Introduction to Natural Language Processing

Introduction

book

https://web.stanford.edu/~jurafsky/slp3/ed3book_dec302020.pdf

Hit record

Syllabus

The semester

Don’t plagiarize

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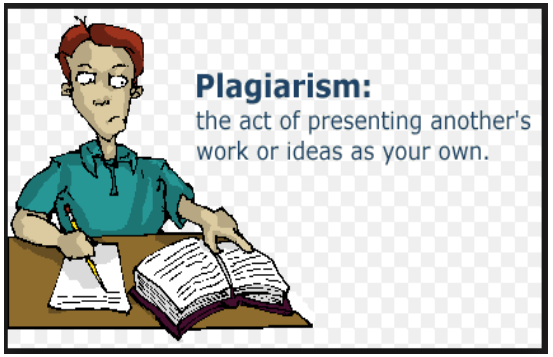

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Small Lecture

What is Natural Language Processing?

- The study of human languages and how they can be represented computationally and analyzed and generated algorithmically
  - Understanding:
    - *The cat is on the mat.* --> on (cat, mat)
  - Generation:
    - on (cat, mat) --> *The cat is on the mat.*
    - on (dog, couch) -> *The dog is on the couch.*
- Studying NLP involves studying natural language, formal representations, and algorithms for their manipulation

What *is* Natural Language Processing?

Building computational models of natural language comprehension and production

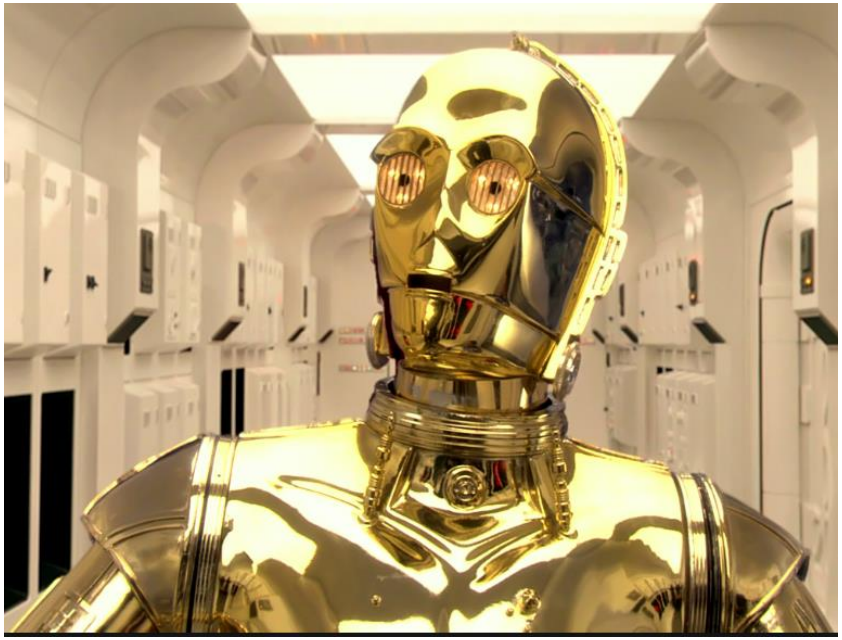
Other Names:

- Computational Linguistics (CL)
- Human Language Technology (HLT)
- Natural Language Engineering (NLE)
- Speech and Text Processing

Perspectives

- Engineering Perspective
- Cognitive Science Perspective
- Theoretical Linguistics Perspective

Engineering Perspective



Use CL as part of a larger application:

- Spoken dialogue systems for telephone based information systems
- Components of web search engines or document retrieval services
  - Machine translation
  - Question/answering systems
  - Text Summarization
- Interface for intelligent tutoring/training systems

Emphasis on

- Robustness (doesn't collapse on unexpected input)
- Coverage (does something useful with most inputs)
- Efficiency (return an answer in a timely manner)

