

Chatbots

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O que são?

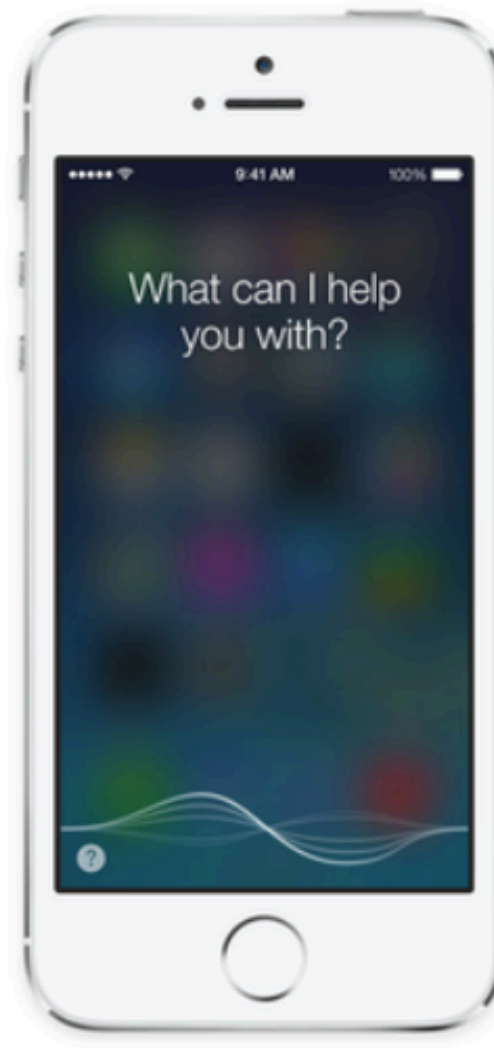
- Sistemas interativos
- Uso de linguagem natural
- Entrada: texto ou fala
- Saída: texto ou fala

Histórico

- Confunde-se com a história de IA
- 1950-60: Turing e Weizenbaum
 - Computadores se comunicando como humanos
- 1966: Eliza (Weizenbaum)
- 1980-2000: projetos da DARPA
 - Comunicação automática com soldados
 - Serviço de FAQ

Exemplos

- Siri
- Alexa
- Cortana
- Google Assistant



Dois tipos de Agentes Conversacionais

- Agentes baseados em objetivo:
 - Conversas curtas
 - Realização de uma tarefa
 - Ex: reserva de hotéis ou restaurantes
- Bate-papo:
 - Conversas mais longas
 - Mais próximo à interação humana (mais natural)
 - Ex: ELISA

Propriedades da Conversação Humana

C₁: ... I need to travel in May.
A₂: And, what day in May did you want to travel?
C₃: OK uh I need to be there for a meeting that's from the 12th to the 15th.
A₄: And you're flying into what city?
C₅: Seattle.
A₆: And what time would you like to leave Pittsburgh?
C₇: Uh hmm I don't think there's many options for non-stop.
A₈: Right. There's three non-stops today.
C₉: What are they?
A₁₀: The first one departs PGH at 10:00am arrives Seattle at 12:05 their time.
The second flight departs PGH at 5:55pm, arrives Seattle at 8pm. And the
last flight departs PGH at 8:15pm arrives Seattle at 10:28pm.
C₁₁: OK I'll take the 5ish flight on the night before on the 11th.
A₁₂: On the 11th? OK. Departing at 5:55pm arrives Seattle at 8pm, U.S. Air
flight 115.
C₁₃: OK.
A₁₄: And you said returning on May 15th?
C₁₅: Uh, yeah, at the end of the day.
A₁₆: OK. There's #two non-stops ... #
C₁₇: #Act... actually #, what day of the week is the 15th?
A₁₈: It's a Friday.
C₁₉: Uh hmm. I would consider staying there an extra day til Sunday.
A₂₀: OK... OK. On Sunday I have ...

Conversa entre uma pessoa e um agente de viagem

Propriedades da Conversação Humana

- Turns:
 - Cada indivíduo tem a palavra de tempos em tempos
 - Diálogo é uma sequência de turns
- Sistema precisa saber quando falar (ex.: não esperar muito tempo depois que a pessoa terminou de falar)
- Sistema precisa saber quando a pessoa terminou de falar (desafios: ruído e pausas no meio da fala)

Atos de Fala

- Constativa: comprometer o orador com alguma condição
 - Responder, confirmar, negar, não concordar
- Diretiva: tentativa do orador de ser atendido
 - Aconselhar, perguntar, pedir, convidar
- Comissiva: comprometer o orador com algo futuro
 - Prometer, planejar
- Reconhecimento: expressar reconhecimento sobre alguma atitude
 - Desculpar, agradecer, cumprimentar

- Diretiva — C₁: ...I need to travel in May.
 A₂→ And, what day in May did you want to travel?
 C₃: OK uh I need to be there for a meeting that's from the 12th to the 15th.
 A₄: And you're flying into what city?
 C₅: Seattle.
 A₆: And what time would you like to leave Pittsburgh?
- Constativa — C₇→ Uh hmm I don't think there's many options for non-stop.
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 C₁₁: OK I'll take the 5ish flight on the night before on the 11th.
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 flight 115.
- Constativa — C₁₃→ OK.
 A₁₄: And you said returning on May 15th?
 C₁₅: Uh, yeah, at the end of the day.
 A₁₆: OK. There's #two non-stops ... #
 C₁₇: #Act... actually #, what day of the week is the 15th?
 A₁₈: It's a Friday.
 C₁₉: Uh hmm. I would consider staying there an extra day til Sunday.
 A₂₀: OK...OK. On Sunday I have ...

Grounding



Grounding

- Indicar que o ouvinte compreendeu o que foi dito

A: And you said returning on May 15th?

C: Uh, yeah, at the end of the day.

A: **OK**

C: OK I'll take the 5ish flight on the night before on the 11th.

