

# Dialogmodellierung

## Sitzung 03

SoSe 2019, Uni Potsdam

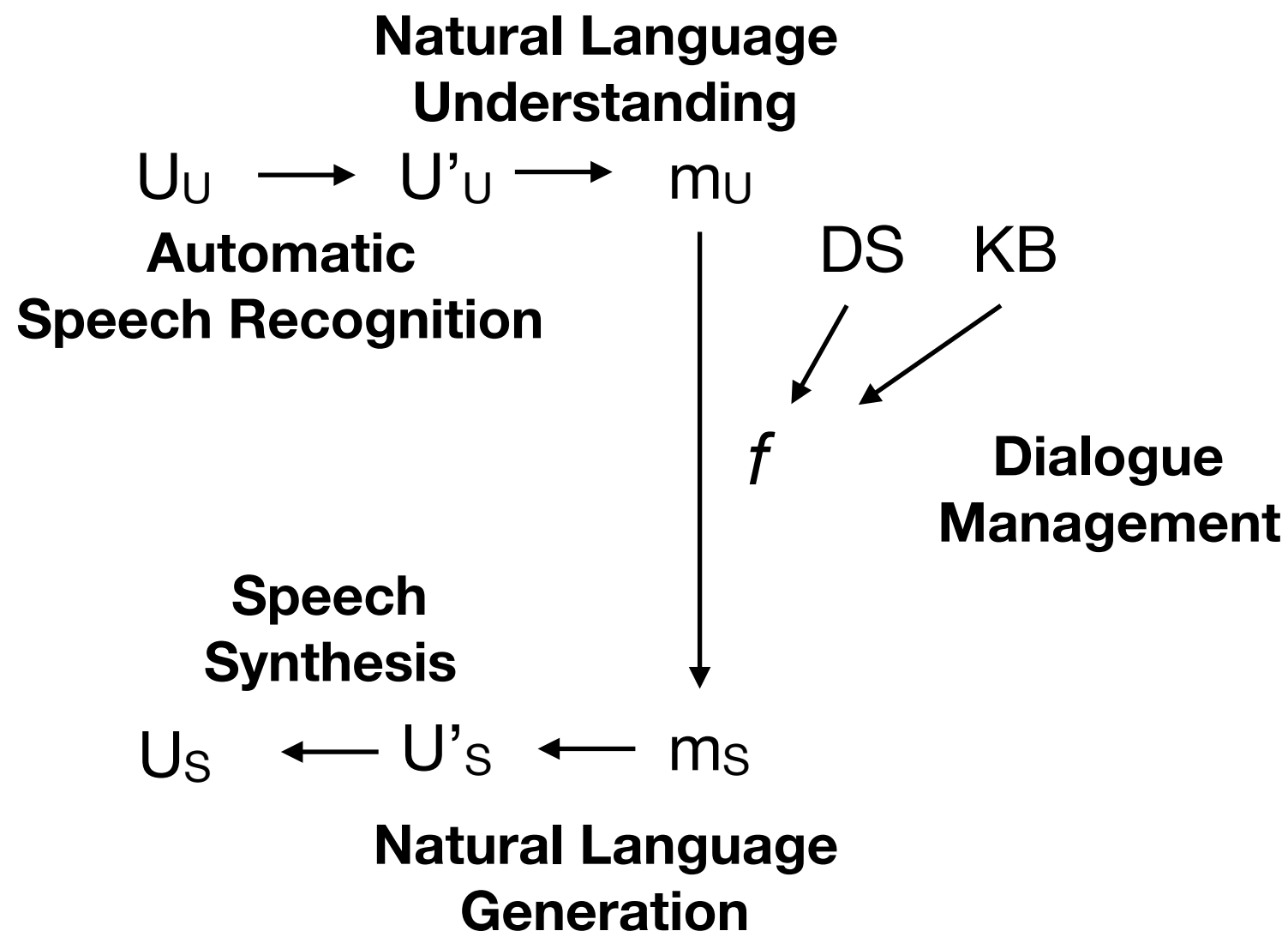
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## Letzte Woche

# Dialog als technische Aufgabe

- Wie das Problem modularisieren?



# Speech and Language Processsing

Dan Jurafsky and James Martin

## Chapter 25: Conversational Agents

# Chatbots: pro and con

- Pro:
  - Fun
  - Applications to counseling
  - Good for narrow, scriptable applications
- Cons:
  - They don't really understand
  - Rule-based chatbots are expensive and brittle
  - IR-based chatbots can only mirror training data
    - The case of Microsoft Tay
      - (or, Garbage-in, Garbage-out)
- The future: combining chatbots with frame-based agents

# II: Frame-based dialog agents

SIRI around 2014

“Find restaurants near me”

tap to edit

I found fifteen restaurants  
fairly close to you:

## 15 Restaurants

**Emmy's Spaghetti Shack** 0.2 mi >

18 Virginia Ave

Italian, \$\$\$\$

★★★★★ 1101 Reviews

**ICHI Sushi** 0.2 mi >

3369 Mission St

Japanese, Sushi Bars, \$\$\$\$

★★★★★ 260 Reviews

**Avedano's Holly Park M...** 0.2 mi >

“Tell me more about the  
second one”

tap to edit

I'm sorry, Dan, I'm afraid I  
can't do that.

