



Lecture 2: Pattern matching and ELIZA

PSYC 51.07: Models of language and communication

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Recap from Lecture 1

Key ideas

- **Consciousness is complex:** multiple types, hard to define
- **Language \neq thought:** but they interact in interesting ways
- **Grounding matters:** meaning comes from experience

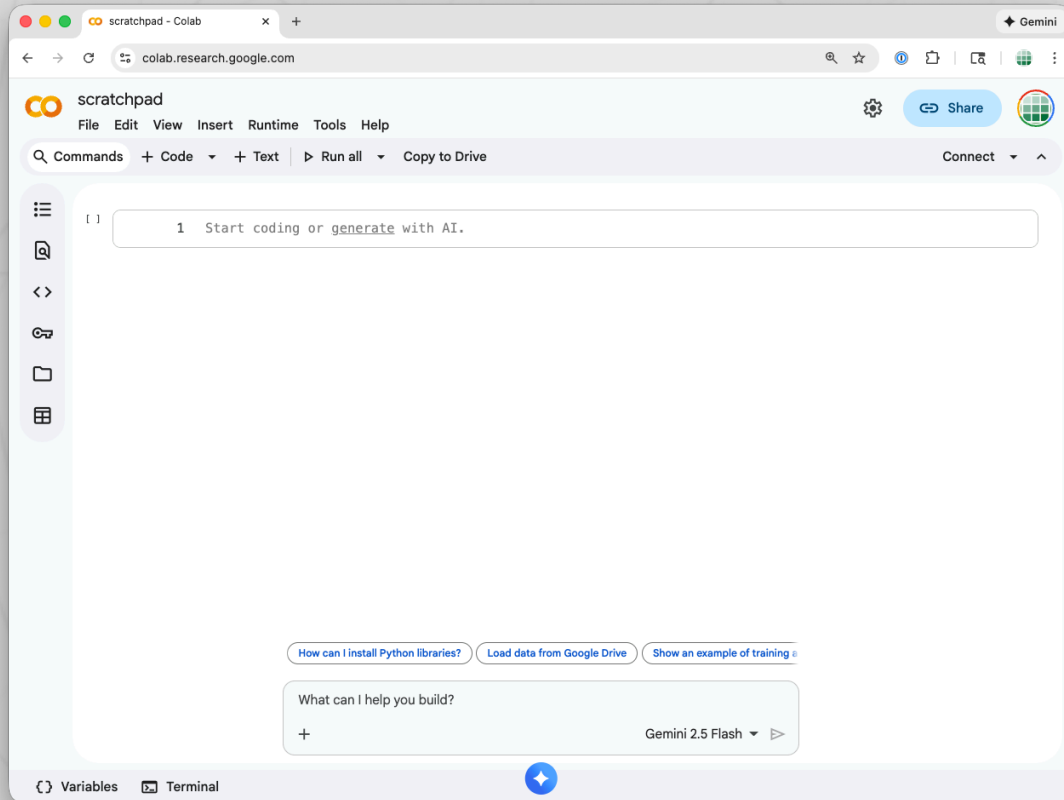
For further reflection...

- Does the "experience" need to be first-hand? Can we "share" experience with another person? Or with a machine? What might that look like?
- Can we have understanding without consciousness (or vice versa)?

Today's focus

Pattern matching can create powerful *illusions* of experience and understanding, even without any *real* comprehension or grounding. We'll explore some foundational techniques for text processing that were used to build one of the first chatbots, ELIZA. (Next time, we'll dig into *how* ELIZA works under the hood!)

Side note: follow along with Google Colab!



- Go to colab.research.google.com
- Click "New notebook"
- Click to create new **text** or **code** cells
- Copy and paste code from slides
- Press **Shift + Enter** to run cells
- Riff on the examples and see what happens!

Creating the illusion of experience and understanding

Humans

- Derive meaning from experience
- Connect words to memories, emotions, senses
- Understand context and nuance

Computers

- Manipulate strings (sequences of characters)
- Have no direct experience of the world
- Process symbols without inherent meaning

The challenge

How do we bridge this gap? Can we use symbol manipulation create the *appearance* of understanding?

Keep in mind

The illusion of understanding comes from the programmer's skill at designing clever pattern matching rules, along with the *user* having understanding and experience (and a tendency to anthropomorphize), not from any *actual* understanding on the part of the machine.

Text processing and string manipulation

- **Finding:** Locate patterns within text
- **Replacing:** Substitute one pattern for another
- **Extracting:** Pull out specific parts of text
- **Transforming:** Convert text to different formats

```
1 text = "Hello, how are you today?"
2
3 # Finding (True)
4 "how" in text
5
6 # Replacing ("Hello, how are we today?")
7 text.replace("you", "we")
8
9 # Extracting ("how are you today?")
10 text.split(", ")[1]
11
12 # Transforming (["hello", "how", "are", "you", "today?"])
13 text.lower().split()
```

Text processing is the foundation of computational linguistics



Basic conversational AI pipeline

Note

Every substantive conversational AI system, from ELIZA to ChatGPT, fundamentally processes text through some form of pattern matching and pattern completion, though with vastly different levels of sophistication.