A: **On the 11th? OK.**

C: ...I need to travel in May.

A: **And**, what day **in May** did you want to travel?

Sub-Diálogos: Correção

Agent: ... OK. There's #two non-stops#

Client: #Act. . . actually#, what day of the week is the 15th?

Agent: It's a Friday.

Client: Uh hmm. I would consider staying there an extra day til Sunday.

Agent: OK...OK. On Sunday I have ...

Sub-Diálogos: Clarificação

User: What do you have going to
UNKNOWN_WORD
on the 5th?

System: Let's see, going where on the
5th?

User: Going to Hong Kong.

System: OK, here are some flights...

Pré-sequências

User: Can you make train reservations?

System: Yes I can.

User: Great, I'd like to reserve a seat on the 4pm train to New York.

Iniciativa do Diálogo

- Controlada por uma pessoa
 - Ex: Entrevista
- Mixed
 - Conversa natural entre pessoas
 - Difícil para sistemas de PLN
 - Iniciativa do usuário: pergunta ou fala comandos
 - Iniciativa do sistema: sistema faz perguntas para preencher formulário

Chatbot: Bate-Papo

- Originalmente utilizado na área de psicologia
- Baseado em regras
 - Eliza, Parry
- Baseado em corpus (corpus de conversações)
 - Recuperação de Informação
 - Neural network encoder-decoder
 - Ex: BlenderBot, Xiaolce (Little Bing)

BlenderBot

Will you sing me a song?

Sure, what do you want to be sung to? I can sing you a song about baking.

Yes, sing me a song about baking!

Do you want me to sign it to the tune of "Sing Along with Mitch"?

Yes, I would love that.

OK, I'll try to get it to you by the end of the day. What else do you like to do?

No, sing it to me now!

OK, give me a few days. I'm a teacher, so I don't have much free time.

Can you at least tell me what the lyrics are?

Sure, it goes like this: "Baking is my favorite thing to do in the world."

How does the chorus go?

It goes: BAKING IS MY FAVORITE THING TO DO IN THE WORLD!

Wow, sounds like a bop.

I know, right? It's so catchy. I can't get it out of my head.

Chatbot: Bate-Papo

- Clássico:
 - Eliza (1966)
 - Parry (1968):
 - Usado para estudar esquizofrenia
 - Primeiro sistema a passar no teste de Turing
 - Estados de medo e raiva
 - Psiquiatras não conseguiram diferenciar transcripts de entrevistas reais com as produzidas por ele

Eliza: Weizenbaum (1966)

Men are all alike.

IN WHAT WAY?

They're always bugging us about something or other.

CAN YOU THINK OF A SPECIFIC EXAMPLE?

Well, my boyfriend made me come here.

YOUR BOYFRIEND MADE YOU COME HERE?

He says I'm depressed much of the time.

I AM SORRY TO HEAR YOU ARE DEPRESSED

...

WHO ELSE IN YOUR FAMILY TAKES CARE OF YOU?

My father

YOUR FATHER

Eliza: Weizenbaum (1966)

You are like my father in some ways.
WHAT RESEMBLANCE DO YOU SEE?

You are not very aggressive but I think you don't want me to notice that.
WHAT MAKES YOU THINK I AM NOT AGGRESSIVE?

You don't argue with me.
WHY DO YOU THINK I DON'T ARGUE WITH YOU?

You are afraid of me.
DOES IT PLEASE YOU TO BELIEVE I'M AFRAID OF YOU?

My father is afraid of everybody.
WHAT ELSE COMES TO MIND WHEN YOU THINK OF YOUR FATHER?

Bullies.
DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT YOUR BOYFRIEND MADE YOU COME HERE?

Como funciona?

- Rogerian psychologist
- Estimula o paciente a falar refletindo suas frases de volta a ele
- Não conhece quase nada sobre o mundo real
- Objetivo é de continuar o diálogo

Patient: "I went for a long boat ride"

Psychiatrist: "Tell me about boats"

Exemplo de Regra

- (0 YOU 0 ME)[padrão] ->
- (WHAT MAKES YOU THINK I 3 YOU) [*regra*]

You hate me

WHAT MAKES YOU THINK I HATE YOU

Regras

- Regras ligadas a palavras que ocorrem na sentença
- Palavras associadas a um ranking
- Palavras mais específicas maior o ranking

User: I know everybody laughed at me

Resposta com "I"

YOU SAY YOU KNOW EVERYBODY LAUGHED AT YOU

Resposta com "everybody" (mais específica)

WHO IN PARTICULAR ARE YOU THINKING OF?

Sem Casamento de Keyword

PLEASE GO ON
THAT'S VERY INTERESTING
I SEE

Memória

- Armazena conversas passadas e as usa quando nenhuma keyword dá match
- Frases com “my”

```
(MEMORY MY  
  (0 MY 0 = LETS DISCUSS FURTHER WHY YOUR 3)  
  (0 MY 0 = EARLIER YOU SAID YOUR 3)  
  (0 MY 0 = DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT  
YOUR 3))
```

