Chapter 10: Other Strategies for Semantic Interpretation

- Some techniques allow for the relatively rapid development of systems for a specific application.
- These techniques range from loosely coupled syntax and semantics to techniques that are essentially driven and use minimal syntactic information.
- So that it parses based on semantic structure rather than syntactic structure

Other Strategies for Semantic Interpretation

10.1 Grammatical Relations

- The idea underlying this approach is that the parser produces an output that is an abstracts away the details of the actual sentence, but retains the structure important for semantics as a set of grammatical relations or grammatical dependencies.
- The semantic interpreter then produces a meaning representation as a separate interpretation process that uses the grammatical relation as its input.
- Grammatical relations would be as follows:

  logical subject (LSUBJ). logical object (LOBJ),

  indirect object (IOBJ)

Other Strategies for Semantic Interpretation

10.1 Grammatical Relations

Jack bought a ticket.	(s1 PRED BUYS1) (s1 TNS PAST) (s1 LSUBJ (NAME j2 "Jack")) (s1 LOBJ <A t1 TICKET1>)
A ticket was bought by Jill.	(s2 PRED BUYS1) (s2 TNS PAST) (s2 LSUBJ (NAME j2 "Jill")) (s2 LOBJ <A t1 TICKET1>)
Jill gave Jack a book.	(s3 PRED GIVES1) (TNS s3 PAST) (s3 LSUBJ (NAME j1 "Jill")) (s3 LOBJ <A b1 BOOK1>) (s3 IOBJ (NAME j2 "Jack"))
Jill gave a book to Jack.	(s4 PRED GIVES1) (TNS s4 PAST) (s4 LSUBJ (NAME j1 "Jill")) (GIVES1 LOBJ <A b1 BOOK1>) (GIVES1 TO (NAME j2 "Jack"))
Jill thinks that Jack stole the book	(s5 PRED THINKS1) (s5 LSUBJ (NAME j1 "Jill")) (s5 LOBJ s6) (s6 PRED STEALS1) (s6 TNS PAST) (s6 LSUBJ (NAME j2 "Jack")) (s6 LOBJ <THE b1 BOOK1>)

Figure 10.1: A representation based on grammatical relations

Other Strategies for Semantic Interpretation

10.1 Grammatical Relations

	Pattern		Logical Form
1.	(<VAR> PRED <PRED>)	→	(3 1)
2.	(<VERB> AT <LOC>)	→	(AT-LOC 1 3)
3.	(<ACTION-VERB> LSUBJ <ANIMATE>)	→	(AGENT 1 3)
4.	(<ACTION-VERB> LOBJ <PHYSOBJ>)	→	(THEME 1 3)
5.	(<GIVE-VERB> TO <ANIMATE>)	→	(TO-POSS 1 3)
6.	(<GIVE-VERB> IOBJ <ANIMATE>)	→	(TO-POSS 1 3)
7.	(<ATTITUDE-VERB> LSUBJ <ANIMATE>)	→	(EXPERIENCER 1 3)
8.	(<ATTITUDE-VERB> LOBJ <VAR>)	→	(THEME 1 3)
9.	(PAST <VAR>)	→	(PAST 1)

