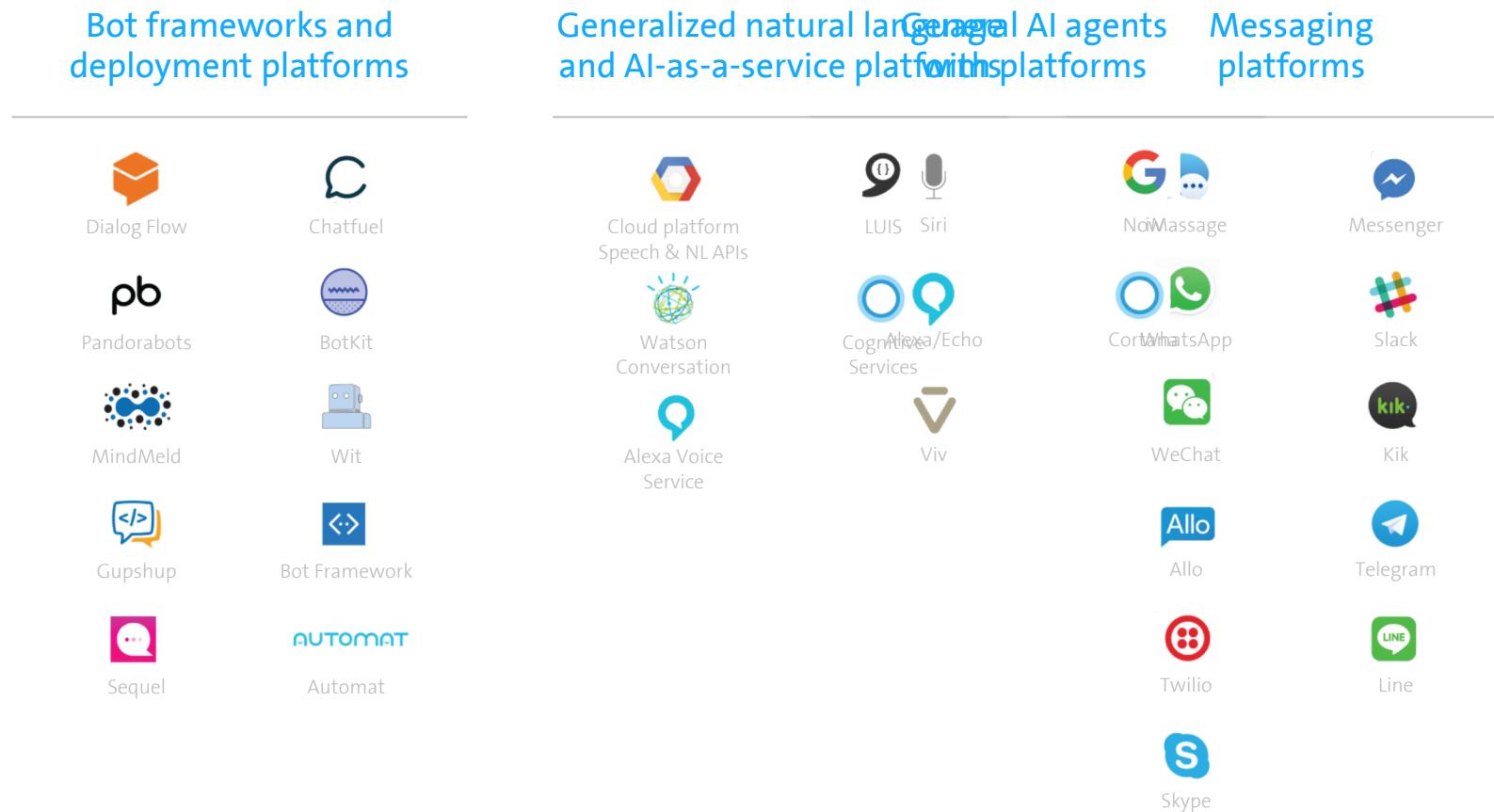
Types of useful bots

- Woman: You don't love me. } Chat
 - Xiaolce: I love you!
 - Woman: how much does Honor 6 Plus cost? } QA
 - Xiaolce: I know this! It's 2,899 RMB.
 - Woman: You know too much.
 - Xiaolce: It's my duty~
 - Woman: My first love
 - Xiaolce: In most cases, first love cannot move towards marriage.
 - Woman: why?
 - Xiaolce: There is no why.
 - [...] more chit-chats happened...]
 - Woman: I want to see some handsome boys.
 - Xiaolce: No problem! [an image of a handsome boy]
 - Woman: Do you know Lee Minho? (a Korean star)
 - Xiaolce: [an image of Lee Minho]
 - Woman: Which cellphone has the best camera?
 - Xiaolce: You can check your appearance by the screen of the phone.
 - Woman: What's the price of OPPO R8007?
 - Xiaolce: I know, it's 2,499 RMB.
 - Woman: So expensive.
 - Xiaolce: It could be better if this is on sale.
 - Woman: I cannot afford it~
 - [...] more chit-chats happened...]
-

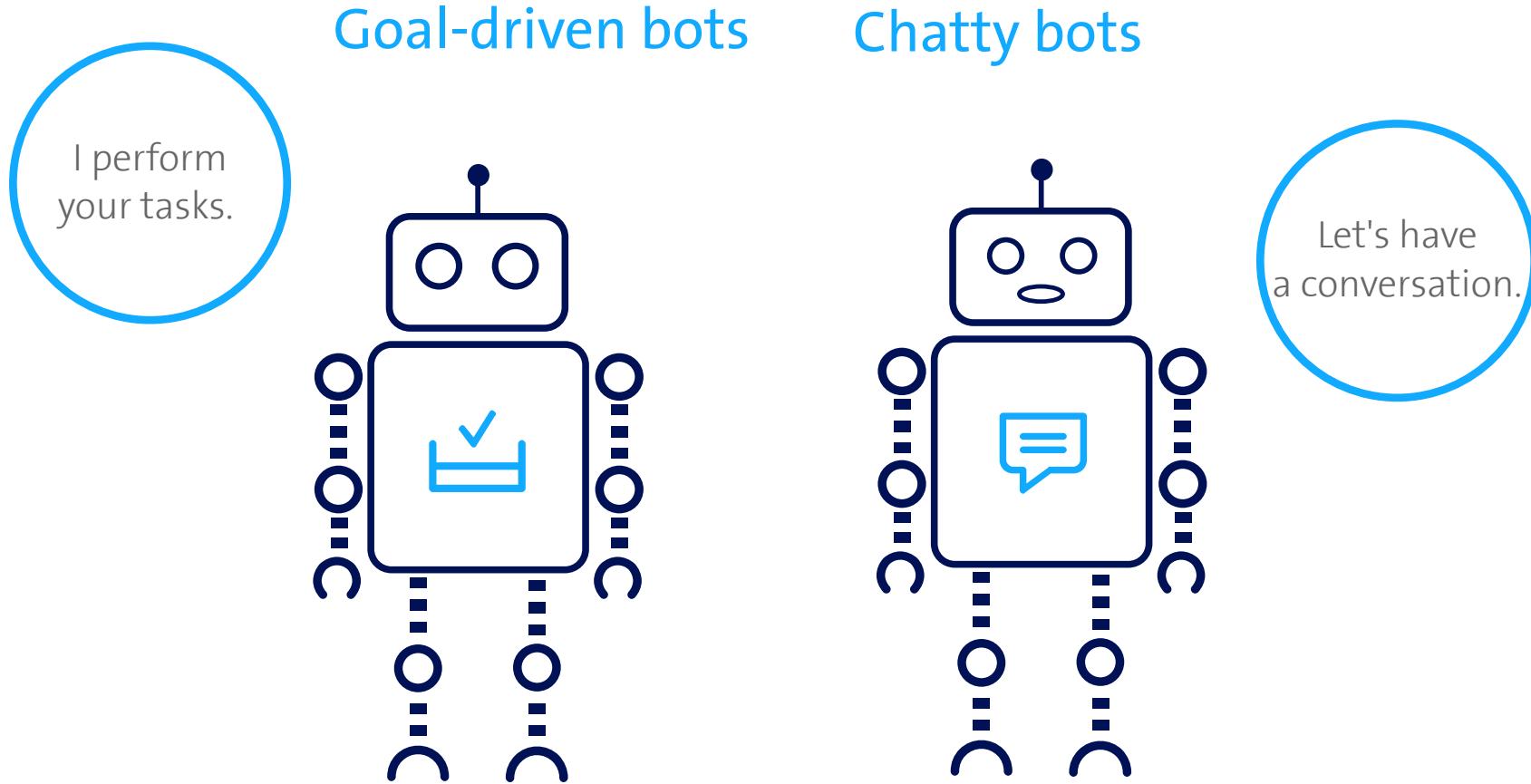
Dimensions to categorize bots

- By audience (specialist vs. generalist)
- By purpose (functional vs. fun)
- By the types of responses it can give (static vs. dynamic vs. generated)
- By the type of dialog system that powers them (tree-based flow vs. AI vs. hybrid)