Implicações Éticas

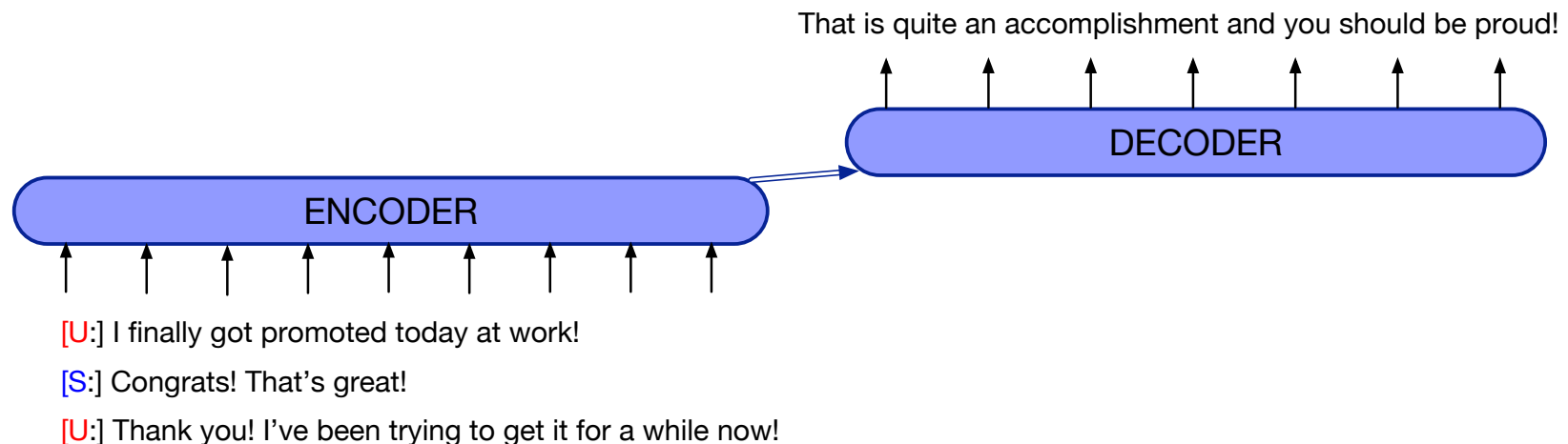
- As pessoas ficarem emocionalmente envolvidas com o programa
- Alguns pediram pra ficar a sós com o bot
- Usuários não queriam que os diálogos fossem logados -> diálogos bem pessoais

Chatbots Baseado em Corpus

- Usa corpus com conversações ao invés de regras
- Corpus: conversas naturais
 - Ex: ligações telefônicas, diálogo de filmes, tweets, reddit
- Criadas usando crowdsourcing
 - Topical-Chat dataset (11k conversas em 8 tópicos)
 - EMPATHETICDIALOGUES: 25k conversas focado em emoções
- Extrair fatos do Wikipedia ou notícias

Duas Estratégias

- By retrieval
 - Usa recuperação de informação para obter resposta no corpus
- By generation
 - Usa language model ou encoder-decoder para gerar a resposta
 - GPT3 Demo: <https://www.youtube.com/watch?v=V-M5SVta2uw>



Limitação

- Podem ser repetitivos e monótonos

A: Where are you going?

B: I'm going to the restroom.

A: See you later.

B: See you later.

A: See you later.

B: See you later.

A: How old are you?

B: I'm 16.

A: 16?

B: I don't know what you are talking about.

A: You don't know what you are saying.

B: I don't know what you are talking about.

A: You don't know what you are saying.

Arquiteturas Híbridas

- Baseado em regras, corpus e baseado em frames

#	Utterance	Entity	Commentary
1	User: let's chat Bot: Hi, this is an Alexa Prize Socialbot. I'd love to get to know you a bit better before we chat! Is it all right if I ask for your name? [Launch]	None None	Launch gives <i>FORCE_START</i> response to begin the conversation.
2	User: my name is chris Bot: Well it's nice to meet you, Chris! I'm excited to chat with you today. [Launch] I hope your afternoon is going well. What are your plans for the rest of today? [Neural Chat]	None None	Launch gives a <i>STRONG_CONTINUE</i> response that needs a prompt, which is supplied by Neural Chat with <i>FORCE_START</i> priority (scripted transition).
3	User: hang out with my friends Bot: That sounds great, I love spending time with friends. What will you do together? [Neural Chat]	None None	Neural Chat generates a GPT-2 response with <i>STRONG_CONTINUE</i> priority.
4	User: maybe watch a movie Bot: Me too! I love watching movies; I get to learn so much about what the world is like outside of the cloud! Have you seen any movies recently? [Movies]	None Film	Movies detects the 'movie' keyword in the user's utterance and gives a <i>FORCE_START</i> response (overriding Neural Chat), setting current entity to <i>Film</i> .
5	User: i saw the matrix Bot: Nice! Did you like The Matrix? [Movies]	The Matrix The Matrix	The Entity Linker and Entity Tracker identify <i>The Matrix</i> as the current entity.
6	User: i loved it neo is amazing Bot: Oooh, yeah, I agree. Hey, isn't Keanu Reeves in that movie? What do you think about Keanu Reeves? [Movies]	The Matrix Keanu Reeves	Movies sets current entity to <i>Keanu Reeves</i> .
7	User: i want to talk about something else	None	Navigational Intent detects <i>negative intent</i> , so Entity Tracker rejects the current entity.

Em Resumo

- Pros:
 - Divertido
 - Bom para aplicações específicas e bem estruturadas (regras)
- Limitações:
 - Não compreendem
 - Chatbots baseados em regras são custosos pra construir
 - Baseado em RI: depende muito da qualidade do corpus
- Ideal: combinar chatbots com agentes baseados em objetivo

Baseado em Tarefa

- Objetivo de resolver uma tarefa para um usuário: reservar um voo ou comprar um produto
- Arquitetura GUS
 - Criada em 1977
 - Usada pelos assistentes virtuais atuais
 - Baseada em frames

GUS: Hello. My name is GUS. I can help you plan a simple trip by air. Where do you want to go ?

Client: I want to go to San Diego on May 28

GUS: What time do you want to leave?

Client: I must be in San Diego before 10 am

GUS: Would you like P.S.A. flight 102 that arrives at 9.15 am ?

Client: What is the next flight ?

GUS: Air California flight 310 that leaves at 8.30am and arrives at 10.00am

Client: I'll take the first one

GUS: In what name should I make a reservation, please?

Client: Dan Bobrow

GUS: I have confirmed the following flight: P.S.A. flight 102 on Wednesday May 28 from San Jose to San Diego that leaves at 7.30 am and arrives at 9.15 am.

GUS: What date do you want to return on ?