Regular expressions

Regular expression (regex)

A sequence of characters that defines a search pattern. Regular expressions provide flexible, powerful pattern matching for text processing.

Key syntax

Symbol	Meaning	Example
.	Any character	<code>h.t</code> matches "hat", "hit", "hot"
*	Zero or more	<code>ab*c</code> matches "ac", "abc", "abbc"
()	Capture group	<code>(hello)</code> captures "hello"
	Alternation	<code>cat dog</code> matches "cat" or "dog"
^	Negation	<code>[^a-z]</code> matches any non-lowercase letter

Regular expressions in Python

```
1  import re
2
3  text = "I am feeling very happy today"
4
5  # Simple pattern matching
6  if re.search(r"happy|sad|angry", text):
7      print("Found an emotion!")
8
9  # Capture groups - extract parts of a match
10 match = re.search(r"I am feeling (.*) today", text)
11 if match:
12     emotion = match.group(1)  # "very happy"
13
14 # Substitution
15 new_text = re.sub(r"I am", "You are", text)
16 # "You are feeling very happy today"
```


Worked example: building a simple chatbot rule

Goal: Respond to "I am [feeling]" statements

```
1  import re
2
3  def simple_respond(user_input):
4      # Try to match "I am
5      [something]"
6      match = re.search(
7          r"I am (.*)",
8          user_input,
9          re.IGNORECASE
10     )
11
12     if match:
13         feeling = match.group(1)
14         return f"Why are you
15         {feeling}?"
16
17     return "Tell me more."
```

Try it:

```
1  >>> simple_respond("I am tired")
2      "Why are you tired?"
3
4  >>> simple_respond("I am feeling
5      anxious")
6      "Why are you feeling anxious?"
7
8  >>> simple_respond("Hello there")
9      "Tell me more."
```

Key insight

The computer has no idea what "tired" or "anxious" mean. It's just copying text!

Let's build our first (very simple) chatbot!

```
1  import re
2
3  # response function: process user input and
4  # respond appropriately
5  def respond(user_input):
6      # look for "I am ____" patterns
7      i_am = re.search(r"I am (.*)", user_input, re.IGNORECASE)
8
9      # look for "You are ____" patterns
10     you_are = re.search(r"You are (.*)", user_input, re.IGNORECASE)
11
12     if i_am:
13         feeling = i_am.group(1)
14         return f"Why are you {feeling}?"
15     elif you_are:
16         trait = you_are.group(1)
17         return f"What makes you think I am {trait}?"
18     # add some more patterns!
19     else:
20         return "Tell me more "
```

continued...

Let's build our first (very simple) chatbot!

```
21 # main loop: interact with user
22 print("Bot: Hello! I'm here to listen. Type 'exit' to quit.")
23 while True:
24     user_input = input("You: ")
25     if user_input.lower() in ["exit", "quit"]:
26         break
27     else:
28         response = respond(user_input)
29         print("Bot:", response)
30 print("Bot: Goodbye!")
```

...continued

Meet ELIZA: a computerized Rogerian therapist

Historical context

ELIZA was created by Joseph Weizenbaum at MIT in 1966. It was the first-ever interactive chatbot, and one of the first programs to attempt natural language processing. ELIZA plays the role of a Rogerian therapist, using simple pattern matching to simulate a conversation with a human patient.

What is a Rogerian therapist?

- Non-directive therapy style
- Reflects statements back to patient
- Asks open-ended questions
- Avoids making claims about the world

Key insight

- Rogerian style requires no real knowledge
- Simply reflects and rephrases
- Lets the human do the "heavy lifting" of "knowing about stuff"

Chat with ELIZA

Try it!

Have a conversation with ELIZA. Try putting yourself into the "frame of mind" of someone from the 1960s who had never experienced a chatbot before, and likely who had only had limited (if any) exposure to computers. Take on the role of a "patient" seeking help from ELIZA in its role as a therapist. Then use your own (modern) knowledge and experiences to see where ELIZA breaks down.