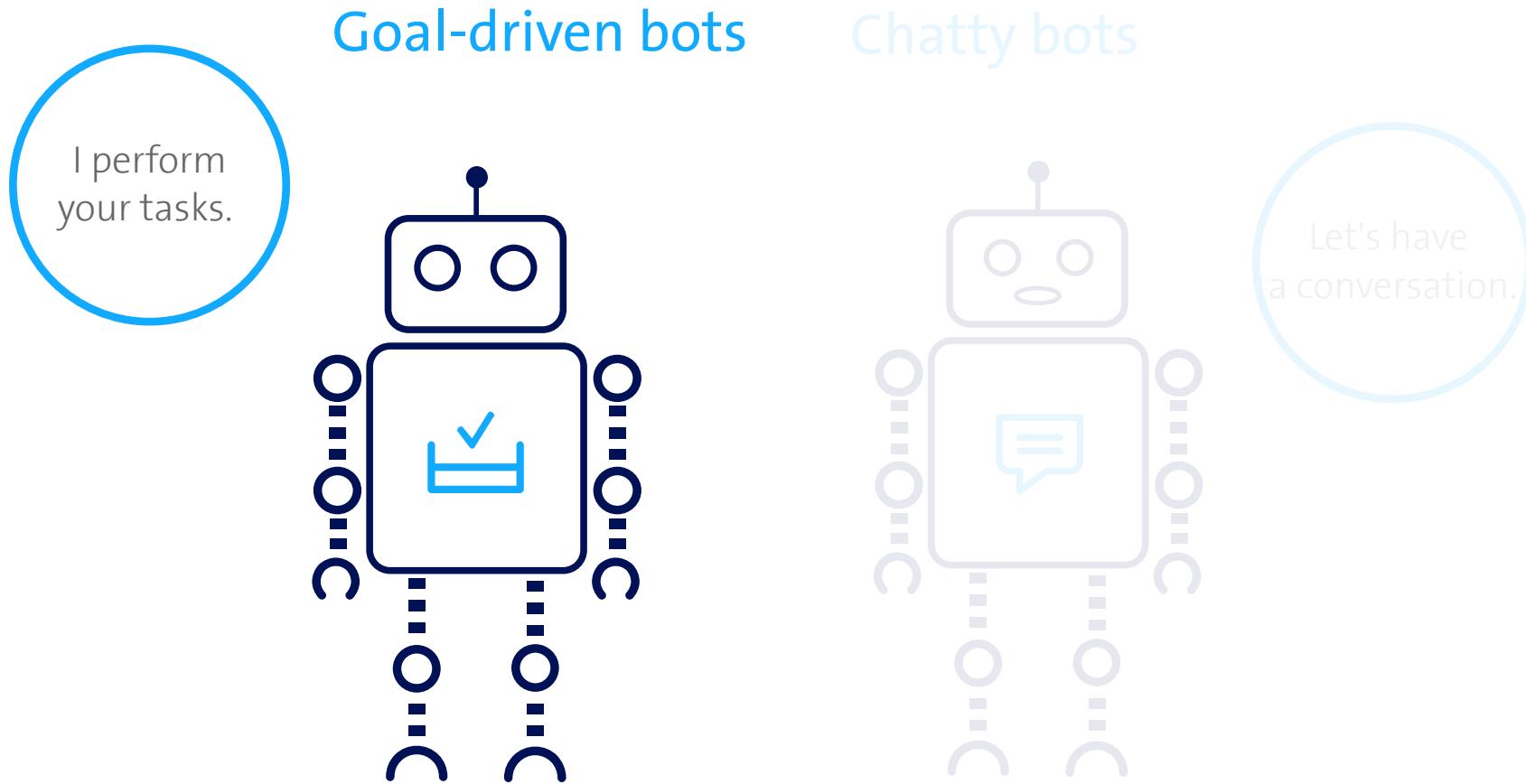
The conversational tech landscape

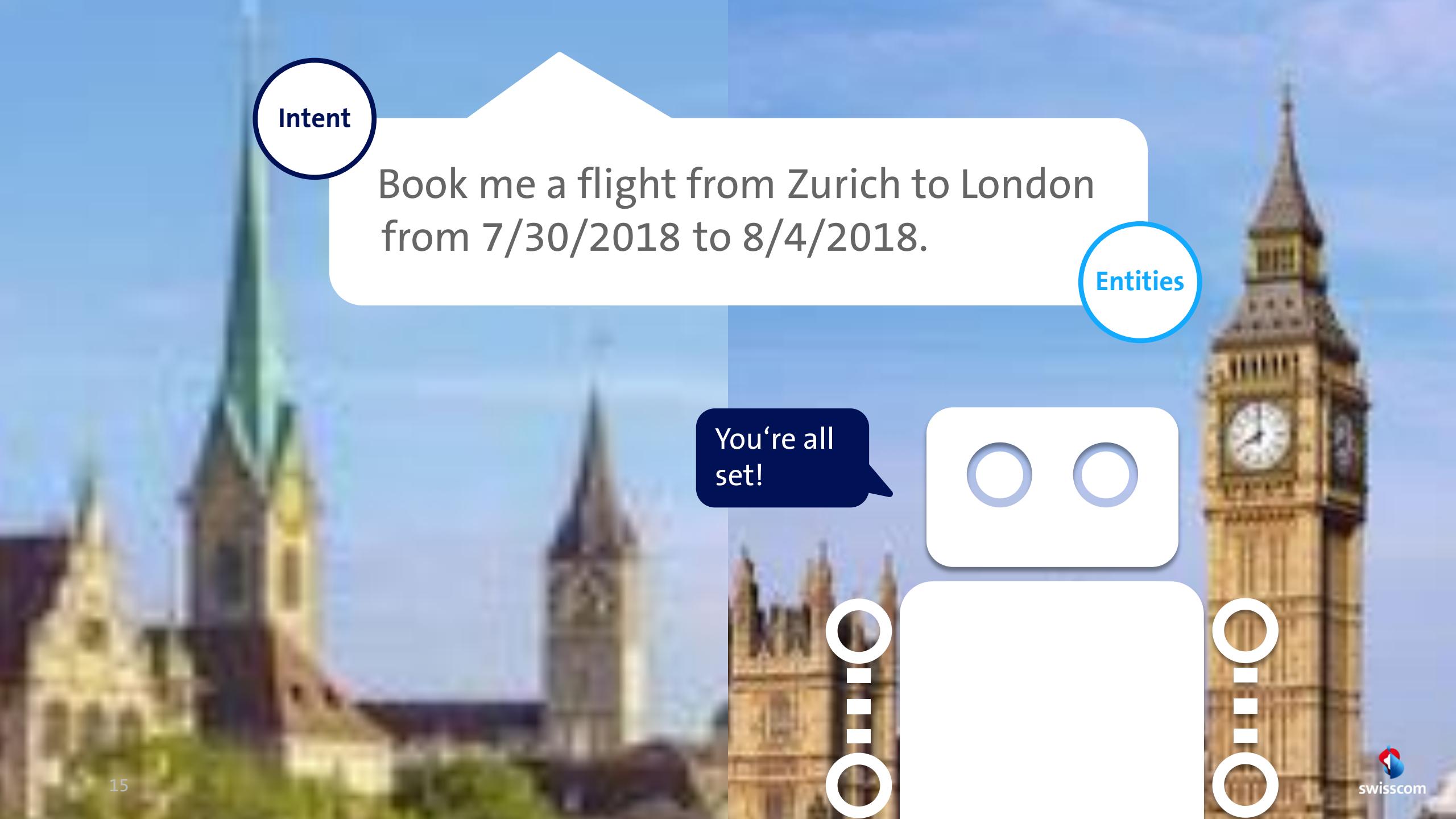


Types of useful bots



Types of useful bots





Intent

Book me a flight from Zurich to London
from 7/30/2018 to 8/4/2018.

Entities

You're all
set!



Goal-driven bots

Bot frameworks and deployment platforms



DialogFlow



Chatfuel



Pandorabots



BotKit



MindMeld



Wit



Gupshup



Bot Framework



Sequel



Automat

Generalized natural language and AI-as-a-service platforms



Cloud platform
Speech & NL APIs



Luis



Watson
Conversation



Cognitive
Services



Alexa Voice
Service

Messaging platforms



iMessage



Messenger



WhatsApp



Slack



WeChat



Kik



Allo



Telegram



Twilio



Line



Skype

General AI agents with platforms



Siri



Now



Alexa/Echo

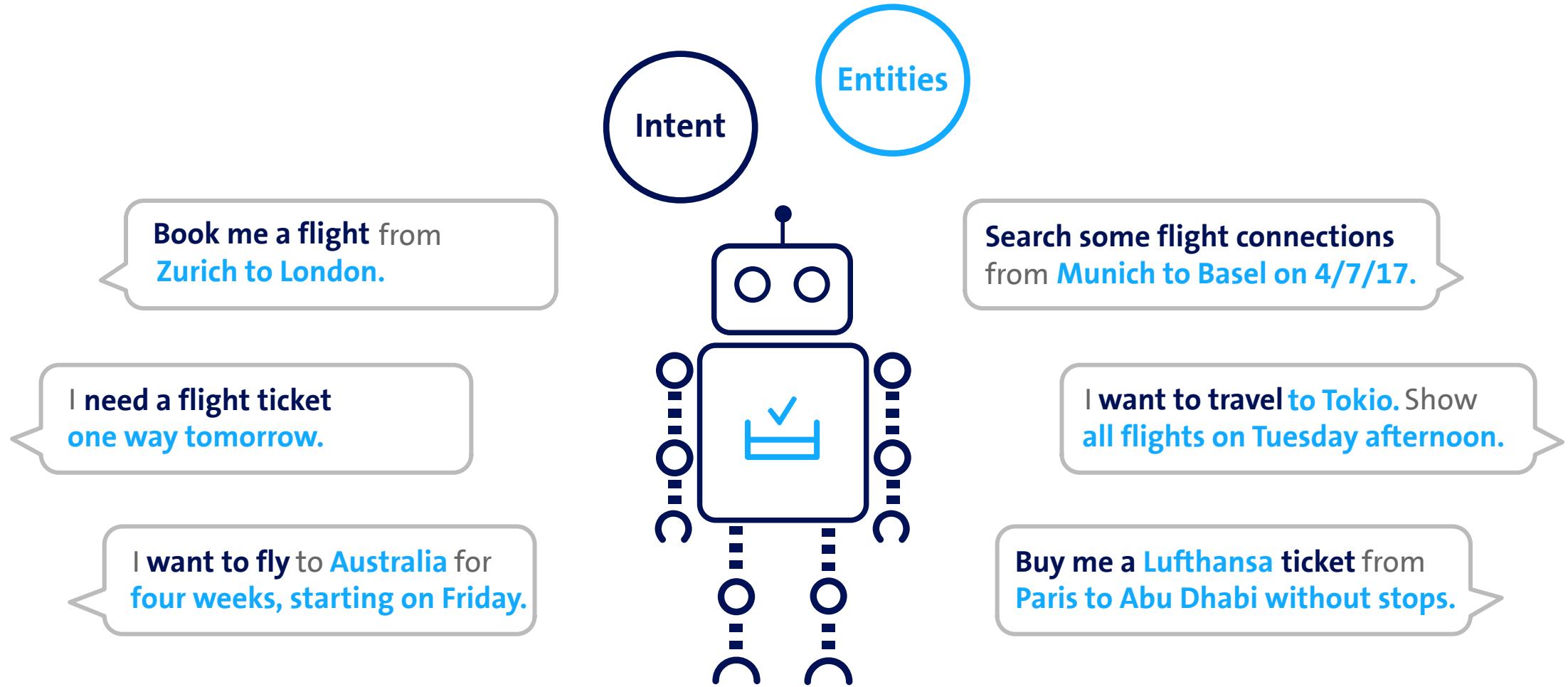


Cortana



Viv

Training for goal-driven bots



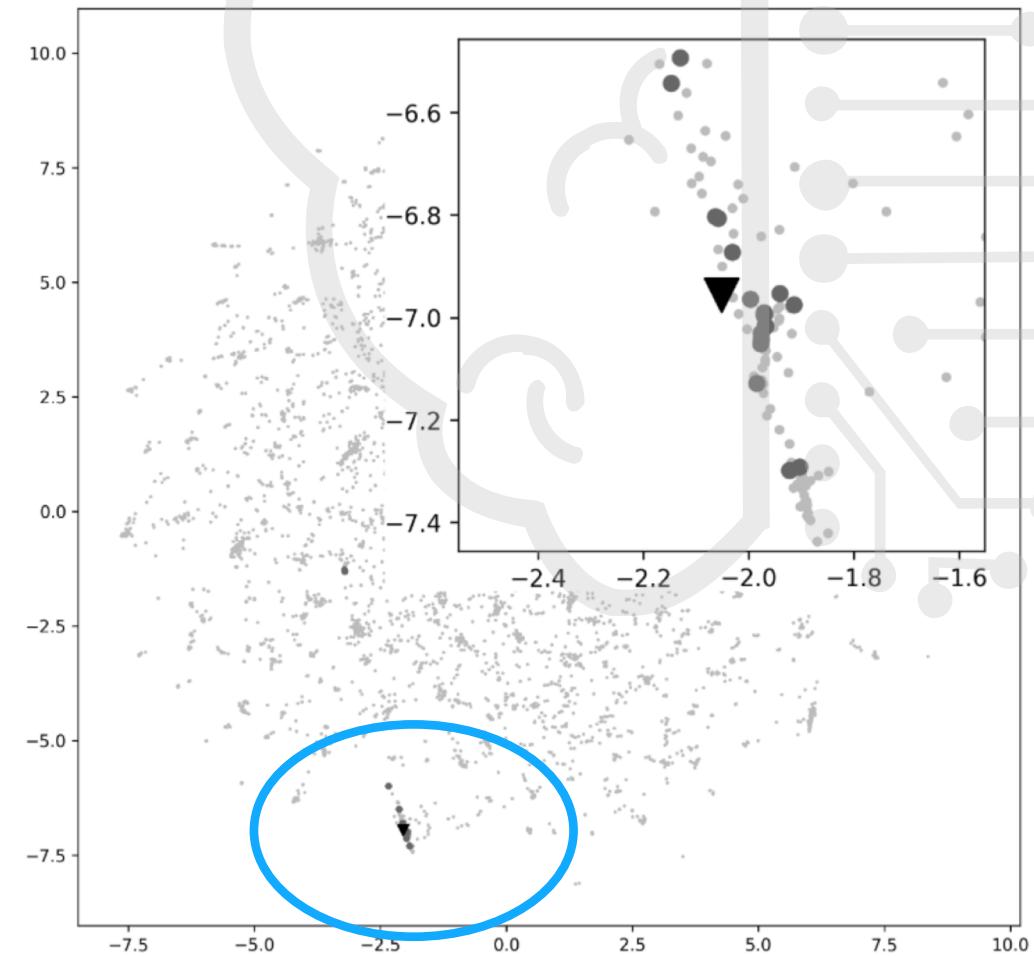
What happens when we don't have enough
training data?

