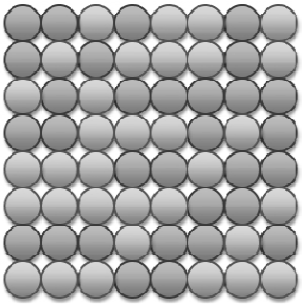


UNIT 13A

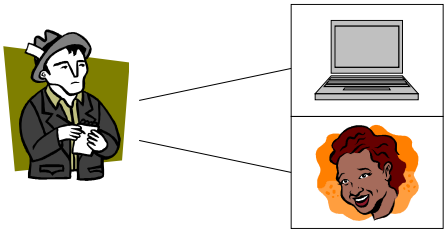
AI: Natural Language Processing

Artificial Intelligence

- Branch of computer science that studies the use of computers to perform computational processes normally associated with human intellect.
- Some areas of AI:
  - Expert systems
  - Knowledge representation
  - Machine learning
  - 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.

Beginnings of AI

McCarthy 

- John McCarthy (inventor of the programming language Lisp) coins the term "artificial intelligence" in 1956 at a Dartmouth conference.
- Allen Newell and Herbert Simon contributed to one of the first AI programs, the General Problem Solver (GPS) in 1957.
  - For more info: http://tip.psychology.org/simon.html
  - Faculty members at Carnegie Mellon University.
  - Awarded the Turing Award in 1975 for "basic contributions to artificial intelligence, the psychology of human cognition, and list processing."

Newell   Simon

Types of AI

- Weak AI
  - The computer is an intelligent, problem-solving device.
- Strong AI
  - Not only can a computer solve problems in an intelligent manner, but the computer is self-aware (or has a sense of consciousness).
  - Arguments against Strong AI:
    - Chinese Room Argument - John Searle 1981
    - Blockhead - Ned Block 1980

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.

Searching a String

```
>> s = "My dog ate the caterpillar."
=> "My dog ate the caterpillar."
>> s.include?("dog")
=> true
>> s.include?("Caterpillar")
=> false
>> s.include?("cat")
=> true
>> s.index("the")
=> 11
>> s.slice!(11,3)
=> "the"
>> s
=> "My dog ate  caterpillar."
```

Regular Expressions

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

```
>> s = "how now brown cow ow"
=> "how now brown cow ow"
>> r = /.ow/
=> /.ow/
>> s.scan(r)
=> ["how", "now", "row", "cow", " ow"]
```

`r` is a regular expression that says match an string consisting of 3 characters, where the first character is anything and the next 2 characters are 'o' and 'w' exactly

RubyLabs: 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

```
>> p1 = Pattern.new("dog",
   ["Tell me more about your pet",
       "Go on"]
=> 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.")
=> nil
```


Groups

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

```
>> p2 = Pattern.new("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.")
=> nil
```

Placeholders

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

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

Wildcards

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

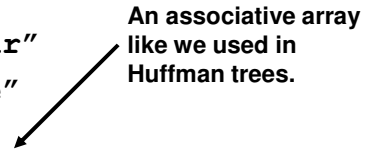
```
>> p = Pattern.new("I am afraid of .*")
>> p.add_response("Why are you afraid of $1?")
>> p.apply("I am afraid of ghosts")
=> "Why are you afraid of ghosts?"
>> p.apply("I am afraid of Tom")
=> "Why are you afraid of Tom?"
```


Postprocessing

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

```
>> p = Pattern.new("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)




```
>> 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 my my.")
=> "Are you really sad, your your your?"
```


Preprocessing

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

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