Natural Language Content Analysis

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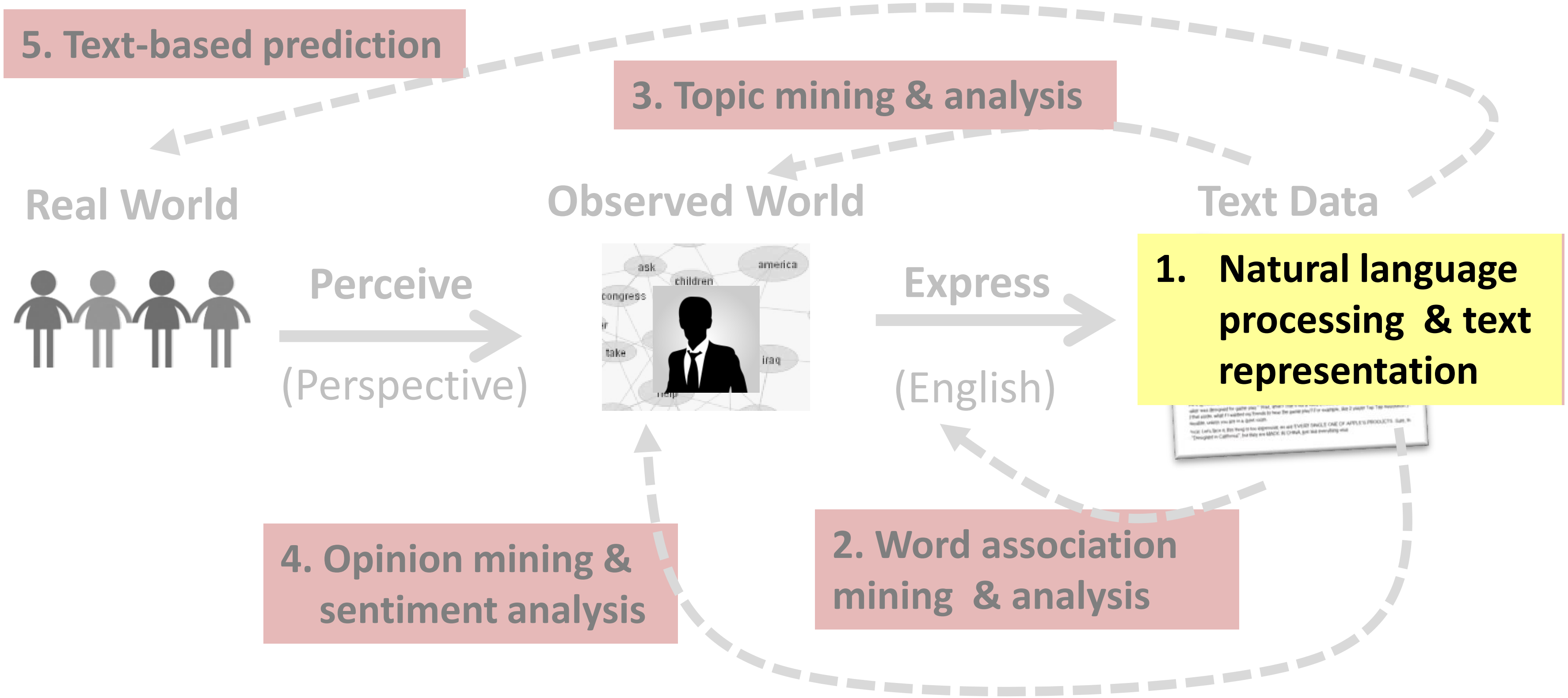


5. Text-based prediction

3. Topic mining & analysis

Real World

Observed World

Text Data

Perceive

(Perspective)

