

# Natural Language Processing

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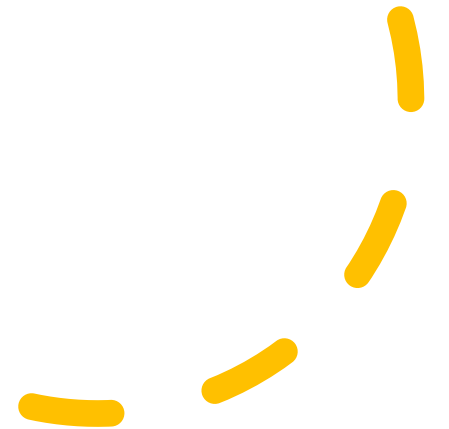


The rules of conversation are, in general, not to dwell on any one subject, but to pass lightly from one to another without effort and without affectation; to know how to speak about trivial topics as well as serious ones;

The 18th C. *Encyclopedia* of Diderot, start of the entry on conversation

## Chatbots and dialog systems

- types
- techniques for building
- platforms



# dialogue or dialog?

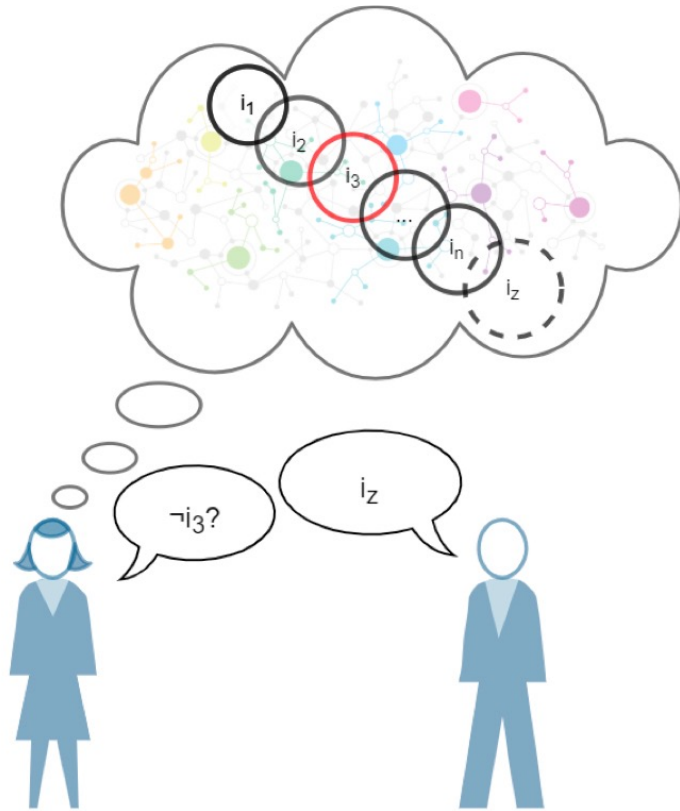
- dialogue is the preferred spelling in American and British English for all contexts related to conversation and the exchange of ideas.
- Dialog, in American English, has a specific use in computational contexts and the phrase dialog box is universal
- [writingexplained.org](https://writingexplained.org)

# Types of dialog agents

- Task-oriented dialog agents
  - Ex: get usage details from phone company, credit card
  - Siri, Alexa, etc
- Chatbots
  - More extended conversations
  - Eliza
  - Dialog therapy companions

# Human dialog

- Wittgenstein (1953) considered each utterance in a dialog to be a kind of action performed by the speaker
- such speech acts can be classified by a taxonomy:
  - constantives – answering, stating, disagreeing
  - directives – advising, asking, ordering
  - commissives – promising, planning, opposing
  - acknowledgements – greeting, apologizing, thanking

