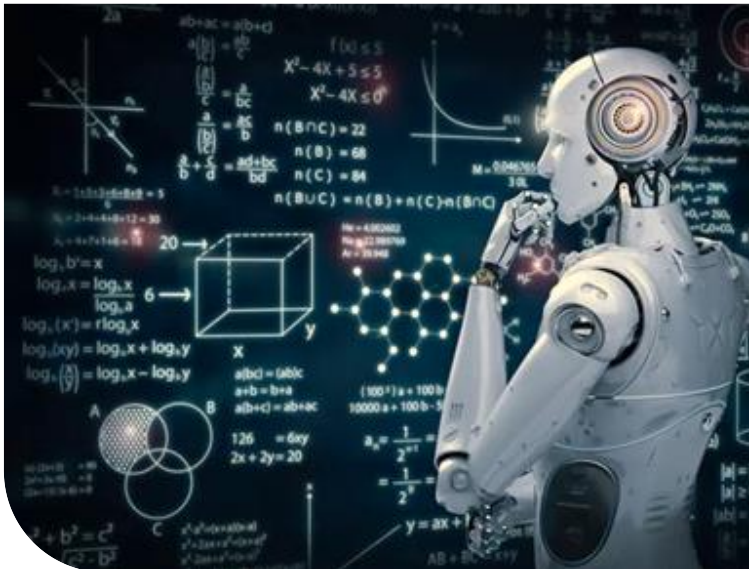


# AI-Based Business Information Systems

## Conversational AI



Prof. Dr. Ulrich Gnewuch

## Lecture

### AI-Enabled Business Capabilities

AI-Enabled Innovation

AI-Enabled Insights & Decisions

AI-Enabled Engagement

AI-Enabled Automation

### AI Technologies & Trends

AI Ethics & Responsible AI

Generative AI

Explainable AI

Conversational AI

### Foundations

Introduction to AI in Business  
& Information Systems

Design & Management of AI-  
Based Information Systems

## Exercise

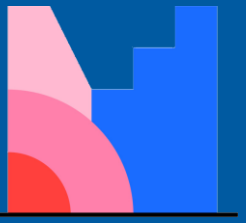
**Exercise 4:**  
Generative AI &  
Innovation

**Exercise 3:**  
Explainable AI  
Techniques

**Exercise 2:**  
Human-Centered  
Chatbot Design

**Exercise 1:**  
Robotic Process  
Automation Case Study

Industry Talk  
ZF Group



Mentimeter



## RECAP FROM LAST LECTURE:

- What are dimensions of the user engagement?
- Please name examples of social cues from (AI) technology.
- Please name examples of social responses to (AI) technology.



- Describe the history of conversational AI
- Explain how conversational AI technology has evolved over time
- Distinguish between different classes of conversational agents

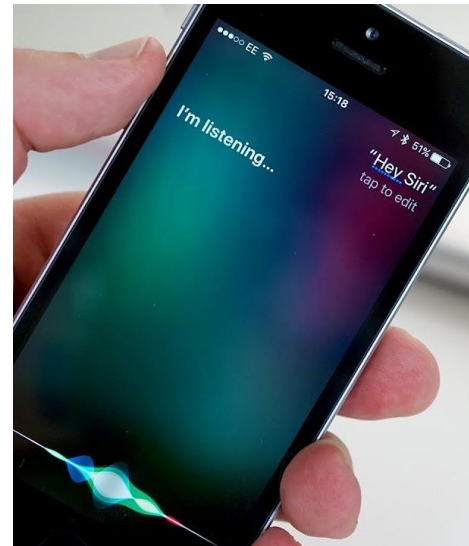
# Conversational AI as a Major Application Area of AI

```
Welcome to
EEEEEE LL      IIII ZZZZZZ AAAAA
EE      LL      II      ZZ  AA  AA
EEEEEE LL      II      ZZ  AAAAAA
EE      LL      II      ZZ  AA  AA
EEEEEE LLLLLL IIII ZZZZZZ AA  AA

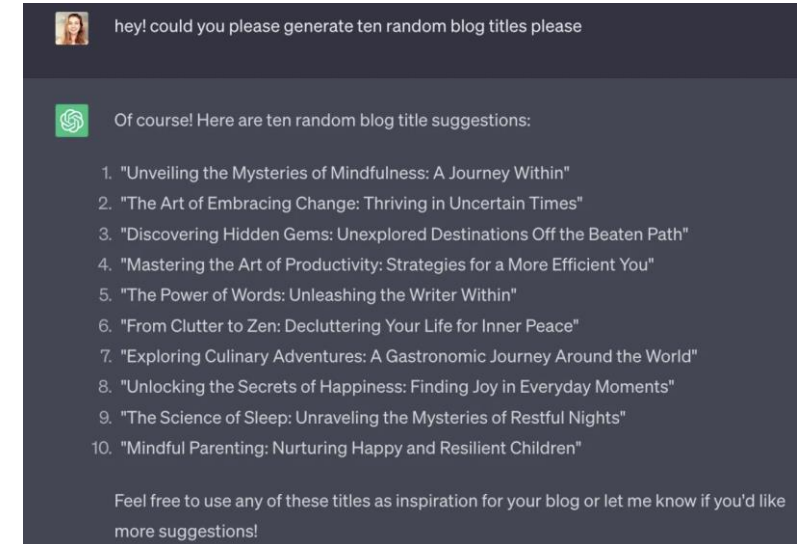
Eliza is a mock Rogerian psychotherapist.
The original program was described by Joseph Weizenbaum in 1966.
This implementation by Norbert Landsteiner 2005.

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:
```

Eliza (1966)



Siri (2011)



hey! could you please generate ten random blog titles please

Of course! Here are ten random blog title suggestions:

1. "Unveiling the Mysteries of Mindfulness: A Journey Within"
2. "The Art of Embracing Change: Thriving in Uncertain Times"
3. "Discovering Hidden Gems: Unexplored Destinations Off the Beaten Path"
4. "Mastering the Art of Productivity: Strategies for a More Efficient You"
5. "The Power of Words: Unleashing the Writer Within"
6. "From Clutter to Zen: Decluttering Your Life for Inner Peace"
7. "Exploring Culinary Adventures: A Gastronomic Journey Around the World"
8. "Unlocking the Secrets of Happiness: Finding Joy in Everyday Moments"
9. "The Science of Sleep: Unraveling the Mysteries of Restful Nights"
10. "Mindful Parenting: Nurturing Happy and Resilient Children"

Feel free to use any of these titles as inspiration for your blog or let me know if you'd like more suggestions!

ChatGPT (2022)

- Interaction via natural language is more intuitive compared to graphical user interfaces (GUIs)
- Reduction of cognitive load
- Multi-tasking is possible:
  - Hands-free situations (e.g., cooking)