Data-constrained Chatbots

- > Intent: Find movie given soundtrack
- > Slot: Song

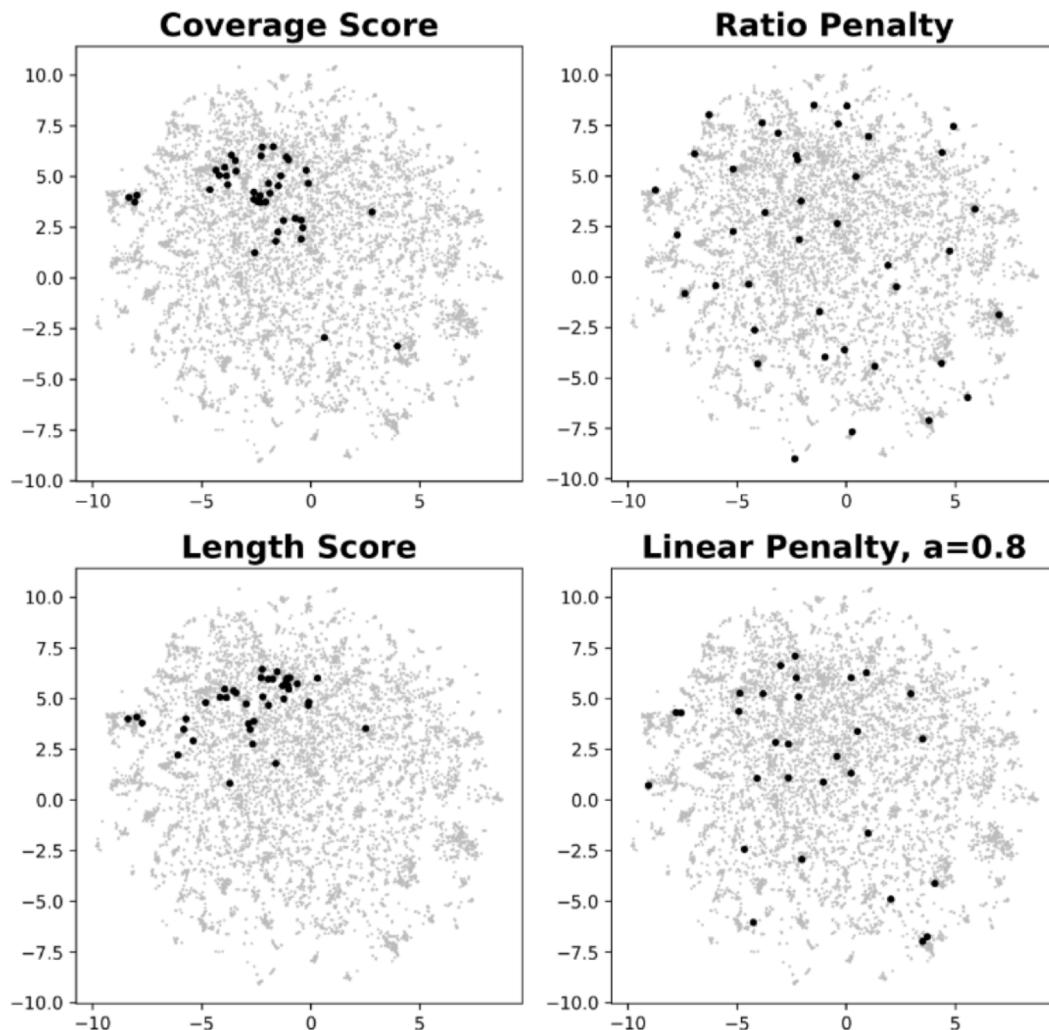
what was the movie that featured that song over the rainbow
find me the movie with the song over the rainbow
what movie was the song somewhere out there featured in
what movie features the song hakuna matata
sow me a movie from the 1930s with the song somewhere over the rainbow
what movie uses the song tubthumping

- > “over the rainbow”
- > “out there”
- > “hakuna matata”
- > ...



- Submodularity-inspired data selection for goal-oriented chatbot training based on sentence embeddings
 - IJCAI 2018

Data-constrained NLU – Sequence Tagging

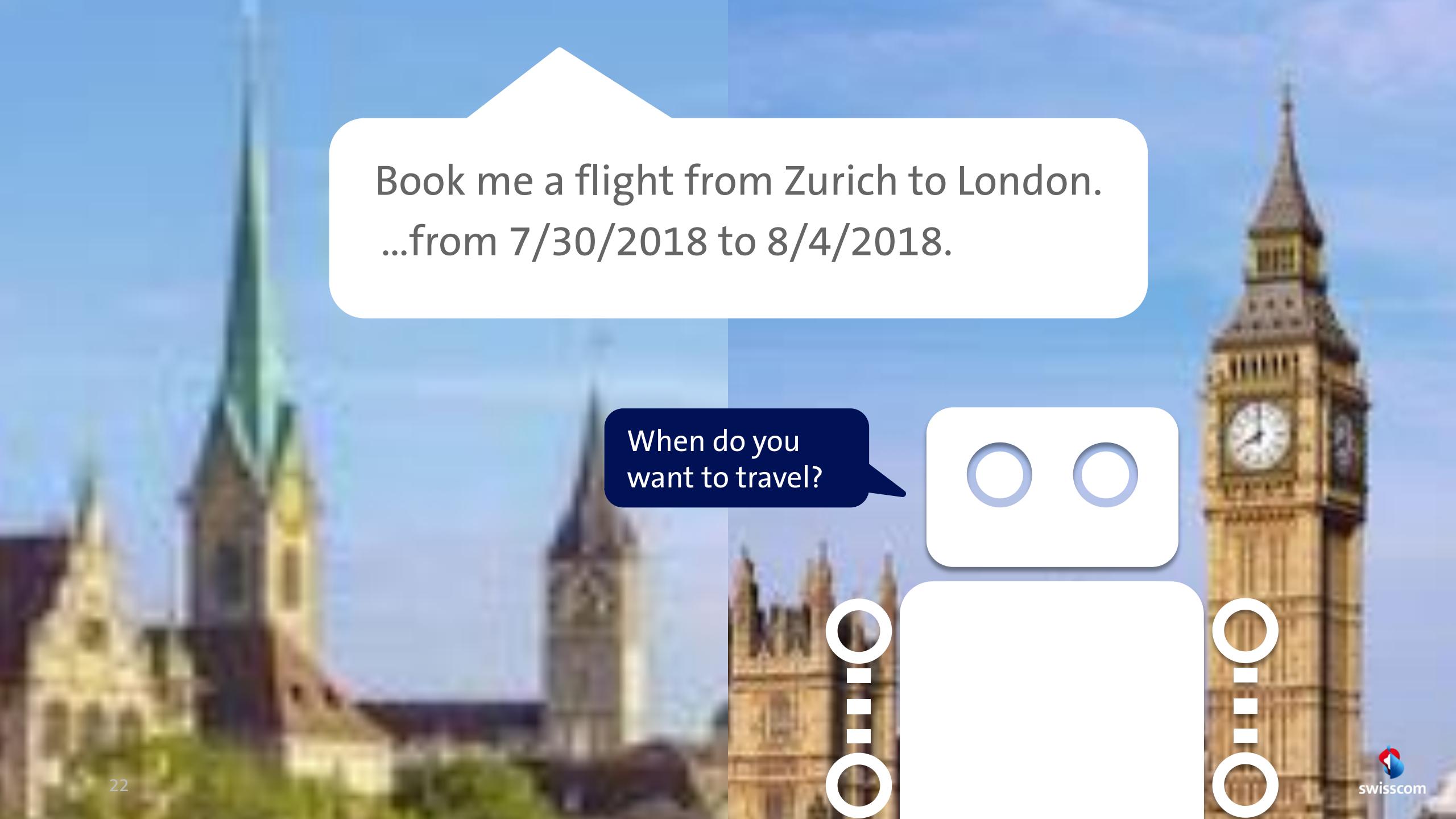


$$F(s|X) = \frac{\sum_{y \in V} \text{sim}(s, y)}{1 + \sum_{x \in X} \text{sim}(s, x)}$$



- Submodularity-inspired data selection for goal-oriented chatbot training based on sentence embeddings

What about multi-turn interactions?



Book me a flight from Zurich to London.
...from 7/30/2018 to 8/4/2018.

When do you
want to travel?



Data-constrained Dialogue Managers



Movie Booking Domain

- Source Domain
- Slots:
 - **city**
 - **date**
 - **number of people**
 - movie name
 - start time
 - theater

inform_slots: {movie_name: "avengers", number_of_people: "3", date: "tomorrow"}, request_slots: {city, theater, start_time}



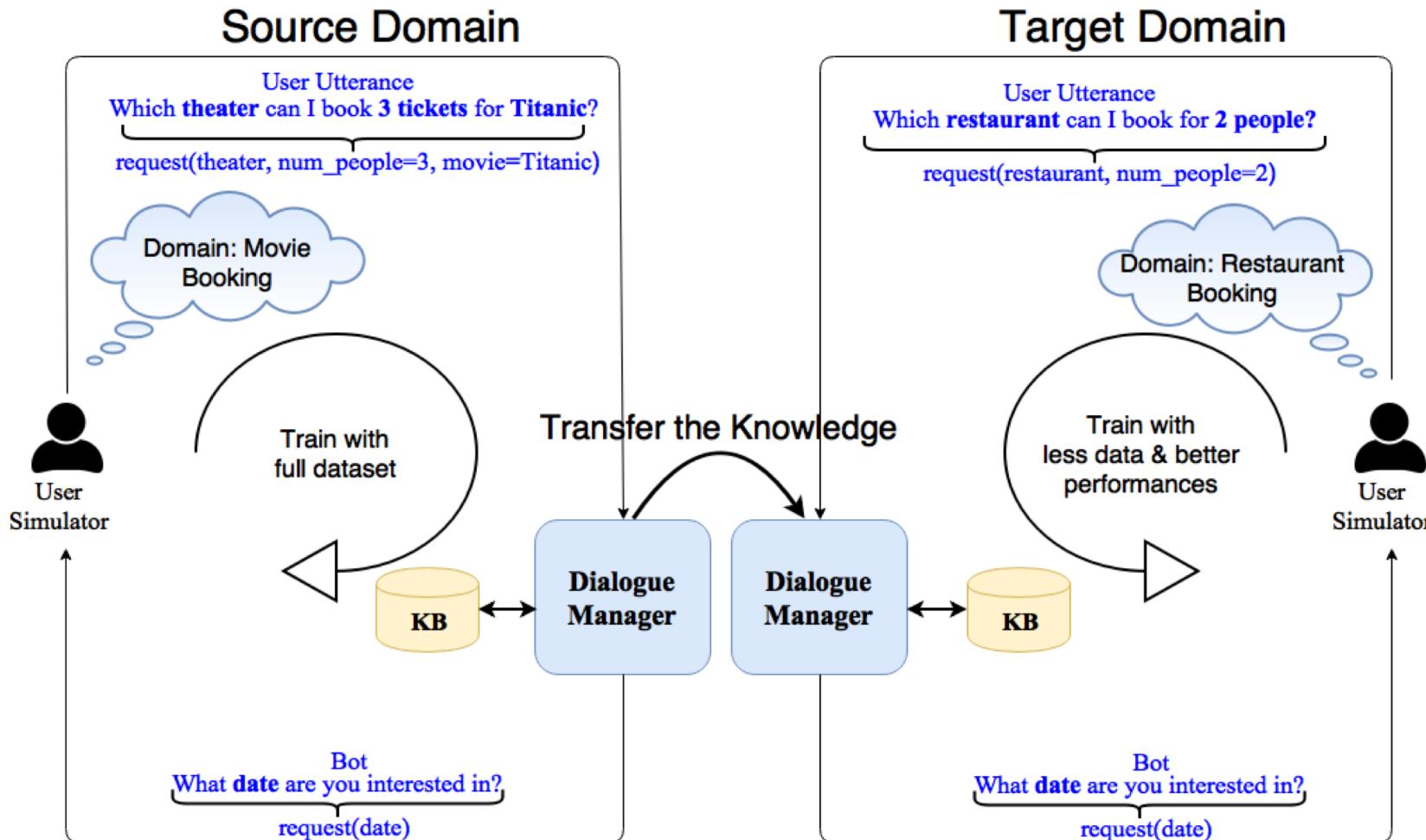
Restaurant Booking Domain

- Target Domain
- Slots:
 - **city**
 - **date**
 - **number of people**
 - food
 - price range
 - address

inform_slots: {food: "Chinese", city: "London", number_of_people: 2}, request_slots: {price_range, date, addr}

