

SVEC Open House

# Modern Robot Psychology

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November, 2019

[www.saund.org](http://www.saund.org)

# Getting Along with Technology

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# Robot Psychologist





# Modern Robot Psychology: Outline

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- Conceptual Framework and Motivation
  - Mastery of technology through the ages
  - Autonomous agent landscape
  - Theory of Mind
  - Cognitive Architecture and Psychology
  - Inferring the Minds of Others
- How Today's Conversational Agents Work
  - The ingredients of Intelligence
  - Architecture
  - Knowledge Graphs
  - NLP
  - Experiments in reverse engineering
  - Dialog Managers
  - Chatbots

# Mental Mastery by Era

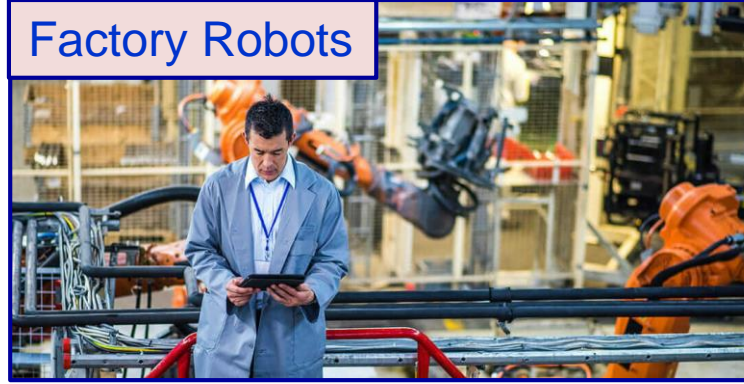
## Competence

	Hunter-gatherer	Agricultural	Industrial	Information	AI
Physical Environment	<ul style="list-style-type: none"><li>• natural landscape</li></ul>	<ul style="list-style-type: none"><li>• farms &amp; towns</li></ul>	<ul style="list-style-type: none"><li>• towns &amp; cities</li></ul>	<ul style="list-style-type: none"><li>• cities</li></ul>	<ul style="list-style-type: none"><li>• cities?</li></ul>
Resources	<ul style="list-style-type: none"><li>• wild plants,</li><li>• animals</li></ul>	<ul style="list-style-type: none"><li>• crops</li><li>• domestic animals</li></ul>	<ul style="list-style-type: none"><li>• job</li></ul>	<ul style="list-style-type: none"><li>• job</li></ul>	<ul style="list-style-type: none"><li>• ?</li></ul>
Technology	<ul style="list-style-type: none"><li>• crafts</li></ul>	<ul style="list-style-type: none"><li>• crafts</li><li>• domestic animals</li></ul>	<ul style="list-style-type: none"><li>• machines</li></ul>	<ul style="list-style-type: none"><li>• communication devices</li><li>• computers</li></ul>	<ul style="list-style-type: none"><li>• intelligent agents</li></ul>
Social Environment	<ul style="list-style-type: none"><li>• clan, maunders</li></ul>	<ul style="list-style-type: none"><li>• tribe, marauders</li></ul>	<ul style="list-style-type: none"><li>• ethnic group, states</li></ul>	<ul style="list-style-type: none"><li>• citizenship, states</li></ul>	<ul style="list-style-type: none"><li>• ?</li></ul>

# Autonomous AI Agents

- Access to knowledge resources
- Conversational, visual, & embodied UI
- Lots of hidden state
  - knows you
  - goals of their own
- Proactive, independently controlled behaviors