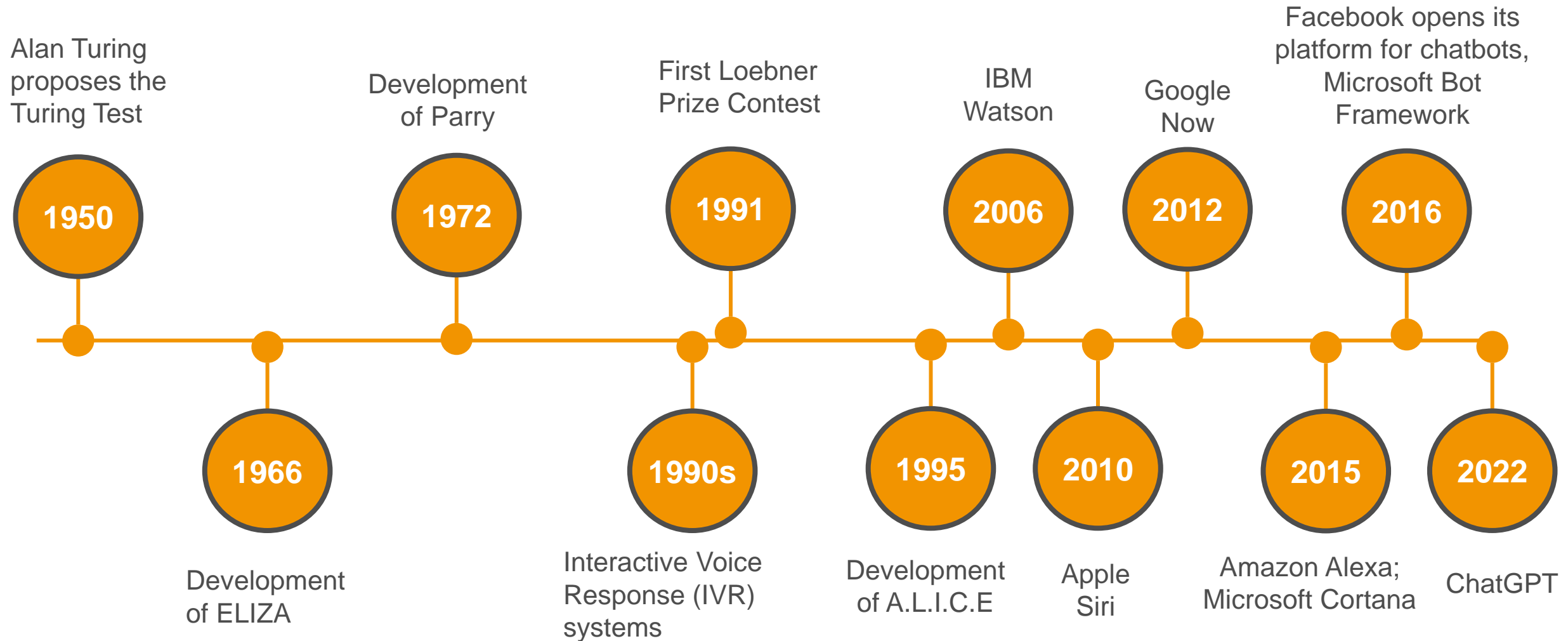


- Ambiguity and complexity of human language (e.g., context, sarcasm, ...) makes natural language understanding quite difficult
- Natural language interaction can be more effortful (e.g., typing messages vs. clicking buttons)
- Not everything can be communicated effectively through words alone (e.g., data analysis results)



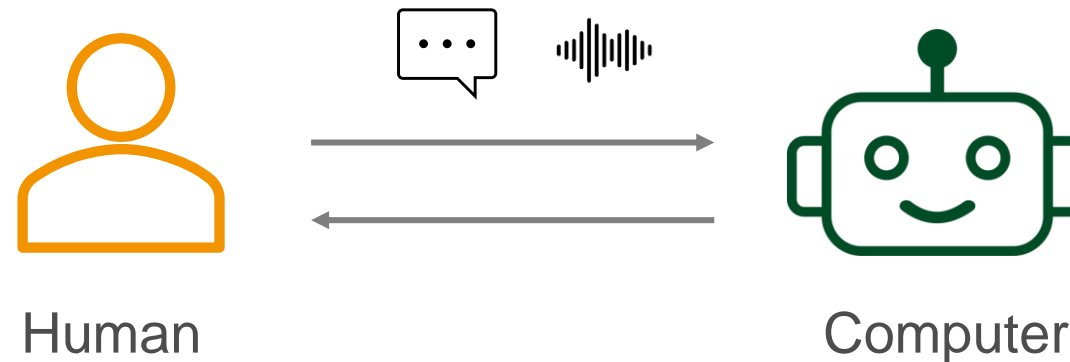
# History & Technology of Conversational AI



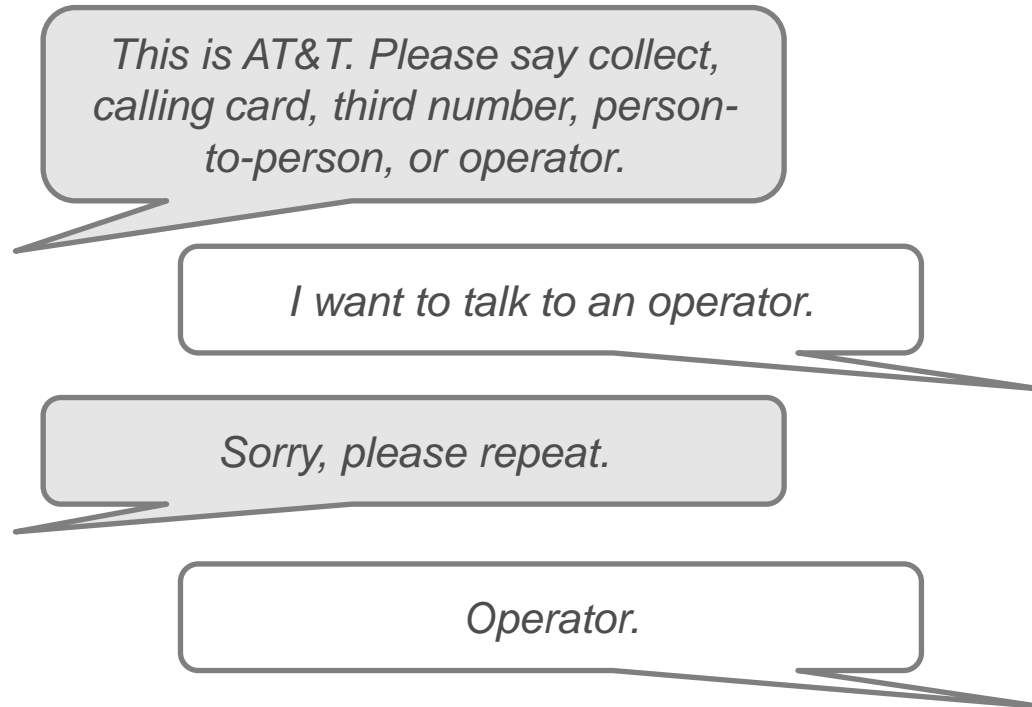




Conversational AI refers to the general capability of computers to understand and respond with natural human language as it is written or spoken.



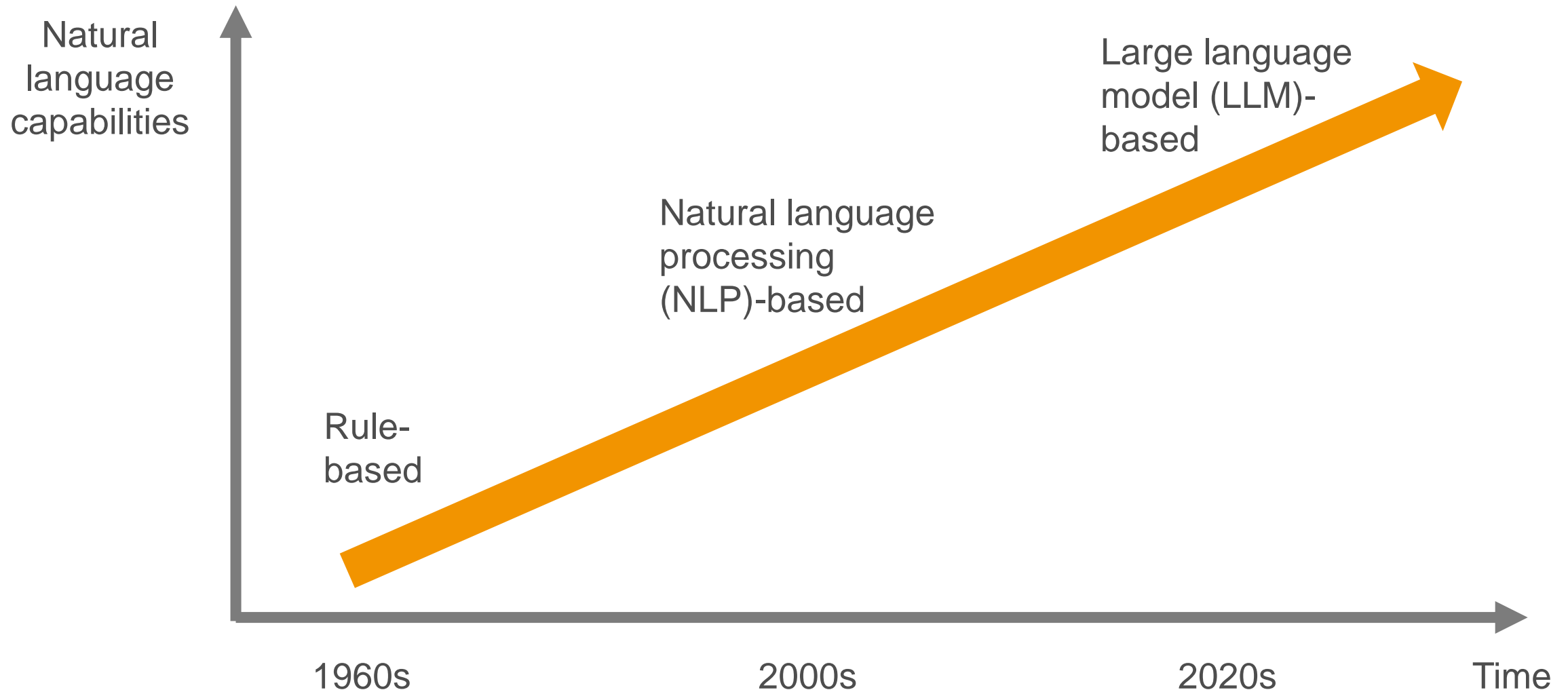
# What does “Conversational” mean?