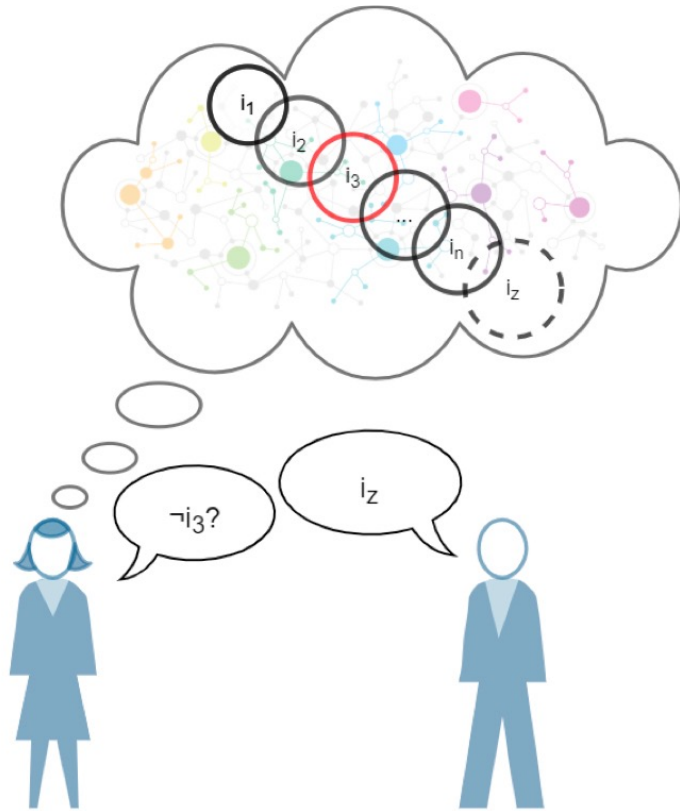


# Human dialog

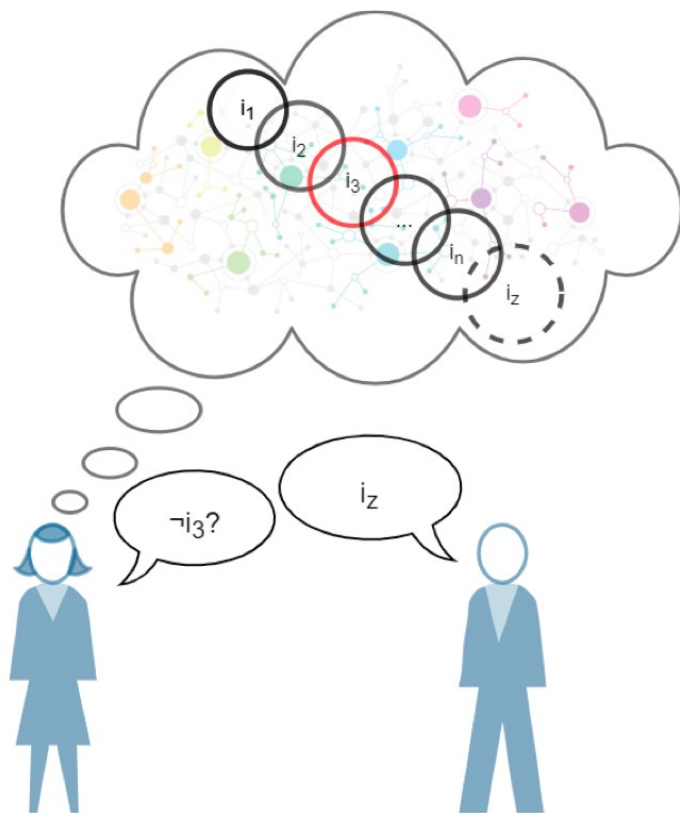
- Grounding is the act of confirming (or not) that a message has been correctly received
- People need grounding for non-linguistic actions as well, like an elevator button lighting up when you press it



# Human dialog



- Forms of grounding:
  - reiterating what the speaker said
  - phrases like uh-huh, right
  - answering a question the speaker asked



# Human dialog

- A dialog act combines speech acts and grounding acts
- a dialog-state architecture keeps track of the user's dialog acts
- includes a policy for generating dialog acts
- these policies can be modeled with a Markov decision process



# Turn-taking in task-oriented agents

- A turn can be a single word, a sentence, a monologue
- Early (2014) versions of Siri could only handle one turn:
  - User: find pizza near me
  - Agent: there are 3 pizza restaurants near you
- Later versions (2017) could handle follow-up questions
  - User: Tell me more about the second one
  - Agent: Joe's pizza averages 3 stars and is inexpensive
- Longer example, next slide, of an autonomous travel agent

# Frame-based dialog agents

- Frames and slots targeted to a narrow domain
- Dialog can be modeled by a finite-state automaton to fill the slots
- Example: automated travel agent, needs to fill slots like DESTINATION, ORIGIN, DEPARTURE TIME, etc.

