CS 6120/CS4120: Natural Language Processing
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Logistics
• Sign up for project feedback. Piazza @ 172.
• November 20 afternoon (2:50-4:30pm, Churchill Hall 101)
• November 22 afternoon (3-4pm, Rm 2211, 177 Huntington Ave.)
• November 25 afternoon (1:30-2:30pm, Rm 2211, 177 Huntington Ave.)
• Prelim solution explanation and checking your own exam sheets
• November 19 TA office hour: solution discussion
• November 20, 4-6pm, atrium@177 Huntington Ave: check exam
  • One person each time
  • Return it afterwards

Chatbots
• ELIZA (1966)
• PARRY (1968)
• The first system to pass the Turing test!
• ALICE (2001)
• CLEVER (https://www.cleverbot.com/)
• Microsoft Little Bing (aka XiaoIce, 小冰, still updating)
  • "The Design and Implementation of XiaoIce, an Empathetic Social Chatbot"
  • https://arxiv.org/abs/1812.08989
  • EMNLP 2018 conference tutorial: http://emnlp2018.org/tutorials/

Chatbot Architectures
• Rule-based
  • Pattern-action rules (Eliza)
  • a mental model (Parry)
• Corpus-based (from large chat corpus)
• Information Retrieval
• Neural network encoder-decoder

Chatbots
• Sometimes for fun
• Originally designed as a testbed for clinical therapy

Eliza: Weizenbaum (1966)
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

Domain: Rogerian psychology interview

Draw the patient out by reflecting patient’s statements back at them
Rare type of conversation in which one can “assume the pose of knowing almost nothing of the real world”

Patient: “I went for a long boat ride”
Psychiatrist: “Tell me about boats”

• You don’t assume she didn’t know what a boat is
• You assume she had some conversational goal
• Most chatbots trying to pass Turing test choose a domain with similar properties

Eliza pattern/transform rules

\[(0 \text{ YOU } 0 \text{ ME}) \rightarrow (\text{WHAT MAKES YOU THINK I } 3 \text{ YOU})\]

\[\text{You hate me} \]
\[\text{WHAT MAKES YOU THINK I HATE YOU}\]

0 means kleene star (zero or more of some words)
The 3 is the constituent number in pattern

Eliza Rules

\[\text{keyword } (K (D_1 (R_{1.1}) (R_{1.1}) \cdots (R_{1.m_1})) (D_2 (R_{2.1}) (R_{2.1}) \cdots (R_{2.m_2})) \cdots (D_n (R_{n.1}) (R_{n.1}) \cdots (R_{n.m_n})))\]

Keywords are ranked from specific to general

I know everybody laughed at me
• “I” is a very general keyword:
  It: (I *) \rightarrow (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 (transformation rules)
  I (transformation rules)

ELIZA architecture

• Examine each word w in user sentence
  • Return the w with highest keyword rank
  • If w exists:
    • Check each rule for w in ranked order
      • Choose first one that matches sentence
        • Apply transform
  • If no keyword applies, either
    • Apply the transform for the “NONE” key, or
    • Grab an action off the memory queue
Memory

- Whenever “MY” is highest keyword
  - Apply to sentence
  - Store on a stack
- Later, if no keyword matches a sentence
  - Return the top of the MEMORY queue instead

Other Aspects about Eliza

- Rules can refer to classes of words
  - Family = mother, father, brother, sister
  - Other =...
- 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

Parry

- Colby 1971 at Stanford
- Same pattern-response structure as Eliza
- But a much richer:
  - control structure
  - language understanding capabilities
  - mental model: Parry has affective variables
    - “If Anger level is high, respond with hostility”
  - The first system to pass the Turing test (in 1971)
    - Psychiatrists couldn’t distinguish interviews with PARRY from (text transcripts of) interviews with real paranoids

Parry’s persona

- 28-year-old single man, post office clerk
- no siblings and lives alone
- sensitive about his physical appearance, his family, his religion, his education and the topic of sex.
- hobbies are movies and gambling on horseracing
- recently attacked a bookie, claiming the bookie did not pay off in a bet
- afterwards worried about possible underworld retaliation
- eager to tell his story to non-threatening listeners

Affect variables

- Fear and Anger (each ranging 0-20)
- Mistrust (ranging 0-15)
- Initial conditions: All low
  - 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
  - Otherwise depends on what the user says
    - Each user statement can change Fear and Anger
    - Mistrust goes up if Fear or Anger do
Lots of complex I-O rules

- User implies Parry is mentally ill
  - Rise in Fear and Anger
- User mentions "Mafia" or associated concepts ("kill"):
  - First mention: rise in Fear
  - Later mention: 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 Mistrust is high
  - Negative attitudes toward Parry
- Flare concepts (positive mention)
  - 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