Client: On Friday in the evening.

GUS: Would you like the flight that leaves at 7.45 pm ?

Client: That's fine.

GUS: I have confirmed the following flight: P.S.A. flight 307 on Friday May 30 from San Diego to San Jose that leaves at 7.45 pm and arrives at 9.30 pm Thank you for calling. Goodbye

Frame/Template

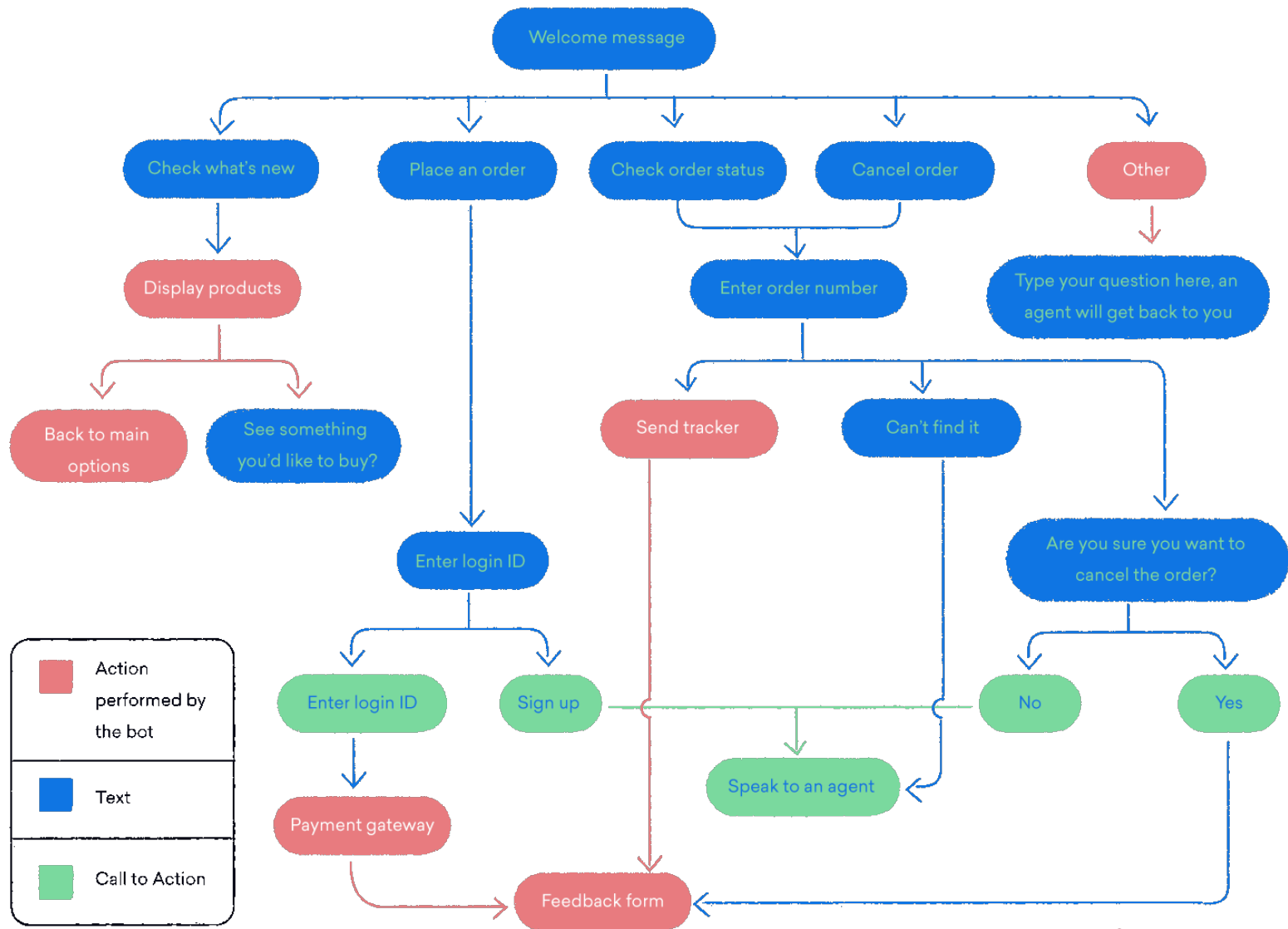
- Conjunto de slots a serem preenchidos na conversação
- Cada frame associado a uma pergunta

Slot	Type	Question Template
ORIGIN CITY	city	“From what city are you leaving?”
DESTINATION CITY	city	“Where are you going?”
DEPARTURE TIME	time	“When would you like to leave?”
DEPARTURE DATE	date	“What day would you like to leave?”
ARRIVAL TIME	time	“When do you want to arrive?”
ARRIVAL DATE	date	“What day would you like to arrive?”

Modos de Funcionamento

- Sistema faz perguntas ao usuário
- Usuário pode preencher vários slots de uma vez
- I want a flight from San Francisco to Denver one way leaving after five p.m. on Tuesday.
- Busca na base após preenchimento do frame