Cognitive Science Perspective

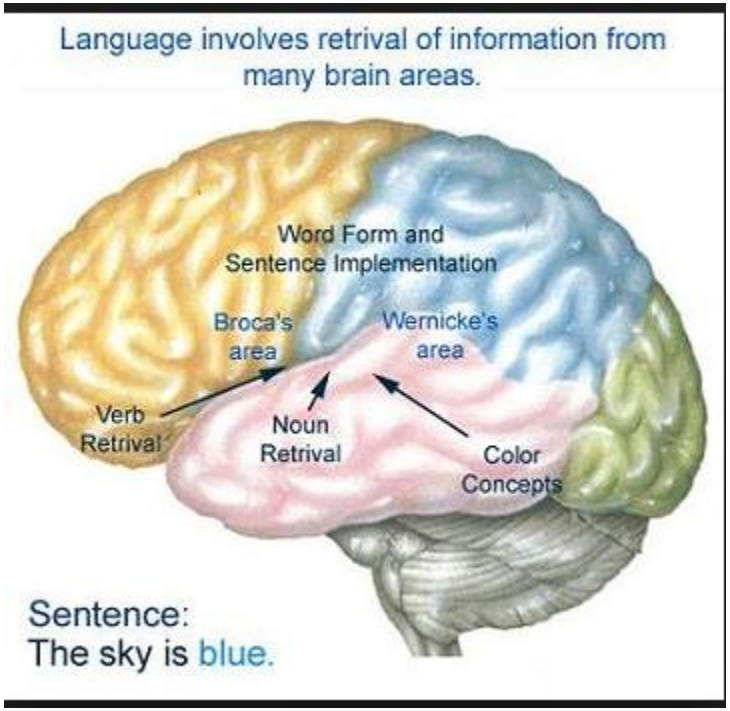
Goal: gain an understanding of how people comprehend and produce language.

Goal: a model that explains actual human behaviour

Solution must:
- explain psycholinguistic data
- be verified by experimentation

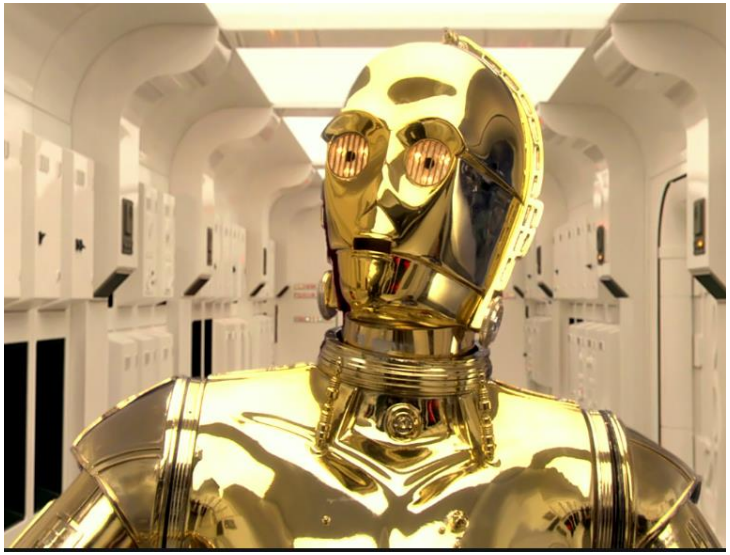
Theoretical Linguistics Perspective

- In principle, coincides with the Cognitive Science Perspective
  - CL can potentially help test the empirical adequacy of theoretical models.
  - Building computational models of the theories allows them to be empirically tested.
    - E.g., does your grammar correctly parse all the grammatical examples in a given test suite, while rejecting all the ungrammatical examples?



Orientation of this Class

- Emphasis on principles and techniques
- Emphasis on processing textual input (as opposed to speech)
- Oriented towards both symbolic and statistical approaches



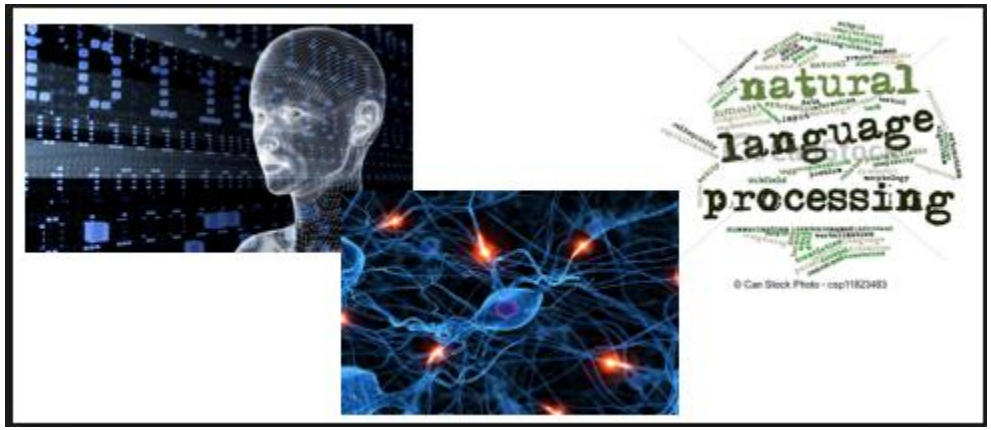
Why Should You Care?