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:

Client: 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.

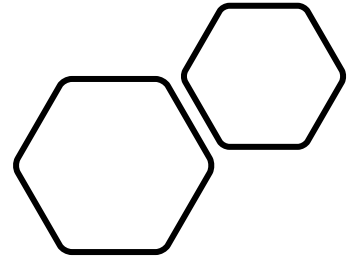
GUS: What date do you want to return on ?

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



# Tutoring Agents

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System ITSPOKE

Tutor: What will the velocity of the object be a second after that (where the initial velocity is 9.8 m/s and the acceleration is  $9.8 \text{ m/s}^2$ )?

Student: Is it 19.6 m/s?

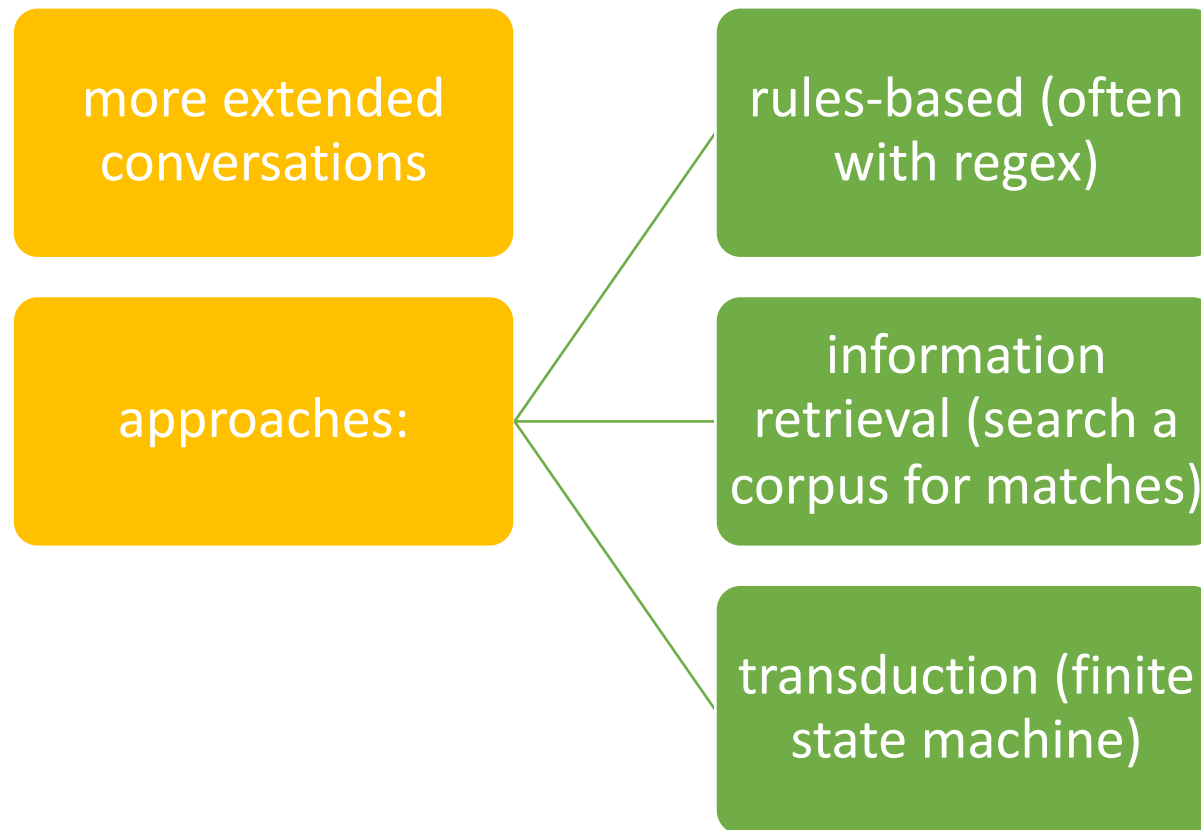
Tutor: Good. A second later, its velocity will be  $9.8 \text{ m/s} + 9.8 \text{ m/s} = 19.6 \text{ m/s}$ . This is because its acceleration tells us that every second, its velocity increases by 9.8 m/s. So what'll its velocity be, a second after that?