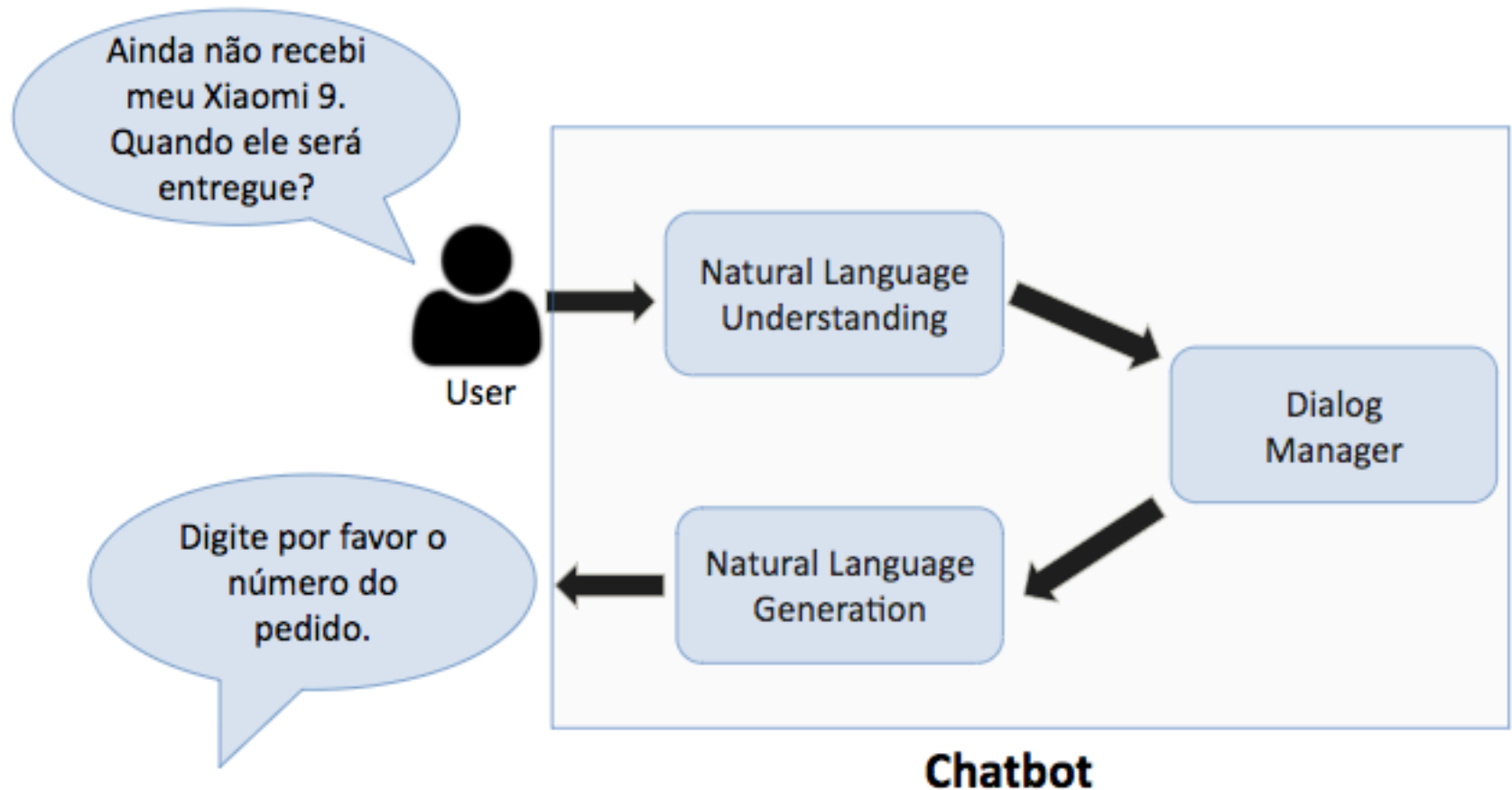
Múltiplos Frames



Fluxo de conversação

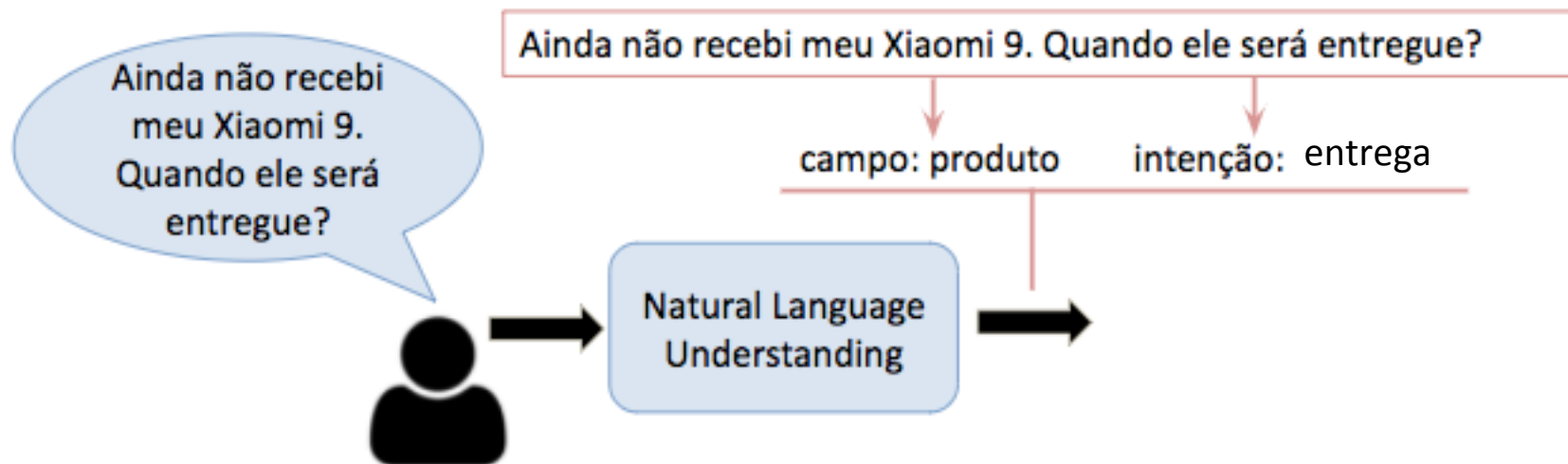
cin.ufpe.br

Arquitetura



Natural Language Understanding

- Classificação do domínio
 - Alarme, transação sobre um produto
- Determinar intenção: qual a tarefa
 - Encontrar um filme, remover um alarme
- Preenchimento dos campos a partir da entrada do usuário



Exemplo

Usuário Wake me tomorrow at six.