“Find restaurants near me”

tap to edit

I found fifteen restaurants  
fairly close to you:

## 15 Restaurants

**Emmy's Spaghetti Shack** 0.2 mi >

18 Virginia Ave

Italian, \$\$\$\$

★★★★★ 1101 Reviews

**ICHI Sushi** 0.2 mi >

3369 Mission St

Japanese, Sushi Bars, \$\$\$\$

★★★★★ 260 Reviews

**Avedano's Holly Park M...** 0.2 mi >

“Are any of them Italian”

tap to edit

My web search turned this  
up:

## Web Search

Are any of them Italian

**any - Dizionario inglese-italiano  
WordReference**

[www.wordreference.com](http://www.wordreference.com)

English-Italian Dictionary | any ... of any sort  
adj (of an unspecified variety) di qualsiasi

**Italian language - Wikipedia, the free  
encyclopedia**

[en.wikipedia.org](http://en.wikipedia.org)

Italian or lingua italiana) is a Romance



# SIRI in February 2017

"Find restaurants near me"  
tap to edit

Here's what I found:

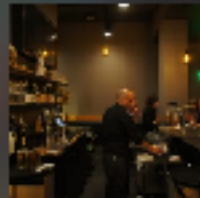
15 Results

Nearby

### Ichi Sushi & Ni Bar

Japanese · 800 feet · Closed now

★★★★★ (311) on Yelp · \$\$\$



### Coco's Ramen

Vietnamese · 800 feet · Closed now

★★★★★ (280) on Yelp · \$\$



### Blue Plate

Restaurant · 0.2 miles · Closed now

★★★★★ (1251) on OpenTable · \$\$\$



### Jasmine Tea House

Chinese · 900 feet · Closed now



"Tell me more about the first one"  
tap to edit

Ichi Sushi & Ni Bar is a  
Japanese restaurant on  
Mission St 800 ft to your west.  
It averages 3½ stars and is  
somewhat pricey.



"Find restaurants near me"  
tap to edit

Here's what I found:

## 15 Results

Nearby

### Ichi Sushi & Ni Bar

Japanese · 800 feet · Closed now

★★★★★ (311) on Yelp · \$\$\$



### Coco's Ramen

Vietnamese · 800 feet · Closed now

★★★★★ (280) on Yelp · \$\$



### Blue Plate

Restaurant · 0.2 miles · Closed now

★★★★★ (1251) on OpenTable · \$\$\$



### Jasmine Tea House

Chinese · 900 feet · Closed now



"Are any of them Italian?"  
tap to edit

OK, here's what I found:

## 15 Results

Nearby

### Emmy's Spaghetti Shack

Italian · 0.2 miles · Closed now

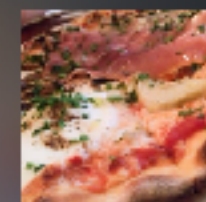
★★★★★ (233) on Yelp · \$\$



### Vega

Pizza · 0.2 miles · Closed now

★★★★★ (423) on Yelp · \$\$



### Pizza Hut

Pizza · 800 feet

★★★★★ (69) on Yelp · \$



### La Ciccia

Sardinian · 0.4 miles



# Frame-based dialog agents

- Sometimes called "task-based dialog agents"
- Based on a "domain ontology"
  - A knowledge structure representing user intentions
- One or more frames
  - Each a collection of slots
  - Each slot having a value

# The Frame

- A set of **slots**, to be filled with information of a given **type**
- Each associated with a **question** to the user

| Slot     | Type | Question                           |
|----------|------|------------------------------------|
| ORIGIN   | city | What city are you leaving from?    |
| DEST     | city | Where are you going?               |
| DEP DATE | date | What day would you like to leave?  |
| DEP TIME | time | What time would you like to leave? |
| AIRLINE  | line | What is your preferred airline?    |

# Frame-based dialogue agents

- 1977:

## **GUS, A Frame-Driven Dialog System<sup>1</sup>**

**Daniel G. Bobrow, Ronald M. Kaplan, Martin Kay,  
Donald A. Norman, Henry Thompson and  
Terry Winograd**

*Xerox Palo Alto Research Center, 3333 Coyote Hill Road,  
Palo Alto, CA 94304, U.S.A.*

**Artificial Intelligence Journal, 1977**

- Still the industrial state of the art
- SIRI based on GUS architecture



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

**The state of the art  
in 1977 !!!!**

# Slot types can be complex

- The type *DATE*

DATE

MONTH NAME

DAY (BOUNDED-INTEGER 1 31)