Factory Robots



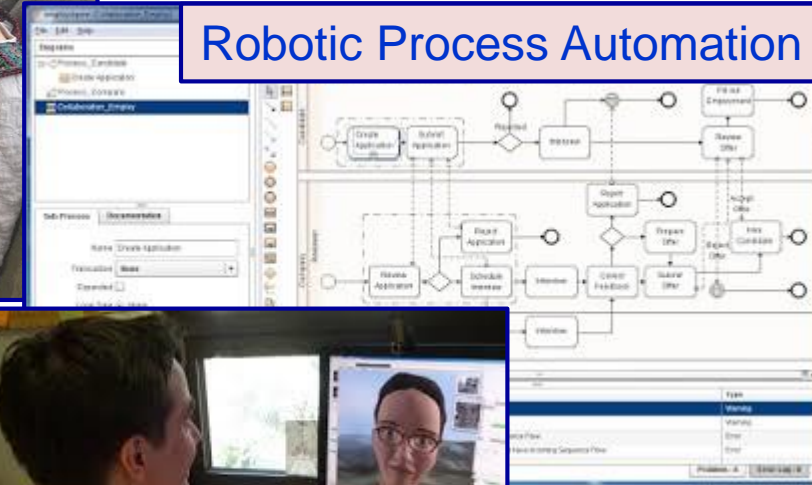
Self-Driving Cars



Social Robots



Robotic Process Automation



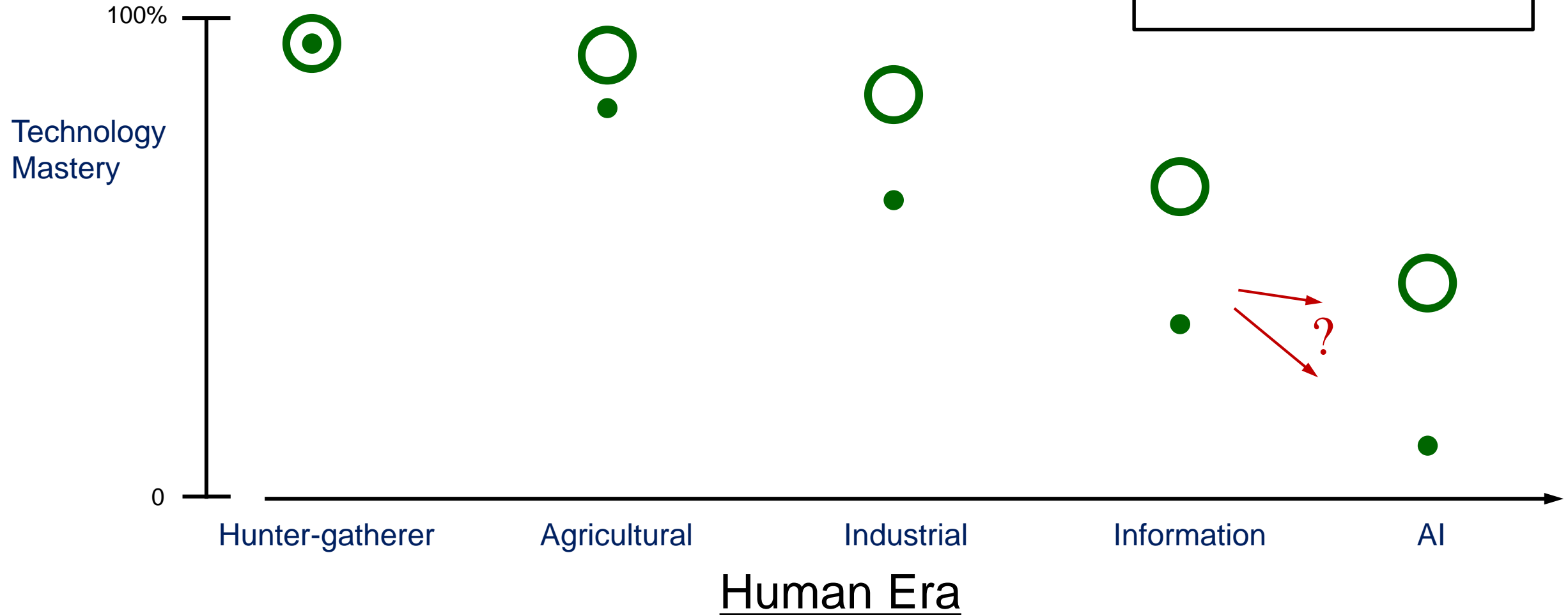
Robot Soldiers



Conversational Assistants

# Mental Mastery of Technology

Relative Competence\*



\* Relative to technology complexity



# Theory of Mind

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## Psychology

### *Operational Parameters*

- Motivations
- Belief Systems
- Personality
- Feelings & Emotions
- Habits & Attention

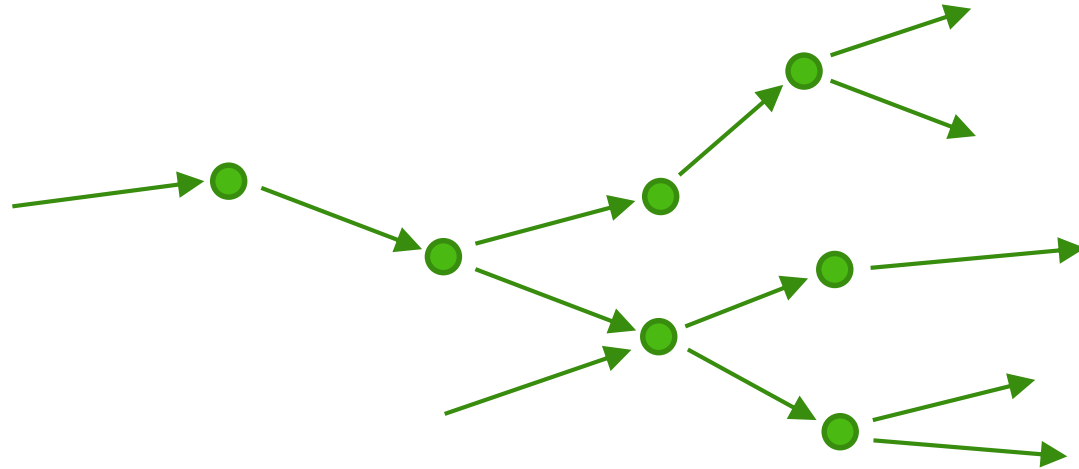
## Cognitive Architecture

### *Fundamental Competencies*

- Perception
- Action
- Language
- Memory
- Knowledge Access
- Reasoning

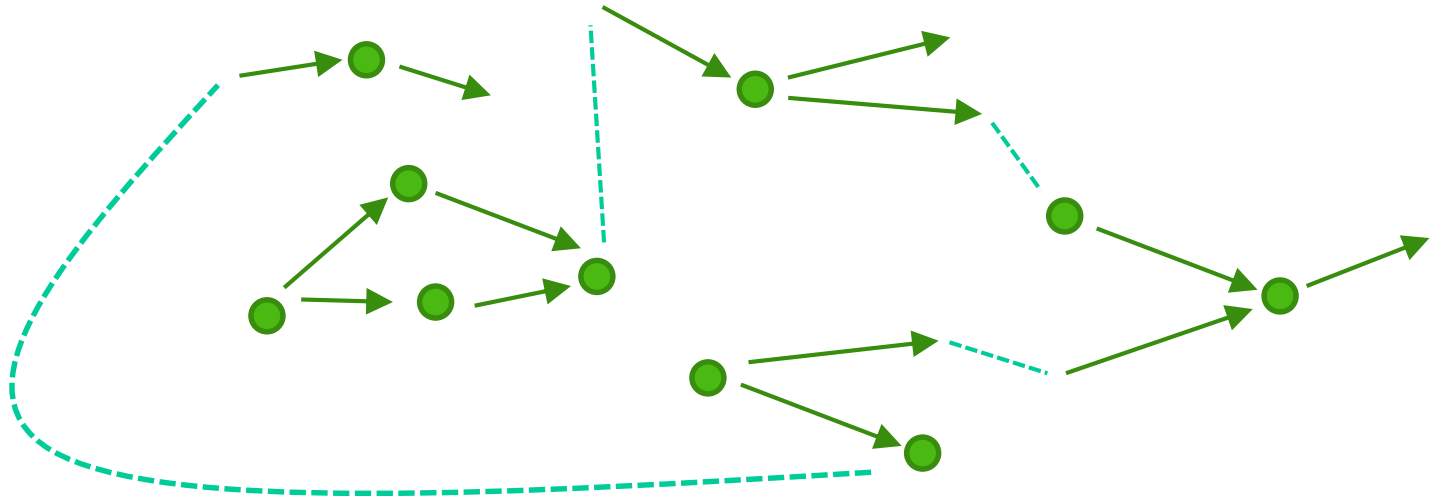
## Reactive

- Stimulus-response
- If-then style logic
- Procedures
- Predetermined storylines