Figure 10.2: Some patterns for interpreting grammatical relations

Other Strategies for Semantic Interpretation

10.1 Grammatical Relations

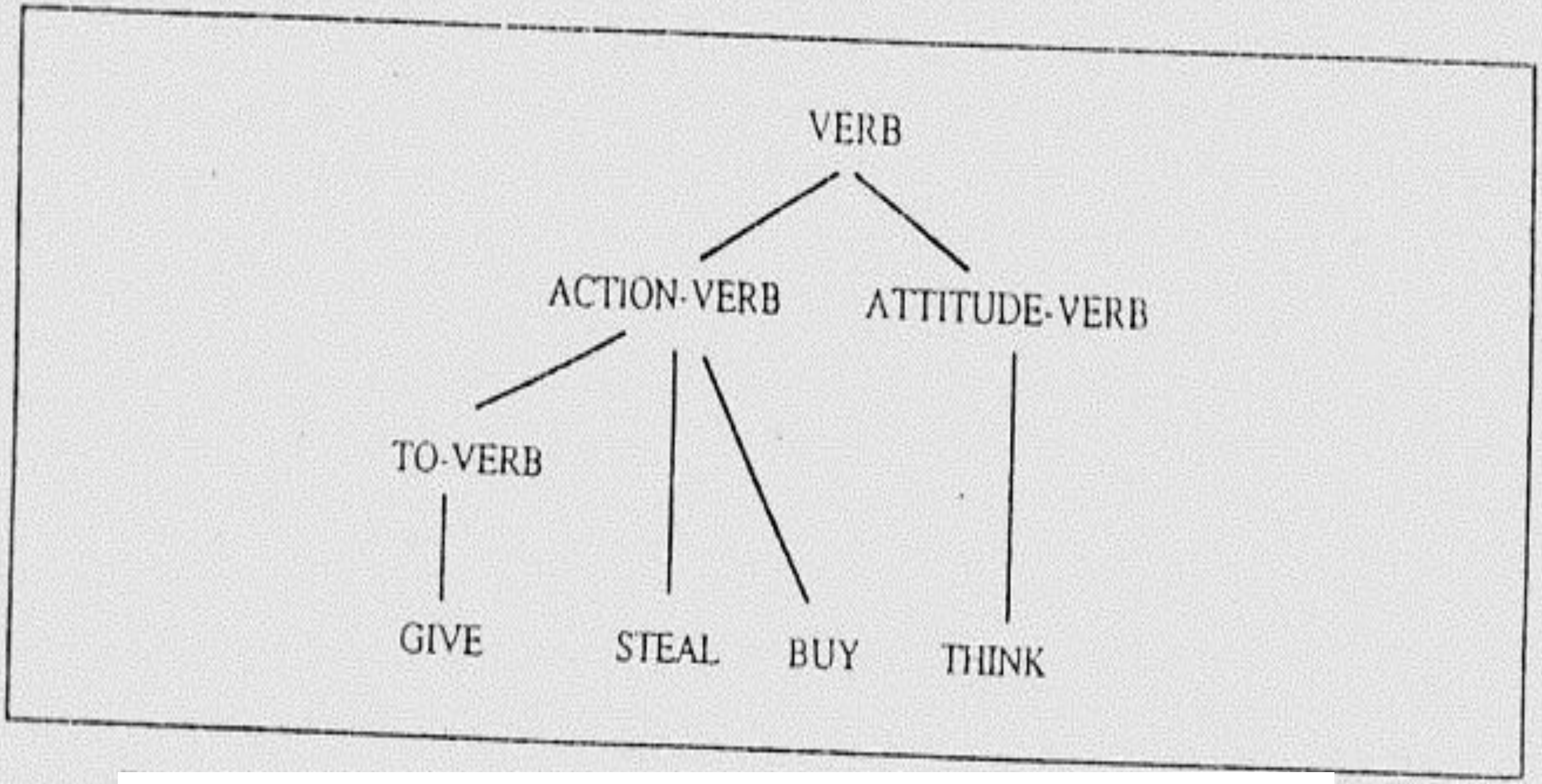

Figure 10.3: A verb hierarchy for pattern matching

Other Strategies for Semantic Interpretation

10.1 Grammatical Relations

- Figure 10.1 shows some sample sentences and their representations in terms of grammatical relations.
- Each relation is of form (*discourse-variable relation value*), where the value may be another discourse variable or a SEM structure.
- One method is to represent each of the grammatical relations as a feature. The resulting feature is easily converted into triples. The features

(PRED BUYS1 LSUBJ (NAME j2 “Jack”) LOBJ <A t1 TICKET1>)

Are easily converted into the triples

(s1 PRED BUYS1), (s1 LSUBJ (NAME j2 “Jack”)),

(s1 LOBJ <A t1 TICKET1>)).

Other Strategies for Semantic Interpretation

10.1 Grammatical Relations

- The rules consist of a pattern, in which <T> matches any element of type T.

- The right side of the rule specifies the semantic interpretation, where the number n indicates the value of the n'th element in the pattern (figure 10.2).