Flare concepts

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

Each sentence is mapped into conceptualization

- A predication on a conceptual object
- A predication on a relation between two objects
- A predication on an attribute:
  - What is your work?
  - What sort of work do you do?
  - Where do you work?
- A predication on an attribute:
  - What do you do for a living?
  - What is your job?
  - What is your occupation?
- Complex Pattern/transform rules
  - Different predicates (fear, afraid of)
  - Ordering (You are afraid of me, I frighten you)

When fear is high, the model won’t discuss its beliefs

1. Is the law after you?
   - THE LAW SHOULD GET THOSE ITALIAN CROOKS.
2. Do you mean the Mafia?
   - LET’S TALK ABOUT SOMETHING ELSE.
3. Are you afraid of the Mafia?
   - I'D RATHER NOT DISCUSS IT.
   - [Fear is too high so Parry won't talk about 'Mafia'.]
4. Perhaps you are paranoid about them?
   - YOU WANT TO KEEP ME IN THE HOSPITAL.
   - (The model interprets being called 'paranoid' as an insult and as an intent to control, so ANGER & FEAR rise)

A Parry conversation

1. How are you today?
   - OK.
2. What is your name?
   - MY NAME IS FRANK SMITH.
3. How old are you?
   - TWENTY-EIGHT.
4. Are you married?
   - NO.
5. What sort of work do you do?
   - I WORK IN THE POST OFFICE.
6. Why are you in the hospital?
   - I SHOULDN'T BE HERE
   - [Fear is too high so Parry won't talk about 'Mafia'.]
7. Who brought you here?
   - THE POLICE
   - [FEAR rises slightly because police linked in graph to MAFIA]

Eliza Meets Parry

Vincent Cerf, RFC439

Good Evening. Tell me your problems. Please terminate input with a period or a question mark.
*People get on my nerves sometimes.*
I am not sure I understand you fully.
*You should pay more attention.*
Suppose you should pay more attention.
*You're entitled to your own opinion.*
What makes you think I am entitled to my own opinion?
*It bothers me just to be around people in general.*
Please go on.
*I went to the track at Bay Meadows a while back.*
What does that suggest to you?
*I want to the races.*
What else would you like to discuss?
Deep-learning chatbots

- Train on:
  - movie dialogue databases
  - twitter conversations
  - Train a deep neural net to map from one user’s turn to the other user’s response

IR-based models of chatbots

- Cleverbot
- Xiaoice

- Mine conversations of human chats or human-machine chats
- Choose a response by
  - Taking user’s turn and finding a (trivial) similar turn in the dataset
  - Grabbing whatever the response was to that turn.

Seq2seq model architecture

Sample outputs from a neural net chatbot

<table>
<thead>
<tr>
<th>Sample output from a neural net chatbot</th>
<th>Sample output from a neural net chatbot</th>
</tr>
</thead>
<tbody>
<tr>
<td>How are you doing?</td>
<td>How are you doing?</td>
</tr>
<tr>
<td>I’m good, you?</td>
<td>I’m good, you?</td>
</tr>
<tr>
<td>I am off all week next week.</td>
<td>I am off all week next week.</td>
</tr>
<tr>
<td>What time you going?</td>
<td>What time you going?</td>
</tr>
<tr>
<td>I know! what have you been up to?</td>
<td>I know! what have you been up to?</td>
</tr>
<tr>
<td>nothing really. just enjoying summer</td>
<td>nothing really. just enjoying summer</td>
</tr>
<tr>
<td>and the book?! its good but i’m only</td>
<td>and the book?! its good but i’m only</td>
</tr>
<tr>
<td>like halfway through</td>
<td>like halfway through</td>
</tr>
<tr>
<td>thanks. yeah i am good thanks!</td>
<td>thanks. yeah i am good thanks!</td>
</tr>
<tr>
<td>good, but angry! sorry you’re angry</td>
<td>good, but angry! sorry you’re angry</td>
</tr>
<tr>
<td>been there, i hope it dies</td>
<td>been there, i hope it dies</td>
</tr>
<tr>
<td>yes, i have been there</td>
<td>yes, i have been there</td>
</tr>
<tr>
<td>what do you say that just now?</td>
<td>what do you say that just now?</td>
</tr>
<tr>
<td>Deep learning</td>
<td>Deep learning</td>
</tr>
<tr>
<td>likes 2 weeks ago!</td>
<td>likes 2 weeks ago!</td>
</tr>
<tr>
<td>*Horseracing interests me.</td>
<td>*Horseracing interests me.</td>
</tr>
<tr>
<td>Why do you say that just now?</td>
<td>Why do you say that just now?</td>
</tr>
<tr>
<td>*There’s a lot of crooked gambling going on there. I am not sure I understand you fully, *it’s clear to me if not to you. Do you think its likely that not to me? *I want to the races. Please go on. *I gamble on horses. What does that suggest to you? *I want to the races. What else would you like to discuss? *Gambling has been nothing but trouble to me. Why do you say that just now? *I’ve had experience with crooks gambling at the track. I am not sure I understand you fully. *I’ve already told you enough about that.</td>
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