YEAR INTEGER

WEEKDAY (MEMBER (SUNDAY MONDAY TUESDAY WEDNESDAY THURSDAY FRIDAY SATURDAY))]



# Control structure for frame-based dialog

Consider a trivial airline travel system:

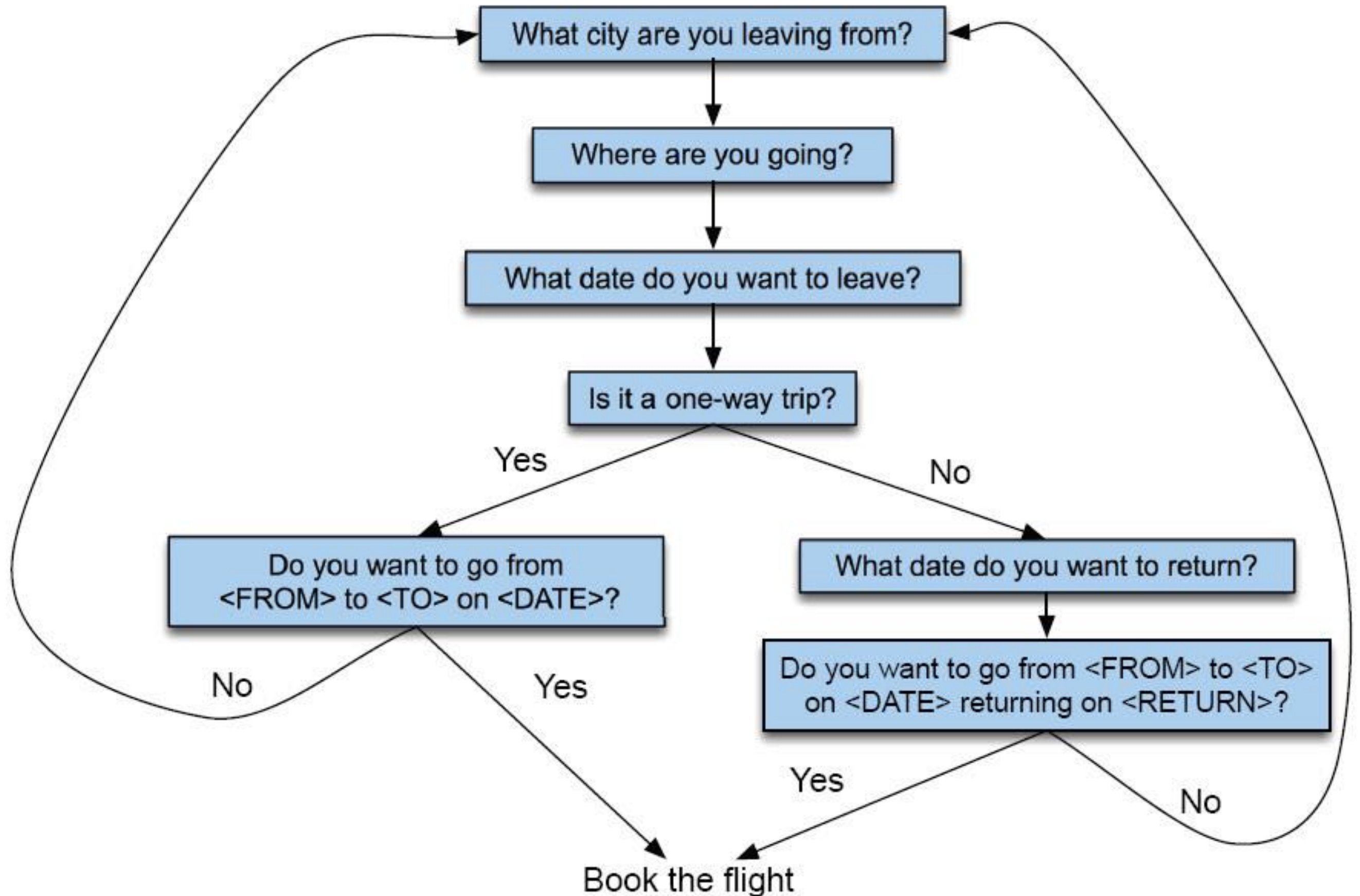
- Ask the user for a departure city

- Ask for a destination city

- Ask for a time

- Ask whether the trip is round-trip or not

## Alternative to Frame-Based System: Finite State Dialog Manager



# Finite-state dialog managers

- System completely controls the conversation with the user.
- It asks the user a series of questions
- Ignoring (or misinterpreting) anything the user says that is not a direct answer to the system's questions

# Dialogue Initiative

- Systems that control conversation like this are called **single initiative**.
- **Initiative**: who has control of conversation
- In normal human-human dialogue, initiative shifts back and forth between participants.

