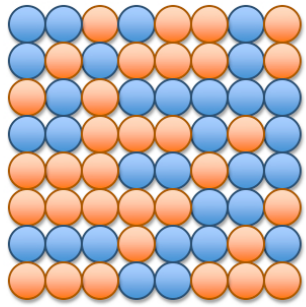
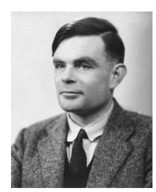
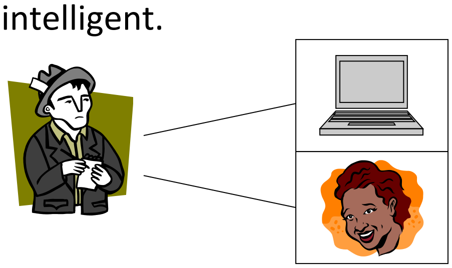


UNIT 12B
AI: Natural Language Processing

The Turing Test



- Turing publishes Computing Machinery and Intelligence in 1950.
- Describes a test (now called the Turing Test) to determine whether a computer can be called intelligent.



A machine is considered intelligent if an interrogator cannot tell if a human or a computer is answering a set of questions using typewritten responses.

Natural Language Processing

- Natural language processing involves the interactions between a computer and a human via spoken (or written) language.
- ELIZA
  - One of the first programs to build a conversation between a human and a computer, created by Joseph Weizenbaum in 1966.
  - Computer responses were created based on *scripts*.
  - Most famous example was DOCTOR which simulated a Rogerian psychotherapist.

ELIZA

H: My father wouldn't buy me a puppy.

C: Tell me more about your family.

H: I am sad I never got a puppy.

C: Can you explain what made you sad you never got a puppy?

H: I am sad we never had a chance to play fetch.

C: I am sorry to hear you are sad we never had a chance to play fetch.

Regular Expressions

- A regular expression is a rule that describes the format required for a specific string.

```
>>> import re
>>> s = "how now brown cow"
>>> match = re.findall(r'\wow', s)
>>> match
['how', 'now', 'row', 'cow']
>>>
```

regular expression that says match any string in s consisting of 3 characters, where the first character is anything (\w) and the next 2 characters are 'o' and 'w' exactly

PythonLabs.ElizaLab: Pattern

- A (sentence) **Pattern** is a mapping from a regular expression to a set of 1 or more responses.
- Example:

creates a regular expression based on the first argument

```
>>> from PythonLabs.ElizaLab import *
>>> p1 = Pattern("dog",
    ["Tell me more about your pet", "Go on"]
>>>
```

More about Patterns

The **`apply`** method tries to match an input sentence to a regular expression. If it can, it returns one of supplied response strings.

```
>>> p1.apply("I love my dog.")
'Tell me more about your pet.'
>>> p1.apply("My dog is really smart.")
'Go on.'
>>> p1.apply("Much smarter than my cat.")
>>>
```


Groups

- We can specify a **group** so that any member will cause a match during a scan.

```
>>> p2 = Pattern("(cat|dog|bird)",
    ["Tell me more about your pet", "Go on"]
>>> p2.apply("My dog is smelly.")
'Go on.'
>>> p2.apply("My cat ate my bird.")
'Tell me more about your pet.'
>>> p2.apply("I miss Polly a lot.")
>>>
```

Placeholders

- We can use placeholders to store the part of a pattern that matches so we can use it in the response.

```
>>> p = Pattern("(cat|dog|bird)")
>>> p.add_response("Tell me more about the
$1")
>>> p.add_response("A $1? Interesting.")
>>> p.apply("A dog ate my homework.")
'Tell me more about the dog.'
>>> p.apply("My cat ate my bird.")
'A cat? Interesting.'
```