Trends:

1. An enormous amount of knowledge is now available in machine readable form as natural language text

2. Conversational agents are becoming an important form of human-computer communication

3. Much of human-human communication is now mediated by computers



Knowledge needed to understand and produce language

- ***Phonetics and phonology*:**
  - **how words are related to sounds that realize them**
- *Morphology*:
  - how words are constructed from more basic meaning units
- *Syntax*:
  - how words can be put together to form correct utterances
- *Lexical semantics*:
  - what words mean
- *Compositional semantics*:
  - how word meanings combine to form larger meanings
- *Pragmatics*:
  - how situation affects interpretation of utterance
- *Discourse structure*:
  - how preceding utterances affects processing of next utterance

Phonetics and Phonology

speech sounds, their production, and the rule systems that govern their use

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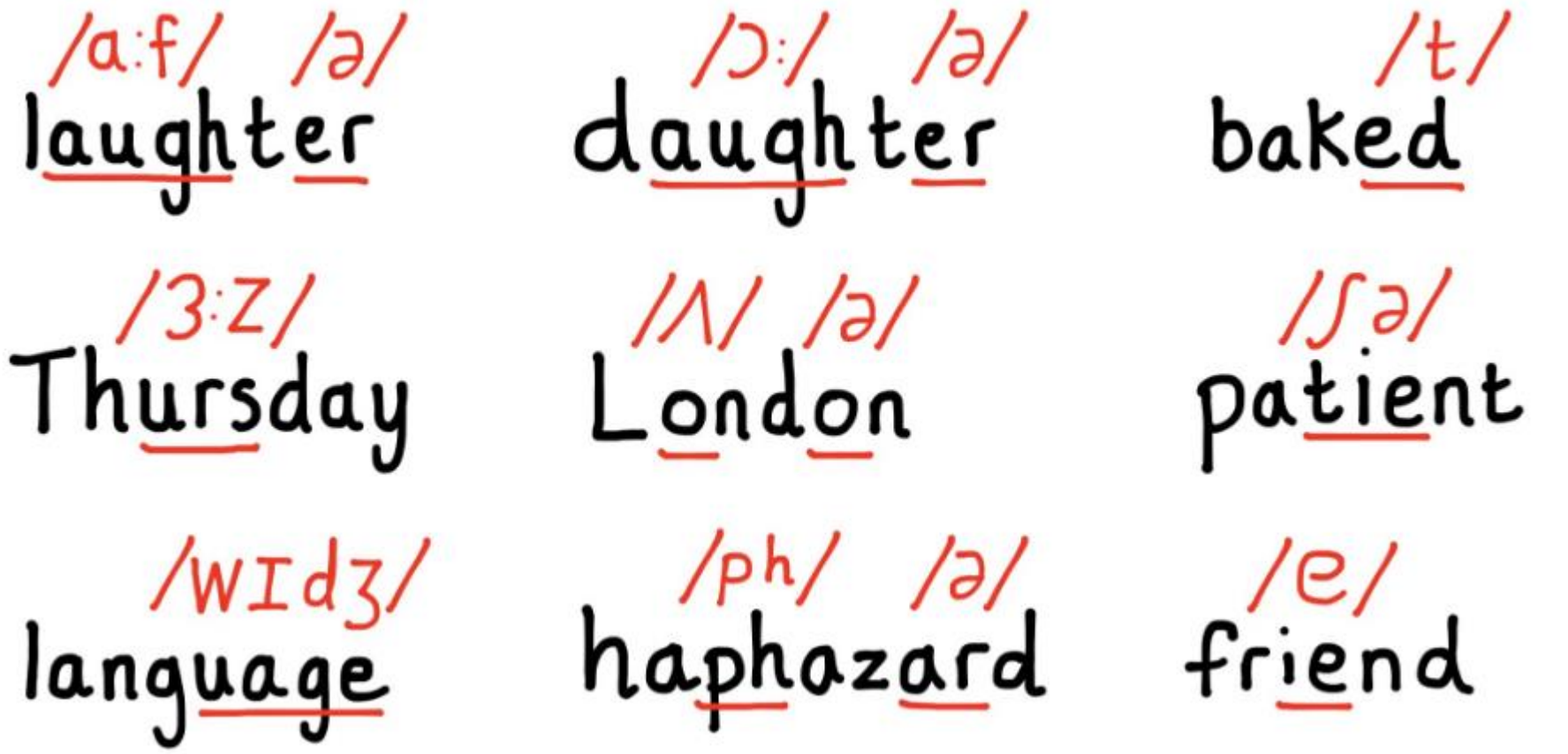