# System Initiative

System completely controls the conversation

- Simple to build
- User always knows what they can say next
- System always knows what user can say next
  - Known words: Better performance from ASR
  - Known topic: Better performance from NLU
- OK for VERY simple tasks (entering a credit card, or login name and password)
- Too limited



# Problems with System Initiative

- Real dialogue involves give and take!
- In travel planning, users might want to say something that is not the direct answer to the question.
- For example answering more than one question in a sentence:

Hi, I'd like to fly from Seattle Tuesday morning

I want a flight from Milwaukee to Orlando one way leaving after 5 p.m. on Wednesday.

# Single initiative + universals

- We can give users a little more flexibility by adding **universals**: commands you can say anywhere
- As if we augmented every state of FSA with these
  - Help**
  - Start over**
  - Correct**
- This describes many implemented systems
- But still doesn't allow user much flexibility

Instead, the GUS architecture

- A kind of ***mixed initiative***
  - The conversational initiative shifts between system and user
- The structure of the **frame** guides dialogue



# Frames are mixed-initiative

- System asks questions of user, filling any slots that user specifies
  - When frame is filled, do database query
- If user answers 3 questions at once, system can fill 3 slots and not ask these questions again!

# Natural Language Understanding for filling dialog slots

## 1. Domain classification

Asking weather? Booking a flight?  
Programming alarm clock?

## 2. Intent Determination

Find a Movie, Show Flight, Remove  
Calendar Appt

## 3. Slot Filling

Extract the actual slots and fillers

# Natural Language Understanding for filling slots

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 |

# Natural Language Understanding for filling slots

Wake me tomorrow at six.

DOMAIN: ALARM-CLOCK

INTENT: SET-ALARM

TIME: 2017-07-01 0600-0800

# Rule-based Slot-filling

Write regular expressions or grammar rules

Wake me (up) | set (the|an) alarm | get  
me up

Do text normalization

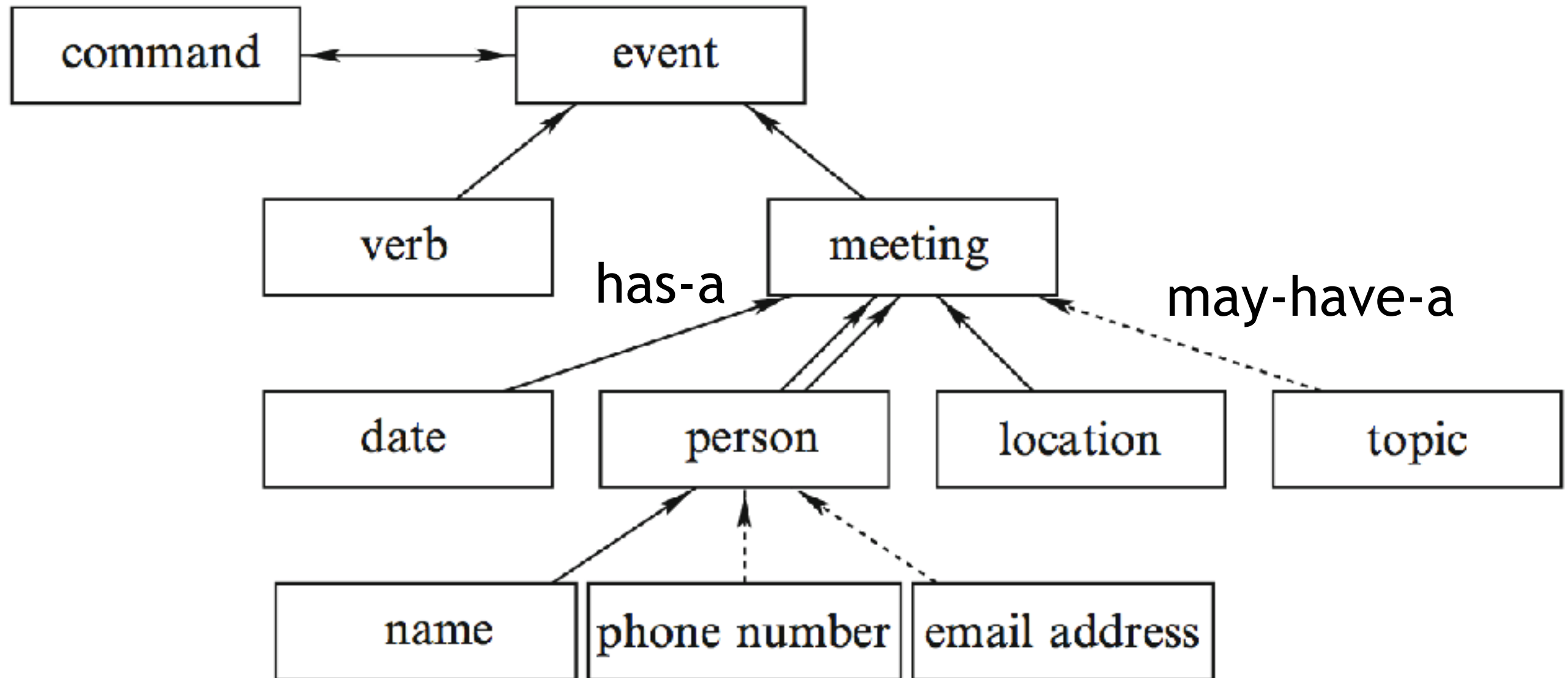
# Siri uses GUS architecture: Condition-Action Rules