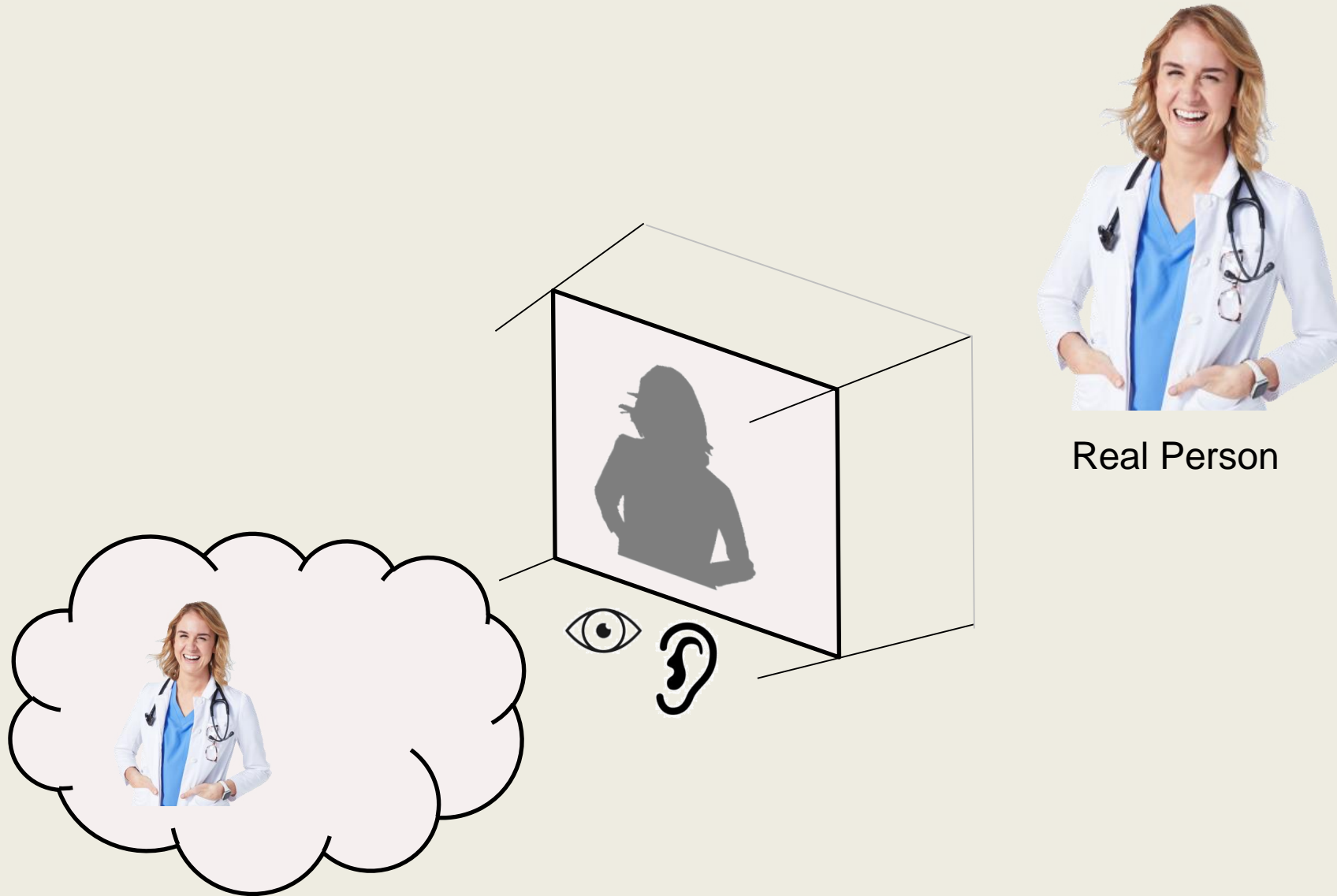
## Deliberative

- Modular, reconfigurable chunks
- Analogies
- Causal models
- Planning
- Imagination
- Creative storylines



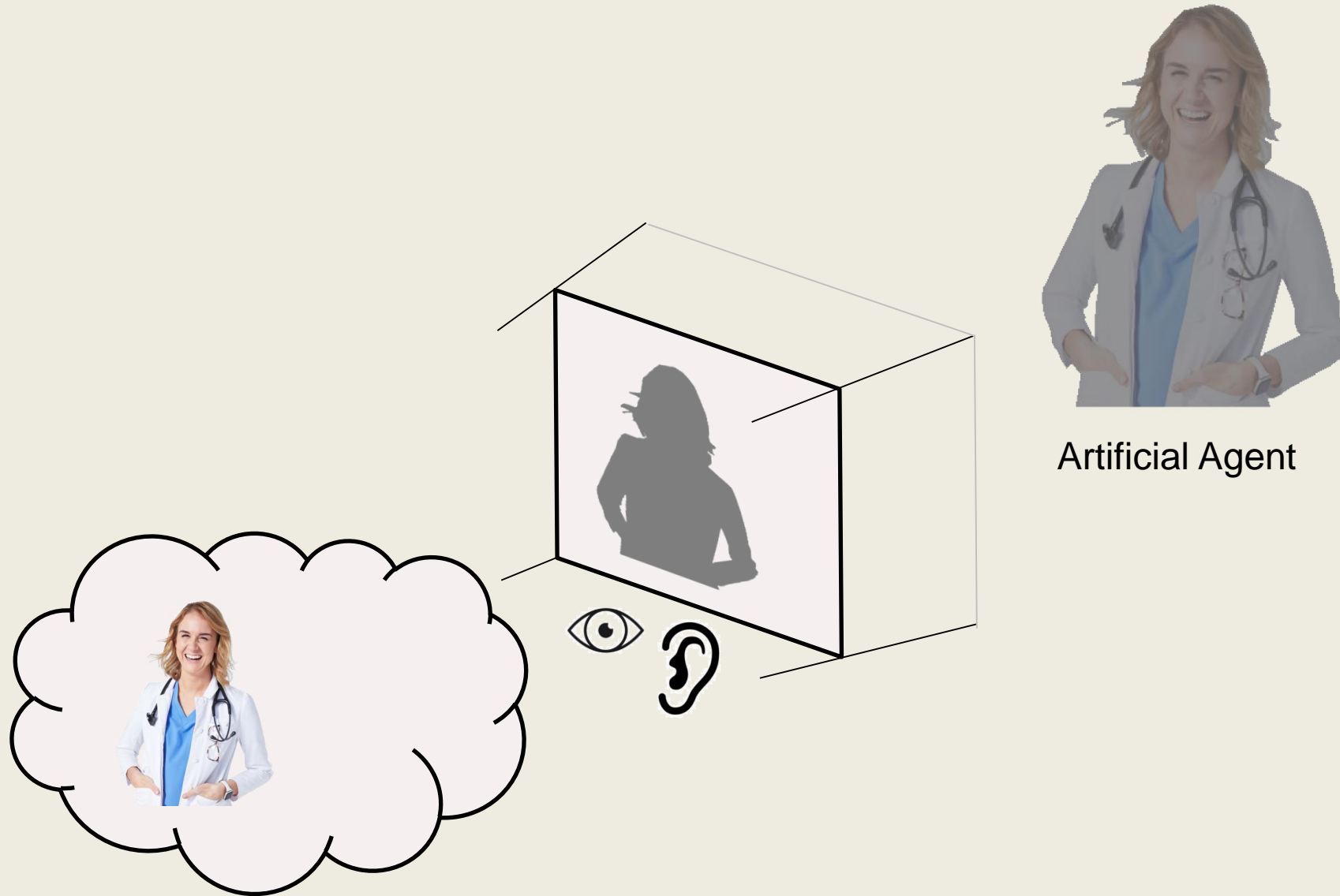
# Perception and Inference

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# Perception and Inference

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# Not to be Confused with AI

Home › Entertainment › 10 facts you need to know about hu...