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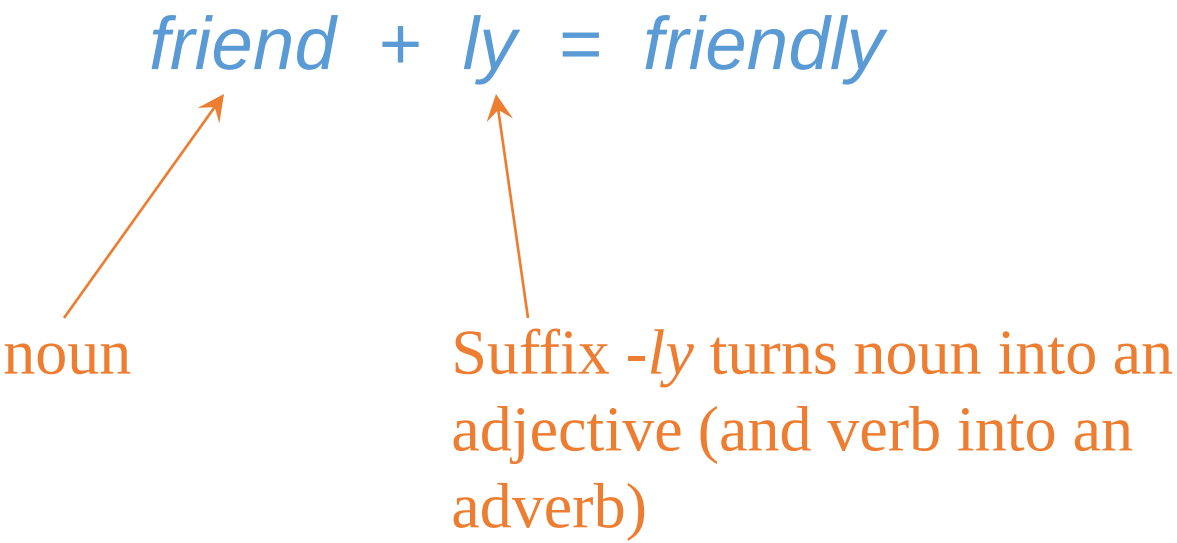
Morphology

- How words are constructed from more basic units, called *morphemes*



Morphology

- Words and their composition can be tricky
    - Pluralization:
        - cat -> cats
        - dog -> dogs

and then we have:

- child -> children
- mouse -> mice

mouse

mouses

Morphology

- Words and their composition can be tricky
  - Pluralization:
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    - dog -> dogs

and then we have:

  - child -> children
  - mouse -> mice

  - Suffixes (or not)
    - undo, union

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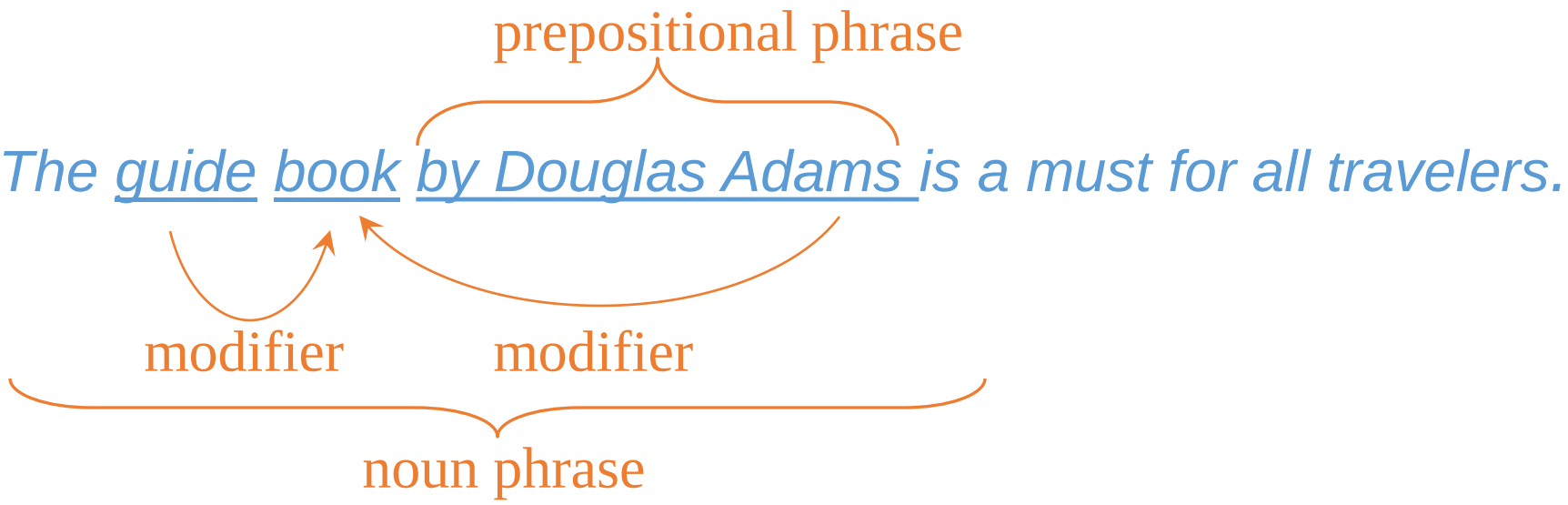
Syntactic Knowledge