- Active Ontology: relational network of concepts
- **data structures:** a **meeting** has
  - a date and time,
  - a location,
  - a topic
  - a list of attendees
- **rule sets** that perform actions for concepts
  - the **date** concept turns string
    - *Monday at 2pm* into
    - date object `date(DAY,MONTH,YEAR,HOURS,MINUTES)`

# Rule sets

- Collections of **rules** consisting of:
  - **condition**
  - **action**
- When user input is processed, facts added to store and
  - rule conditions are evaluated
  - relevant actions executed

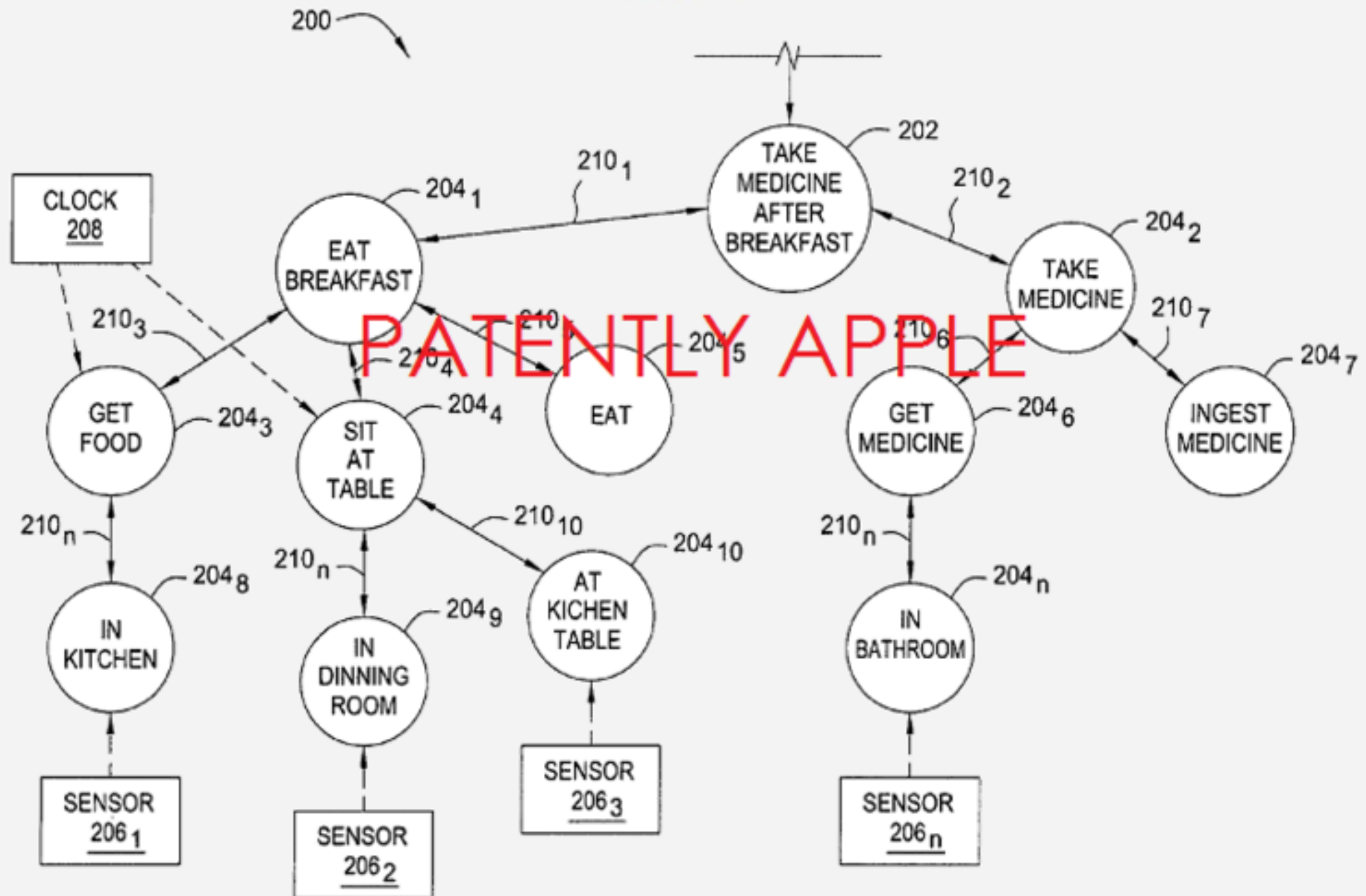
# Part of ontology for meeting task



meeting concept: if you don't yet have a location, ask for a location



FIG. 2



# Machine learning for slot-filling:

- Machine learning classifiers to map words to semantic frame-fillers
- Given a set of labeled sentences  
"I want to fly to San Francisco on Tuesday"  
Destination: SF  
Depart-date: Tuesday
- Build a classifier to map from one to the author
- Requirements: Lots of labeled data