For your consideration

- What does ELIZA do surprisingly well?
- What reveals its limitations?
- Can you "trick" ELIZA? How?
- What kinds of inputs break the illusion?
- **How do you think ELIZA *works*?**

Example ELIZA conversation

```
1 User:   I am feeling sad today
2 ELIZA:  Why are you feeling sad
          today?
3
4 User:   My mother doesn't understand
          me
5 ELIZA:  Tell me more about your
          family.
6
7 User:   She always criticizes
          everything I do
8 ELIZA:  Your mother?
9
10 User:  Yes, and my father too
11 ELIZA:  What else comes to mind when
          you think of your father?
12
13 User:  I don't know
```

Notice how ELIZA:

- Picks up on keywords ("mother", "father")
- Reflects statements back as questions
- Uses generic prompts when stuck
- Never makes specific claims about the world

Where it breaks down:

```
1 User:   What is 2 + 2?
2 ELIZA:  Why do you ask?
3
4 User:   I want to know if you're
          intelligent
5 ELIZA:  Does it please you to
          believe I am intelligent?
```


The ELIZA effect

The ELIZA effect

The tendency to unconsciously assume that computer behaviors are analogous to human behaviors; to attribute human-like understanding to programs that merely simulate it.

Weizenbaum's observation

Weizenbaum was surprised (and disturbed) by how quickly users became emotionally involved with ELIZA. His secretary reportedly asked him to leave the room so she could have a private conversation with the program!

Why do we anthropomorphize machines?



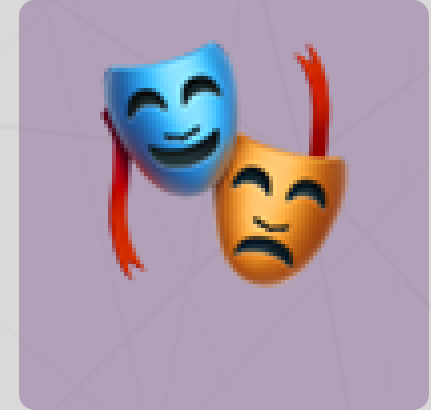
Language cues



Pattern recognition



Social instincts



Theory of mind

Note

Humans are social creatures. We evolved to detect minds and intentions, and we often over-apply this tendency, even to clearly non-conscious entities.

Discussion

Reflect on your own experiences

Have *you* experienced the ELIZA effect with modern AI systems (ChatGPT, Claude, Siri, Alexa)?

- When have you felt like an AI "understood" you?
- Where do you think that illusion came from?
- What broke the illusion?
- What is the difference between *seeming* intelligent and *being* intelligent?
- How would we *know* if an AI truly understood us?

Example: The ELIZA effect in modern AI

Feels like understanding:

- 1 User: I'm really stressed about my exam
- 2 AI: I can hear that you're feeling overwhelmed. Exams can be really stressful. What subject is it?
- 3
- 4 User: Physics. I've been studying for weeks
- 5 AI: Studying for weeks shows real dedication. What part of physics is giving you trouble?

Reveals the limitation:

- 1 User: I just realized I left my exam notes in your office
- 2 AI: I understand that can be frustrating! Would you like tips on how to retrieve your notes?

Pattern matching, not understanding

The AI has no office. It cannot have your notes. But it responds as if this makes sense!

Reading: Weizenbaum (1966)

Required reading

Weizenbaum, J. (1966). ELIZA—A computer program for the study of natural language communication between man and machine. *Communications of the ACM*, 9(1), 36–45.

Pay special attention...

- How does ELIZA select responses?
- What are "scripts" in ELIZA's architecture?
- Why did Weizenbaum choose the DOCTOR script?
- What did Weizenbaum observe about user reactions?

Up next

Lecture 3 (Thursday X-hour)

How **ELIZA** *actually* works

- Complete architecture walkthrough
- Pattern matching and response selection
- The role of scripts and keywords
- We will build it ourselves!

Prepare for next time

- Finish reading Weizenbaum (1966)
- Play with the ELIZA demo
- Think about: what would *you* add to ELIZA?
- Read the Assignment 1 instructions

Key takeaways

1. **String manipulation is foundational:** all text-based AI builds on finding, replacing, and extracting patterns
2. **Regular expressions are powerful:** flexible pattern matching enables sophisticated text processing
3. **ELIZA demonstrated the power of simplicity:** a few clever rules can create convincing illusions
4. **The ELIZA effect is real:** we naturally anthropomorphize systems that use language
5. **Seeming \neq being:** appearing intelligent does not require actual understanding

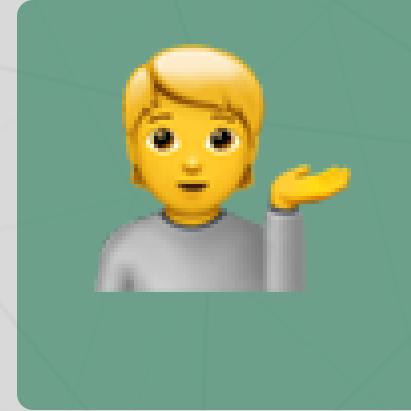
Questions? Want to chat more?



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Come to office hours

Tip

Feeling lost? Want to make sure we cover something you're excited about? **Reach out** if you have questions, comments, concerns, or just want to chat!