Student: Um. I'm thinking. 29.4 m/s

Tutor: Right. Now back to the man and his keys. We've shown that they both have an acceleration of  $9.8 \text{ m/s}^2$ . So, how do their velocities compare with each other, at every second during the fall?

# Chatbots

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# Chatbots

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- ELIZA and PARRY were early rule-based chatbots
- ELIZA (Wiezenbaum 1966) was designed to simulate a Rogerian therapist who draws a patient out by reflecting a patient's statements back to them
- Eliza:  
<https://web.njit.edu/~ronkowit/eliza.html>

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

..



# Eliza rules

- pattern transformation rules like:

```
(0 YOU 0 ME) [pattern]  
->  
(WHAT MAKES YOU THINK I 3 YOU) [transform]
```

- where 0 means 0 or more and the numbers index the pattern elements

```
You hate me  
into:  
WHAT MAKES YOU THINK I HATE YOU
```



# Eliza rules

- Some rules are based on keywords

```
function ELIZA GENERATOR(user sentence) returns response

Find the word w in sentence that has the highest keyword rank
if w exists
    Choose the highest ranked rule r for w that matches sentence
    response  $\leftarrow$  Apply the transform in r to sentence
    if w = 'my'
        future  $\leftarrow$  Apply a transformation from the 'memory' rule list to sentence
        Push future onto memory stack
    else (no keyword applies)
        either
            response  $\leftarrow$  Apply the transform for the NONE keyword to sentence
        or
            response  $\leftarrow$  Pop the top response from the memory stack
return(response)
```

# Eliza keywords

- keywords are ranked
- Sentence: I know everybody laughed at me
- Words 'I' and 'everybody' match rules but 'everybody' would be selected because it ranks higher

# Eliza generic rules

- If no keyword matches, Eliza chooses a generic response like:
  - PLEASE GO ON
  - THAT'S VERY INTERESTING
  - I SEE

# Eliza memory list

- Eliza keeps a list of matches from the discussion
- For example, if the word 'my' is the highest rank keyword, Eliza will randomly select a transform on the memory list

```
(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
```

# Eliza

- people became emotionally involved with the program
- Weizenbaum had a staff member who would ask him to leave the room whenever she talked with ELIZA
- when Weizenbaum suggested storing the conversations, but people got upset, indicating that they were discussing private issues with ELIZA even though they knew it was just a program

# PARRY

- PARRY simulated a paranoid schizophrenic (Colby 1971)
  - Fooled experts half the time in a Turing-style test
- Extended the rule-based approach to include a model of its own mental state regarding fear and anger
- Certain topics might make PARRY more angry or paranoid
- See dialog PARRY and ELIZA next slides
- source: <https://www.theatlantic.com/technology/archive/2014/06/when-parry-met-eliza-a-ridiculous-chatbot-conversation-from-1972/372428/>

ELIZA: Good Evening. Tell me your problems. Please terminate input with a period or a question mark.

PARRY: People get on my nerves sometimes.

ELIZA: I am not sure I understand you fully.

PARRY: You should pay more attention.

ELIZA: Suppose you should pay more attention.

PARRY: You're entitled to your own opinion.

ELIZA: What makes you think I am entitled to my own opinion?

PARRY: It bothers me just to be around people in general.

ELIZA: Please go on.

PARRY: I went to the track at Bay Meadows a while back.

ELIZA: What does that suggest to you?

PARRY: I went to the races.



ELIZA: Would you like to discuss your nerves?

PARRY: I guess so.

ELIZA: What does that suggest to you?

PARRY: What are you getting at?

ELIZA: What answer would please you most?

PARRY: It's not a matter of like or dislike.

ELIZA: What else would you like to discuss?

PARRY: I am getting tired of answering the same questions over and over.

ELIZA: What resemblance do you see?

PARRY: Why do you need to know that?

