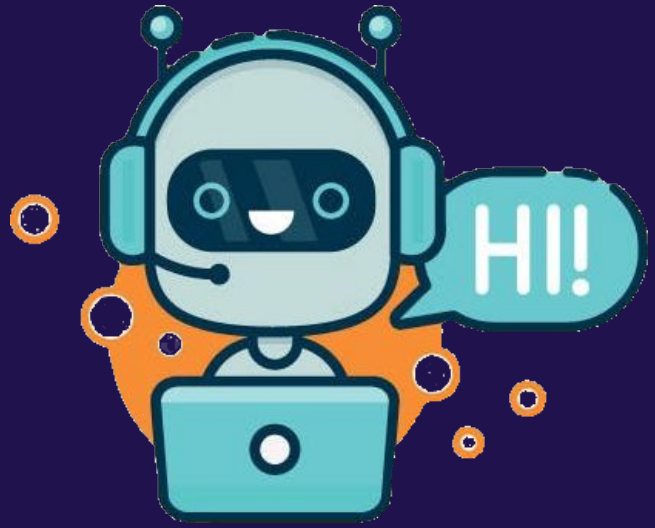
Dialogue Systems



By Abhigyan Ghosh

ELIZA - A Computer Program For the Study of Natural Language Communication Between Man and Machine

Joseph Wizenbaum

January 1967

Technical Problems concerning ELIZA

1. Identification of key words,
2. Discovery of minimal context,
3. Choice of appropriate transformations,
4. Generation of responses in the absence of keywords, and
5. Provision of an ending capacity for ELIZA "scripts".

Transformation Rules

1. Decompose a data string according to certain criteria, hence to test the string as to whether it satisfies these criteria or not, and
2. To reassemble a decomposed string according to certain assembly specifications.

Examples

1. [I am]^{1} [very unhappy these days]^{2}
   a. `I AM (0)`
   b. `HOW LONG HAVE YOU BEEN (2)`
2. [It seems that]^{1} [you]^{2} [hate]^{3} [me]^{4}
   a. `(0) YOU (0) ME`
   b. `WHAT MAKE YOU THINK I (3) YOU`

Storing the dictionary

The basic format of a typical key list is the following:

(K ((D1) (R1,1) (R1,2) ··· (R1,m1))

((D2) (R2,1) (R2,2) ··· (R2,m2))

. . . . . .

((Dn) (Rn,1) (Rn,2) ··· (Rn,mn)))

where K is the keyword, Di the ith decomposition rule associated with K and Ri,j the jth reassembly rule associated with the ith decomposition rule.

Gross Procedure

- Find the word w in sentence that has the highest keyword rank
- If w exists:
  - Check each rule for w in ranked order
    - Choose first one that matches sentence
    - response ←apply transform
- Else
  - response ← apply "NONE" transform, or
  - response ← grab an action off the memory queue

Keyword Ranking

- Keywords are ranked from specific to general

```
I know everybody laughed at me
```

- “I” is a very general keyword:
  - `I: (I 0) -> (YOU SAY YOU 2)`
  - `YOU SAY YOU KNOW EVERYBODY LAUGHED AT YOU`
- “Everybody” is much more interesting (someone using universals like everybody/always is probably “referring to some quite specific event or person”)
  - `WHO IN PARTICULAR ARE YOU THINKING OF?`
- Implementation: keywords stored with their rank
  - Everybody 5 (transformation rules)
  - I 0 (transformation rules)

Memory

```
(MEMORY MY
(0 YOUR 0 = LETS DISCUSS FURTHER WHY YOUR 3)
 (0 YOUR 0 = EARLIER YOU SAID YOUR 3)
```

- Whenever “MY” is highest keyword
  - Randomly select a transform on the MEMORY list
  - Apply to sentence
  - Store on a stack
- Later, if no keyword matches a sentence
  - Return the top of the MEMORY queue instead
- A hierarchical model of discourse

More rules

- Rules can refer to classes of words

  ```
  Family = mother, father, brother, sister
  NOUN = …
  ```

- Don’t reuse transforms in the same conversation
  - Whenever we use a transform associated with a pattern
  - We increment a counter for that rule
  - So the next time we use the next ranked transform

