1 introduction

Vocabulary

Conversational agent: A conversational agent (CA), or dialogue system, is a interfaces system intended to converse with a human. Dialogue systems employed one or more of text, speech, graphics, haptics, gestures, and other modes for communication on both the input and output channel.

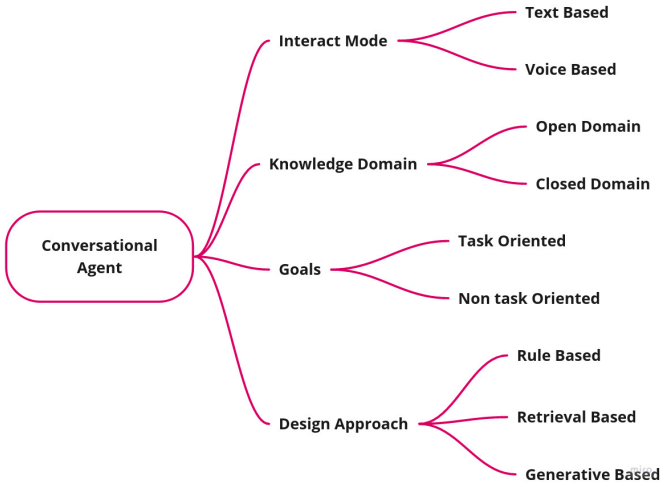


Figure 1: conversational agent taxonomy

chatbot: was coined by Mauldin [1] to describe systems that could mimic human interaction and there by pass the Turing Test.

Knowledge-grounded chatbot:is a dialogue system that can-communicate by recalling internal and external knowledge [2].

2 Properties of Human Conversation

In human-to-human conversations, people communicate based on contextual knowledge (i.e., knowledge obtained from previous utterances) or external knowledge (i.e., knowledge obtained from various media)[2].

Turn-taking is a type of organization in conversation and discourse where participants speak one at a time in alternating turns.

End-pointing is the ability to decide whether the user has stopped talking.

Speech Acts

Speech Acts are used by a speaker to act on his or her environment through words.Same primitive speech acts:

Constatives: committing the speaker to something's being the case (answering, claiming, confirming, denying, disagreeing, stating) (e.g. "I need to travel in May")

Directives: attempts by the speaker to get the addressee to do something (advising, asking, forbidding, inviting, ordering, requesting)(e.g."What day in May do you want to travel?")

Commissives: committing the speaker to some future course of action (promising, planning, vowing, betting, opposing)

Acknowledgments: express the speaker's attitude regrading the hearer with respect to some social action (apologizing, greeting, thanking, accepting an acknowledgment) (e.g."Thanks")

Characteristics of human-human dialogue that also (should) hold for human-computer dialogue:

–Collaboration: purpose, cooperation, initiative;
–Turn-taking;
–Dialogue acts;
–Grounding;
–Global and local structure;
–Conversational implicature.

3 Rule-based Chatbots

Rule-based chatbots are also referred to as decision-tree bots. As the name suggests, they use a series of defined rules. Here a Chatbot system works on basis of certain rules. However when input pattern does not match with any predefined rule then this Chatbot system is inefficient to answer the question [3].

ELIZA

ELIZA was first Chatbot which is created by Joseph Weizenbaum in 1966 [4]. ELIZA was designed to work as a therapist who ask questions and give respond to user. ELIZA is a simple program that uses pattern matching to recognize phrases like "I need X" and translate them into suitable outputs like "What would it mean to you if you got X?"

ELIZA simulates a written dialogue with a Rogerian psychotherapist by simply rephrasing most of the "patient" user's responses in the form of questions. Today, the expression "ELIZA effect" refers to the tendency to unconsciously assimilate the dialogue with a computer to that with a human being.

Fig. 2 shows the most famous ELIZA conversation, in which ELIZA seems to give very sophisticated therapeutic advice.

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
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

Figure 2: Sample ELIZA dialogue from Weizenbaum (1966).

ELIZA works by having a series or cascade of regular expression substitutions each of which matches and changes some part of the input lines. Input lines are first uppercased. The first substitutions then change all instances of MY to YOUR, and I'M to YOU ARE, and so on. The next set of substitutions matches and replaces other patterns in the input. Here are an example:

```
s/.* I'M (depressed|sad) .*/I AM SORRY TO HEAR YOU ARE \ 1/
s/.* I AM (depressed|sad) .*/WHY DO YOU THINK YOU ARE \1/
s/.* all .*/IN WHAT WAY/
```

Algorithm 1: ELIZA GENERATOR(user sentence)

Result: response
Find the word w in sentence that has the highest keyword rank;
if w *exists* **then**
  Choose the highest ranked rule r for w that matches sentence;
  response ← Apply the transform in r to sentence;
  if w = *'my'* **then**
    future ← Apply a transformation from the 'memory' rule list to sentence;
    Push future onto memory stack
  end
else no keyword applies
  either
    response ← Apply the transform for the NONE keyword to sentence;
  Or
    response ← Pop the top response from the memory stack
end

