Comp24412 Symbolic AI
Lecture 15: Natural Language Parsing III

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2016–17
Outline

The syntax of relative clauses

Parsing relative clauses
• Consider the sentences
  The boy who saw Mary loved Jane
  The boy who Mary saw loved Jane
• The red phrases are called **relative clauses**
• Syntactically, relative clauses are adjuncts
• They are classified as **complementizer phrases** (CPs)
• Thus:
• Similarly:

```
IP
  NP
    Det N'        I'
    The N'      loves Jane
      N  CP
      who Mary saw
      N
      boy
```
These CPs contain little sentences with references to the boy missing:

The boy who [saw Mary] loves Jane

The boy who(m) [Mary saw ] loves Jane
• This observation motivates the postulation of **WH-movement** inside CPs.

• Thus, from the deep structures
• ...we obtain the following surface structures.
• (The t is called a trace)
Outline

The syntax of relative clauses

Parsing relative clauses
- It is straightforward to write dcg’s to handle Wh-movement.
- The CP-rules are as you would expect, except for an extra argument to IP:

\[
\text{cp}(\text{cp}(\text{cpSpec}, \text{CBarSyn})) \rightarrow \\
\text{cpSpec(} \text{WhMvL}, \text{cBar(} \text{CBarSyn, WhMvL})).
\]

\[
\text{cpSpec([np(RelPro)]]} \rightarrow \\
[\text{RelPro}], \\
\{\text{isRelPro(RelPro)}\}.
\]

\[
\text{cBar(cBar(c(empty), IPSyn), WhMvL)} \rightarrow \\
\text{ip(} \text{IPSyn, WhMvL})).
\]
The IP-rules are also as you would expect, except for the extra argument

\[
\text{ip}(\text{ip}(\text{NPSyn}, \text{IBarSyn}), \text{WhMvL}) \rightarrow \\
\text{np}(\text{NPSyn}, \text{WhMvL}, \text{WhMvL}_1), \\
\text{iBar}(\text{IBarSyn}, \text{WhMvL}_1).
\]

\[
\text{iBar}(\text{iBar}(\text{ISyn}, \text{VPSyn}), \text{WhMvL}) \rightarrow \\
\text{i}(\text{ISyn}, \text{VbMvL}), \\
\text{vp}(\text{VPSyn}, \text{VbMvL}, \text{WhMvL}).
\]

\[
\text{i}(\text{i}(\text{Aux}), []) \rightarrow [\text{Aux}], \{\text{isAux}(\text{Aux})\}. \\
\text{i}(\text{i}(\text{past}), [\text{VbMv}]) \rightarrow \\
[\text{Verb}], \\
\{\text{verbInflect}(\text{VbMv}, \text{Verb}), \text{isVerb}(\text{VbMv})\}.
\]
• And similarly for the VP-rules:

\[ \text{vp}(\text{vp}(V\text{barSyn}),V\text{bMvL},WhMvL) \rightarrow v\text{bar}(V\text{barSyn},V\text{bMvL},WhMvL). \]

\[ v\text{bar}(v\text{bar}(V\text{Syn},N\text{PSyn}),V\text{bMvL},WhMvL) \rightarrow v(V\text{Syn},V\text{bMvL}), np(N\text{PSyn},WhMvL,[]). \]

\[ v(v(V\text{verb}),[]) \rightarrow [V\text{verb}], \{\text{isVerb}(V\text{verb})\}. \]

\[ v(v(V\text{bMv}),[V\text{bMv}]) \rightarrow []. \]
The really clever bit goes on in the rules for NP:

\[
\text{np}(\text{np}(\text{PN}), \text{WhMvL}, \text{WhMvL}) \rightarrow \\
\text{[PN]}, \{\text{isPN}(\text{PN})\}.
\]

\[
\text{np}(\text{NPSyn}, [\text{NPSyn} | \text{WhMvL}], \text{WhMvL}) \rightarrow \\
[],
\]

\[
\text{np}(\text{np}(\text{DetSyn}, \text{NbarSyn}), \text{WhMvL}, \text{WhMvL}) \rightarrow \\
\text{det}(\text{DetSyn}), \text{nbar}(\text{NbarSyn}).
\]

\[
\text{nbar}(\text{nbar}(\text{NSyn})) \rightarrow \\
\text{n}(\text{NSyn}).
\]

\[
\text{nbar}(\text{nbar}(\text{NSyn}, \text{CPSyn})) \rightarrow \\
\text{n}(\text{NSyn}), \text{cp}(\text{CPSyn}).
\]
• Seems to work okay:

?- ip([the, boy, who, saw, mary, loved, jane]).
[ip(np(det(the)
    nbar(n(boy)
        cp(cpSpec
            cBar(c(empty)
                ip(np(who)
                    iBar(i(past)
                        vp(vbar(v(see)
                            np(mary)...)
                    iBar(i(past)
                        vp(vbar(v(love)
                            np(jane))))))])
    iBar(i(past)
        vp(vbar(v(see)
            np(mary)...)))]
The syntax of relative clauses

**Graphically:**

```
NP
  Det  N'
    The  N
    boy CP
CP-Spec  C'
  C
  IP

IP
  NP
    I'
    I  VP
    -ed  V  NP
      love Jane

I'
  VP
    -ed  V  NP
      see Mary
```

...