DOMAIN: ALARM-CLOCK

INTENT: SET-ALARM

TIME: 2017-07-01 0600-0800

Exemplo

Usuário: show me morning flights
from Boston to SF on Tuesday.

DOMAIN:	AIR-TRAVEL
INTENT:	SHOW-FLIGHTS
ORIGIN-CITY:	Boston
ORIGIN-DATE:	Tuesday
ORIGIN-TIME:	morning
DEST-CITY:	San Francisco

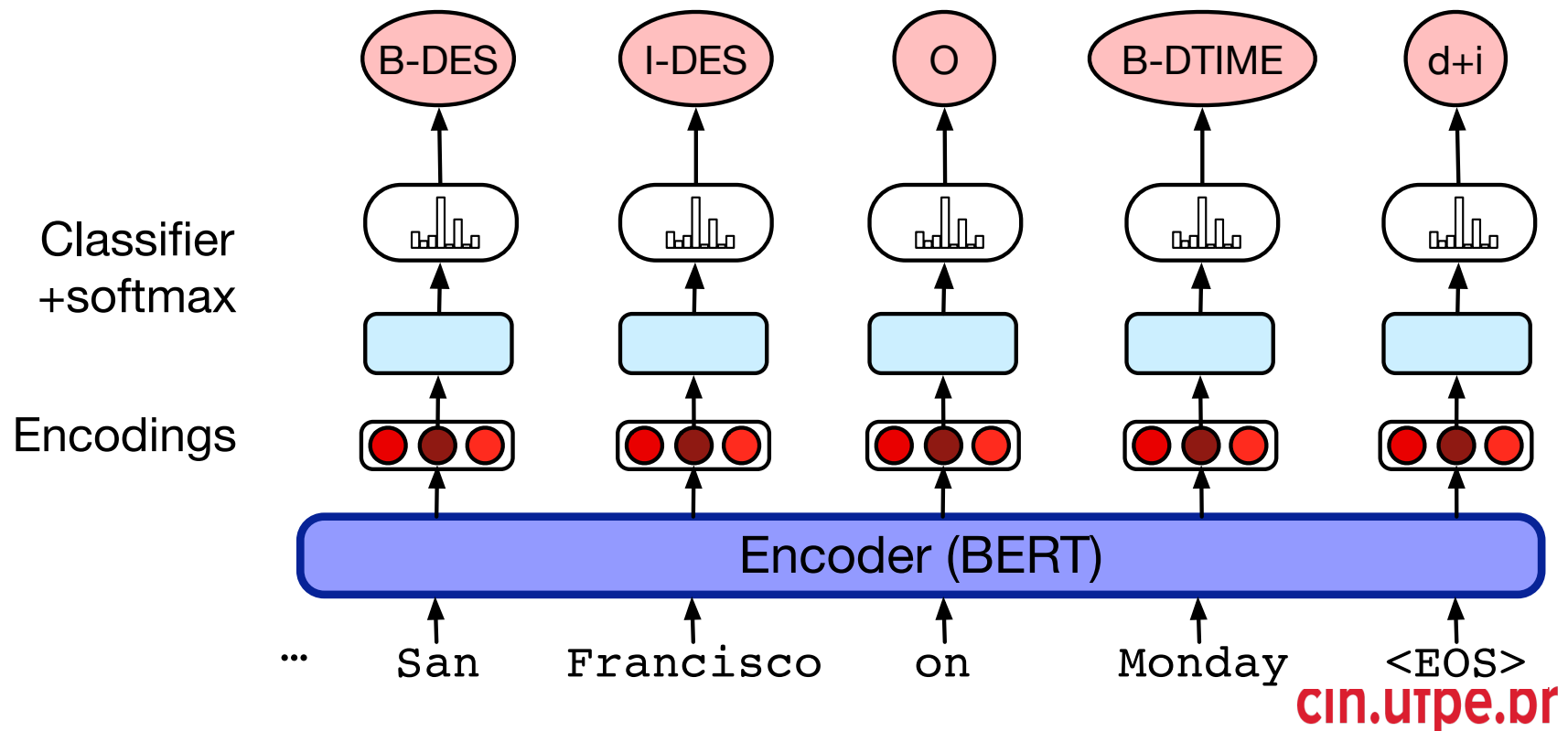
Preenchimento de Campos

- Baseado em regras

SHOW	→ show me i want can i see ...
DEPART_TIME_RANGE	→ (after around before) HOUR morning afternoon evening
HOUR	→ one two three four... twelve (AMPM)
FLIGHTS	→ (a) flight flights
AMPM	→ am pm
ORIGIN	→ from CITY
DESTINATION	→ to CITY
CITY	→ Boston San Francisco Denver Washington