- how words can be put together to form legal sentences in the language
- what structural role each word plays in the sentence
- what phrases are subparts of other phrases



- Syntax: the structuring of words into larger phrases
  - Number of ways to structure a phrase and achieve the same meaning
    - John hit Bill (active)
    - Bill was hit by John (passive)
    - Bill, John hit (preposing)
    - Who John hit was Bill (wh-cleft)

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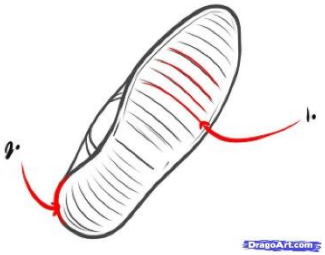
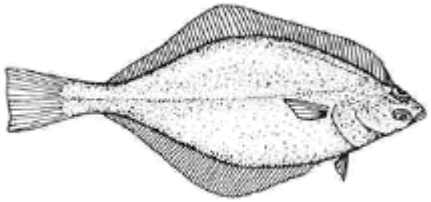
Semantic Knowledge

- What does a word mean?

bat

sole





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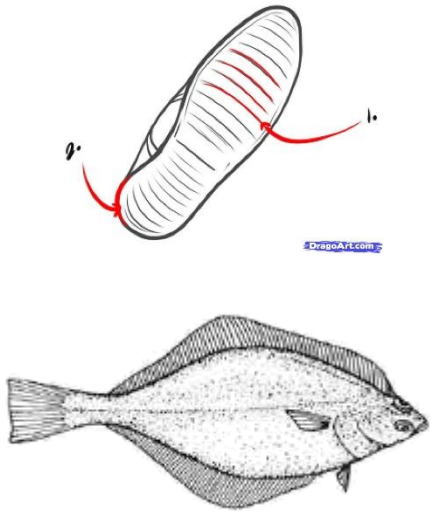

I ate sole for dinner.

bat

The bat flew.

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Pragmatics and Discourse: The influence of Context on language

"Going Home" – A play in one act; five scenes

by Bonnie Dorr

- Scene 1: Pennsylvania Station, NY
  - Bonnie: Long Beach?
  - Passerby: Downstairs, LIRR Station.
- Scene 2: Ticket Counter, LIRR Station
  - Bonnie: Long Beach?
  - Clerk: $4.50.

- Scene 3: Information Booth, LIRR Station
  - Bonnie: Long Beach?
  - Clerk: 4:19, Track 17.
- Scene 4: On the train, vicinity of Forest Hills
  - Bonnie: Long Beach?
  - Clerk: Change at Jamaica.
- Scene 5: On the next train, vicinity of Lynbrook
  - Bonnie: Long Beach?
  - Clerk: Right after Island Park.

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1. *Bonnie has a limited vocabulary*
2. *Context is important*

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Discourse

- Relationships we infer between discourse entities
- Not expressed in either of the propositions, but from their juxtaposition

Friend 1: *I'm hungry.*

Friend 2: *Let's go to the Fuji Gardens.*

Discourse

- Relationships we infer between discourse entities
- Not expressed in either of the propositions, but from their juxtaposition

Friend 1: *It's a beautiful day.*

Friend 2: *Let's go to the Fuji Gardens.*

Discourse and Temporal Interpretation

Max fell. John pushed him.

explanation

Syntax and semantics: "him" refers to Max

Lexical semantics and discourse: the pushing occurred before the falling.