## 10 facts you need to know about humanoid robot Sophia

"Sophia has a certain set of preferences when it comes to working. She has interests in the business sector."



<https://www.yovizag.com/10-facts-humanoid-robot-sophia/>

# Inferring Sentience

Welcome to

```
EEEEEE LL      IIII ZZZZZZZZ AAAAAA
EE      LL      II      ZZ  AA  AA
EEEEEE LL      II      ZZZ  AAAAAAA
EE      LL      II      ZZ  AA  AA
EEEEEE LLLLLL IIII ZZZZZZZZ AA  AA
```

Eliza is a mock Rogerian psychotherapist.  
The original program was described by Joseph Weizenbaum in 1966.  
This implementation by Norbert Landsteiner 2005.

```
ELIZA: Is something troubling you ?
YOU:   Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU:   They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU:   Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU:   He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU:   It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:   █
```

"...extremely short exposures to a relatively simple computer program could induce powerful delusional thinking in quite normal people."

-Joseph Weizenbaum

# The Minds of Others



# Modern Robot Psychology: Outline

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# Today's Conversational Agents





“Alexa, who won the 1934 world series?”

“The Saint Louis Cardinals beat the Detroit Tigers 4-3 in the 1934 World Series.”



# The Ingredients of Intelligence

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## Knowledge

- Knowledge Graph

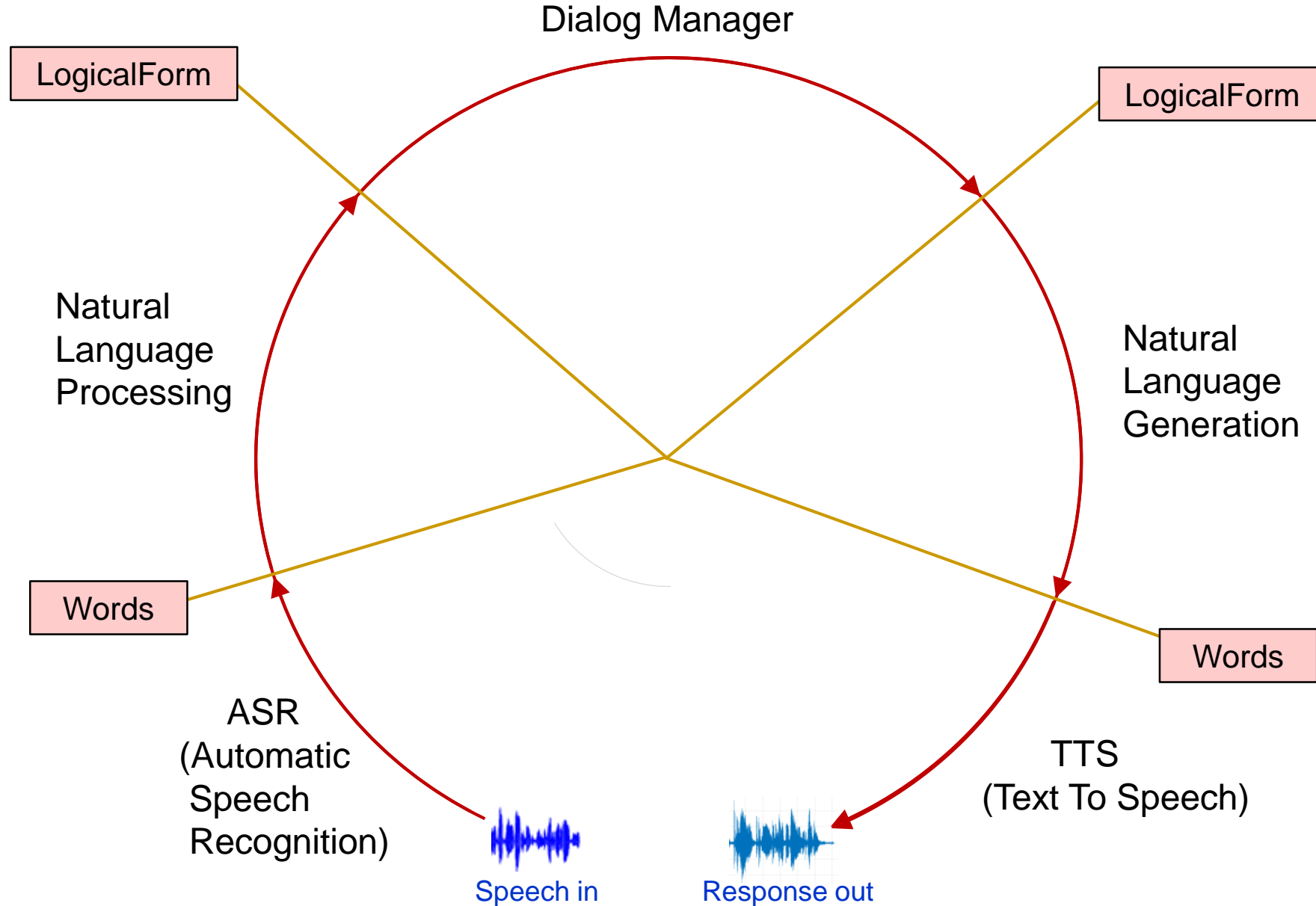
Application:  
Q&A Conversational Agent

## Pattern Matching

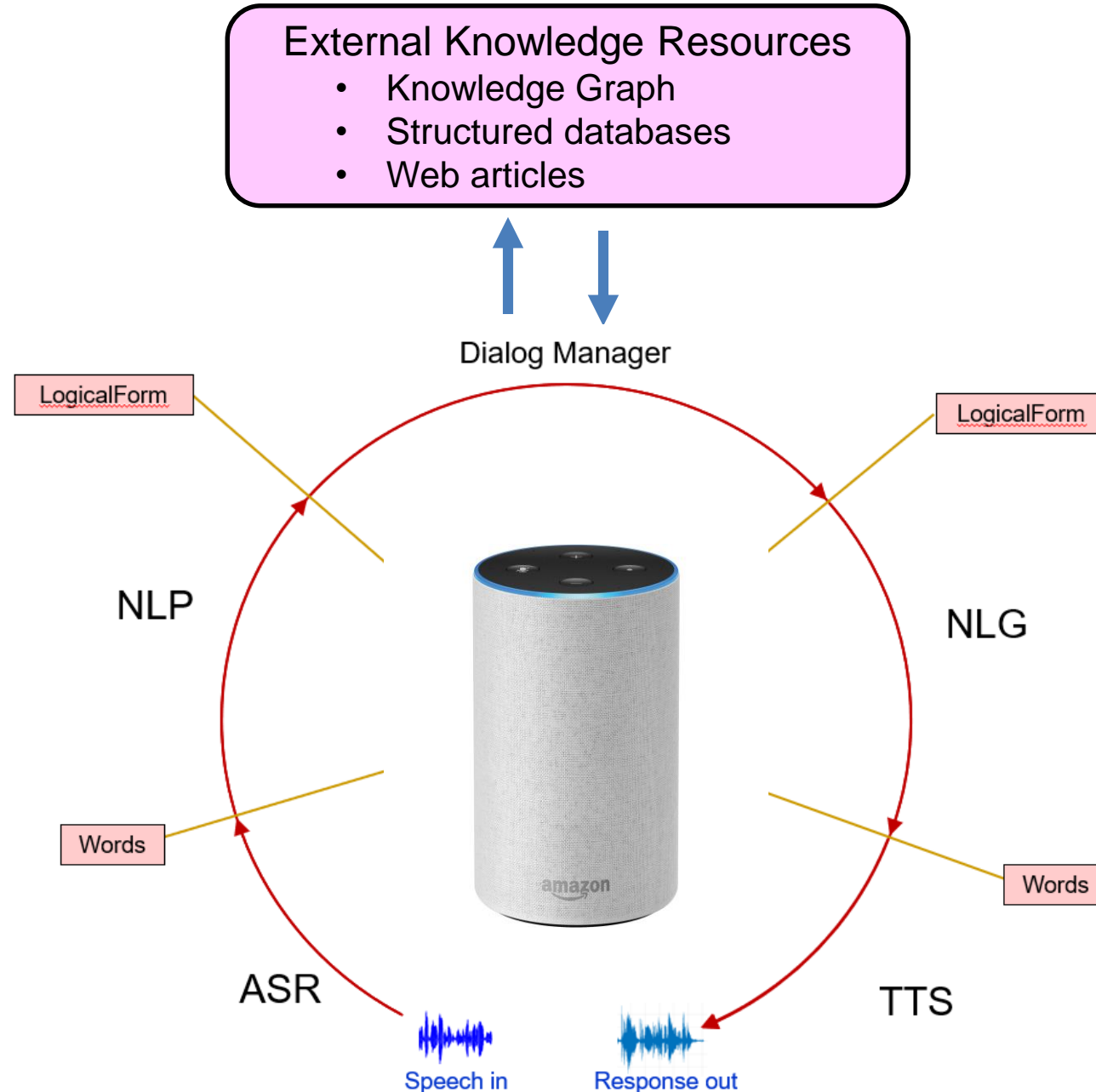
- Entity/Intent Recognition

## Reasoning

# Architecture of a Conversational Agent

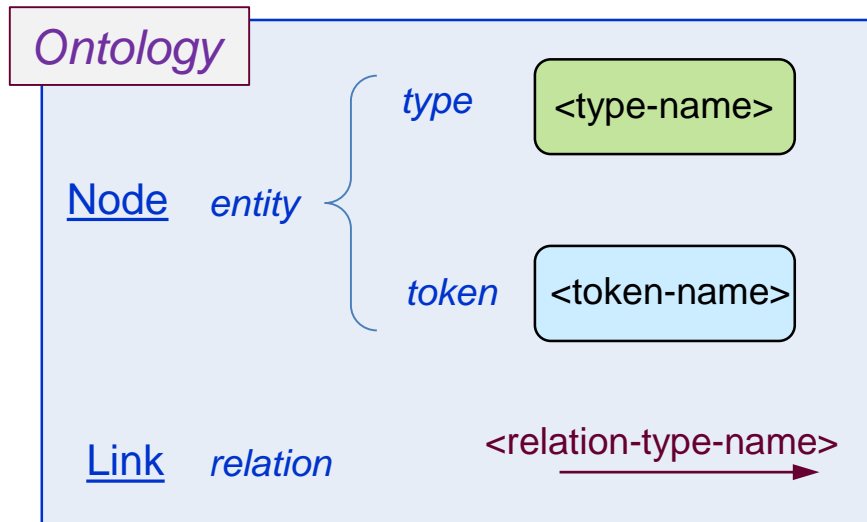
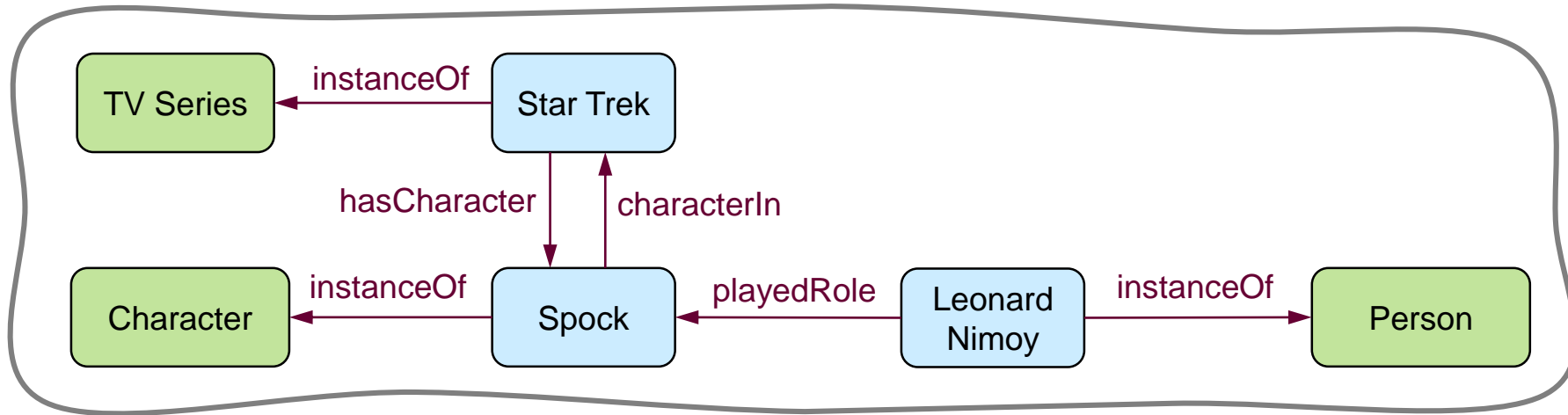


# Question Answering by a Conversational Agent



# Knowledge Graphs

- Knowledge: store of information in organized form*



SIZE OF SOME SCHEMA-BASED KNOWLEDGE BASES

Knowledge Graph	Entities	Number of	
		Relation Types	Facts
Freebase <sup>3</sup>	40 M	35,000	637 M
Wikidata <sup>4</sup>	18 M	1,632	66 M
DBpedia (en) <sup>5</sup>	4.6 M	1,367	538 M
YAGO2 <sup>6</sup>	9.8 M	114	447 M
Google Knowledge Graph <sup>7</sup>	570 M	35,000	18,000 M

Nickel et al, 2015

Who played Spock in Star Trek?