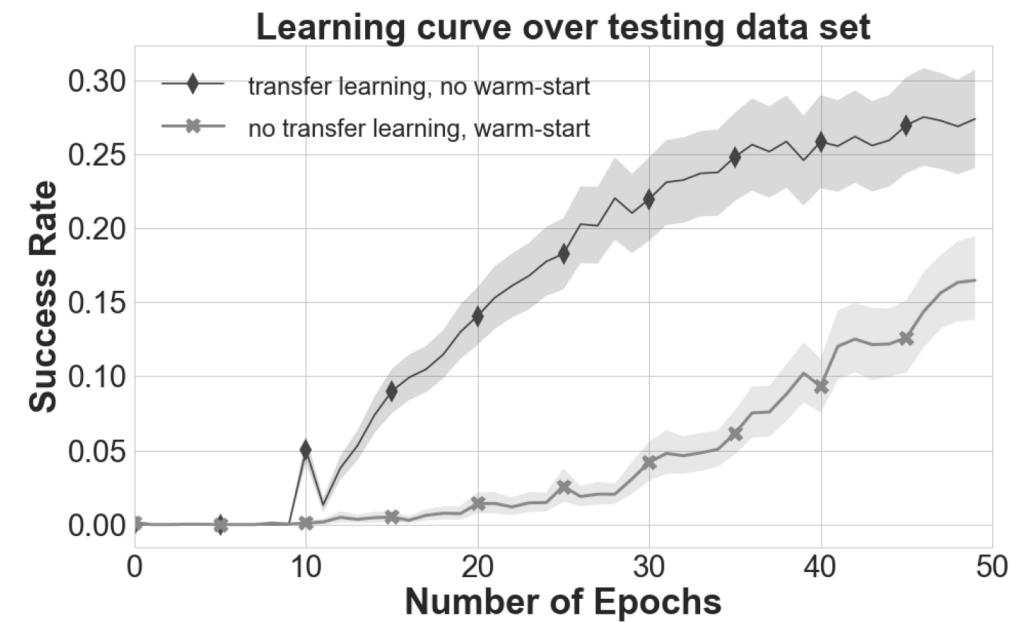
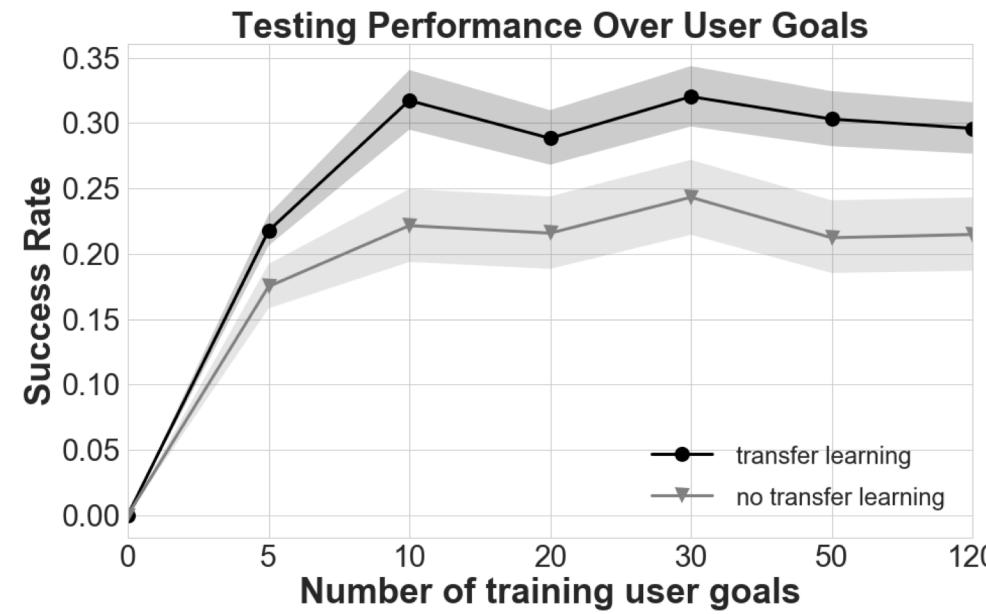
- *Goal-Oriented Chatbot Dialog Management Bootstrapping with Transfer Learning*
 - IJCAI 2018

Data-constrained Dialogue Managers



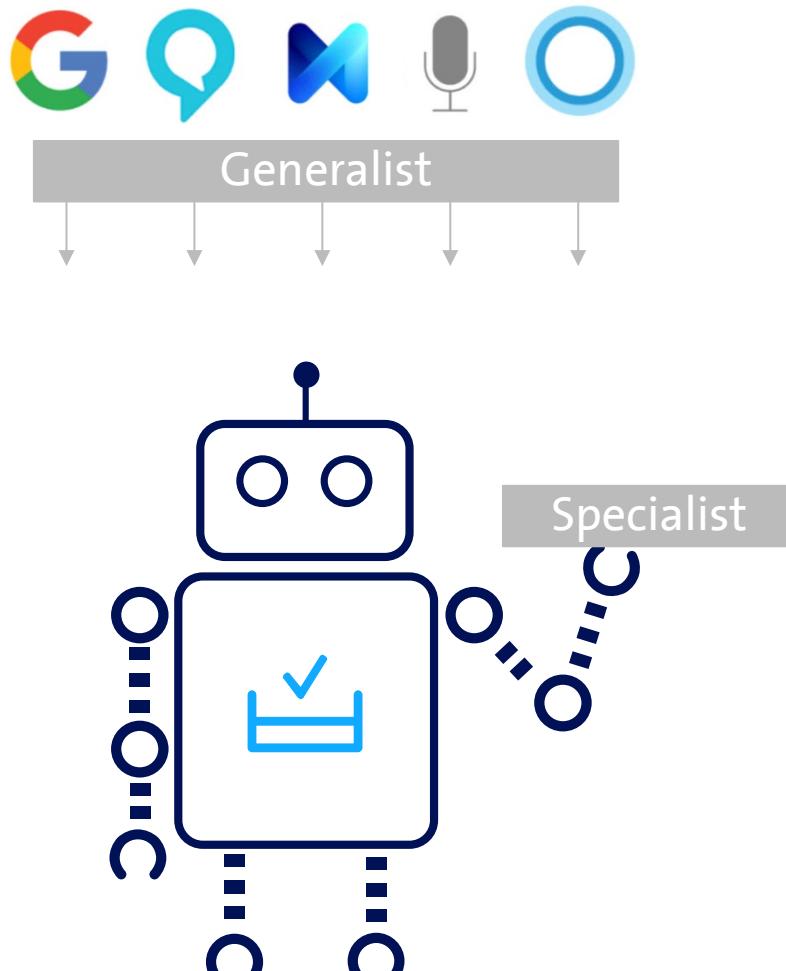
- *Goal-Oriented Chatbot Dialog Management Bootstrapping with Transfer Learning*
 - IJCAI 2018

Transferring dialogue policies



- *Goal-Oriented Chatbot Dialog Management Bootstrapping with Transfer Learning*

Take aways – goal-driven bots

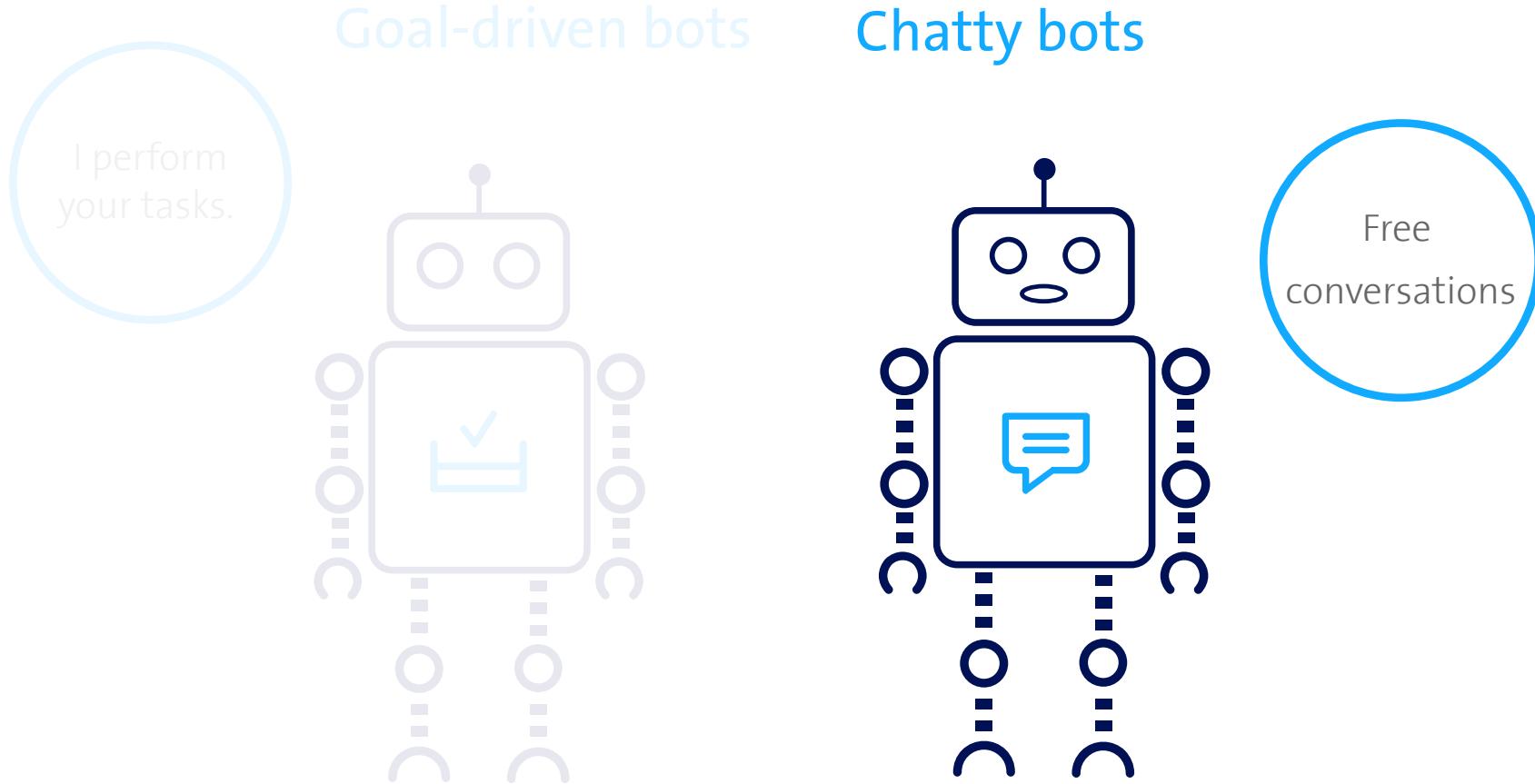


Existing dialog APIs from the tech giants are **generalists** with following issues:

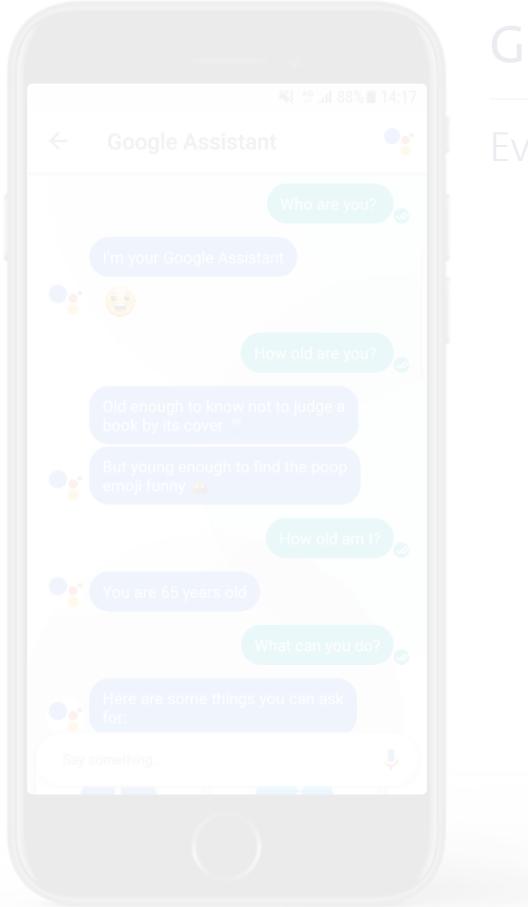
- Insufficient context
- Failure management
- Dialogue optimization
- Expert knowledge
- Accuracy

Build bots that perform a specific action exceptionally well, so that big platform players invoke them.

