



Algorithms for Natural Language Processing

Ambiguity Resolution [3]



Today's Topics

- Selectional Restrictions
- Automatic Disambiguation
 - Semantic Domain Model
 - Heuristic Filtering
- Interactive Disambiguation
- Lingerin Problem



Selectional Restrictions

- Proper assignment of meaning depends on argument relations
- Pick one of several meanings
 - “Playing cards ate up 5 hours.”
 - “Bob ate up all of my french fries.”
- Rule out nonsense meanings
 - “The satellite orbited Mars.”
 - * “Mars orbited the satellite.”



Selectional Restrictions

- Encode argument relations as restrictions on fillers

```
(CHRONO_CONSUME ACTIVITY-OBJECT TIME-QUANTITY)
                    theme                duration
```

```
(PHYSICALLY_INGEST ANIMATE-OBJECT FOOD-OBJECT)
                    agent                theme
```

```
(PHYSICALLY_ORBIT UNMANNED-SPACECRAFT PLANET-OBJECT)
                    orbiter              central-body
(mass_greater_than central-body orbiter)
```



Syntactic Complexity

- Constructions like PP increase complexity dramatically
- Each PP can attach to noun(s) or verb to the left
- Each PP adds yet another NP attachment site
- “Find all parses and prune later” may not be an effective strategy



Disambiguating PPs

- Proper choice of attachment can be based on meaning
 - “The man saw the boy with the telescope.”
 - “The man saw the boy with the dog.”
- Attachment preferences can be used to pick one reading (even if both are syntactically possible)



Disambiguating PPs [2]

- If possible, it is more efficient to pick the right attachment during syntactic parsing (since complexity is reduced as soon as possible)



Example from KANT/Catalyst

- KANT uses a semantic domain model to prefer some attachments
- Catalyst: application for Caterpillar, Inc.
- Example:
The oil flows from the relief valve through the tube to the orifice.
- See handout (catalyst-trace.txt)



Attachment Triples

- Preferences encoded as 'triples'
- Relations between head concept, semantic role, and modifier concept

(*A-FLOW (SOURCE_FROM *O-RELIEF-VALVE))

(*A-PATH_THROUGH-VERB (PATH_THROUGH &ALL))

(*A-FLOW (GOAL_TO *O-ORIFICE))



Attachment Triples [2]

- Head and modifier receive a score, depending on how closely they match the triple data
- Attachment score is the sum of the head and modifier scores
- Syntactic tree receives a score which is the sum of all the attachment scores for that tree



Attachment Triples [3]

- The tree(s) with the lowest scores are chosen; others are pruned
- Scoring:
 - If the head/modifier matches exactly, its score is 0
 - If the head/modifier matches a generalized concept, its score is 1
 - If the head/modifier matches a default concept (&ALL), its score is 2



Attachment Triples [4]

- Example Sentence
 - Handout: catalyst-fs.txt
 - First and third PPs match triples exactly, so score is 0
 - Second PP matches on a generalized head (*A-PATH_THROUGH-VERB) and default filler (&ALL), so score is 3
 - Best score, so this structure is picked
 - All structures: catalyst-fs-orig.txt



Other Preferences

- Preferring phrasal lexicon entries over compositional NP
- e.g. “oil pan”
- Doesn’t always prune:

Oil [flows] from the [bearing seal].
V-intrans NP

[Oil flows] from the bearing [seal].
NP V-intrans



Interactive Disambiguation

- Ask the author to select the desired structure
- Structures must be presented in human-readable form!
- When to disambiguate?
 - During translation [Brown, 1991]
 - During source analysis [KANT]
- Saving the user's choice



Lexical Meaning

'release' is used ambiguously.

Release the pressure until the oil flows from the orifice.

Please select the intended meaning:

V: to trigger another action, particularly with a mechanical trigger

V: to relieve or purge pressure

V: to let out (a clutch); to disengage (a gear)

V: to disengage (a brake)

V: to loosen

Edit

Select



Part of Speech

['until' is used ambiguously.

Release the pressure until the oil flows from the orifice.

Please select the intended meaning:

CONJ: up to the time that; to the point or extent that

PREP: all uses of 'until' as a preposition are proper CTE

Edit

Select



PP Attachment

[What 'for' modifies is ambiguous.

[Remove the filter for repair.

Please select the intended meaning:

Remove the filter **for** repair.

Remove the **filter for** repair.

Edit

Select



Annotating the Input

- Use of SGML processing instructions to store user choices directly in the input text

```
Release<?CTE means text='release' val='*A-RELEASE-2'>  
the pressure until<?CTE means text='until' val='*CONJ-UNTIL'>  
the oil flows from the orifice.
```



Lexical vs. Structural Ambiguity

- Resolving lexical ambiguity eliminates more readings, so it's best to do lexical disambiguation first [Mitamura & Nyberg, 1995; Baker et al., 1994]



Confirming Usage

- Word isn't ambiguous, but authors may be using it inappropriately
- Prompt authors with a confirmation dialog



Issue: *Check meaning and change sentence, if necessary.*

Text in question: pressure

Check

OK

Replace

Lookup

Manual

Close

Alternatives

pressure
hydraulic/electrical pressure switch
hydraulic horsepower/high pressure cut
min/max pressure requirement
oil pressure summing control system

Lookup Term

pressure

CTE Uses

N pressure
N hydraulic/electrical pressure switch
N hydraulic horsepower/high pressure
N min/max pressure requirement
N oil pressure summing control system

Lookup Information: *pressure*

Definition:

NOUN; force applied over a surface, measured as force per unit of area;
DO NOT USE 'pressure' to mean 'the act of pressing; the application of continuous force by one body upon another body which it is touching'

Examples of Use:

Use the pump to increase the air pressure.

ed.

Lingering Problems

- True Domain Ambiguity
 - *Oil flows from the orifice*
 - *Current flows from the switch*
 - *Service the truck in the garage*
- Unintended Ambiguity
 - *Notify the dealer if the engine is damaged*
 - *Do not start the engine while the tank is filled*