4 Corpus-based chatbots

Corpus-based chatbots or IR-based chatbots mine conversations of human-human conversations or human-machine chat. These systems are enormously data-intensive.
Corpus-based chatbots are mainly divided into 2 types according to the methods used to generate the responses to a user's.
Retrieval methods
In this method the user's turn is considered as a query q and we manage to extract and repeat an adequate turn r as an answer from a corpus of conversations C.The scoring metric is similarity.
Response by Retrieval

$$\text{response}\ (q,C) = \underset{r \in C}{\text{argmax}} \frac{q \cdot r}{|q||r|}$$

Example:

$q =$ "do you like Doctor Who"
$r =$ Cdo you like Doctor Strangelove"
response $(q,C) =$ "Yes, so funny"

Another approach involves the use of neural IR techniques such as bi-encoder model.In this model tow encoders are trained separately, one for encoding the user query and the other to encode the condidate response.after that the dot product is used between the tow vectors as in the (fig. 2)

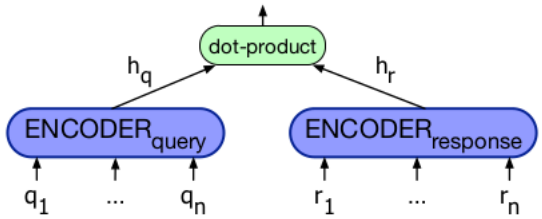


Figure 3: bi-encoder model for Response by Retrieval methods [5]

Generation methods in this approach the response production is modeled as encoder-decoder task. Using this approach the system learns from a corpus to transduce a question to an answer (you can visualize this as a machine learning version of ELIZA). Encoder decoder models generate each token r_t of the response by conditioning on the encoding of the entire query q and the response so far $r_1 \ldots r_{t-1}$ [5]:

$$\hat{r}_t = \text{argmax}_{w \in V} P(w \mid q, r_1 \ldots r_{t-1})$$

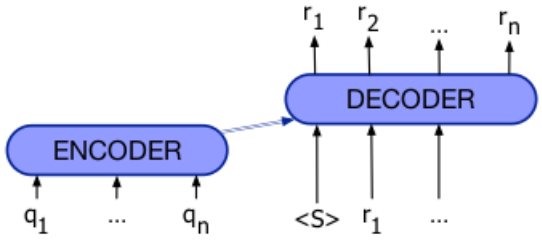
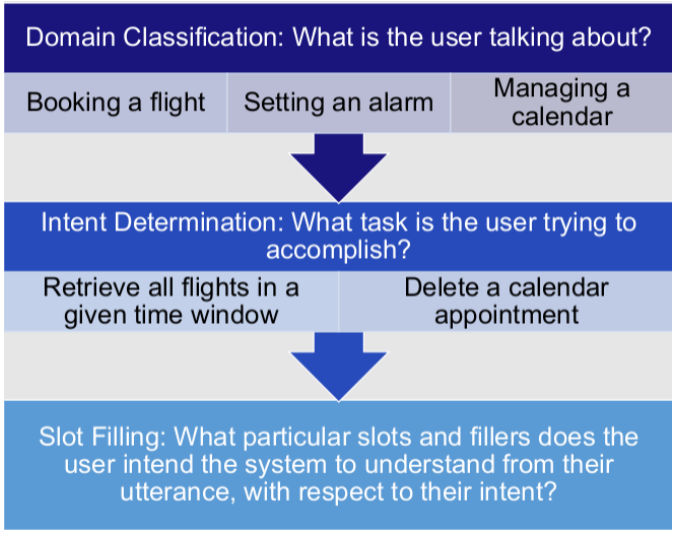


Figure 4: Encoder decoder for dialogue response generation [5]

5 Frame-based Dialog Agents: The GUS Architecture

Task-based dialog is a dialog system that is designed to help a user solve a task such as booking an airplane or purchasing a product. In this section, we present the very simple architecture of the GUS (Genial Understander System) for task-oriented dialogue
Task-based dialogue systems are based around **frames**. A frame is the knowledge structure representing what can the system extract from user sentences, and consists of a collection of slots.
In a frame-based dialogue system, natural language understanding is necessary for performing three tasks:

- Domain classification
- Intent determination
- Slot filling



NLU for Slot Filling in Frame-based Dialogue Systems example

Show me the morning flights from Chicago to Dallas on Thursday.
Domain: AIR-TRAVEL
Intent: SHOW FLIGHTS
Origin-City: Chicago
Origin-Date: Thursday
Origin-Time: morning
Destination-City: Dallas

In GUS, and in many commercial applications, slots are filled using handwritten rules. Rule-based systems often include large quantities of rules structured as semantic grammars. A context- free grammar in which the left- hand side of each rule corresponds to the semantic entities (slot names) being expresse.
example:
SHOW → show me — i want — can i see
FLIGHTS → (a) flight — flights

6 Evaluation and Design

Evaluating dialogue systems is a challenging task.Chatbots and task-based systems are generally evaluated differently, since they have different goals. The objective of an evaluation method is to have an automated evaluation procedure that is repeatable and highly correlated with human judgments, capable of differentiating between different dialogue strategies and explaining the characteristics of dialogue systems that are important [6].

