Lecture 18: Semantic Role Labeling & Semantic Parsing

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Course webpage: http://kwchang.net/teaching/NLP16
Computational Semantics

- Many high-level applications
  - Question answering
  - Information extraction
  - Internet bots
  - Siri/Cortana/Alexa/Google Now
  - Translation

- Shallow vs. deep semantics
  - Cheap, fast, low-level techniques v.s. computational expensive, high-level techniques
Semantic Roles

- **Predicates**: some words represent events
- **Arguments**: specific roles that involves in the event
- **PropBank**: Several other alternative role lexicons

```
run.01 (operate)
  ARG0 (operator)
  ARG1 (machine/operation)
  ARG2 (employer)
  ARG3 (co-worker)
  ARG4 (instrument)
```
His father would come upstairs and stand self-consciously at the foot of the bed and look at his son.
Semantic Role Labelling

- Give a sentence, identify predicate frames and annotate semantic roles

Mr. Stromach wants to resume a more influential role in running the company.

---

I. Frame identification

II. Role labeling
Role Identification

Mr. Stromach wants to resume a more influential role in running the company.

ARG0

II. Role labeling

ARG1

run.01

I. Frame identification

We can model it as multi-class classification
Role labeling

Conduct constrained inference
Semantic parsing

- Motivation: programming language
- What is the meaning of 3+5*6

Examples from Chris Manning’s NLP course
Semantic parsing

- More complex meaning
  - $3+5^x$: we don’t know $x$ at the compile time

- “Meaning” at a node is a piece of code

- Form is “rule-to-rule” translation

We provide a way to form the semantics from bottom-up
Semantic Parsing

- Parse a natural language narrative to a machine readable format
- Logic form:
  John smokes.” “Everyone who smokes snores.”
  \[ \forall x. \text{smoke}(x) \rightarrow \text{snore}(x) \]
  \[ \text{smoke}(\text{John}) \rightarrow \text{snore}(\text{John}) \]
- Equations:
  Maria is now four times as old as Kate. Four years ago, Maria was six times as old as Kate. Find their ages now.
  \[ m = 4 \times n \]
  \[ m - 4 = 6 \times (n - 4) \]
Logic

- **Boolean**: semantic values of sentences
- **Entities**: e.g., objects, times, etc.
- **Function of various types**
  A function returning a boolean called “predicate”
  e.g., green (x)
  Function can return other functions or take functions as arguments
Logic: $\lambda$ terms

- $\lambda$ terms:
  - `square = \lambda x \ x^x`, `square(3) = 3*3`
  - `even = \lambda x \ (x \ mod \ 2 == 0)`  
    a predicate

- Can take multiple arguments:
  - `$\lambda x. [\lambda y. \times(x,y)]$`
Parse tree with associated semantics

Sentence
\(\text{loves}(\text{john}, \text{mary})\)

Noun Phrase
\(\text{john}\)

Name
\(\text{john}\)

“John”

Noun Phrase
\(\text{mary}\)

Name
\(\text{mary}\)

Verb Phrase
\(\lambda x. \text{loves}(x, \text{mary})\)

Verb
\(\lambda y. \lambda x. \text{loves}(x, y)\)

“loves”

\(\lambda y. \lambda x. \text{loves}(x, y)\)

“Mary”
my friends who live in [id:12345] \( \cap \) residents(12345)

Parse tree node: Display text
Semantic

[start]

[user-head]
my friends
friends(me)

[user-filter]
who live in [id:12345]
residents(12345)

[who]
who
-

[friends-head]
my friends
friends(me)

[live-in-verb]
live in
Residents()

{city}
\[id:12345\]
12345
San Francisco
Paper presentations

- We will learn recent NLP research
  - Techniques and applications
- Peer review
  - Go to Collab → Select peer grading