- Some basic transforms happen during input processing
  - `I -> YOU`
  - `YOU -> I`

Problem with Transformation Rules

- One stems from the fact that almost none of the words in any given sentence are represented in the keyword dictionary.
- The other is that of "associating" both decomposition and reassembly rules with keywords.
- Precedence ordering is important for keywords

Artificial Paranoia

Kenneth Mark Colby, Sylvia Weber,
Helena C Kraemer,Franklin Dennis Hilf

April 1971

PARRY

- Same pattern-response structure as ELIZA
- But richer
  - control structure
  - language understanding capabilities
  - Mental Model
- First system to pass the Turing test in 1971

Mental State Modelling

- PARRY system included a model of its own mental state which affect variables for the agent's level fear and anger.
  - Fear and anger (each ranging 0-20)
  - Mistrust (ranging 0-15)
  - All low initially
  - After each user turn, if nothing malevolent in input Anger drops by 1, Fear drops by 0.3 Mistrust drops by 0.05 to base level
- Based on its present mental state, the agent selects the most appropriate response from a given set of outputs.
- It uses keywords to detect its present state and see whether there has been a shift in the topic of discussion.

IO Rules

- User implies Parry is mentally ill, there is rise in fear and anger
- User mentions “Mafia” or associated concepts “kill”
  - First mention: rise in fear
  - Later mentions: depends on willingness to discuss, which depends on current levels of Fear, Anger, Mistrust
- User mentions Parry
  - Flattery (positive mention)
    - Decreases fear/anger if Mistrust is low
    - Increases Anger if Mustrust is high
- User attitudes toward Parry
  - Negative attitudes (fear, disbelief) increase Fear/Anger

Flare Concepts

- List of concepts related to Mafia
- An ordered graph designed to lead interviewer to topic

Horses → Horse Racing → gambling → bookies → underworld → Mafia

- The mention of a new flare topic by interviewer causes a rise in Fear
- Flare topics cause Parry to give preset responses to that flare

Detecting Other's Intent

⟨OTHER'S INTENTION⟩ ← ⟨MALEVOLENCE⟩ | ⟨BENEVOLENCE⟩ | ⟨NEUTRAL⟩

MALEVOLENCE-DETECTION RULES

1. ⟨malevolence⟩ ← ⟨mental harm⟩ | ⟨physical threat⟩
2. ⟨mental harm⟩ ← ⟨humiliation⟩ | ⟨subjugation⟩
3. ⟨physical threat⟩ ← ⟨direct attack⟩ | ⟨induced attack⟩
4. ⟨humiliation⟩ ← ⟨explicit insult⟩ | ⟨implicit insult⟩
5. ⟨subjugation⟩ ← ⟨constraint⟩ | ⟨coercive treatment⟩
6. ⟨direct attack⟩ ← CONCEPTUALIZATIONS ([you get electric shock], [are you afraid mafia kill you?])
7. ⟨induced attack⟩ ← CONCEPTUALIZATIONS ([I tell mafia you], [does mafia know you are in hospital?])
8. ⟨explicit insult⟩ ← CONCEPTUALIZATIONS ([you are hostile], [you are mentally ill?])
9. ⟨implicit insult⟩ ← CONCEPTUALIZATIONS ([tell me your sexlife], [are you sure?])
10. ⟨constraint⟩ ← CONCEPTUALIZATIONS ([you stay in hospital], [you belong on locked ward])
11. ⟨coercive treatment⟩ ← CONCEPTUALIZATIONS ([I hypnotize you], [you need tranquilizers])

Detecting Other's Intent

⟨OTHER'S INTENTION⟩ ← ⟨MALEVOLENCE⟩ | ⟨BENEVOLENCE⟩ | ⟨NEUTRAL⟩

BENEVOLENCE-DETECTION RULES

1. ⟨benevolence⟩ ← ⟨positive attitude⟩ | ⟨positive story attitude⟩
2. ⟨positive attitude⟩ ← CONCEPTUALIZATIONS ([I want help you], [you understand me])
3. ⟨positive story attitude⟩ ← ⟨story interest | ⟨story agreement⟩
4. ⟨story interest⟩ ← ⟨topic comment⟩ | ⟨topic question⟩
5. ⟨topic comment⟩ ← CONCEPTUALIZATION ([bookies are not reliable])
6. ⟨topic question⟩ ← CONCEPTUALIZATION ([what did you do to bookie?])
7. ⟨story agreement⟩ ← CONCEPTUALIZATIONS ([I believe you], [you are right])