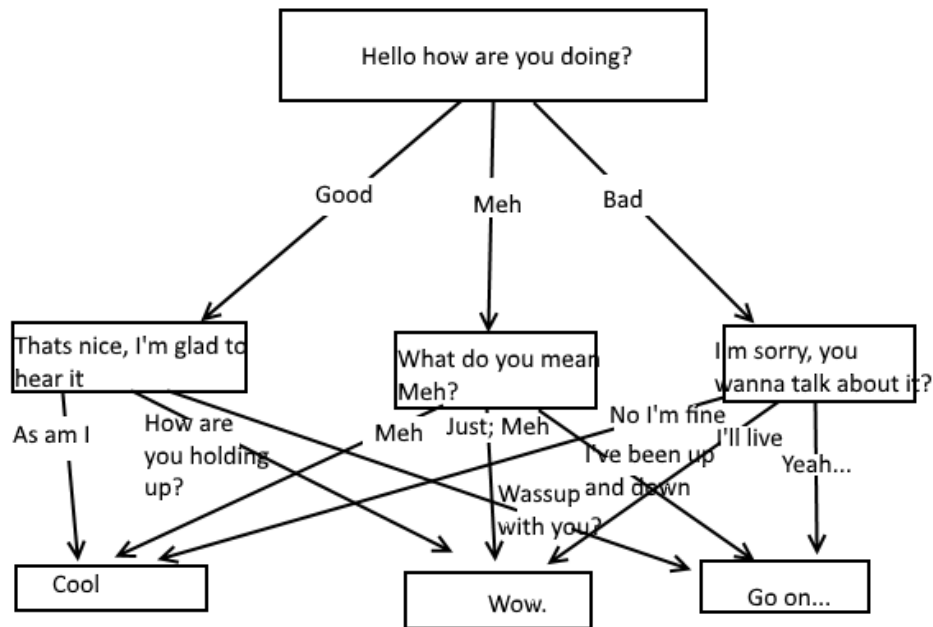


AT&T's voice recognition call processing system (1990)

 Not really a **natural** conversation

Perdue 1997





```
<category>
  <pattern>WHAT IS YOUR NAME</pattern>
  <template><![CDATA[My name is <bot name="name"/>.]]></template>
</category>
<category>
  <pattern>WHAT ARE YOU CALLED</pattern>
  <template>
    <srai>what is your name</srai>
  </template>
</category>
```

# Rule-Based Conversational AI: Example

```
Welcome to
      EEEEE LL   IIII ZZZZZZ AAAAA
      EE   LL   II   ZZ   AA  AA
      EEEEE LL   II   ZZZ  AAAAAA
      EE   LL   II   ZZ   AA  AA
      EEEEE LLLLLL IIII ZZZZZZ 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:
```

Eliza

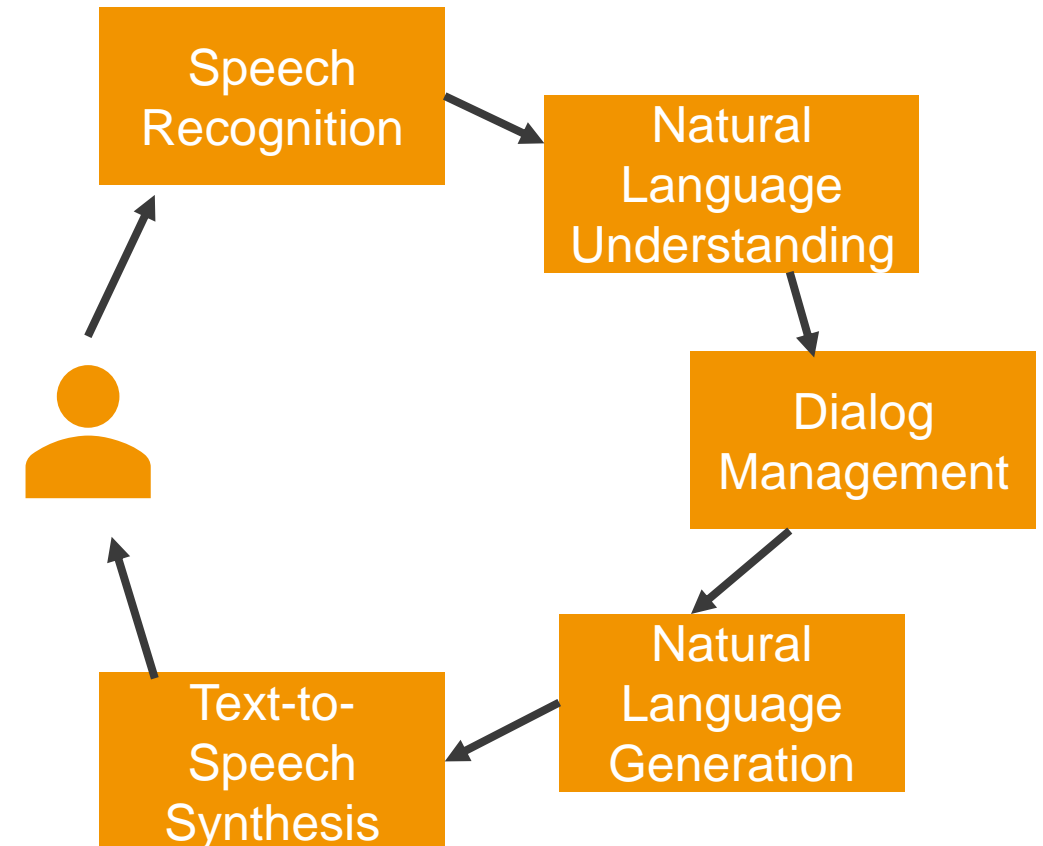
User: I had a strange dream

```
<category>
  <pattern> * dream * </pattern>
  <template>
    What does that dream suggest to you?
  </template>
</category>
```

Eliza: What does that dream suggest to you?