Placeholders (cont'd)

```
>>> p = Pattern("I (like|love|hate) my (cat|
  dog|bird).")
>>> p.add_response("Why do you $1 your $2?")
>>> p.add_response("Tell me about your $2.")
>>> p.apply("I like my dog.")
'Why do you like your dog?'
>>> p.apply("I hate my cat.")
'Tell me about your cat.'
```

Wildcards

- We can use a wildcard symbol (.*) to match any number of characters.

```
>>> p = Pattern("I am afraid of (.*)")
>>> p.add_response("Why are you afraid of $1?")
>>> p.apply("I am afraid of ghosts")
'Why are you afraid of ghosts?'
>>> p.apply("I am afraid of Tom")
'Why are you afraid of Tom?'
```


A Note About **Pattern**

- Pattern takes a string and converts it to a regular expression, adding some special characters.

  e.g. \b word boundary

```
>> p = Pattern("dog")
>> p              => \bdog\b
>> p = Pattern("I like .*")
>> p              => \bI like (.*)
>> p = Pattern(".eat")
>> p              => .eat\b
```

Another Note About **Pattern**

- If you want to match against a character used as a special regular expression code, use \

```
>>> p = Pattern("I like .*.")
>>> p              => \bI like (.*).
```
(any number of characters followed by any character)
```
>>> p = Pattern("I like .*\.")
>>> p              => \bI like (.*)\.
```
(any number of characters followed by a period)

Postprocessing

- To make things more realistic, we can replace personal pronouns with their opposites.

```
>>> p = Pattern("I am (.*)",
        ["Are you really $1?"])
>>> p.apply("I am near my car")
'Are you really near my car?'
>>> p.apply("I am annoyed at you")
'Are you really annoyed at you?'
```

Postprocessing (cont’d)

An associative array maps one element to another.

```
>>> Eliza.post[“my”] = “your”
>>> Eliza.post[“you”] = “me”
>>> Eliza.post
{'my' : 'your', 'you' : 'me' }
>>> p.apply("I am near my car.")
'Are you really near your car?'
>>> p.apply("I am annoyed at you.")
'Are you really annoyed at me?'
>>> p.apply("I am sad, my oh my.")
'Are you really sad, your oh your?'
```


Preprocessing

- Preprocessing is used to transform part of a sentence before pattern matching is performed.

```
>>> p = Pattern("I am afraid of (.*)")
>>> p.add_response("Why are you afraid of
  $1?")
>>> p.apply("I’m afraid of ghosts")
>>> Eliza.pre["I’m"] = "I am"
>>> p.apply("I’m afraid of ghosts")
'Why are you afraid of ghosts?'
```

Algorithm for a Conversation

1. Perform any preprocessing on the sentence.
2. Break the sentence into words.
3. If there is a rule for a word, add the rule to a priority queue.
4. Try the rules in order of decreasing priority.
5. If a rule applies to the input sentence, apply postprocessing rules to placeholder variables and return the response.

Eliza and the Turing Test

- Human (natural) language is very complex.

  "You said I wouldn't be afraid of horses if I visited a state fair, but when I was there I was chased by a pig, and now I'm having nightmares about bacon."

  Natural language processors (NLPs) must use **parsers** to break a sentence down into its constituent parts (noun, verb, etc.) to determine an appropriate response.

Eliza and the Turing Test

- Human (natural) language is very complex.

  "The lions were lying down in the grass."
  A: Go on.

  "They were quiet"
  A: Why were the lions quiet?

  Natural language processors (NLPs) must have **memory** to associate words (e.g. "they") to words from previous sentences.

Eliza and the Turing Test

- Human (natural) language is very complex.

  "The elephant was huge."
  A: How big was it?

  "The cat fell into the well."
  A: Was it able to get out?

  NLPs must use **semantics** to assign meaning to certain phrases in order to generate appropriate responses.

Eliza and the Turing Test

- Human (natural) language is very complex.

  "The dog ran across the backyard while I waited on my patio."

  A: What happened when the dog reached the patio?

  NLPs must establish **inferences** to add information to sentences that is not given but is assumed.