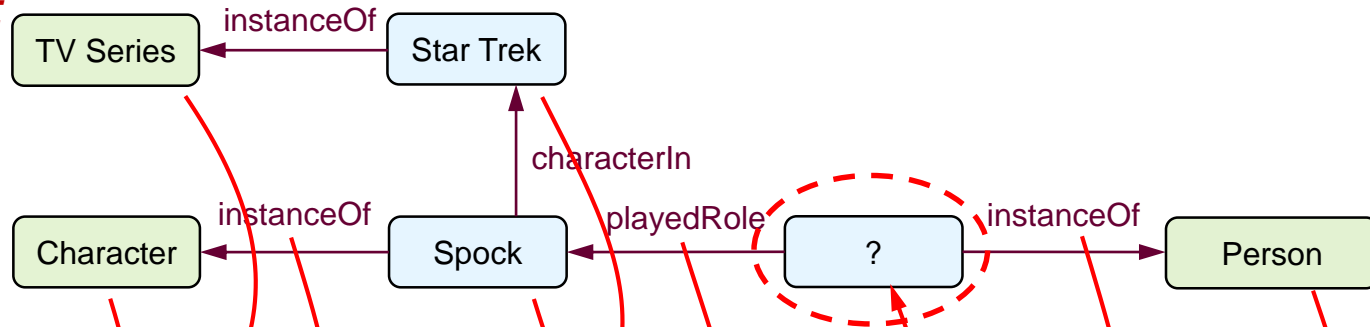
# Querying a Knowledge Graph

*LogicalForm:*

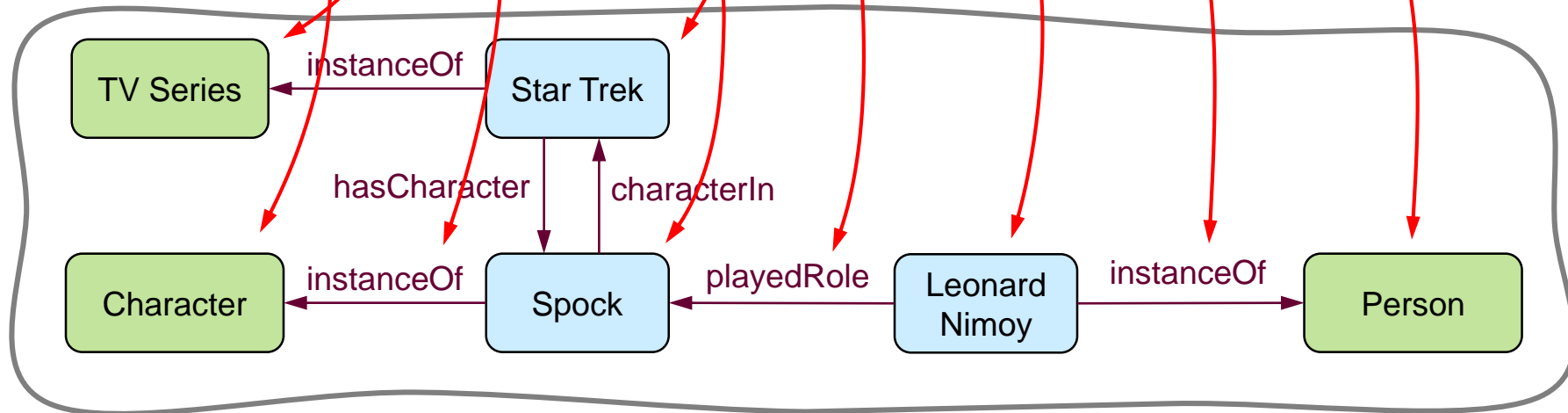
```
Query( playedRole,  
      Person ( ? ),  
      Character ( Spock,  
                  characterIn ( Spock,  
                               TVSeries ( Star Trek ) ) ) )
```



*Query Graph:*



*Subgraph Matching:*



# Knowledge Queries in a Conversational Agent (1)

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Who played Spock in Star Trek?



Spock was played by Leonard Nimoy in Star Trek, the original series.

Who did Leonard Nimoy play in Star Trek?



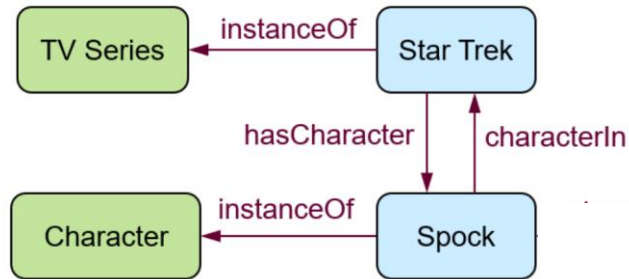
...

Is Leonard Nimoy a Person?



Yes. Leonard Nimoy was an American actor...

# Knowledge Queries in a Conversational Agent (2)



Is Star Trek a television series?



Yes. Star Trek, ,th

Is Spock a character in Star Trek?



Yes. Spock is a fic

Is Spock a character in a television series?

Here's something I found on Wikipedia...

Is Star Trek a pineapple?



No. Star Trek is not a pineapple.

Is Star Trek a pineapple in Mexico?



Hmm. I'm not sure

Is Los Angeles a City?

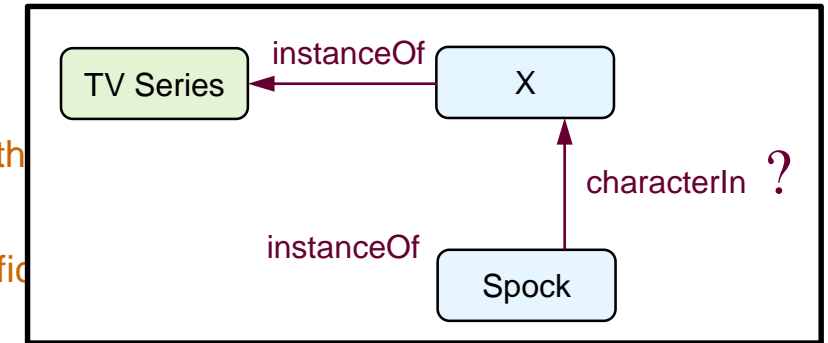


...

Is Los Angeles a Person?



The Rams are third in the NFC West...



# Knowledge Queries and Reasoning



Is a refrigerator heavier than a peanut?



Yes. A refrigerator is heavier than a peanut.

$$\begin{matrix} 1\text{M} \\ \text{Entities} \end{matrix} \times \begin{matrix} 10 \\ \text{Relations} \end{matrix} \times \begin{matrix} 1\text{M} \\ \text{Entities} \end{matrix} = 10^{13}$$

Is Barack Obama taller than William Shatner?