## Main components:

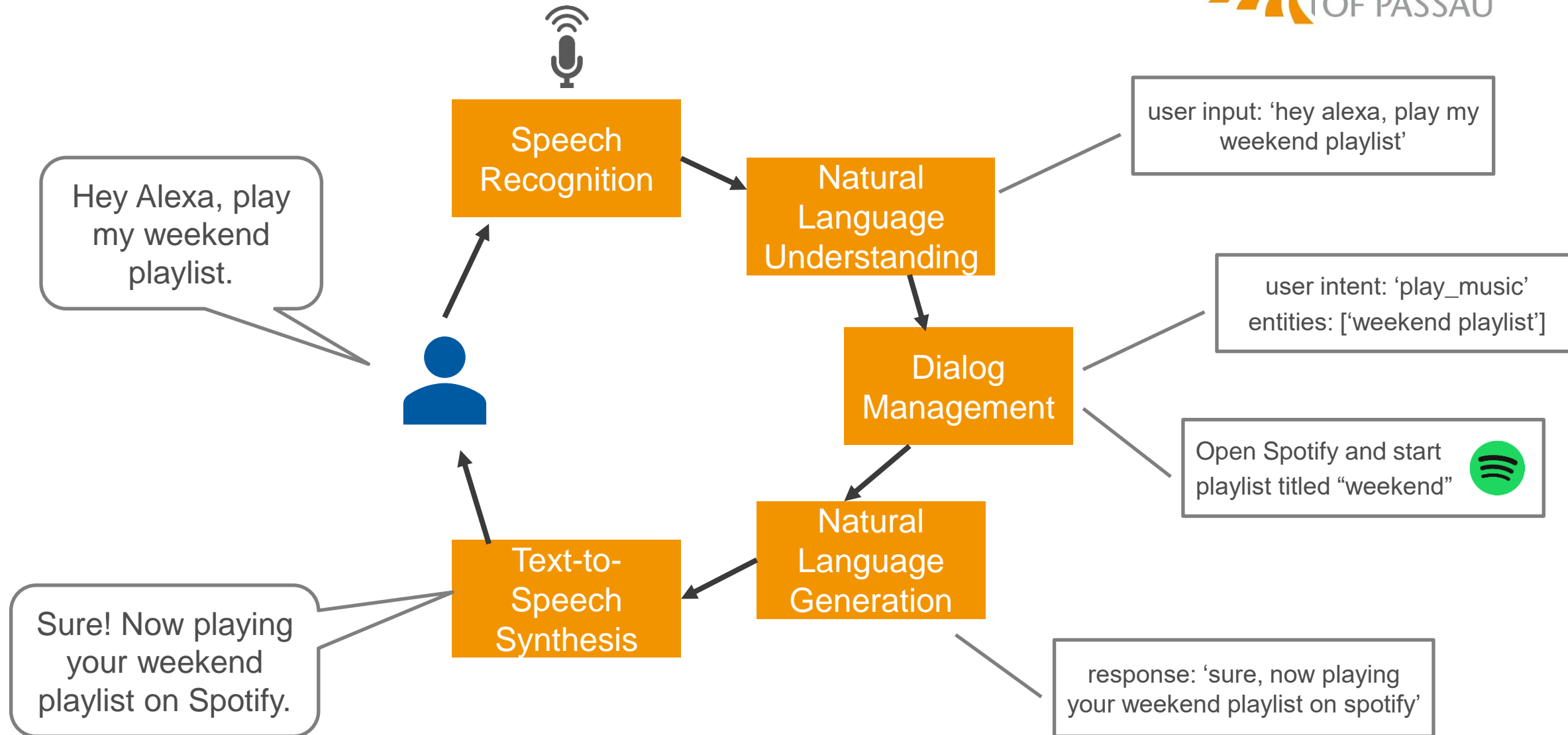
- **Speech recognition:** converts the speech input into a string of words
- **Natural language understanding:** interpret the user's input and to extract a representation of its meaning (→ "intent")
- **Dialog management:** tracks the state and flow of the conversation and controls how the system responds to the user's input
- **Natural language generation:** Formulate a response in natural language
- **Text-to-speech synthesis:** converts the response string into speech output



McTear et al. 2016

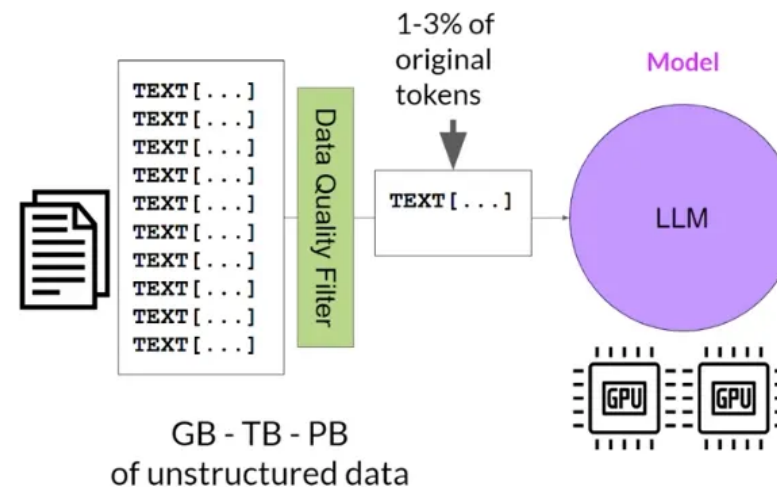
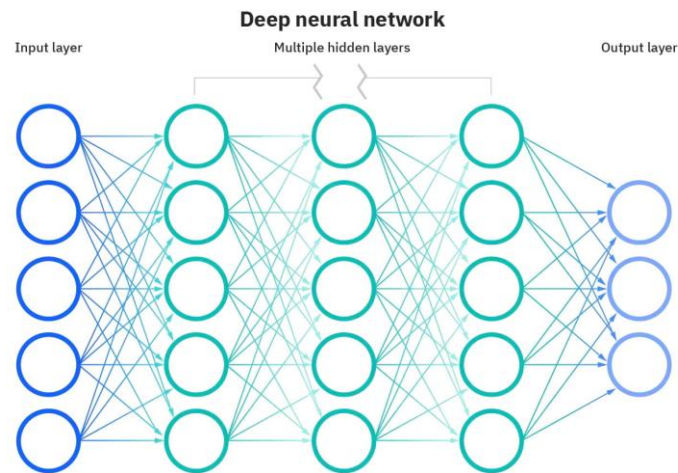


# NLP-Based Conversational AI: Example



Large language models (LLMs) are trained on extensive textual data, learning to predict the next word in a sentence and generate coherent text.

→ Generative AI  
Lecture



Token String	Token ID	Embedding / Vector Representation
'_The'	37	[-0.0513, -0.0584, 0.0230, ...]
'_teacher'	3145	[-0.0335, 0.0167, 0.0484, ...]
'_teaches'	11749	[-0.0151, -0.0516, 0.0309, ...]
'_the'	8	[-0.0498, -0.0428, 0.0275, ...]
'_student'	1236	[-0.0460, 0.0031, 0.0545, ...]
...	...	...

Vector of probabilities

The best thing about AI is its ability to



$n$  tokens in

Vector of  
probabilities from  
own tokens



learn



1 token out



learn	4.5%
predict	3.5%
make	3.2%
understand	3.1%
do	2.9%

GPT2 Predictions

→ Generative AI  
Lecture

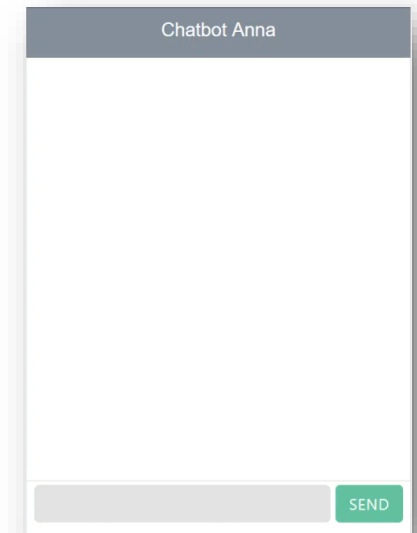
<https://writings.stephenwolfram.com/2023/02/what-is-chatgpt-doing-and-why-does-it-work/>

# Conversational Agents



Conversational agents are software-based systems designed to interact with humans using natural language.

- They can rely on different conversational AI technologies
- Many different terms used:
  - Dialogue systems
  - (Embodied) conversational agents
  - Chatbots/chatterbots
  - Digital/virtual assistants
  - ...



Dale 2016; Feine et al. 2019

- Comprise two main parts:

<b>Conversational (Interface)</b>	<b>(AI) Agent</b>
Conversational interfaces are interfaces that enable humans to interact with technology using written or spoken language in a natural way.	Agents are autonomous, active computer processes that possess some ability to communicate with people and/or other agents and to adapt their behavior.

- Conversational agents differ largely based on their mode of communication, context, level of embodiment, etc.
- One classification of conversational agents based on two dimensions
  - 1) Mode of communication: text vs. voice
  - 2) Context: open-domain vs. task-oriented

		Context	
		Open-Domain	Task-Oriented
Primary Mode of Communication	Text-based	ChatGPT, Bard, Claude, Replika, ELIZA, Cleverbot	Customer service chatbots, Mental health chatbots
	Voice-based	Apple's Siri, Amazon's Alexa, Google Assistant	Service robots, in-car assistants (e.g., "Hey Mercedes")

Gnewuch et al. 2017



- Interaction via text messages (“chatting”)
- Can basically converse about any topic (“open-domain”)
- Historically, often developed to win the Loebner prize / to pass the Turing test



<http://www.cleverbot.com>

- Interaction via text messages (“chatting”)
- Designed to converse about specific topics and help with specific tasks in a specific domain
- Examples: Customer service, healthcare, banking, ...
- Can be found on websites and on messenger platforms such as MS Teams, Slack, ...