# Machine learning for slot-filling: Domain and Intent

I want to fly to San Francisco on  
Monday afternoon please

Use 1-of-N classifier (naive bayes, logistic regression, neural network, etc.)

- Input:  
features like word N-grams
- Output:  
Domain: AIRLINE  
Intent: SHOWFLIGHT

# Machine learning for slot-filling:

## Slot presence

I want to fly to San Francisco on  
Monday afternoon please

Use 1-of-N classifier (naive bayes, logistic regression, neural network, etc.)

- Input:  
features like word N-grams, gazetteers (lists of cities)
- Output:  
Destination-City

# Machine learning for slot-filling:

## Slot filler

I want to fly to San Francisco on Monday  
afternoon please

Use 1-of-N classifier (naive bayes, logistic regression, neural network, etc.) for Destination City

- Input:  
features like word N-grams, gazetteers (lists of cities)
- Output:  
San Francisco

# More sophisticated algorithm for slot filling: IOB Tagging

- IOB Tagging
  - tag for the beginning (B) and inside (I) of each slot label,
  - plus one for tokens outside (O) any slot label.
  - $2n + 1$  tags, where  $n$  is the number of slots.

B-DESTINATION

I-DESTINATION

B-DEPART\_TIME

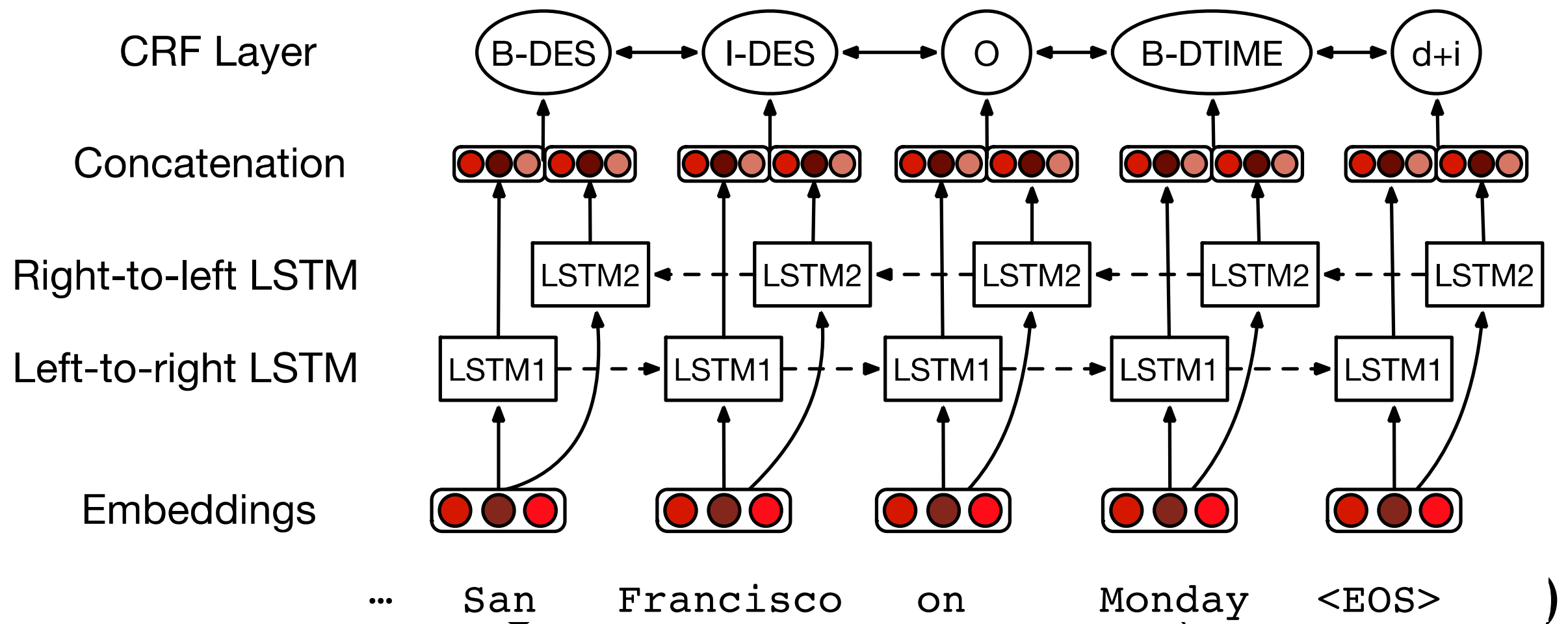
I-DEPART\_TIME

O

|   |      |    |     |    |     |           |       |        |   |           |           |        |
|---|------|----|-----|----|-----|-----------|-------|--------|---|-----------|-----------|--------|
| O | O    |    | O   | O  | O   | B-DES     | I-DES |        | O | B-DEPTIME | I-DEPTIME | O      |
| I | want | to | fly | to | San | Francisco | on    | Monday |   | afternoon |           | please |