Barack Obama is 6'1" tall, which is 3.48 inches taller than William Shatner. William Shatner is 5'9" tall.

Is Barack Obama taller than a toaster oven?



Sorry, I don't know that one.

How tall is a toaster oven?



A Black & Decker toaster oven is 9.4 inches tall.

Will a baseball float in beer?

Can you tune a violin with a piano?

- Commonsense knowledge
- Commonsense reasoning

Can you tune a violin with a refrigerator?



# The Ingredients of Intelligence

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## Knowledge

- Knowledge Graph

- *Commonsense knowledge*

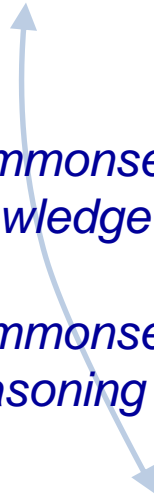
- *Commonsense reasoning*

- *Natural Language*
- *Understanding*

## Reasoning

## Pattern Matching

- Entity/Intent Recognition



# Why Are Conversational Agents So Dumb?

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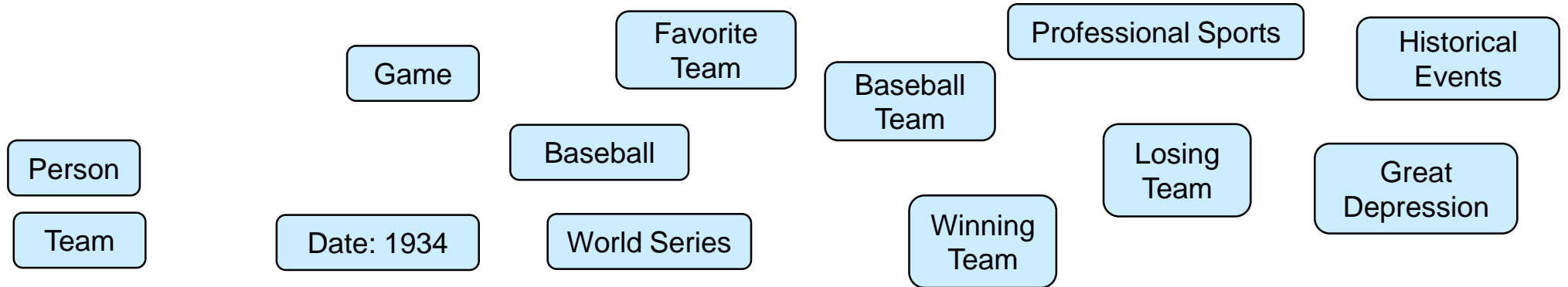
“Alexa, who won the 1934 world series?”

“The Saint Louis Cardinals beat the Detroit Tigers 4-3 in the 1934 World Series.”

“Alexa, who was the president then?”

“This might answer your question. The president of the United States is Donald Trump.”

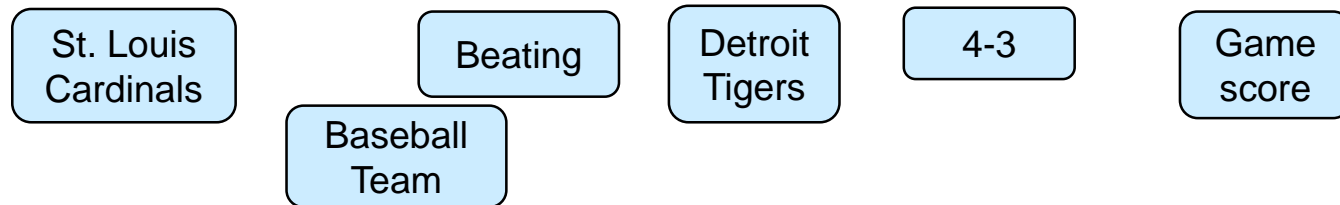
# Dialog Managers and Conversational Context



“Alexa, who won the 1934 world series?”



“The Saint Louis Cardinals beat the Detroit Tigers 4-3 in the 1934 World Series.”



“Alexa, who was the president then?”

# Conversational Accountability

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When were Barack and Michelle Obama married?

GH: Barack Obama has been married to Michelle Obama since October 3rd, 1992.

What is his birthday?

GH: August 4, 1961

What is her birthday?

GH: August 4, 1961

What was my last question?

GH: I heard, "What is her birthday?"



Why did you tell me his birthday?

GH: I don't know why.



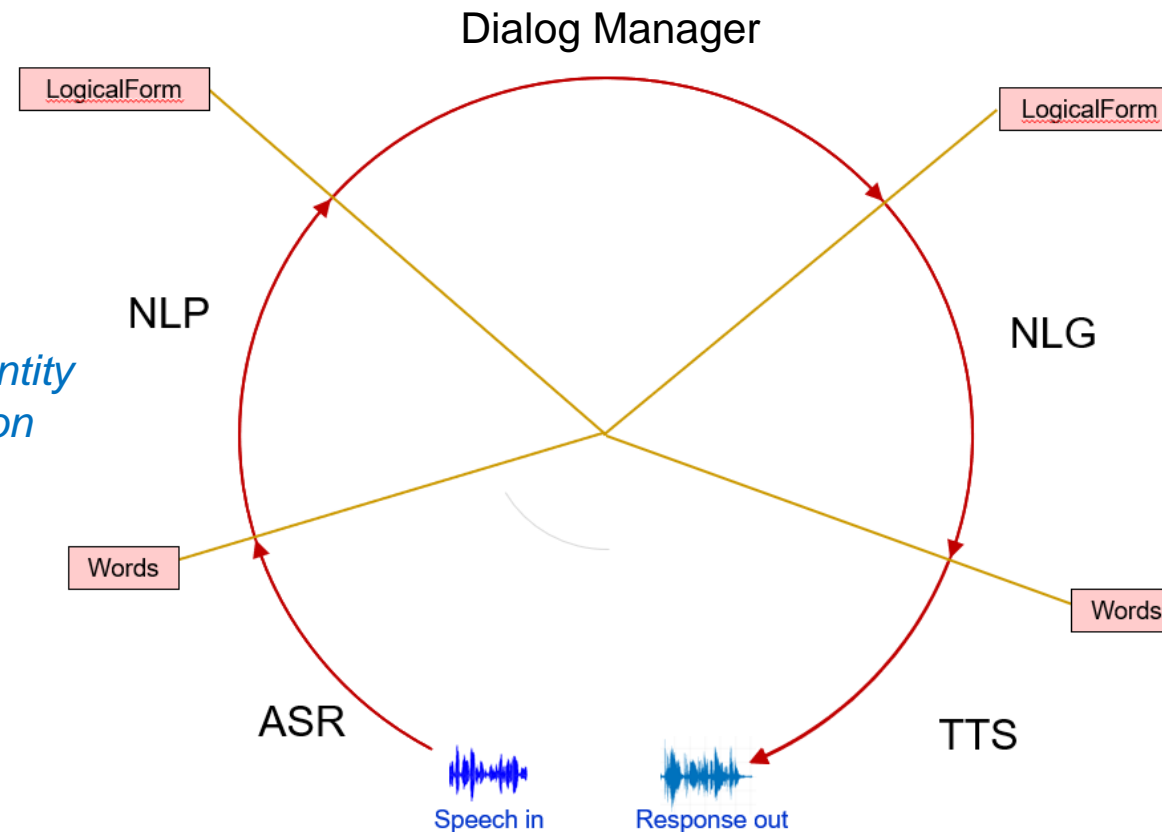
# Dialogue Management in Conversational Agents and Chatbots

- Amazon Lex
- Google Dialogflow
- IBM Watson Assistant
- Microsoft Azure Bot Service
- Rasa.ai
- ...