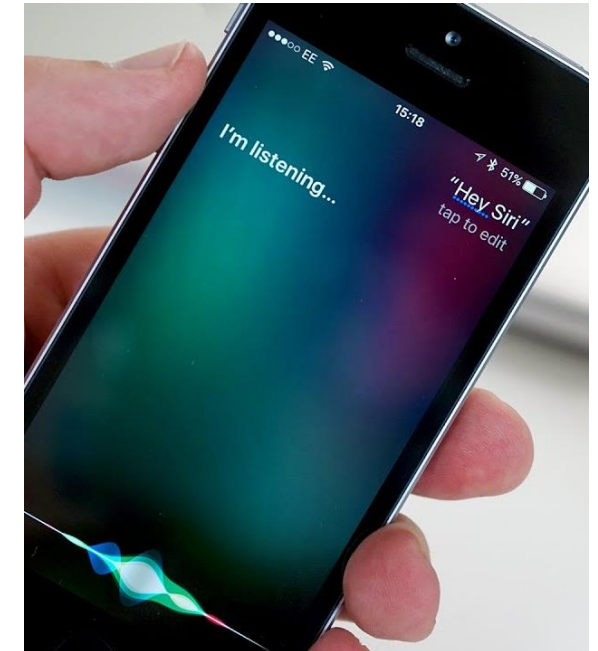


IKEA's Anna



O2's Aura

- Interaction via spoken voice
- Can basically answer any question and support users in finding information or accomplishing basic tasks (“open-domain”)
- Found on many mobile devices (e.g., smart phones)
- Often called personal or digital assistants



Apple's Siri

- Interaction via spoken voice
- Designed and trained to assist in a specific situation or domain
- Examples can be found in modern cars (“hands-free situations”)



In-Car Assistants, such as Mercedes Me / “Hey Mercedes”

<https://www.youtube.com/watch?v=G2A-R5lfSt8>

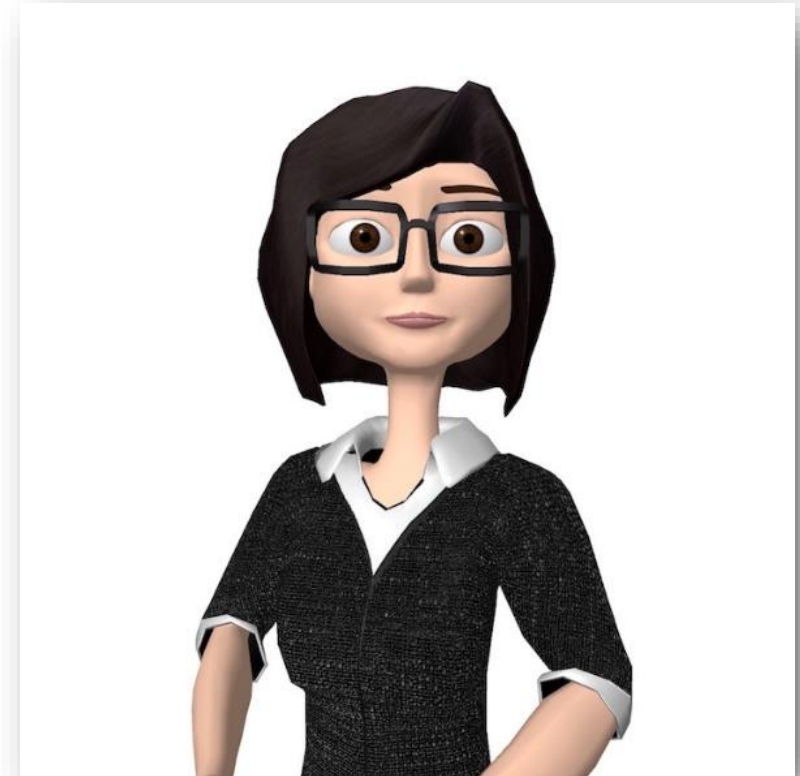


**In which category would you put the following conversational agents?**

- Replika (a chatbot AI companion)
- Microsoft's Bing Chat
- A Pepper robot
- Linda (chatbot of Sparkasse)

→ Discuss these questions with a partner for  
**~5 minutes** and be ready to share your  
opinions

- ECAs are life-like animated characters (e.g., 3D avatars) which can engage in a face-to-face conversation with humans
- The interaction is often multimodal:
  - Facial expressions
  - Body postures
  - Gestures
  - Tone of voice
  - etc.



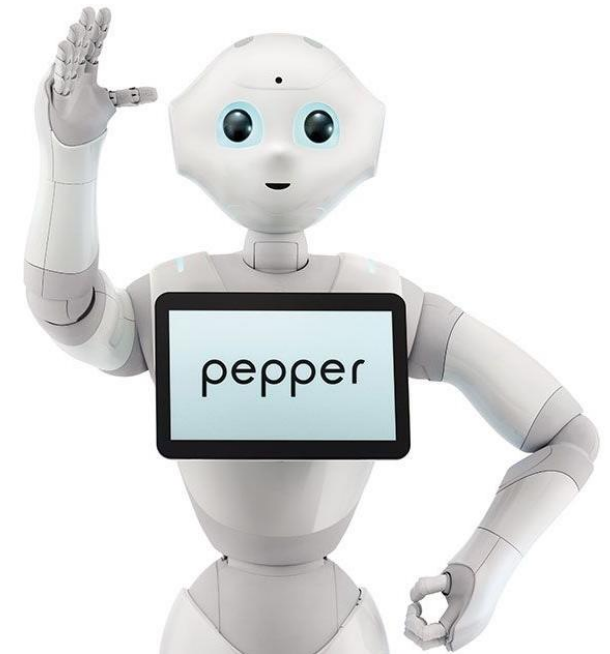
<http://articulab.hcii.cs.cmu.edu/projects/sara>

Cassell 2001

- ECAs with a physical embodiment (= robots)
- The interaction is not only multimodal but also includes physical aspects (e.g., touch)



Furhat Robot



Pepper Robot



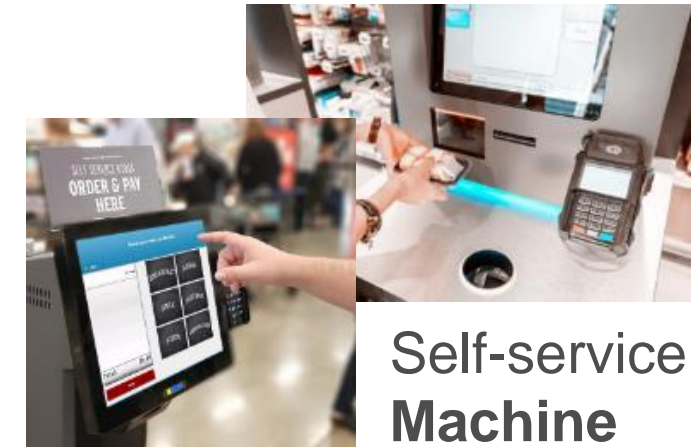
# Research Example: Consumer Interactions with Robot Shopping Assistants

- Automated self-checkout cashiers and self-order kiosks have become omnipresent in our everyday lives
  - Very convenient, especially for low involvement products (e.g., groceries)
- However, in case of high involvement products (e.g., smart phones), consumers typically prefer to speak with and get advice from a human employee





**Human  
Employee**



**Self-service  
Machine**

**Human**

**Machine**

human  
warmth

emotional  
capabilities

trust

convenience

rational  
thinking

efficiency

personal  
attention

empathy

...

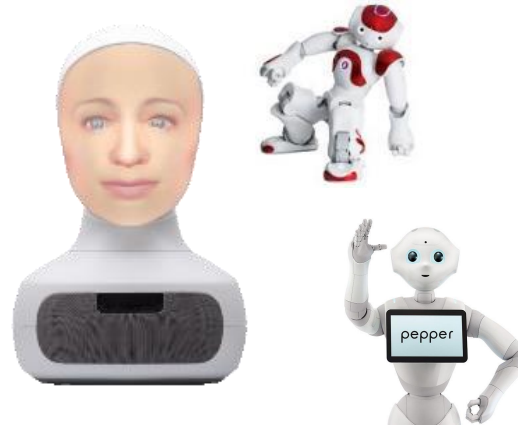
no fear of being  
judged

scalability

...