Express

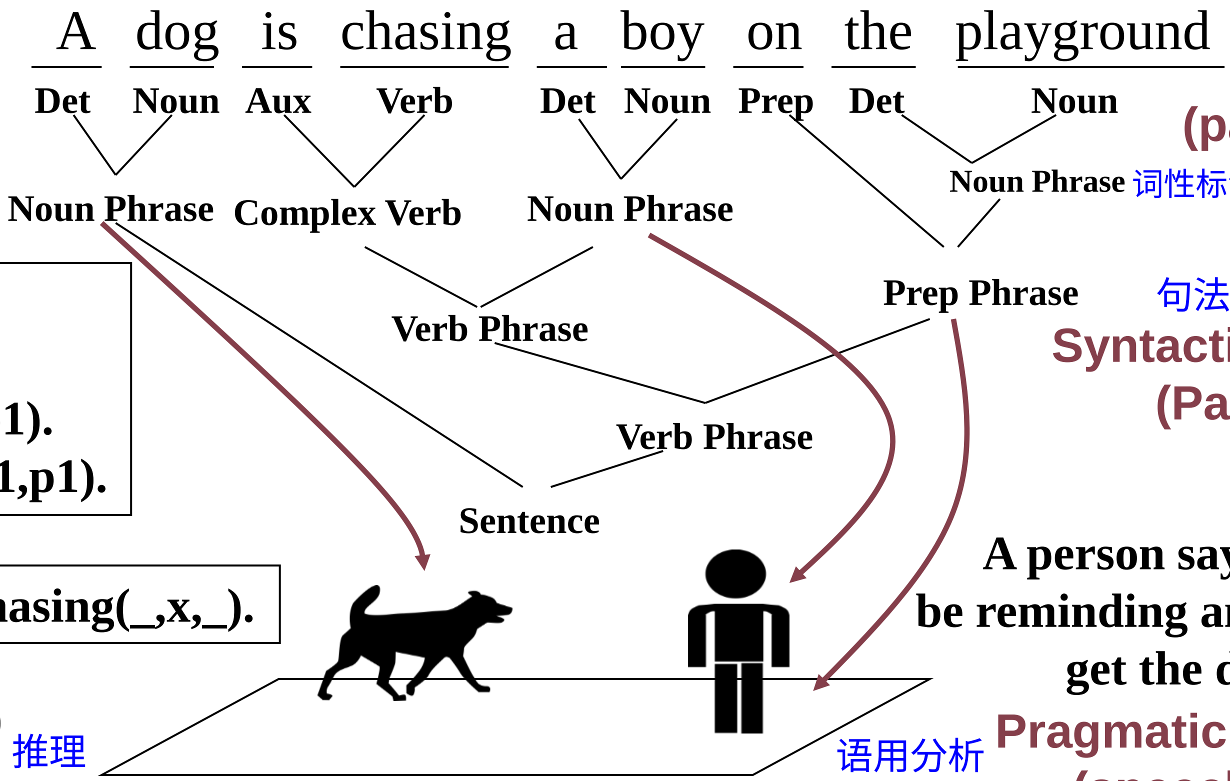
(English)

1. Natural language processing & text representation

4. Opinion mining & sentiment analysis

2. Word association mining & analysis

Basic Concepts in NLP



A dog is chasing a boy on the playground

Det Noun Aux Verb Det Noun Prep Det Noun

Noun Phrase

Complex Verb

Noun Phrase

Noun Phrase

Verb Phrase

Prep Phrase

Verb Phrase

Sentence

词法分析
Lexical analysis (part-of-speech 词性标注tagging)

句法分析
Syntactic analysis (Parsing) 分词

语义分析
Semantic analysis

Dog(d1).
Boy(b1).
Playground(p1).
Chasing(d1,b1,p1).

+

Scared(x) if Chasing(_,x,_).

Scared(b1)
Inference 推理

A person saying this may be reminding another person to get the dog back.

语用分析 Pragmatic analysis (speech act)

NLP Is Difficult!

- Natural language is designed to make human communication efficient. As a result,
  - we omit a lot of *common sense* knowledge, which we assume the hearer/reader possesses.
  - we keep a lot of ambiguities, which we assume the hearer/reader knows how to resolve.
- This makes EVERY step in NLP hard
  - Ambiguity is a *killer*! 难点：歧义性
  - Common sense reasoning is pre-required.