Types of (useful) bots



Domain Specificity



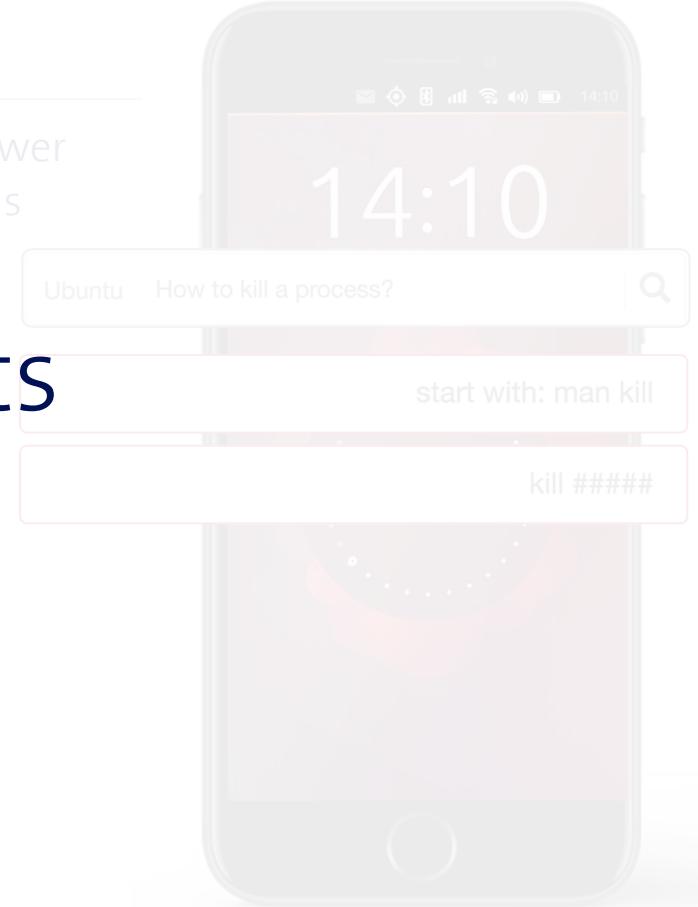
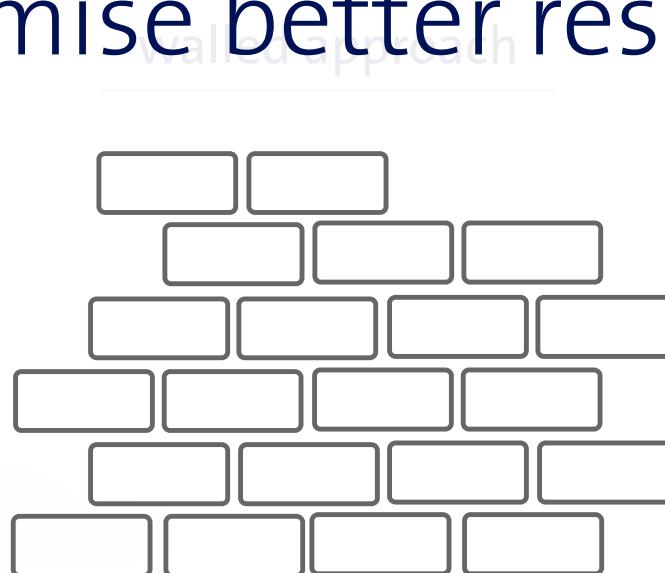
Google

Every day live questions

Ubuntu

General bots answer
General questions

Specialist bots
promise better results

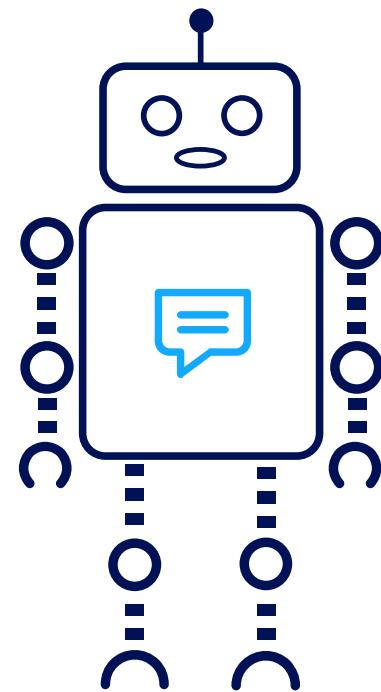


Chat bot types

Retrieval Bots

No new content.
Select the best existing reply.

I retrieve
the best
answer.



I create
a new
answer

Generative Bots

Never-before seen answers,
based on question and existing
conversations.

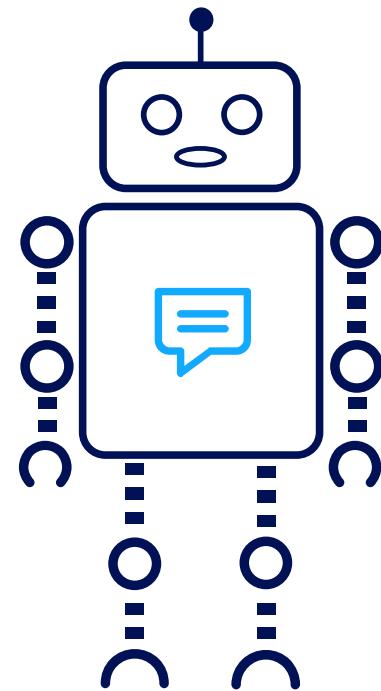
Retrieval bots

1. User message

“How do I kill a process”

2. Context

3. Responses



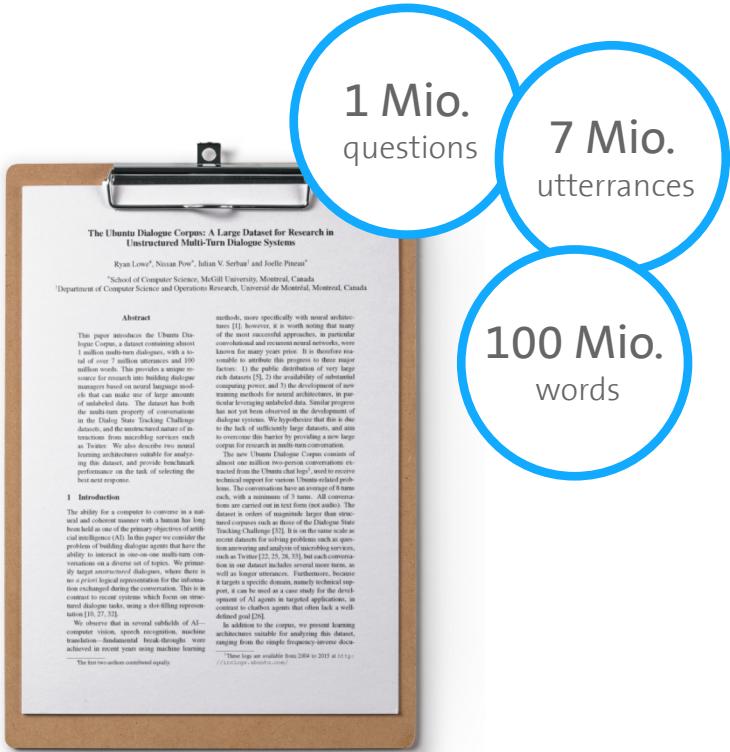
I retrieve
the best
answer.

“start with: man kill”

Three measures to retrieve
the answers:

- Traditional IR: Inverted Index
- Neural reranking
- Database access bots

Ubuntu Dialog Corpus



Ubuntu Statistics



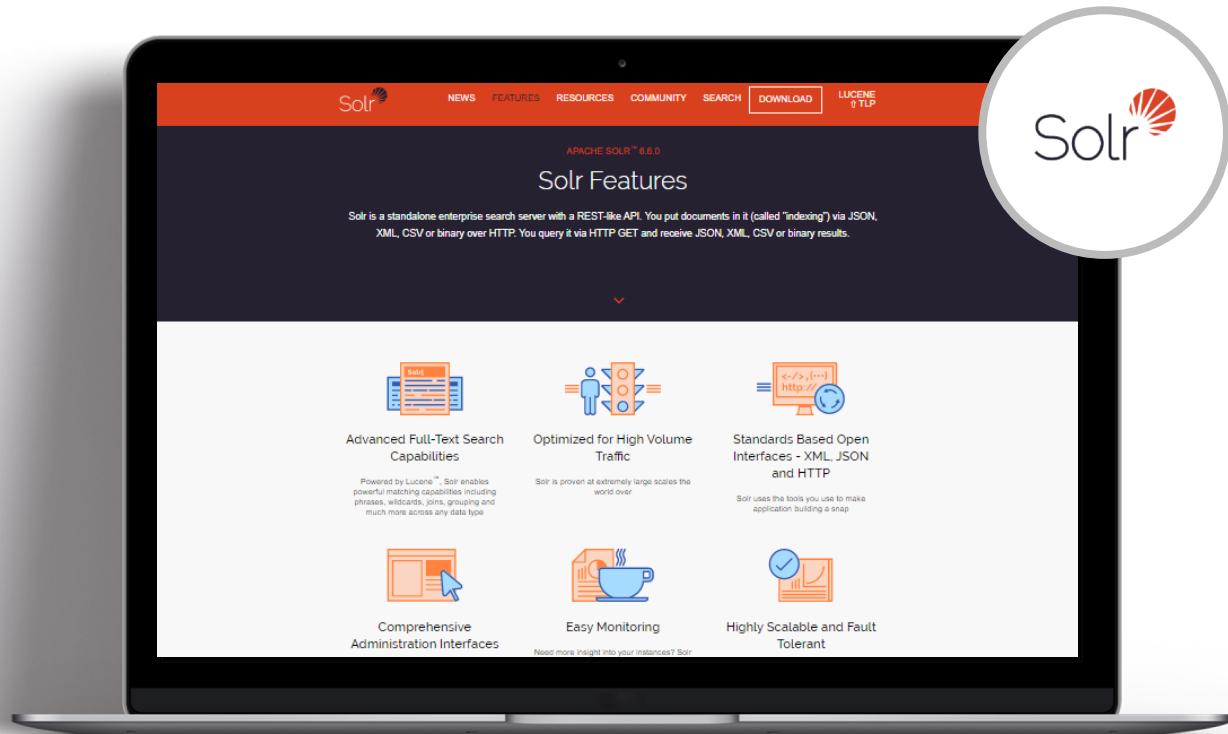
Sample Questions



Human Dialogs

Lowe et al., 2015

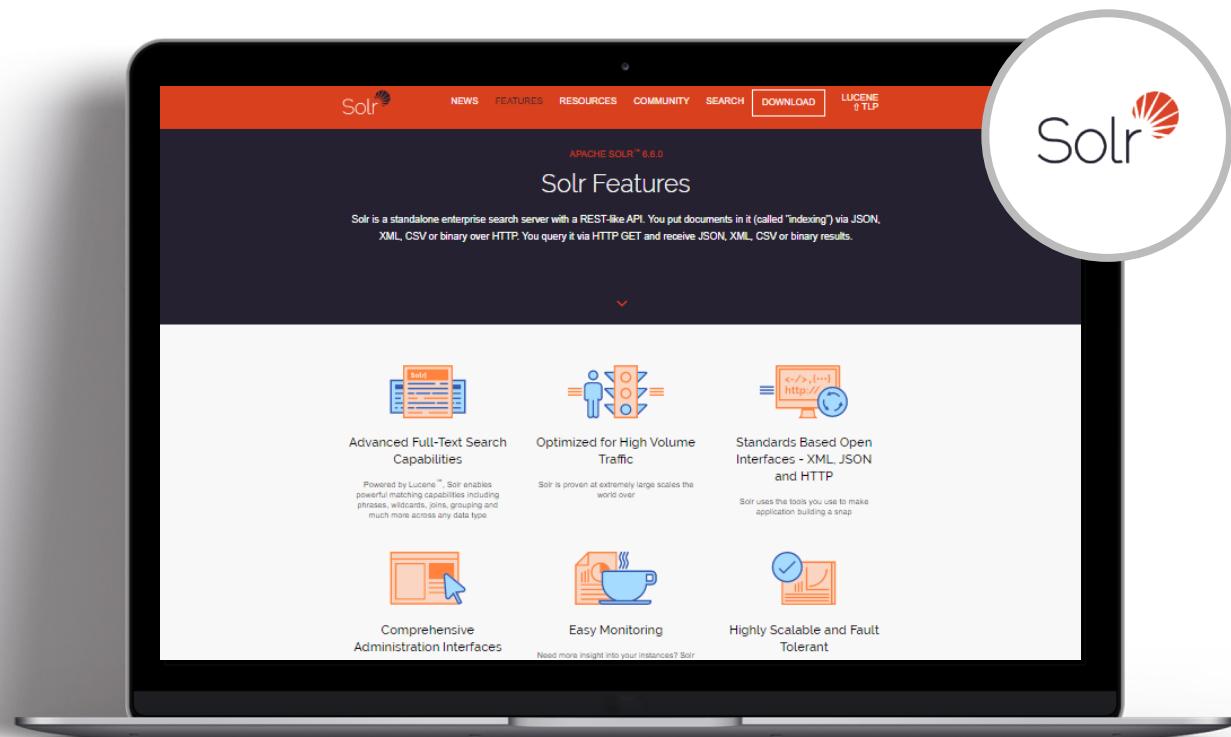
Baseline – Inverted index



Inverted Index

Apache Solr is an open source search platform. Idea: search for the closest question in the existing data and output the answer.