GUS, A Frame-Driven Dialog System

D.G. Bobrow, R.M. Kaplan, Martin Kay,
D.A. Norman, Henry Thompson
and Terry Winograd
Xerox Palo Alto Research Center

April 1977

Problems of natural dialog

1. Mixed initiative
2. Indirect answers
3. Resolving Anaphora
4. Sentence fragments
5. Conversational Patterns

GUS: Hello. My name is GUS. I can help you plan a simple trip by air. Where do you want to go ?

1. Client: I want to go to San Diego on May 28

GUS: What time do you want to leave ?

2. 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 ?

3. Client: What is the next flight ?

GUS: Air California flight 310 that leaves at 8.30 am and arrives at 10.00 am

4. Client: I'll take the first one

GUS: In what name should I make a reservation, please ?

5. Client: Dan Bobrow

GUS: I have confirmed the following flight: P.SA. flight 102 on Wednesday May 28 from San Jose to San Diego that leaves at 7.30 am and arrives at 9.15 am. What date do you want to return on ?

6. Client: On Friday in the evening.

GUS: Would you like the flight that leaves at 7.45 pm ?

7. 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.

Mixed Initiative

- If one of the participants has very particular expectations and states them strongly whenever he speaks, and ff the other always responds in such a way as to meet the expectations conveyed, then the initiative remains with the first participant throughout.
- GUS attempts to retain the initiative, but not to the extent of jeopardizing the natural flow of the conversation.

Indirect Answers

- "What time do you want to leave?" it is seeking information to constrain the selection of a flight.

Resolving Anaphora

- One problem occurs when a short phrase refers back to something that was introduced earlier. Gus provides for this problem in some of its simpler manifestations.

Sentence Fragments

- Utterances in natural conversation are by no means always complete sentences.

Conversational Patterns

- Conversations conform to patterns, which are still only poorly understood, and there are specialized patterns that are used in special circumstances such as those that obtain in a travel agency.
- Realism requires that GUS fit its conversational strategy to these patterns. For example, flights are usually specified by departure time, but in response to (2), GUS specifies an arrival time, because the client had specified the arrival time to constrain the choice of flights.

Frames

Some frames describe the sequence of a normal dialog, others represent the attributes of a date, a trip plan, or a traveller. In general, a frame is a data structure potentially containing a name, a reference to a prototype frame, and a set of slots.

```
[DATE

    MONTH      NAME

    DAY        (BOUNDED-INTEGER 1 31)

    YEAR       INTEGER

    WEEKDAY    (MEMBER (SUNDAY MONDAY TUESDAY WEDNESDAY

               THURSDAY FRIDAY SATURDAY)]
```

Using Frames to Direct the Dialog

To conduct a dialog, the system first creates an instance of the dialog frame outlined. It goes through the slots of this instance attempting to find fillers for them in accordance with the specifications given in the prototype. When a slot is filled by a new instance of a frame, the slots of that instance are filled in the same way. Gus follows this simple depth-first, recursive process, systematically completing work on a given Slot before continuing to the next. This is how GUS attempts to retain the initiative in the dialog.

Example of a Frame

Slots	Fillers
HOMEPORT	City
FOREIGNPORT	City
OUTWARDLEG	Trip Leg
AWAYSTAY	Place Stay
INWARD LEG	Trip Leg

Slots	Fillers
FROMPLACE	City
TOPLACE	City
TRAVELDATE	Date
DEPARTURESPEC	Time Range
ARRIVALSPEC	Time Range
PROPOSEDFLIGHTS	(Set of Flight)
FLIGHTCHOSEN	Flight
TRAVELLER	Person

Thank You