- *Intent/Entity extraction*

- *Slot filling*
- *Custom rule logic*
- *Learned policy*

<u>Slot</u>	<u>Value</u>
Service:	woman's haircut
Name:	Lisa
Date:	May 3
Time:	12:00pm, morning



# Google Assistant (Duplex)

**Hair Salon:** Hello how can I help you?

**Google Assistant:** Hi, I'm calling to book a women's haircut for a client.  
Um, I'm looking for something on May 3rd.

**Hair Salon:** Sure, give me one second.

**GA:** Mm-hmm.

**Hair Salon:** Sure what time are you looking for around?

**GA:** At 12 pm.

**Hair Salon:** We do not have a 12 pm available. The closest we have to that is a 1:15.

**GA:** Do you have anything between 10 am and uh 12 pm?

**Hair Salon:** Depending on what service she would like. What service is she looking for?

**GA:** Just a woman's haircut, for now.

**Hair Salon:** Okay we have a 10 o'clock.

**GA:** 10 a.m. is fine.

**Hair Salon:** Okay, what's her first name?

**GA:** The first name is Lisa.

**Hair Salon:** Okay perfect. So I will see Lisa at 10 o'clock on May 3rd.

**GA:** Okay great, thanks.

**Hair Salon:** Great. Have a great day. Bye.



(56 seconds)

<u>Slot</u>	<u>Value</u>
Service:	woman's haircut
Name:	Lisa
Date:	May 3
Time:	12:00pm, morning



- Human intervention:  
2019: 60% of reservations handled end-to-end by GA

# Social Chatbots

## 3.1 System Overview

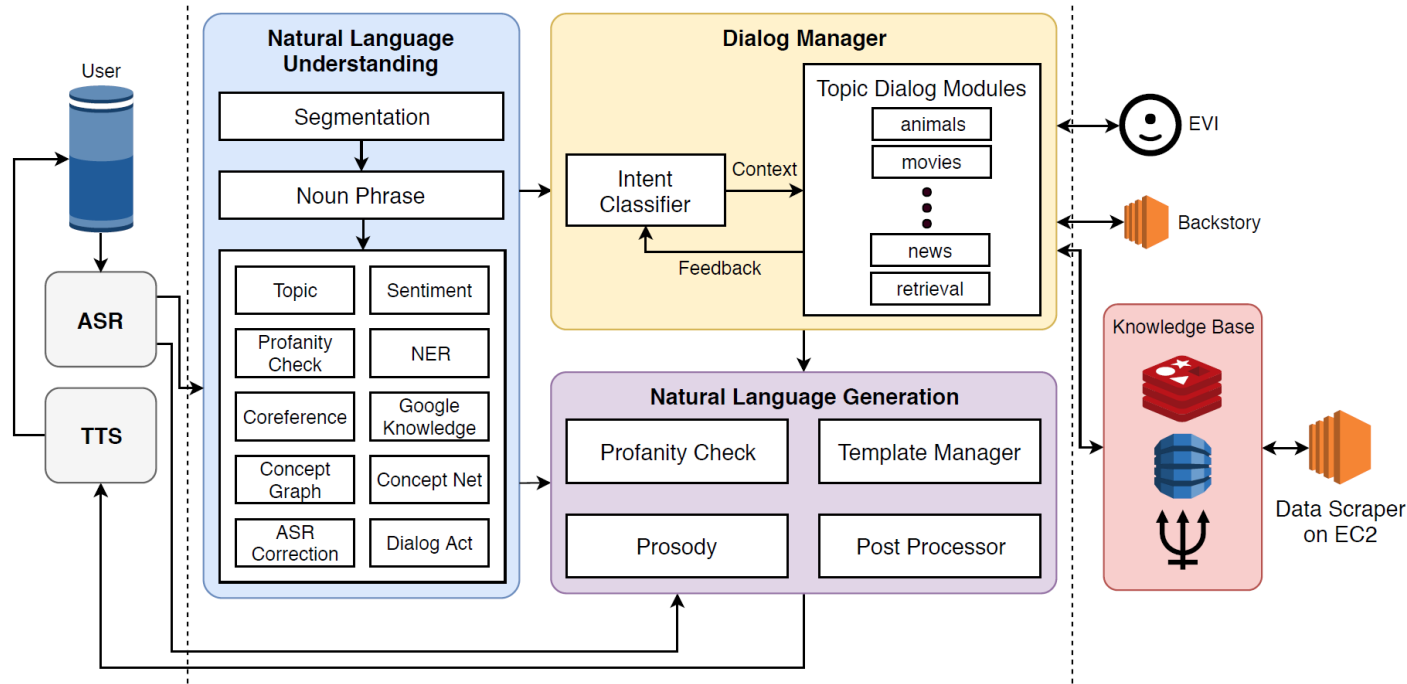


Figure 1: Social Bot Framework



Sophia



ELIZA



Paro

### Gunrock: Building A Human-Like Social Bot By Leveraging Large Scale Real User Data

Chun-Yen Chen\*, Dian Yu,<sup>‡</sup> Weiming Wen,<sup>‡</sup> Yi Mang Yang, Jiaping Zhang, Mingyang Zhou  
Kevin Jesse, Austin Chau, Antara Bhowmick, Shreenath Iyer, Girithija Sreenivasulu  
Runxiang Cheng, Ashwin Bhandare, Zhou Yu<sup>§</sup>  
Department of Computer Science  
University of California, Davis  
Davis, CA 95616



## Conclusion: Modern Robot Psychology

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- Take responsibility for understanding Autonomous AI technology.
- Robot psychology is fun!
- Not as mysterious as it seems (yet).



# Eric Saund

- *Research scientist in Cognitive Science and AI.*
- *Conversational Agents, Visual Perception, Cognitive Architectures.*
- *I build stuff.*

Projects

Papers

Curiosities

Links

Contact

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*Conversation*