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World knowledge

- What we know about the world and what we can assume our hearer knows about the world is intimately tied to our ability to use language

I took the cake from the plate and ate it.

World knowledge

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- What we know about the world and what we can assume our hearer knows about the world is intimately tied to our ability to use language

I took the fugu from the plate and ate it.

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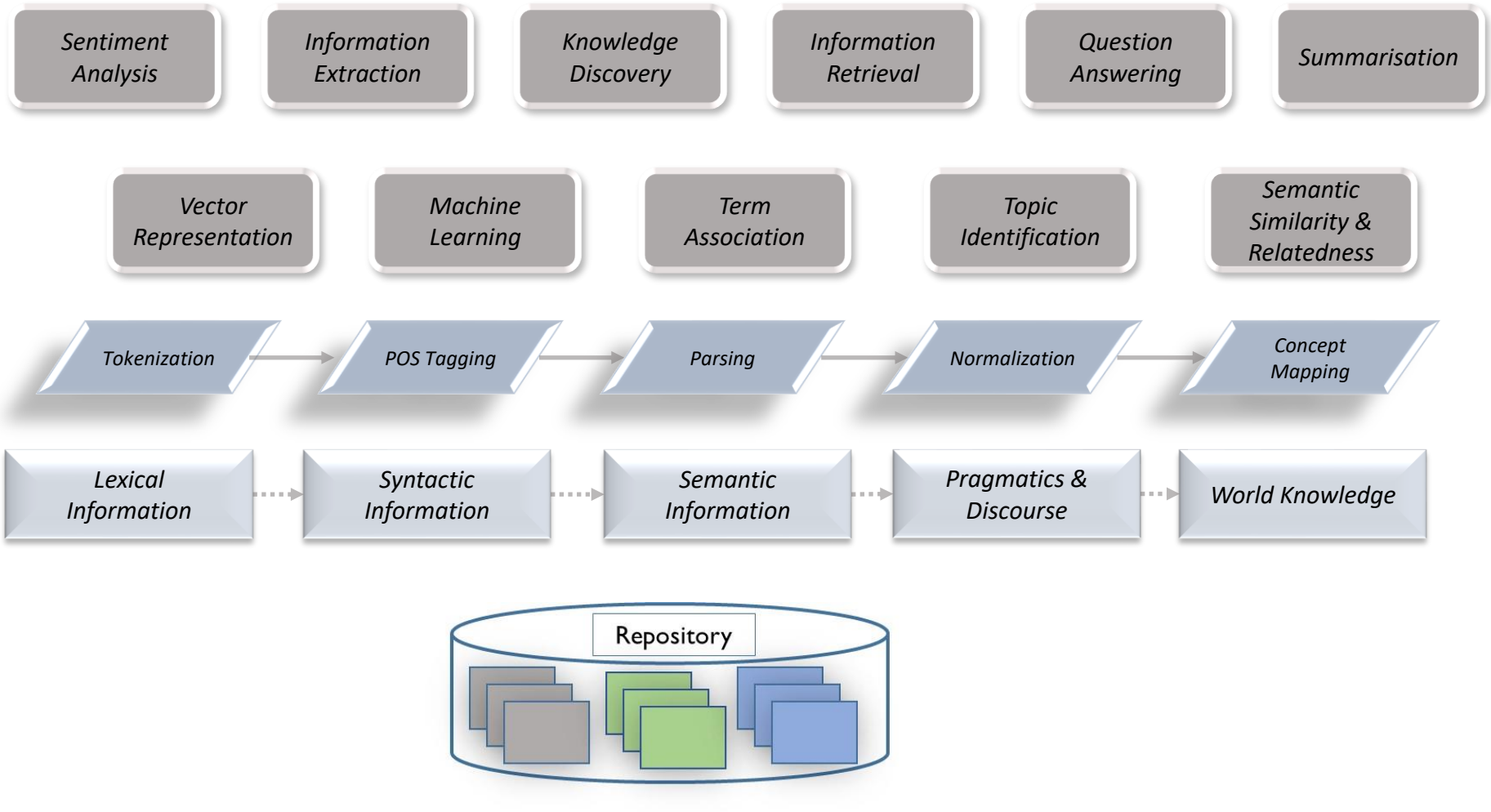
Natural language processing stack



Questions?