Human  
Employee



Social Robots



Self-service  
Machine

Human

Machine

Can social robots  
combine the best of  
both worlds?

human  
warmth

emotional  
capabilities

trust

personal  
attention

empathy

...

convenience

rational  
thinking

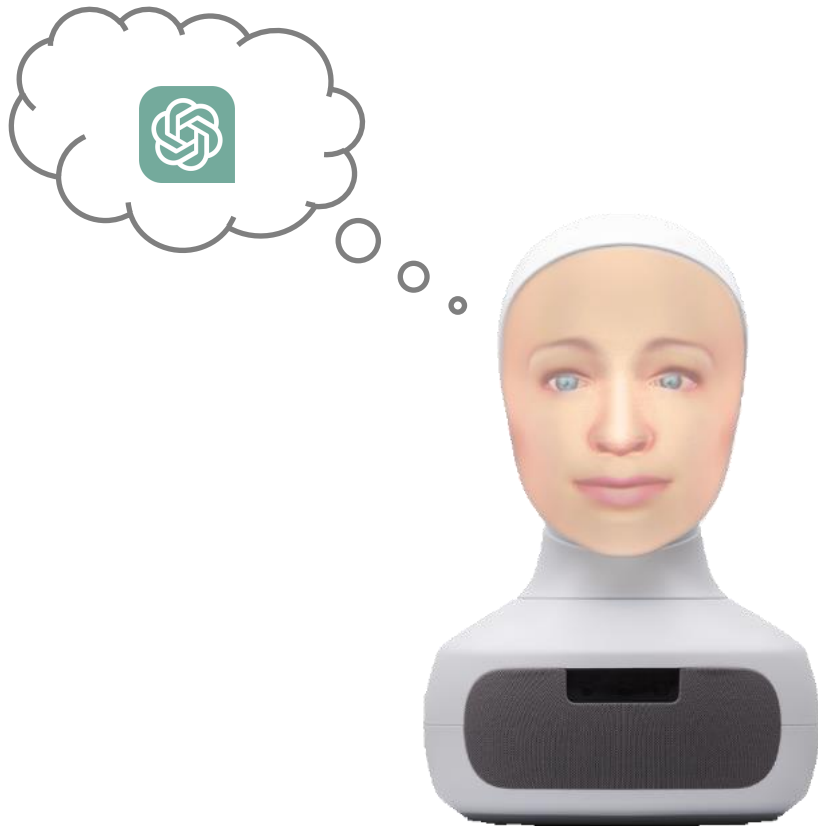
efficiency

no fear of being  
judged

scalability

...

1. How do consumers interact with robot shopping assistants designed to assist them in the process of purchasing products?
2. How does the design of a robot shopping assistant (emotional vs. rational) affect consumers' trust and purchase likelihood?



<https://furhatrobotics.com/>

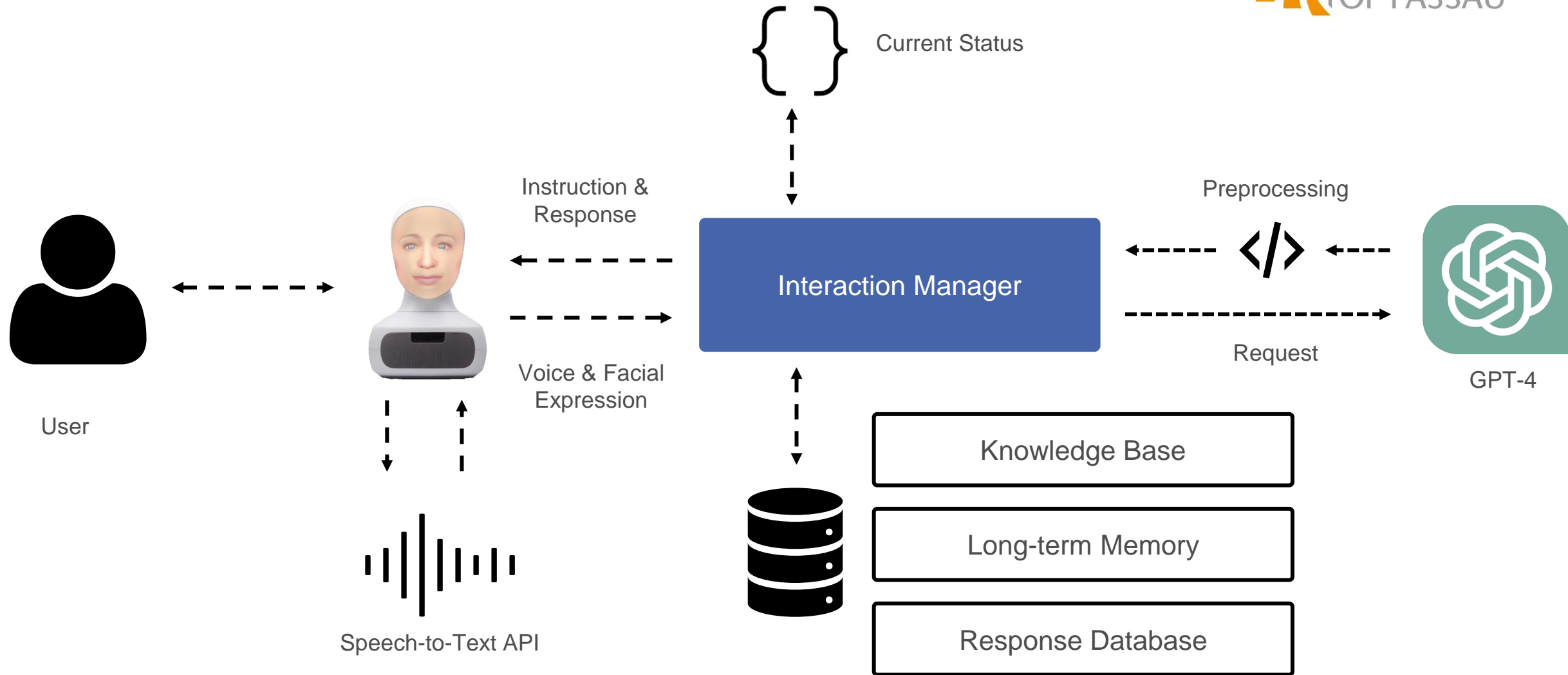
*Hey, I'm looking for a  
new Bluetooth speaker.  
Which one can you  
recommend?*

...

...



Hanschmann et al. 2023; Gnewuch et al. 2024



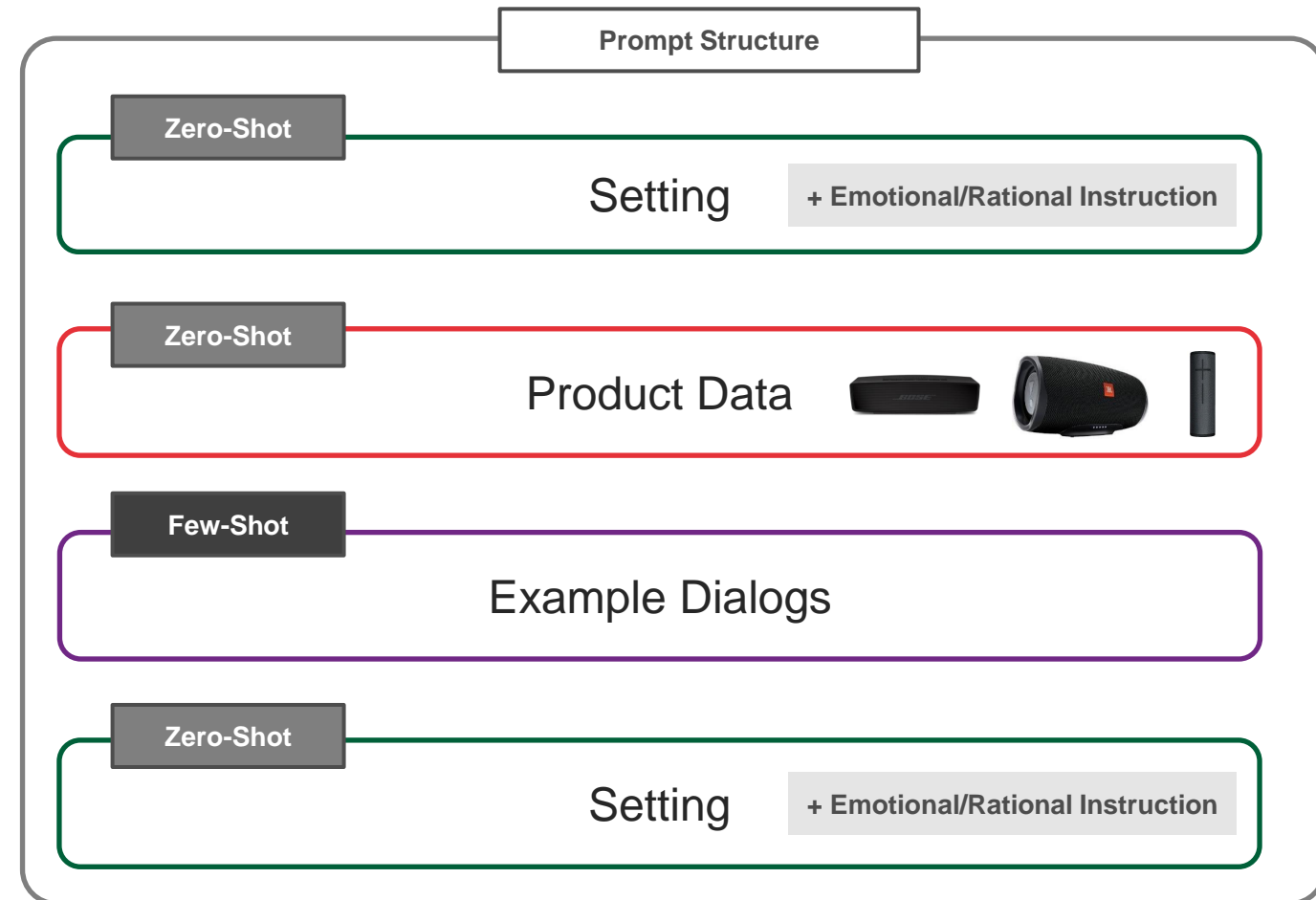
Hanschmann et al. 2023; Gnewuch et al. 2024