Baseline – Inverted index



Example

Bots:
 $\{1,2\}$

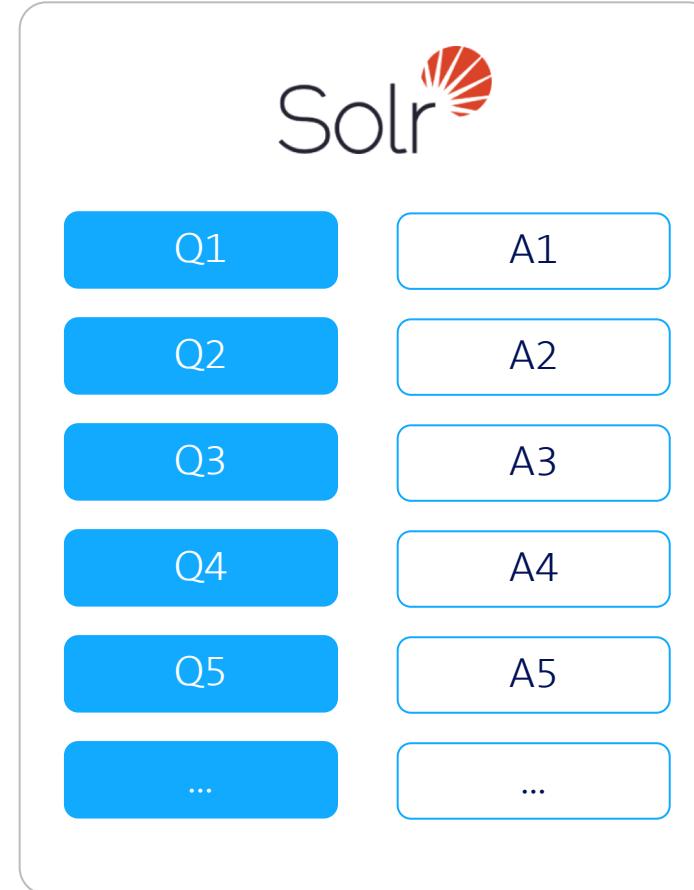
-  I am now studying Solr in the context of bots.
-  Bots can also be generative.
-  I need a coffee.

Baseline – Inverted index



User Query

“What is the command
to remove a file?”

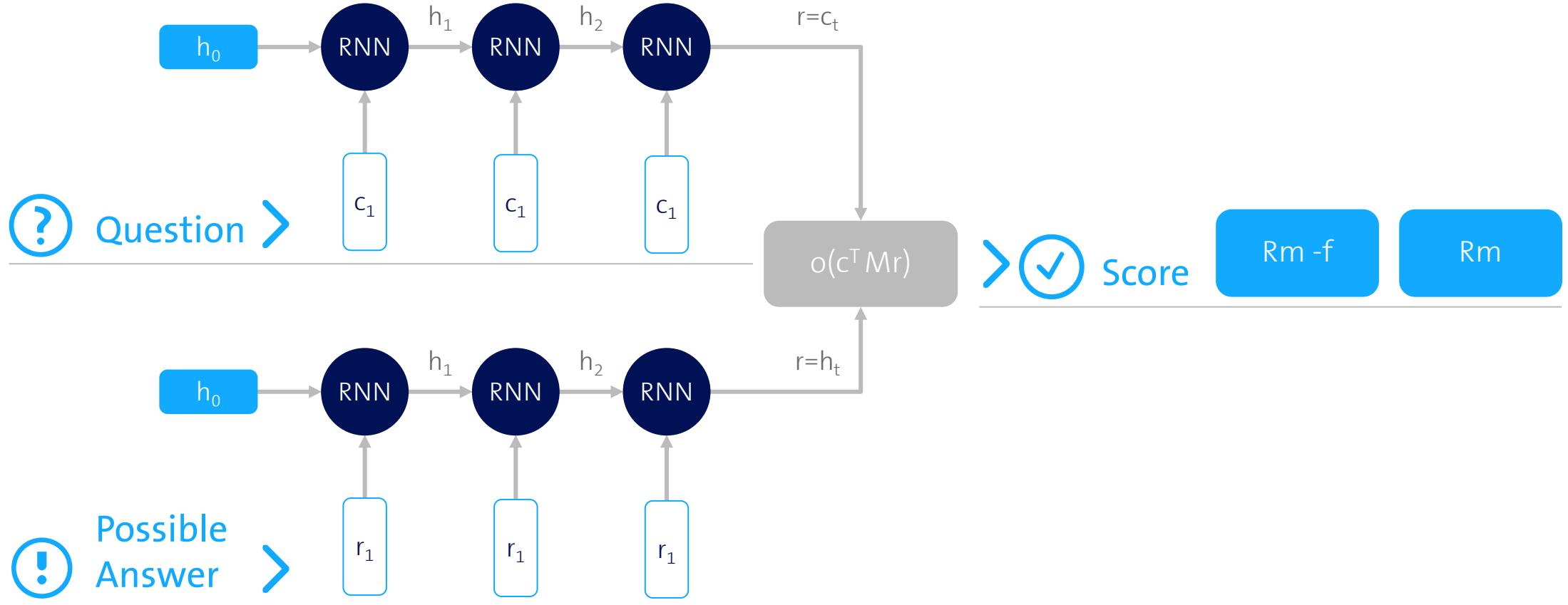


What is the rm-rf
remove command?

rm-rf foldername

rmdir

Dual Encoder



Kadlec et al., 2015

AI if it's in Powerpoint

ML if it's in Python

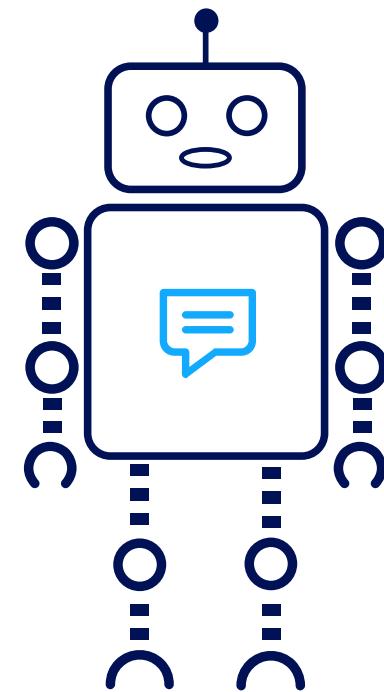


Generative Bots

1. User message

“How do I remove a file”