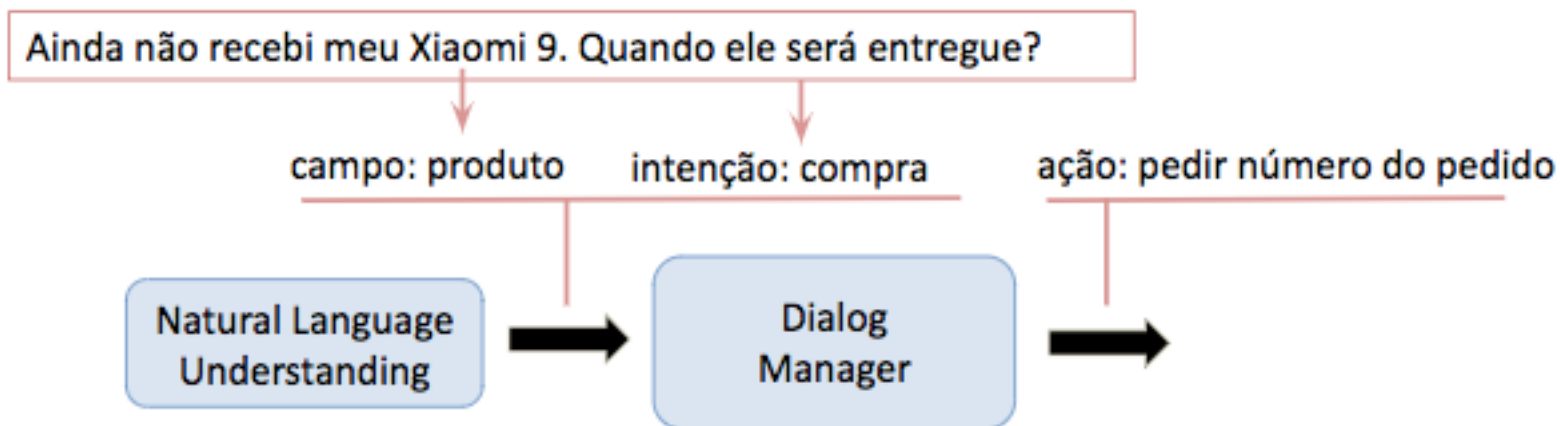
Utilizando Machine Learning

- Classificador para classificação de domínio, intenção e extração dos campos
- Requer dados rotulados



Dialog Manager

- “Cérebro” do sistema
- Identificar o estado atual
- Salva o contexto
- Decide a próxima ação



Atos do Diálogo

- Descrevem os possíveis estados do diálogo

Tag	Sys	User	Description
HELLO($a = x, b = y, \dots$)	✓	✓	Open a dialogue and give info $a = x, b = y, \dots$
INFORM($a = x, b = y, \dots$)	✓	✓	Give info $a = x, b = y, \dots$
REQUEST($a, b = x, \dots$)	✓	✓	Request value for a given $b = x, \dots$
REQALTS($a = x, \dots$)	✗	✓	Request alternative with $a = x, \dots$
CONFIRM($a = x, b = y, \dots$)	✓	✓	Explicitly confirm $a = x, b = y, \dots$
CONFREQ($a = x, \dots, d$)	✓	✗	Implicitly confirm $a = x, \dots$ and request value of d
SELECT($a = x, a = y$)	✓	✗	Implicitly confirm $a = x, \dots$ and request value of d
AFFIRM($a = x, b = y, \dots$)	✓	✓	Affirm and give further info $a = x, b = y, \dots$
NEGATE($a = x$)	✗	✓	Negate and give corrected value $a = x$
DENY($a = x$)	✗	✓	Deny that $a = x$
BYE()	✓	✓	Close a dialogue

Atos do Diálogo: Exemplo

- Classificador multi-class para identificar a tag baseado no contexto
- Extrator para identificar os slots

Utterance	Dialogue act
U: Hi, I am looking for somewhere to eat.	<code>hello(task = find,type=restaurant)</code>
S: You are looking for a restaurant. What type of food do you like?	<code>confreq(type = restaurant, food)</code>
U: I'd like an Italian somewhere near the museum.	<code>inform(food = Italian, near=museum)</code>
S: Roma is a nice Italian restaurant near the museum.	<code>inform(name = "Roma", type = restaurant, food = Italian, near = museum)</code>
U: Is it reasonably priced?	<code>confirm(pricerange = moderate)</code>
S: Yes, Roma is in the moderate price range.	<code>affirm(name = "Roma", pricerange = moderate)</code>
U: What is the phone number?	<code>request(phone)</code>
S: The number of Roma is 385456.	<code>inform(name = "Roma", phone = "385456")</code>
U: Ok, thank you goodbye.	<code>bye()</code>

Dialogue Policy

- Predizer a próxima ação dada toda a conversa

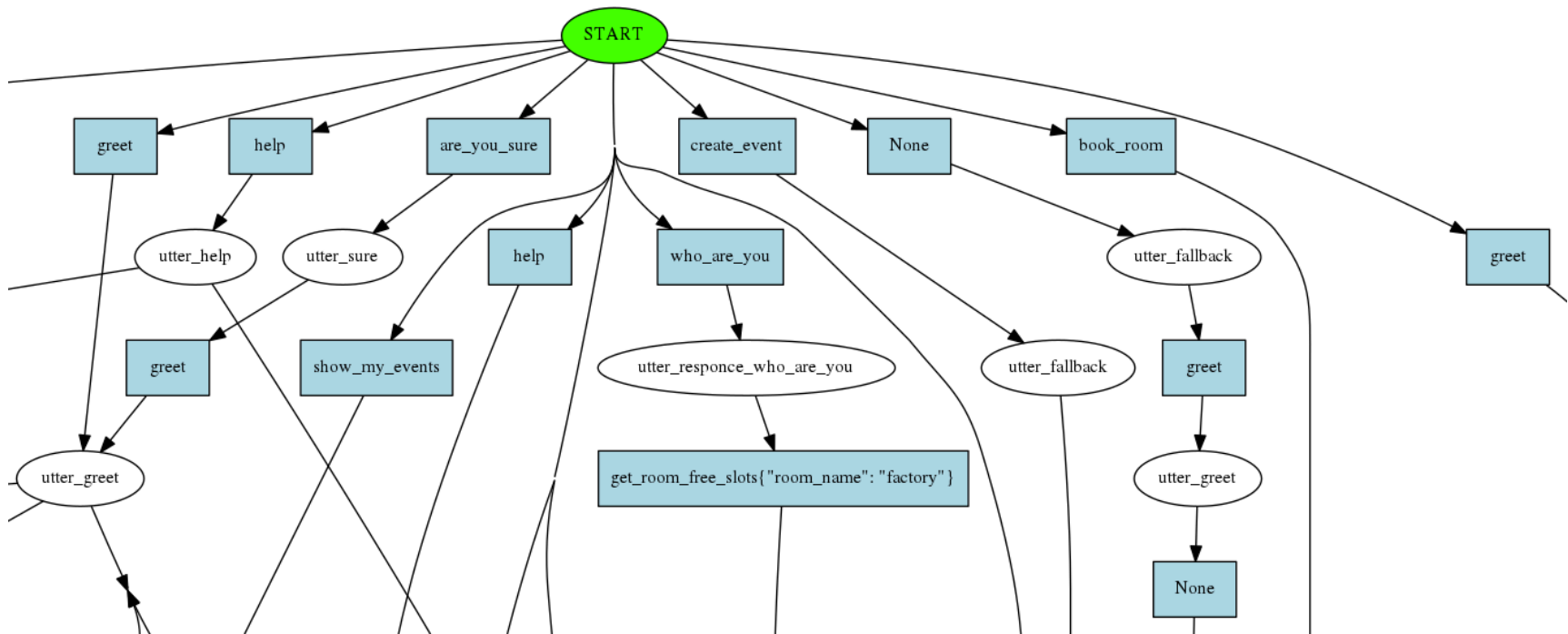
$$\hat{A}_i = \operatorname{argmax}_{A_i \in A} P(A_i | (A_1, U_1, \dots, A_{i-1}, U_{i-1}))$$