Examples of Challenges

- Word-level ambiguity: 难点：歧义性
  - “design” can be a noun or a verb (ambiguous POS)
  - “root” has multiple meanings (ambiguous sense)
- Syntactic ambiguity: 1，自然语言的处理，2，自然的语言处理
  - “natural language processing” (modification) 谁拿着望远镜——介词短语歧义
  - “A man saw a boy *with a telescope*.” (PP Attachment)

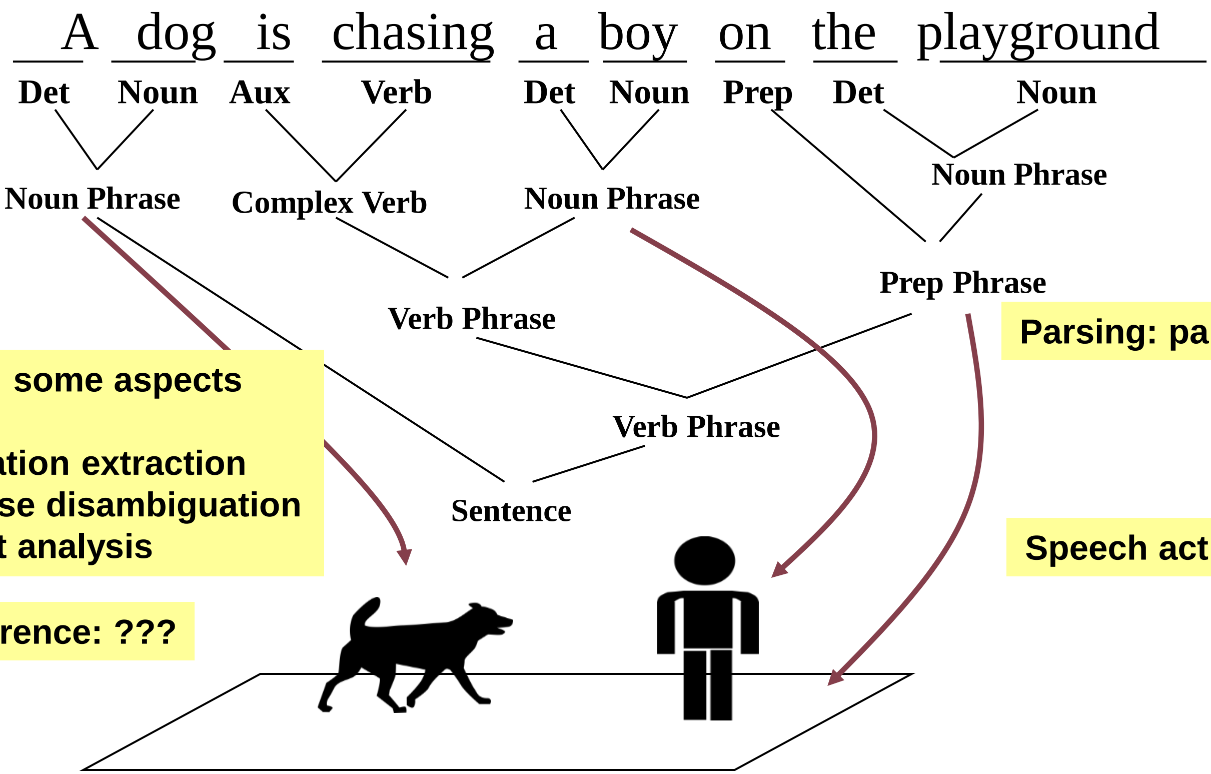
指代消解

- Anaphora resolution: “John persuaded Bill to buy a TV for *himself*.” (himself = John or Bill?)

预设，前提

- Presupposition: “He has quit smoking” implies that he smoked before.

The State of the Art



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Sentence

POS Tagging: 97%

Parsing: partial >90%(?)

Semantics: some aspects

- **Entity/relation extraction**
- **Word sense disambiguation**
- **Sentiment analysis**

Speech act analysis: ???

Inference: ???

What We Can’t Do

- 100% POS tagging
  - “He turned off the highway.” vs “He turned off the fan.”
- General complete parsing
  - “A man saw a boy with a telescope.”
- Precise deep semantic analysis
  - Will we ever be able to precisely define the meaning of “own” in “John owns a restaurant”?

Robust and general NLP tends to be *shallow* while *deep* understanding doesn’t scale up.

Summary

- NLP is the foundation for text mining
- Computers are far from being able to understand natural language
  - Deep NLP requires common sense knowledge and inferences, thus only working for very limited domains
  - Shallow NLP based on statistical methods can be done in large scale and is thus more broadly applicable
- In practice: statistical NLP as the basis, while humans provide help as needed

Additional Reading

Manning, Chris and Hinrich Schütze. *Foundations of Statistical Natural Language Processing*. Cambridge: MIT Press, 1999.