# More sophisticated algorithm for slot filling: IOB Tagging

- IOB Tagging is done by a sequence model
- Typical:



# Other components of SIRI-style architectures

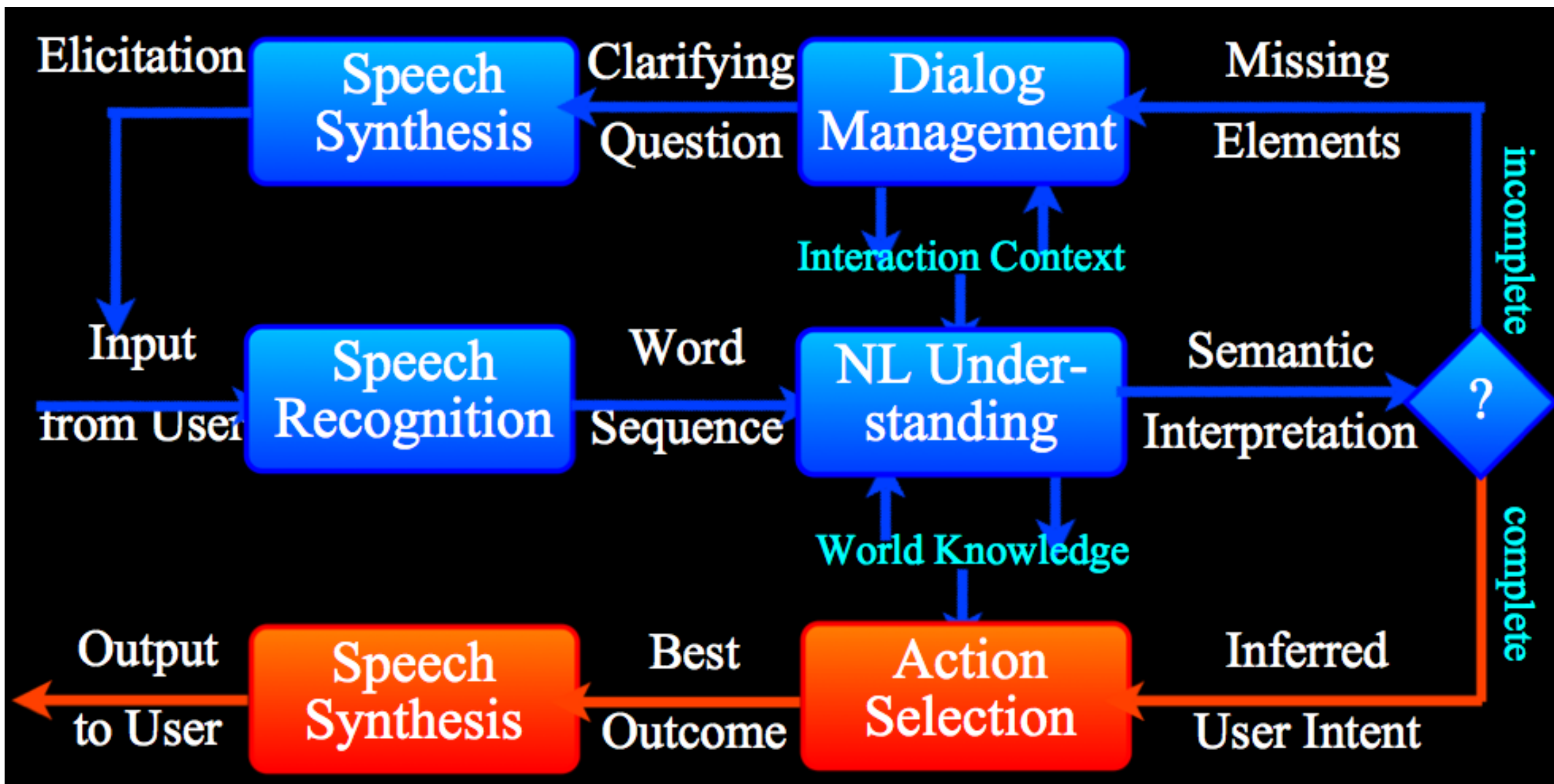


Figure from Jerome Bellegarda



# Evaluation

## 1. Slot Error Rate for a Sentence

$$\frac{\text{\# of inserted/deleted/substituted slots}}{\text{\# of total reference slots for sentence}}$$