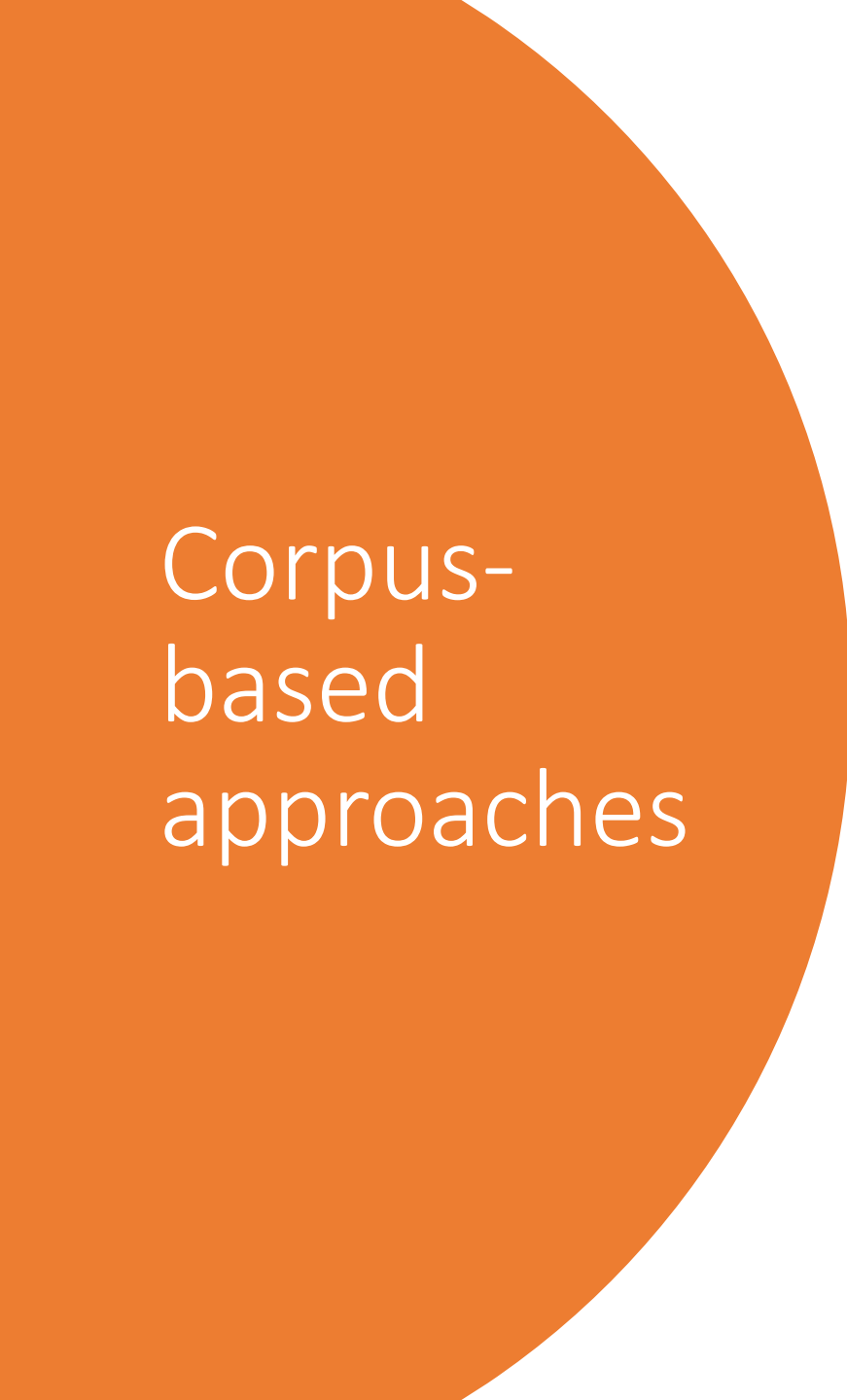
ELIZA: What do you think?

PARRY: I don't understand your motives.

ELIZA: Why don't you understand my motives?

# Rules-based approach

- still used in systems such as Siri, Google, but combined with machine learning approaches

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# Corpus- based approaches

- Two approaches:
  - Information retrieval
  - Supervised machine learning



# Information-retrieval approach

- examples of automatically generated responses from Jafarpour et al. 2009,
- <https://aritter.github.io/chat.pdf>

Query	Suggested Response
I play football a lot I like Oranges How is the weather in Seattle?	how long have you been playing ? i 've been on 2 years unless you eat like 10 acre of them at one time ... no perfect for a day off ...