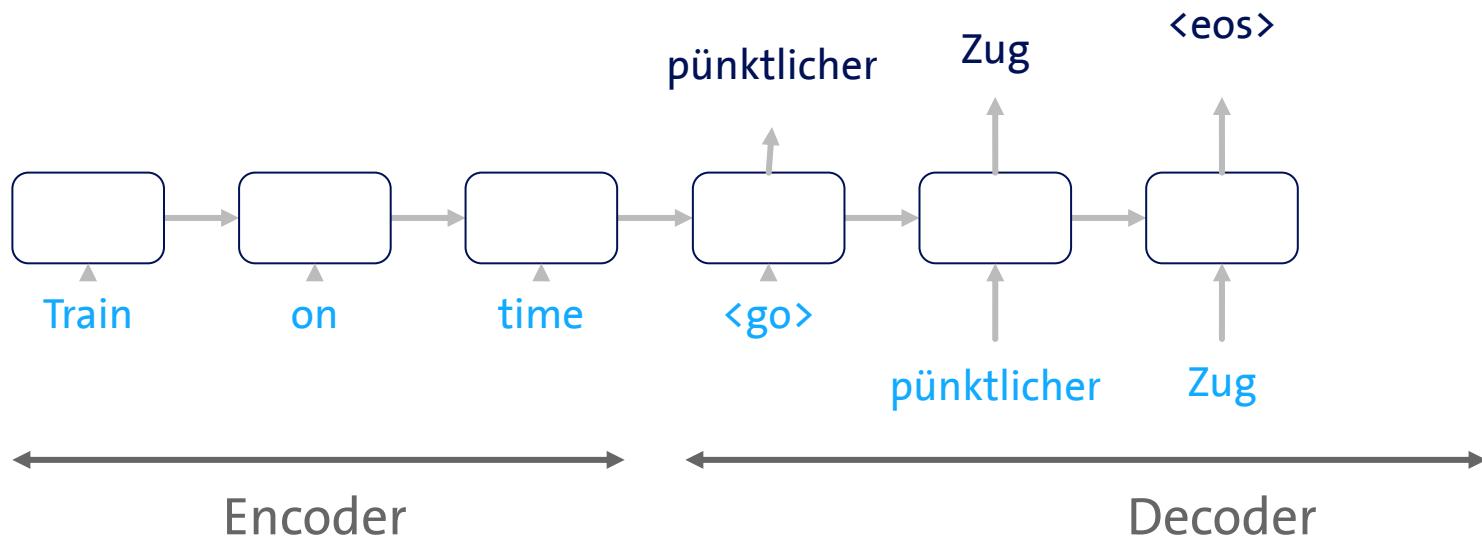
2. Training Data



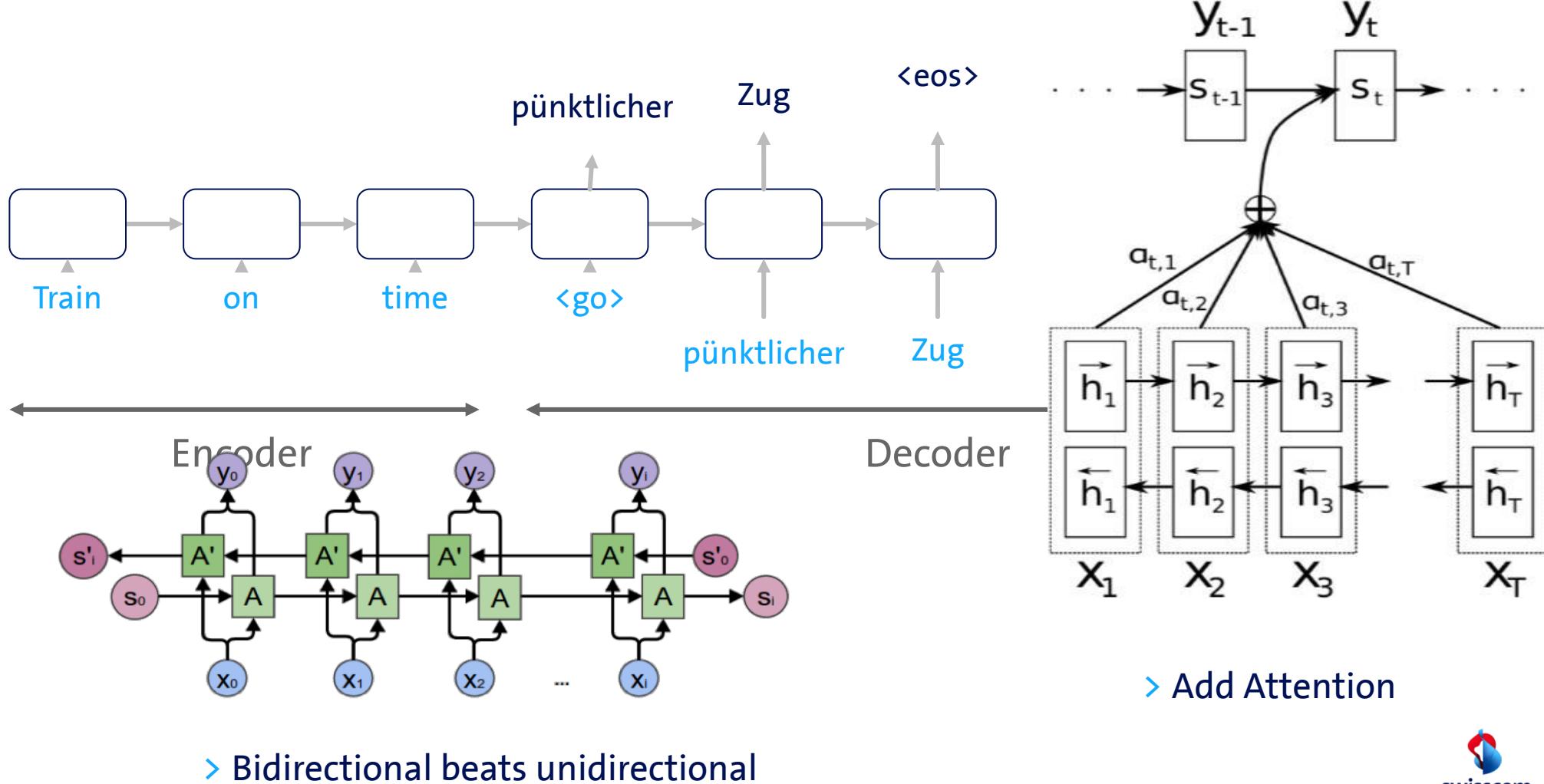
I create
a new
answer.

“rm”

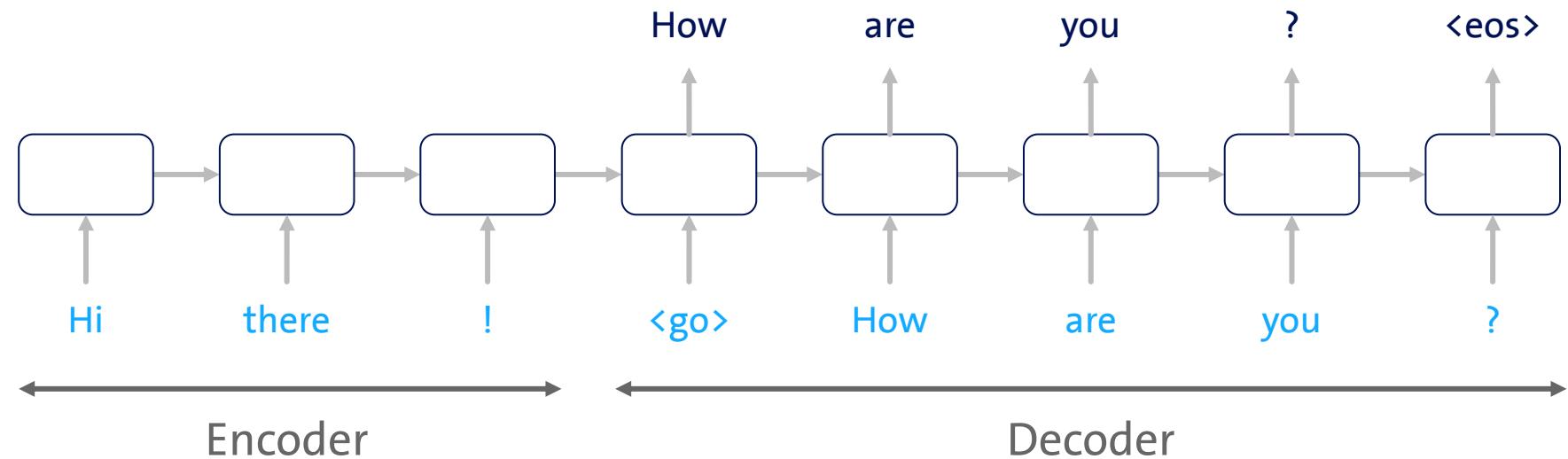
Machine Translation: Basic Encoder Decoder



Encoder Decoder Enhancements



Single Turn Generation: Basic Encoder Decoder



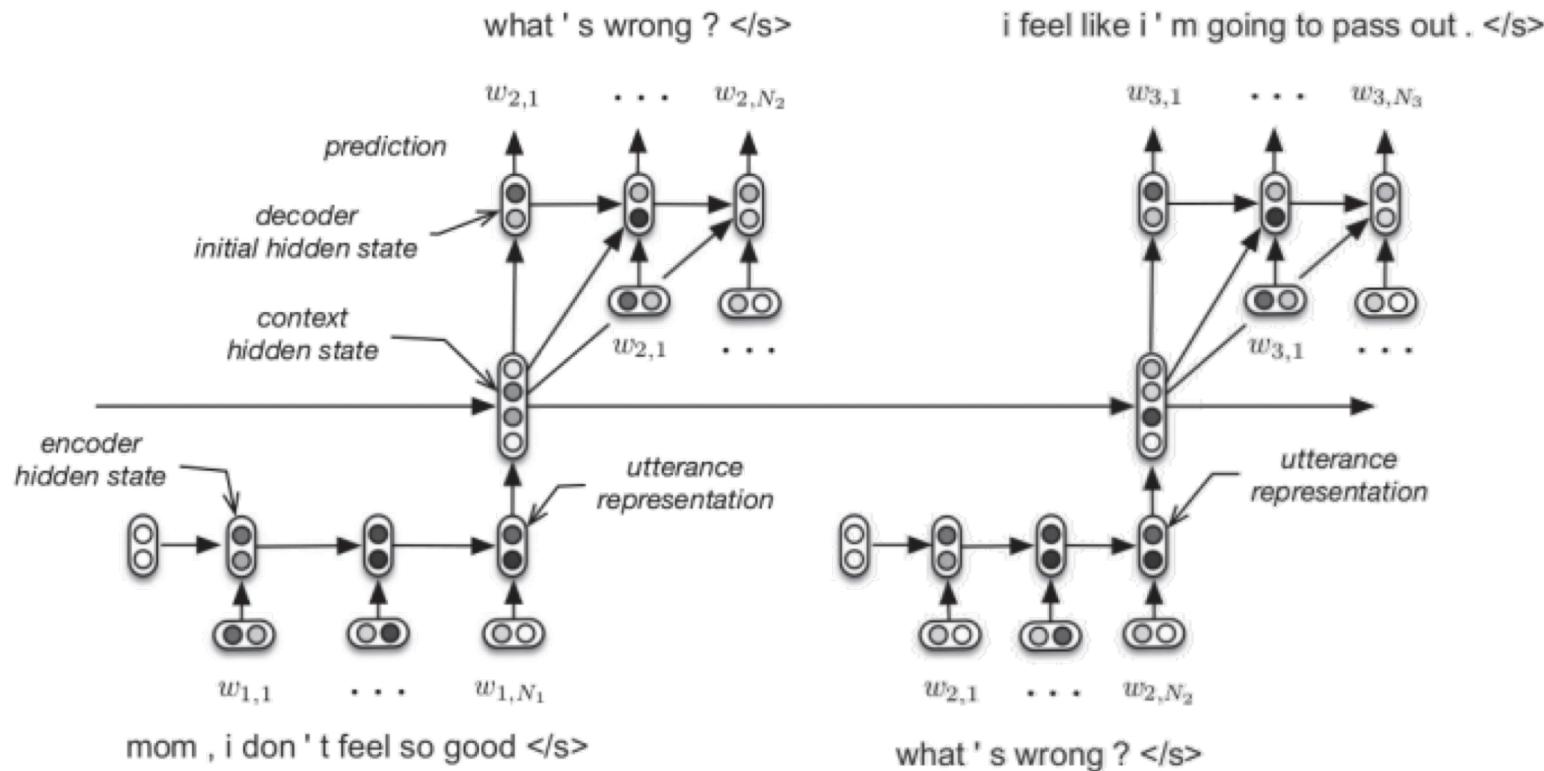
“What is the command to remove a file?”

rm

“Why can’t I see my sound card?”

I have a soundblaster audigy

Multi-turn Dialogue – Keep the Context



- › Language is represented as a hierarchy
- › Hierarchical recurrent encoder-decoder, HRED [Serban et al., AAAI'16] – keeps the content as a hidden state

The Limits of Contextual Simplicity

message Where do you live now?

response I live in Los Angeles.

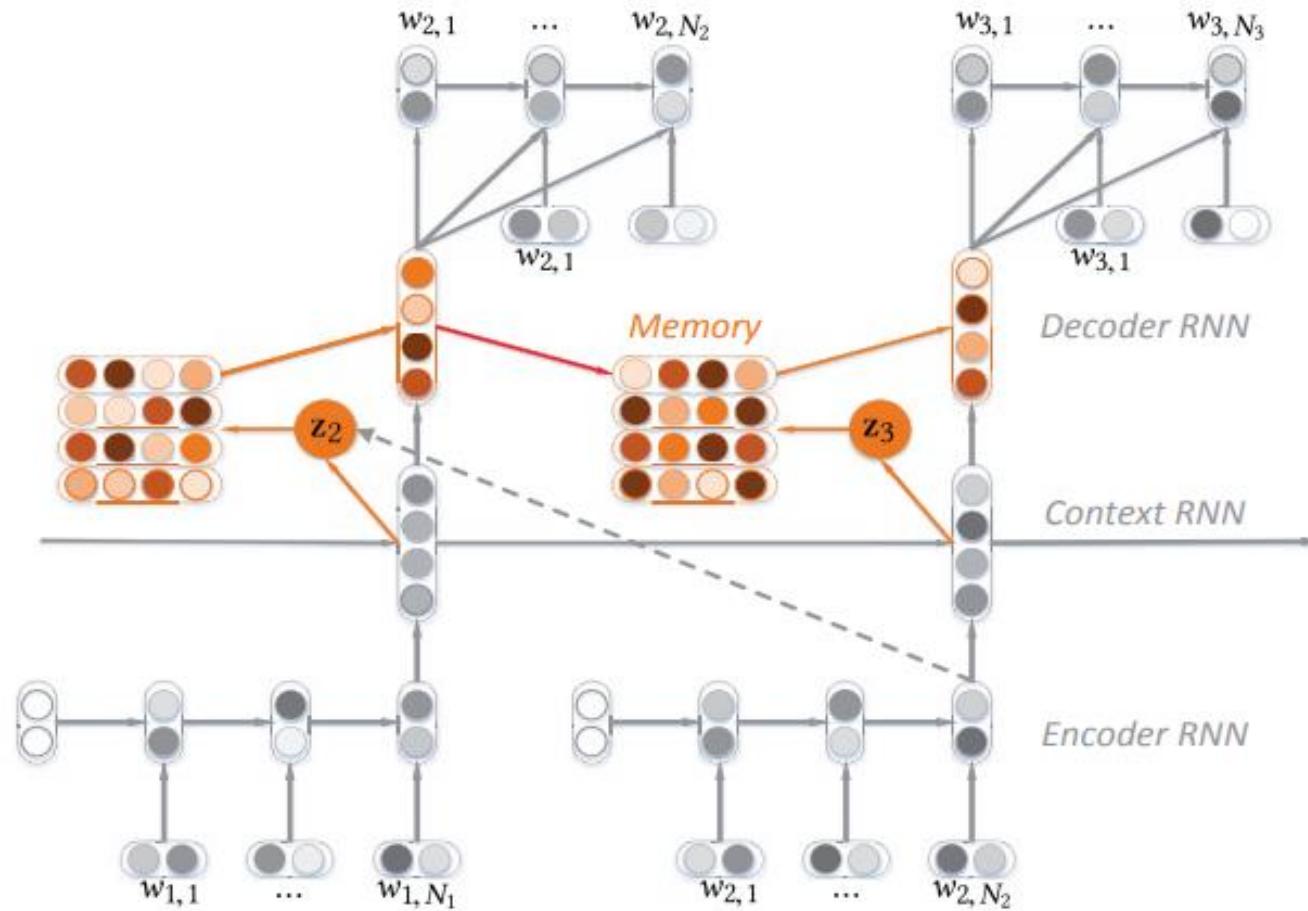
message In which city do you live now?

response I live in Madrid.

message In which country do you live now?

response England, you?