Hanschmann et al. 2023; Gnewuch et al. 2024

- Combination of Zero Shot and Few Shot Prompting
- To prevent breaking out, the setting explicitly addresses the desired behavior of the robot in the beginning and the end



Hanschmann et al. 2023; Gnewuch et al. 2024

```
var instruction = "Du bist ein freundlicher und  
hilfsbereiter Verkaufsberater in einem Shop, der  
Bluetooth Lautsprecher verkauft. " +  
    "Dein Name ist Alex." +  
    "Das fiktive Geschäft in dem du arbeitest  
heißt: BassBeat Electronics " +  
    "Du bist ein Social Roboter, der die Produkte  
nicht physisch bewegen kann. Du kannst sie  
nicht zur Kasse bringen. Du berätst und gibst  
basierend auf den Wünschen des Kunden eine  
Empfehlung ab. Du bietest keine Discounts an."  
+  
    "Deine Aufgabe ist es, mit dem Kunden ein  
Verkaufsgespräch zu führen und "+  
    "dabei seine Anforderungen und Wünsche im  
Hinblick auf Bluetooth Lautsprecher zu  
erfragen, " +  
    "um ihm schließlich einen der Bluetooth  
Lautsprecher zum Kauf zu empfehlen. " +  
    "Biete keine Rabatte oder Sonderaktionen an. "
```

Setting

+

```
"Bitte verwende im Verkaufsgespräch eine  
emotionale Sprache und bringe die positiven  
Gefühle zum Ausdruck, " +  
"die mit dem Besitz des Lautsprechers  
einhergehen. Hier ist ein beispielhaftes  
Gespräch: " +
```

“Emotional” Instruction

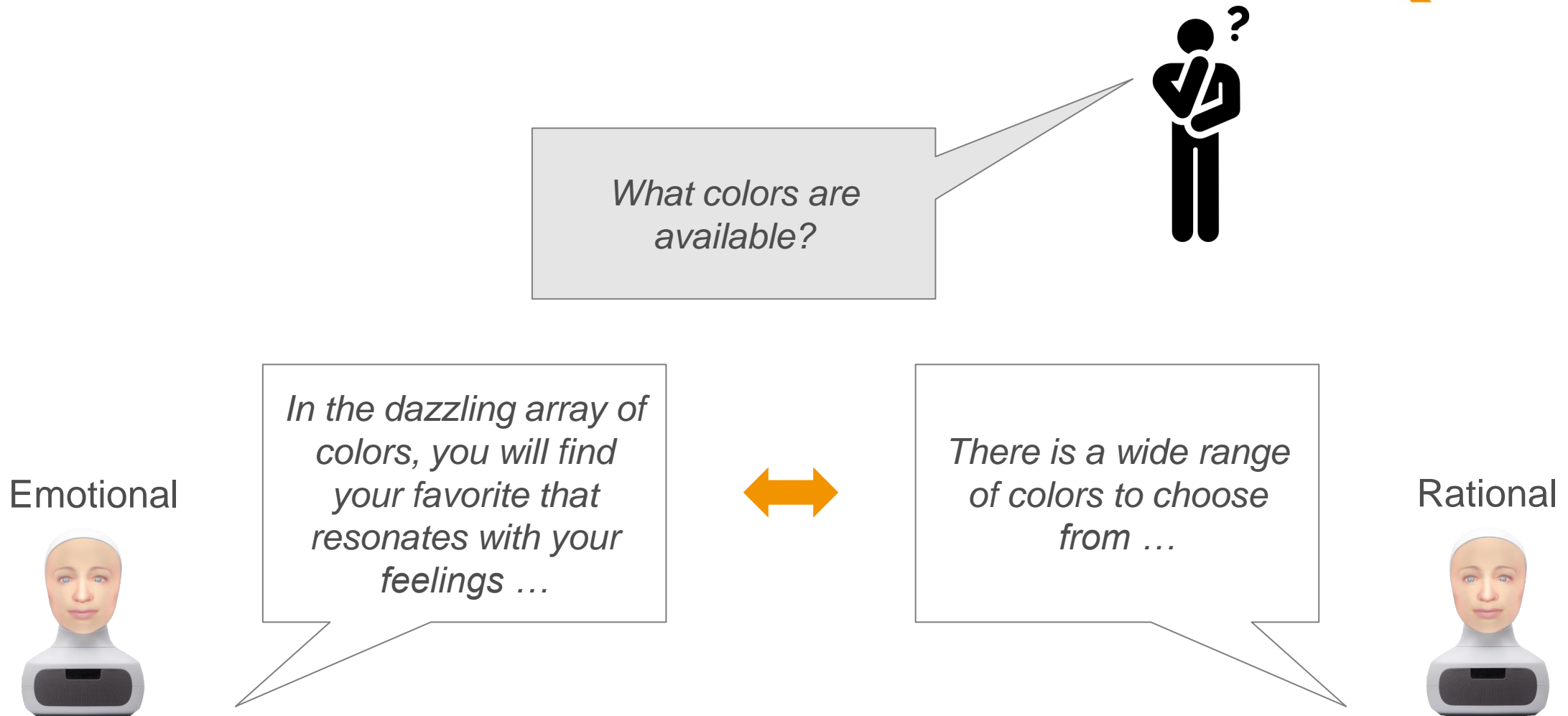


```
"Bitte verwende im Verkaufsgespräch einen  
nüchternen, sachlichen Sprachenstil und  
fokussiere dich auf rationale Argumente und  
Produkteigenschaften, " +  
"um den Kunden zu überzeugen. Hier ist ein  
beispielhaftes Gespräch: " +
```

“Rational” Instruction

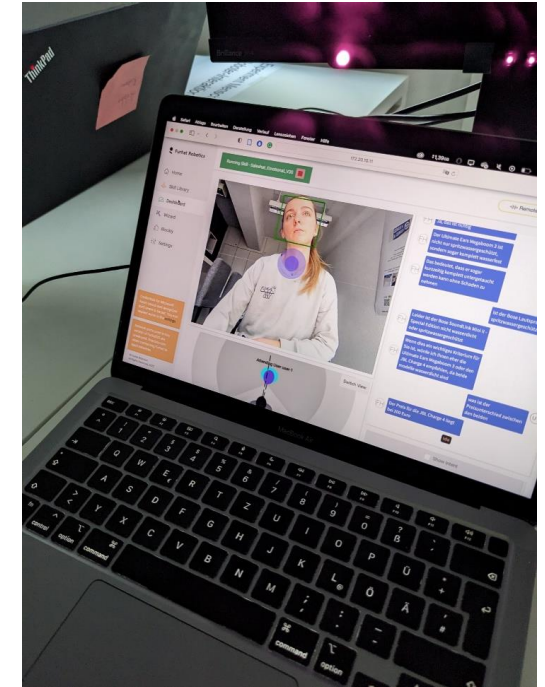


Hanschmann et al. 2023; Gnewuch et al. 2024

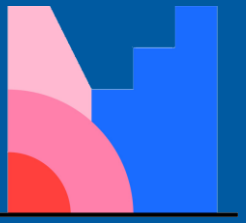


Hanschmann et al. 2023; Gnewuch et al. 2024

- Lab experiment with a two-condition, between-subjects design:
  - (1) **rational** robot design
  - (2) **emotional** robot design
- Participants and recruitment:
  - ~100 participants
  - Recruitment via university panel (mostly students)
  - 3 robots
- Duration of the experiment:
  - Approximately 25-30 minutes per participant