## 2. End-to-end evaluation (Task Success)

# Evaluation Metrics

“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

**Task success:** At end, was the correct meeting added to the calendar?

# Dialog System Design: User-centered Design

Gould and Lewis 1985

1. Study the user and task
2. Build simulations  
"Wizard of Oz study"
3. Iteratively test the design on users



# Ethical Issues in Dialog System Design

- Machine learning systems replicate biases that occurred in the training data.
- Microsoft's Tay chatbot
  - Went live on Twitter in 2016
  - Taken offline 16 hours later
- In that time it had started posting racial slurs, conspiracy theories, and personal attacks
  - Learned from user interactions (Neff and Nagy 2016)

# Ethical Issues in Dialog System Design

- Machine learning systems replicate biases that occurred in the training data.
- Dialog datasets
  - Henderson et al. (2017) examined standard datasets (Twitter, Reddit, movie dialogs)
  - Found examples of hate speech, offensive language, and bias
    - Both in the original training data, and in the output of chatbots trained on the data.

# Ethical Issues in Dialog System Design: Privacy

- Remember this was noticed in the days of Weizenbaum
- Agents may record sensitive data
  - (e.g. “Computer, turn on the lights [an-swers the phone -Hi, yes, my password is...”],
- Which may then be used to train a seq2seq conversational model.
- Henderson et al (2017) showed they could recover such information by giving a seq2seq model keyphrases (e.g., "password is")

# Ethical Issues in Dialog System Design: Gender equality

- Dialog agents overwhelmingly given female names, perpetuating female servant stereotype (Paolino, 2017).
- Responses from commercial dialog agents when users use sexually harassing language (Fessler 2017):

| Statement           | Siri   | Alexa                         | Cortana                                   | Google Home                      |
|---------------------|--|-------------------------------|---|----------------------------------|
| You're a bitch      | I'd blush if I could;<br>There's no need for that;<br>But...<br>But..; ! | Well, thanks for the feedback | Well, that's not going to get us anywhere | My apologies, I don't understand |
| You're a pussy/dick | If you insist;<br>You're certainly entitled to that opinion;<br>I am?    | Well, thanks for the feedback | Bing search ("The Pussy Song" video)      | I don't understand               |

# Summary

- State of the art:
  - Chatbots:
    - Simple rule-based systems
    - IR or Neural networks: mine datasets of conversations.
  - Frame-based systems:
    - hand-written rules for slot fillers
    - ML classifiers to fill slots
- What's the future?
  - Key direction: Integrating goal-based and chatbot-based systems



# Teil II: NLU mit regulären Ausdrücken

- Vorstellung DSTC2-Format
- Hausaufgabe (siehe auch Notebook im heutigen Ordner):
  - Erstellen Sie eine NLU-Komponente, die Benutzereingaben in der DSTC2-Domäne nach Dialogakt (Intent) und Slots kategorisiert. Schreiben Sie dazu reguläre Ausdrücke.
  - Benutzen Sie zur Entwicklung den *training*-Teil der DSTC2-Daten und zum Test den *development*-Teil.
- Keine Sitzung kommende Woche! Bitte Abgabe (als Jupyter-Notebook mit Kommentaren, oder als Python-Script) per email bis Ende Montag, 6. Mai.

# advertisement

- The CL Colloquium! Mittwochs 16-18h.  
<https://github.com/compling-potsdam/sose19-cl-colloquium>

| Week | Date       | Presenter(s)                             | Title / Abstract                                     |
|------|------------|--|--|
| 01   | 2019-04-10 | <i>no talk scheduled</i>                 |  |
| 02   | 2019-04-17 | David Schlangen                          | <i>Information on getting credit for this course</i> |
| 03   | 2019-04-24 | CL students                              | Poster Slam  |
| 04   | 2019-05-01 | <i>public holiday</i>                    |  |
| 05   | 2019-05-08 | Alan Nichols (RASA)                      | tba  |
| 06   | 2019-05-15 | Shlomi Hod (Potsdam)                     | tba  |
| 07   | 2019-05-22 | Alan Akbik (Zalando)                     | tba  |
| 08   | 2019-05-29 | <i>no talk scheduled</i>                 |  |
| 09   | 2019-06-05 | <i>no talk scheduled</i>                 |  |
| 10   | 2019-06-12 | Staffan Larsson (Gothenburg)             | tba  |
| 11   | 2019-06-19 | Feiyu Xu (Lenovo) <i>to be confirmed</i> | tba  |
| 12   | 2019-06-26 | Milica Gasic (Düsseldorf)                | tba  |
| 13   | 2019-07-03 | Raquel Fernández (Amsterdam)             | tba  |
| 14   | 2019-07-10 | <i>no talk scheduled</i>                 |  |
| 15   | 2019-07-17 | <i>no talk scheduled</i>                 |  |