Memory



- Hierarchical Variational Memory Network for Dialogue Generation. In WWW'18.

Mixed Models



Which Arsenal player has a salary of 12 345 600 dollars?

Which players are Spanish?

Mixed Model

Which players are spanish?

A solution is to train a model that learns a program from a user query and by performing that program we get the right result from the table.

Player	Nationality	Team	Titles	Age	Salary	Position	Matches	Goals	Assists	Red Cards
Iker Casillas	Spain	FC Porto	3	36	7.500.000 €	Goalkeeper	164	0	0	0
Cristiano Ronaldo	Portugal	Real Madrid CF	4	32	32.000.000 €	Forward	140	105	31	0
Andres Iniesta	Spain	FC Barcelona	4	33	14.000.000 €	Midfield	122	11	16	0
Zlatan Ibrahimovic	Sweden	Manchester United	0	35	12.000.000 €	Forward	119	48	22	4
Leo Messi	Argentina	FC Barcelona	4	30	40.000.000 €	Forward	115	94	24	0
Petr Cech	Czech Republic	FC Arsenal	1	35	7.000.000 €	Goalkeeper	111	0	0	0
Gianluigi Buffon	Italy	Juventus FC	0	39	4.000.000 €	Goalkeeper	108	0	0	0
Sergio Ramos	Spain	Real Madrid CF	3	31	10.000.000 €	Defender	103	10	6	3

Neural Programmer, Neelakantan et al. 2016

Retrieving from Databases



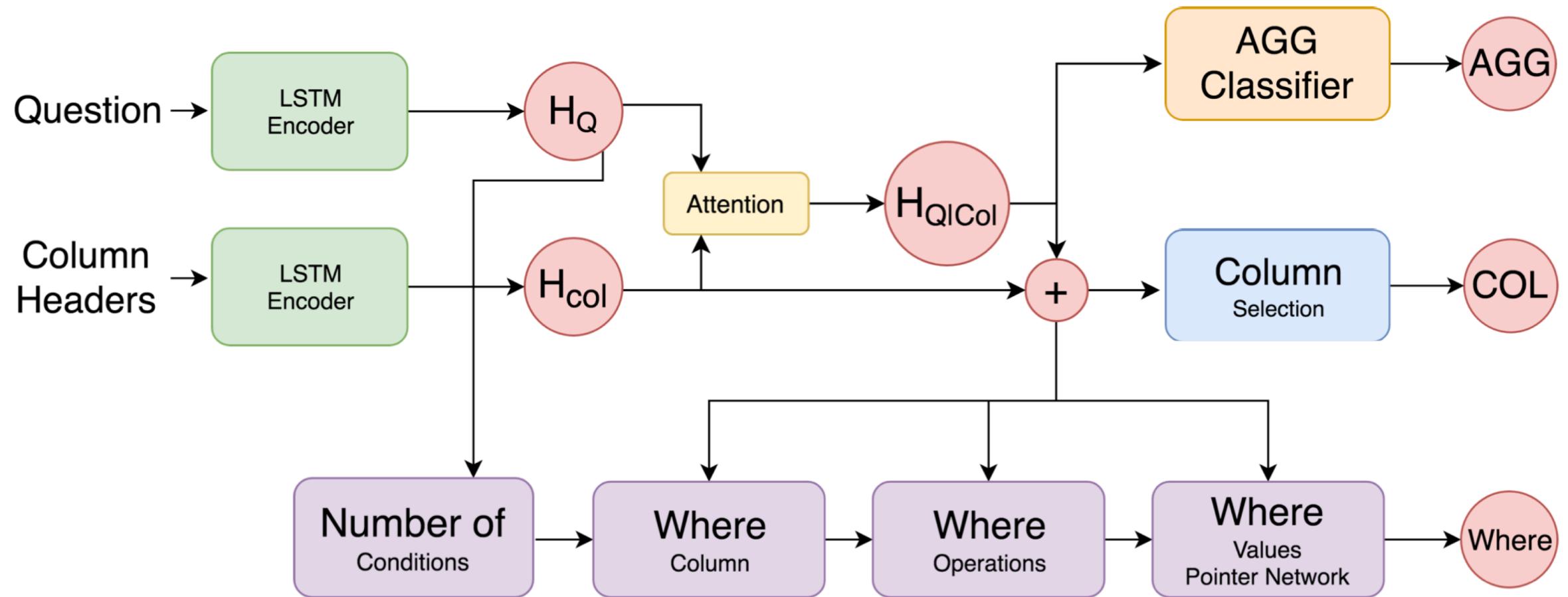
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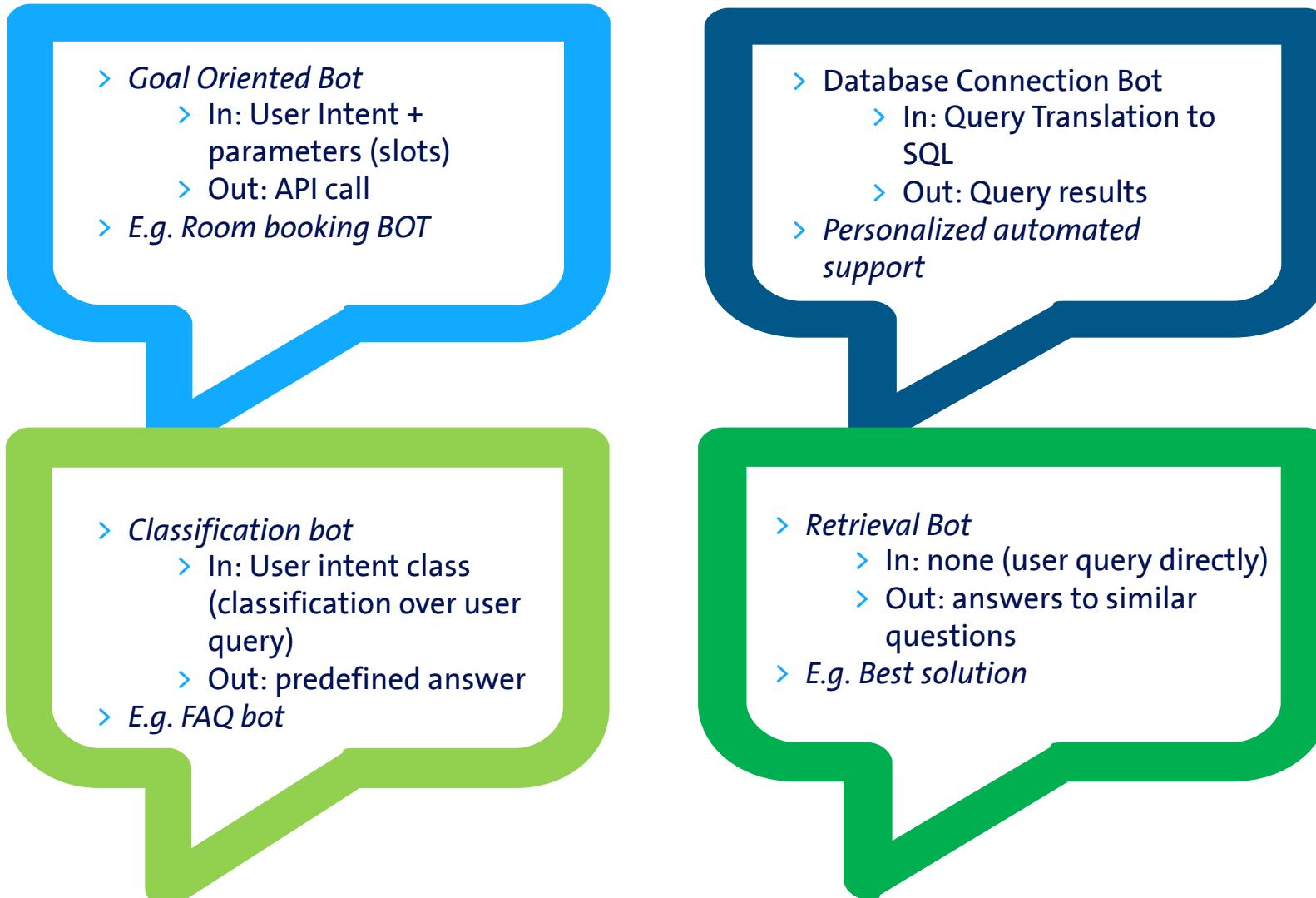
SQLNet



Difficulty overview

Retrieval Bot Versatility Map

> User understanding (in)
complexity

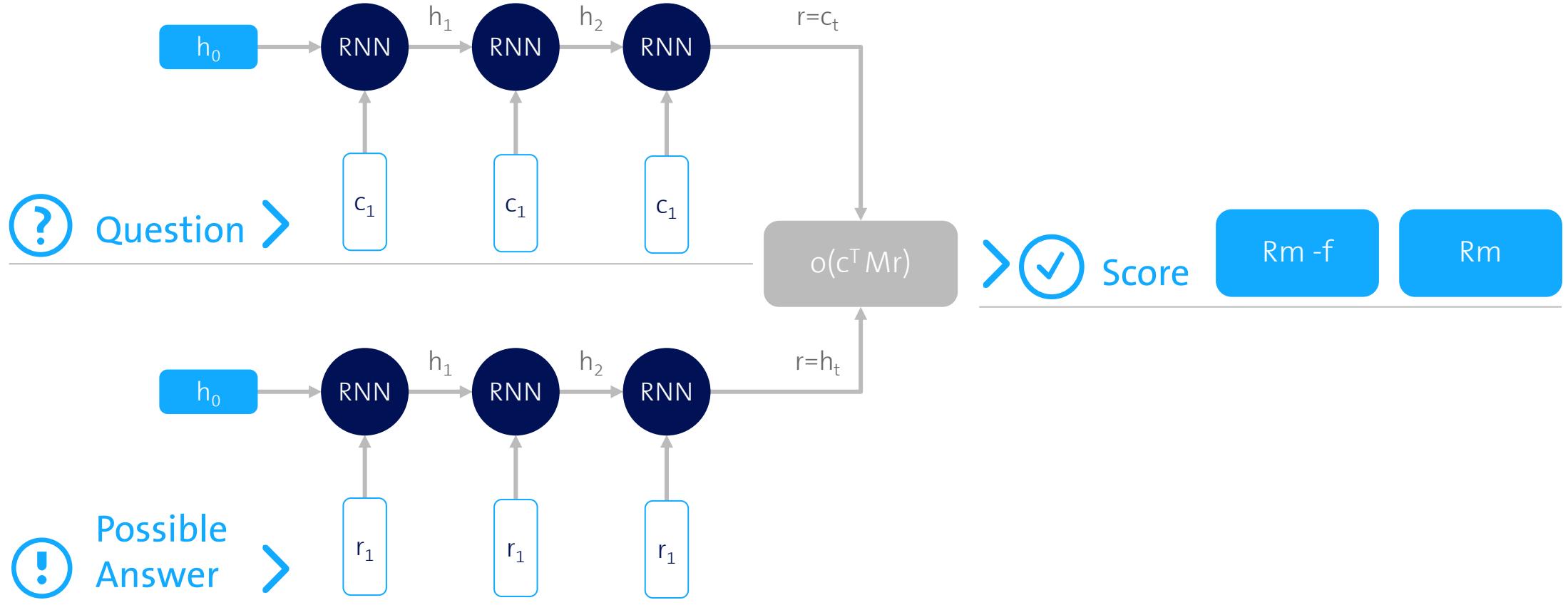


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