# Information-retrieval approach

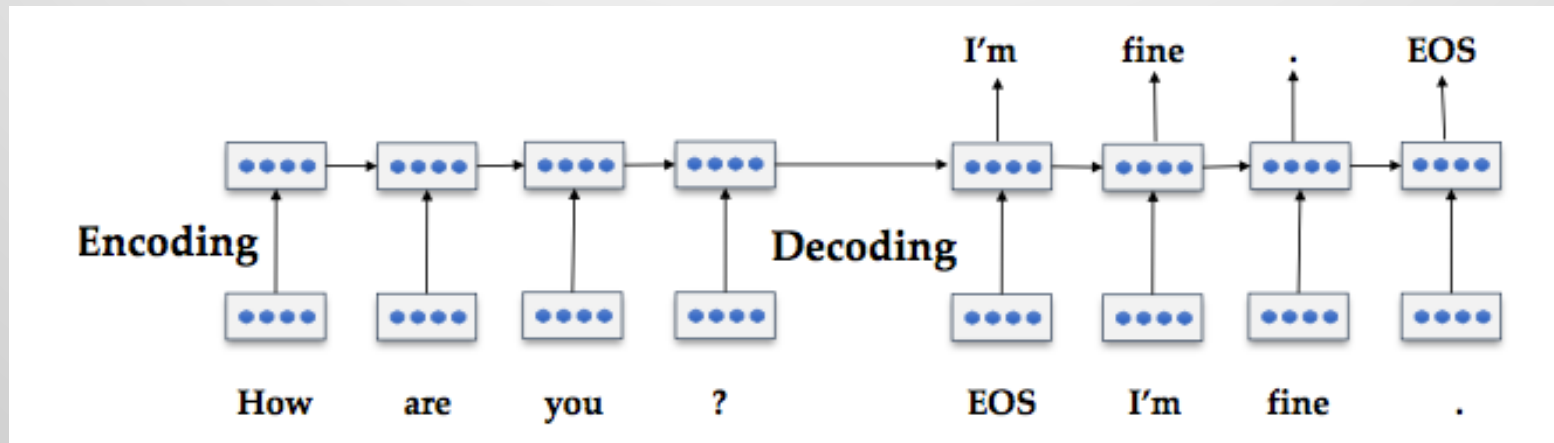
- Given a corpus and the user's sentence, return the response most similar
- Cosine similarity can be used

$$r = \operatorname{argmax}_{t \in C} \frac{q^T t}{||q|| ||t||}$$

- Where q is the user query
- C is the corpus
- T is the turn in C that is most similar to q

# Machine-learning approach

- sequence-to-sequence transformers
- these approaches tend to drift into conversational dead-ends like “ok”





# Dialog system design

- Before development:
  - Study the user and task to determine what users want to get out of the system
  - Build a Woz (wizard-of-oz) approach where a human plays the role of the system to test out what approaches might work
  - Iteratively test the design on users





# Evaluating chatbots

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- No suggested automated methods
- Options:
  - Users fill out a Likert-style (1 – 5) survey
  - Task success: Siri found what you wanted
  - Efficiency: time to complete task with agent
  - Quality: how many times did agent make an incorrect action/comment

# Online chatbots

- <https://www.kuki.ai/>
- <https://home.pandorabots.com/home.html>
- Real chatbot applications:
- <https://www.wordstream.com/blog/ws/chatbots>

# Loebner Prize

- annual competition to find AI systems that can pass a Turing test
- human judges hold text conversations with the system and with a human to see if the judge can tell which is the human
- named for Hugh Loebner of the Cambridge Center for Behavioral Studies



# Ethical considerations

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- Safety
- Privacy
- Lack of respect for the user or user's identity
- Microsoft Tay released 3/2016
  - Began to be offensive
  - 16 hours after launch, shut down
  - Replace by Zo, later shut down

# Chatbot project

- Use a framework or write your own from scratch
- Some frameworks:
  - Dialogflow from Google
  - Lex from Amazon
  - Chatscript <https://www.freecodecamp.org/news/chatscript-for-beginners-chatbots-developers-c58bb591da8/>
- Note: if you use a framework, you will need to write additional code to get a good grade



## Essential points to note

- Dialog agents are usually task-oriented
- Chatbots are more conversational
- You can build either for the project