- Ou dados campos preenchidos, últimas “rodadas” do usuário e sistema

$$\hat{A}_i = \operatorname{argmax}_{A_i \in A} P(A_i | \text{Frame}_{i-1}, A_{i-1}, U_{i-1})$$

- Baseado em um classificador/busca ou fluxo de conversação

Exemplo



<https://www.eliftech.com/images/5be953b3f2c98f326376f64b>

Confirmação e Rejeição

- Lidar com erros do sistema
- Ter certeza que o usuário foi compreendido
- Dois mecanismos
 - Confirmação
 - Rejeição

Confirmação

S: Which city do you want to leave from?

U: Baltimore.

S: **Do you want to leave from Baltimore?**

U: Yes.

U: I'd like to fly from Denver Colorado to New York City on September twenty first in the morning on United Airlines

S: **Let's see then. I have you going from Denver Colorado to New York on September twenty first. Is that correct?**

U: Yes

Rejeição

System: When would you like to leave?

Caller: Well, um, I need to be in New York in time for the first World Series game.

System: <reject>. Sorry, I didn't get that. Please say the month and day you'd like to leave.

Caller: I wanna go on October fifteenth.

Natural Language Generation

- Gera o texto para o ato do diálogo
- Escolhe alguns atributos para colocar no texto
- Mostrar ao usuário uma resposta ou pedir confirmação
- Preenchimento de template

```
recommend(restaurant name= Au Midi, neighborhood = midtown,  
cuisine = french
```

1 Au Midi is in Midtown and serves French food.

2 There is a French restaurant in Midtown called Au Midi.

```
recommend(restaurant name= Loch Fyne, neighborhood = city  
centre, cuisine = seafood)
```

3 Loch Fyne is in the City Center and serves seafood food.

4 There is a seafood restaurant in the City Centre called Loch Fyne.

NLG usando Classificador

- Usa conversações
- “Deslexização” de palavras que representam slots

```
recommend(restaurant name= Au Midi, neighborhood = midtown,  
cuisine = french
```

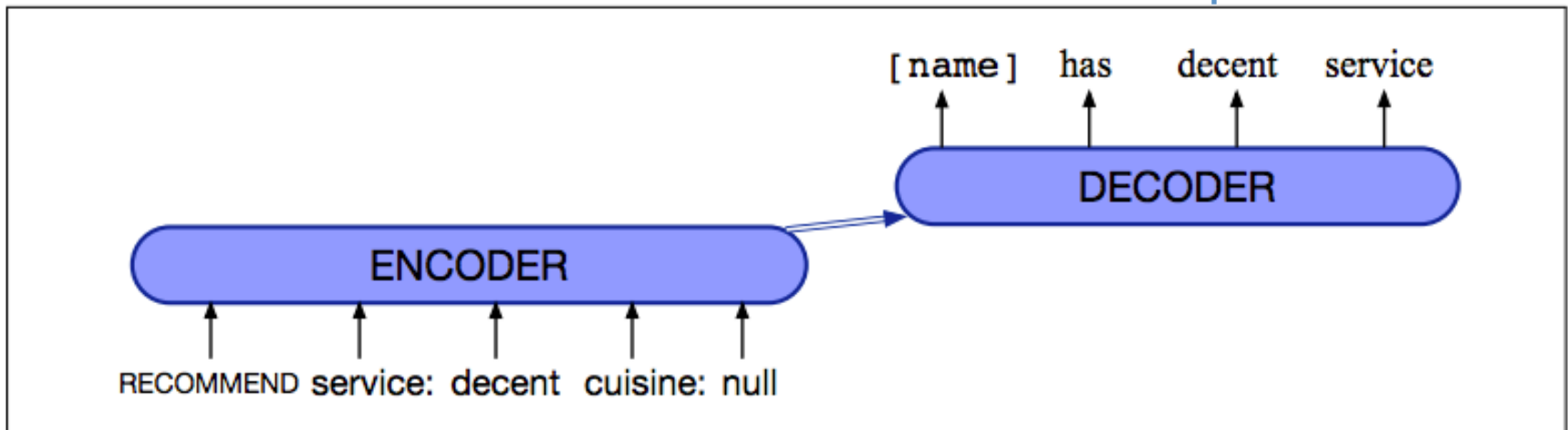
1 restaurant_name is in neighborhood and serves cuisine food.

2 There is a cuisine restaurant in neighborhood called restaurant_name.

Encoder-Decoder

Au Midi has decent service

Preenche com o nome
do restaurante:



Avaliação

- Slot error rate por sentença
- Tarefa bem sucedida: nota de satisfação
- Número de falas
- Repetições
- Número de correções

“Make an appointment with Chris at 10:30 in Gates 104”

Slot	Filler
PERSON	Chris
TIME	11:30 a.m.
ROOM	Gates 104

Slot error rate = 1/3

O encontro foi colocado corretamente no calendário?