Evaluating Task-based Dialogue Systems

The evaluation is made on the following points:

- Task success
- User satisfaction
- Efficiency cost
- Quality cost

Measuring Task Success

the following metrics can be defined.

Slot Error Rate: The percentage of slots that were filled with incorrect values

$$\text{Slot Error Rate} = \frac{\text{\# of inserted, deleted, or substituted slots}}{\text{\# of total reference slots}}$$

Task Error Rate: The percentage of times that the overall task was completed incorrectly

we can also apply standard NLP metrics: Precision - Recall - F-measure

Measuring User Satisfaction

User Satisfaction is Typically survey-based measurement.

Measuring Efficiency Cost

How efficiently does the system help users perform tasks?

- Total elapsed time
- Number of total turns
- Number of system turns
- Number of user queries

Measuring Quality Cost

Quality cost measures other aspects of the interactions that affect user's perception of the system.

- Number of times the ASR system fails to return anything useful
- Number of times the user had to interrupt the system
- Number of times the user didn't respond to the system quickly enough
- Appropriateness/correctness of the system's questions, answers, and error messages.

Evaluating Chatbots

Chatbots are evaluated by humans, who assign a score.

Some evaluation criteria [5]:

Engagingness: How much did you enjoy talking to this user?

• Not at all • A little • Somewhat • A lot

Avoiding Repetition: How repetitive was this user?

• Repeated themselves over and over
• Sometimes said the same thing twice
• Always said something new

Making sense: How often did this user say something which did NOT make sense?

• Never made any sense
• Most responses didn't make sense
• Some re- sponses didn't make sense
• Everything made perfect sense

Dialogue System Design

- Users play an important role in designing dialogue systems
- Research in dialogue systems is closely linked to research in human- computer interaction
- Design of dialogue strategies, prompts, and error messages is often referred to as voice user interface design

7 Ethical Issues in Conversational Agents

Conversational agents are naturally compared to a human being, whether or not their interlocutor is aware of their artificial nature. This natural aspect of dialogue is likely to influence the human being: this is the fundamental problem of chatbots ethics. Since their deployment is a recent phenomenon, there is not enough experimental data to evaluate their effects on human beings in the long term.

Conversational agents must meet a large number of requirements in terms of security, transparency, traceability, usefulness, privacy protection, etc.

Summary

The technological barriers to chatbot adoption have largely been removed. Some mature technologies are available, others are in constant and rapid evolution. In a chatbot context dedicated to the health field, the choice of the technological approach requires particular attention, on the one hand to guarantee the quality of the message transmitted to the user, but also to ensure the protection of the data exchanged. The objective is to provide conversations that are fluid, friendly and in conformity with recommended practices and regulations.

References

[1] Michael L. Mauldin. Chatterbots, tinymuds, and the turing test: Entering the loebner prize competition. In *Proceedings of the Twelfth National Conference on Artificial Intelligence (Vol. 1)*, AAAI '94, page 16–21, USA, 1994. American Association for Artificial Intelligence.

[2] Sihyung Kim, Oh-Woog Kwon, and Harksoo Kim. Knowledge-grounded chatbot based on dual wasserstein generative adversarial networks with effective attention mechanisms. *Applied Sciences*, 10:3335, 05 2020.

[3] Sandeep A. Vishakha Jadhav. A review on implementation issues of rule-based chatbot systems. *Proceedings of the International Conference on Innovative Computing & Communications (ICICC)*, 2020.

[4] Joseph Weizenbaum. Eliza—a computer program for the study of natural language communication between man and machine. *Commun. ACM*, 9(1):36–45, January 1966.

[5] Dan Jurafsky and James H. Martin. Speech and language processing, dec 2020.

[6] Jan Deriu, Álvaro Rodrigo, Arantxa Otegi, Guillermo Echegoyen, Sophie Rosset, Eneko Agirre, and Mark Cieliebak. Survey on evaluation methods for dialogue systems. *CoRR*, abs/1905.04071, 2019.

Conversational agents (aka "bots"): an overview
www.nexthink.com/blog/conversational-agents-aka-bots-an-overview/
Innovative Innovation
https://github.com/innovativeinnovation
Dialogue system
https://en.wikipedia.org/wiki/Dialogue_system