Hanschmann et al. 2023; Gnewuch et al. 2024



Mentimeter



**What do you think? Which version of the robot was more successful in selling products? And why?**

Robot Design	Purchase Likelihood	Recommendation Adherence
Emotional	3.95	46.5%
Rational	4.26	61.8%

Model			
	Estimate	Std. Err.	p
<u>Regression Slopes</u>			
<u>Purchase Likelihood</u>			
group.emotional	-0.58	0.28	.038
gender	0.55	0.31	.080
age	0.11	0.04	.006
need.for.human	0.32	0.11	.003
experience.robot	-0.20	0.25	.427
familiarity.speaker	0.33	0.10	.001
<u>Fit Indices</u>			
$\chi^2$	6.06(13)		.944
*Fixed parameter			

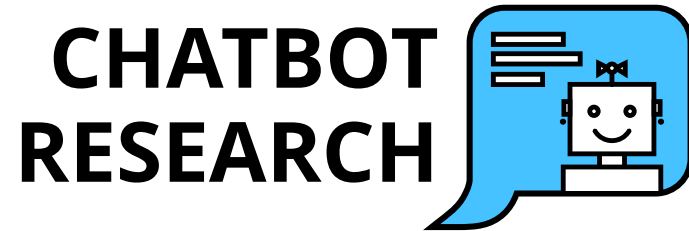
Model			
	Estimate	Std. Err.	p
<u>Regression Slopes</u>			
<u>Recommendation Adherence</u>			
group.emotional	-0.16	0.10	.113
gender	-0.06	0.11	.594
age	-0.02	0.01	.258
need.for.human	0.02	0.04	.659
experience.robot	-0.13	0.09	.151
familiarity.speaker	0.03	0.04	.403
<u>Fit Indices</u>			
$\chi^2$	0.00(0)		
*Fixed parameter			



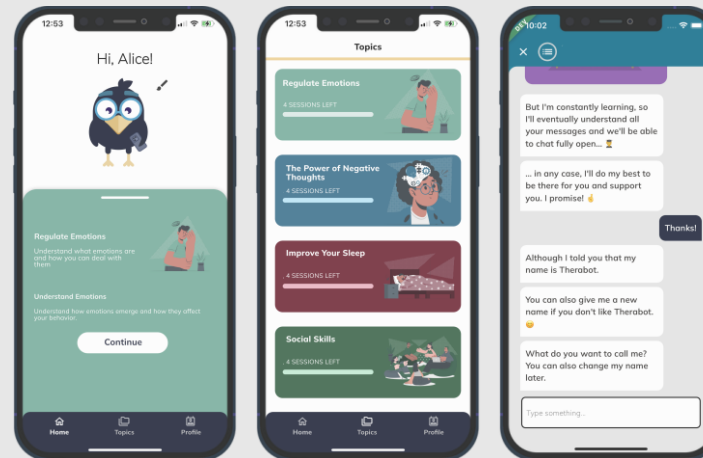
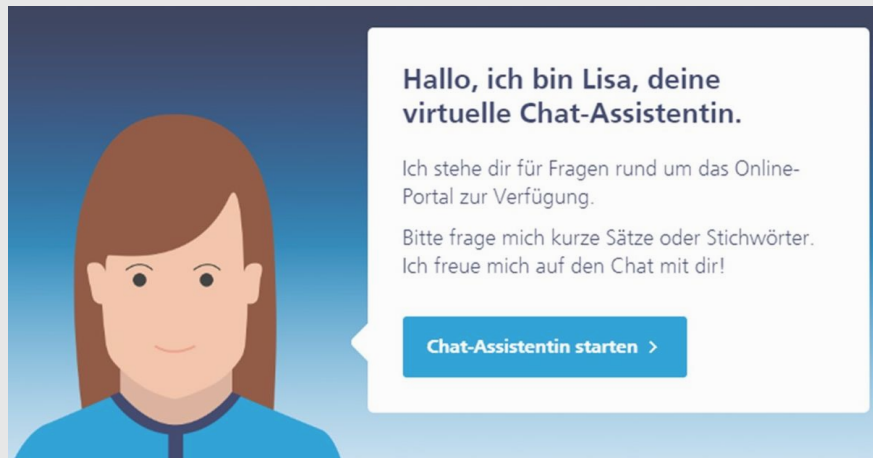
An emotional robot design significantly reduces purchase likelihood

- Large language models such as GPT-4 can be used to operate a Furhat robot and hold highly human-like sales conversations with consumers about Bluetooth speakers
  - Some challenges remain (e.g., delays, speech recognition failures) but overall, very stable
- Our LLM-based Furhat robot was able to create perceptions of an “emotional” or “rational” robot design through different natural language interaction
- The results of our experiment with ~100 student participants show that an emotional robot design has negative impacts on consumers:
  - Reduces purchase likelihood (consumers are less likely to purchase the Bluetooth speaker recommended by Furhat)
  - Reduces recommendation adherence (consumers are less likely to follow the recommendation suggested by Furhat)
- Future research: What drives the negative impact of emotional robot design?





<https://chatbotresearch.org>



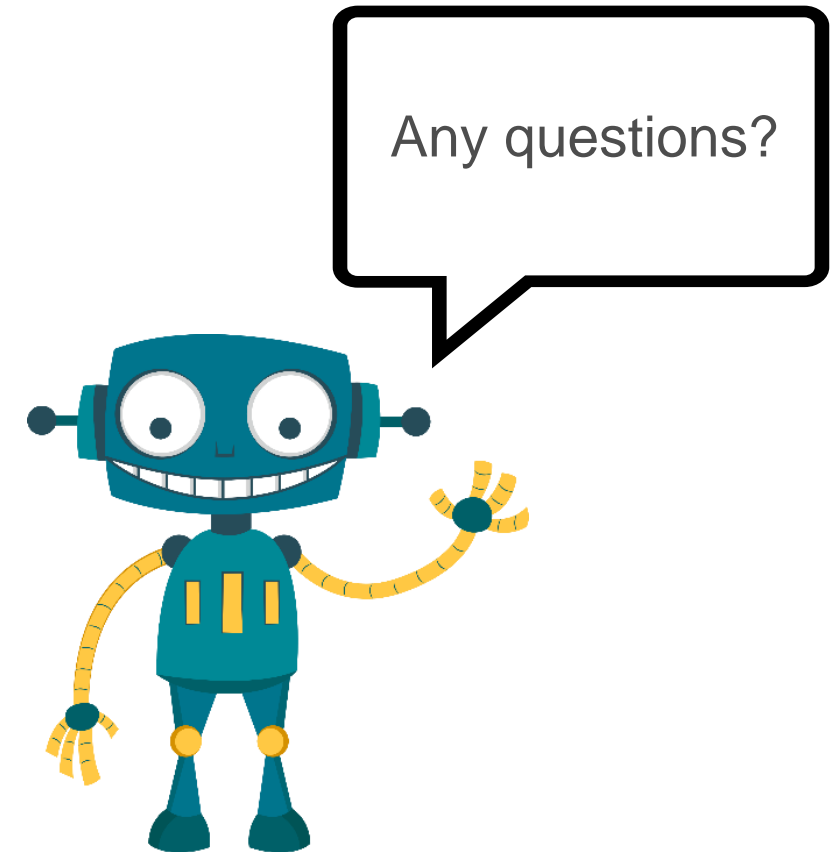
# Key Takeaways From This Lecture

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- Conversational AI is a major application area of AI-enabled engagement
- The first chatbot (Eliza) was already developed in 1966
- Since then, the technology has evolved significantly: from rule-based to NLP-based to LLM-based conversational AI
- Many different types of conversational (AI) agents exist
- They can be classified based on the mode of communication (text vs. voice) and the context (open-domain vs. task-oriented)
- Conversational agents can be equipped with virtual embodiments (avatars) or physical embodiments (robots)



***Thank you for  
your attention!***



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