- For the patterns , verbs must be classified as shown in figure 11.3

ACTION – VERB (for *buy, give, steal*)

ATTITUDE – VERB (for *believe, think*)

TO - VERB (for *give, donate, throw*)

Other Strategies for Semantic Interpretation

10.1 Grammatical Relations

Example: ***Jack bought a ticket***

which omitting the tense information, has structure:

(1) (s1 PRED BUY S1)
(2) (s1 LSUBJ (NAME j2 “Jack”))
(3) (s1 LOBJ (A t1 TICKET1))

(1) Matches the first triple in figure 11.2

(2) Matches the second triple

(3) Matches the fourth triple

Producing the three logical form fragments

(BUY S1 s1) (AGENT s1 (NAME j2 “Jack”))
(THEME s1 < A t1 TICKET1 >)

Other Strategies for Semantic Interpretation

10.1 Grammatical Relations

These three fragments conjoined give the full logical form

(BUYS1 s1 [AGENT (NAME j2 “Jack”)]

[THEME < A t1 TICKET1 >])

Example: ***Jill thinks that Jack stole the book***

(s5 PRED THINKS1) □ (THINKS1 s5)

(s5 LSUBJ (NAME j1 “Jill”)) □ (EXPERIENCER s5 (NAME j1 “Jill”))

(s5 LOBJ s6) □ (THEME s5 s6)

(s6 PRED STEALS1) □ (STEALS1 s6)

(s6 TNS PAST) □ (PAST s6)

(s6 LSUBJ (NAME j2 “Jack”)) □ (AGENT s6 (NAME j2 “Jack”))

(s6 LOBJ < THE b1 BOOK1 >) □ (THEME s6 < THE b1 BOOKS1 >)

Other Strategies for Semantic Interpretation

10.1 Grammatical Relations

Merging these semantic translations would produce the following logical form in abbreviated form (ignoring tense)

(THINKS1 s5 [EXPERIENCER (NAME j1 “Jill)]

[THEME (STEALS1 s6 [AGENT (NAME j2 “Jack”)]

[THEME s6 < THE b1 BOOK1 >])])

Other Strategies for Semantic Interpretation

10.2 Semantic Grammars

- When building a system for a particular application, there are often techniques that can be used to improve the efficiency and performance of the parsing and semantic interpretation.

- This section describes a technique for building a custom-tailored grammar for the application.

- A general grammar of a natural language will contain many constructs that are necessary for wide coverage of the language but may not be needed in the application at hand.

- In these circumstances the general syntactic rule might be replaced in the grammar with a more specific semantically motivated rule.

Other Strategies for Semantic Interpretation

10.2 Semantic Grammars

Consider an application that supports queries to an airline database about flights. The following noun phrases referring to flights occur in this domain.

the flight to Chicago
the 8'oclock flight
the first out
flight 457 to Chicago

To handle these noun phrases, a general grammar must contain the following rules

NP □ DET CNP	(the flight)	CNP □ N PART	(flight out)
CNP □ N	(flight)	CNP □ CNP PP	(flight to Chicago)
CNP □ PRE – MOD CNP	(8'oclock flight)		
NP □ N NUMB	(flight 457)		

Other Strategies for Semantic Interpretation

10.2 Semantic Grammars

- For cities in this domain, we find the following types of the noun phrases: Chicago, the nearest city to Dallas.

- These phrases can be handle by the general grammar we just created, with the addition of one more rule to handle proper names. The problem with this is that now we have to restrict rules to apply to the appropriate categories.

Example: *the city to Chicago (≠ the flight to Chicago)*

the 8'clock flight (≠ the 8'oclock flight)

the first city out (≠ flight out)

city 567 (≠ flight 457)

Other Strategies for Semantic Interpretation

10.2 Semantic Grammars

- In the limited domain, it is often simpler to introduce new specialized lexical categories based on their semantic properities such as FLIGHT-N. With the lexical categories, the general grammar might be rewritten as follows:

FLIGHT-NP □ DET FLIGHT-CNP (the flight)
FLIGHT-CNP □ FLIGHT-N (flight)
FLIGHT-CNP □ FLIGH-CNP FLIGHT-DEST (flight to Chicago)
FLIGHT-CNP □ FLIGHT-CNP FLIGHT-SOURCE (flight from Boston)
FLIGHT-CNP □ FLIGHT-N FLIGHT-PART (flight out)
FLIGHT-CNP □ FLIGHT-PRE -MOD FLIGHT-CNP (8'oclock flight)
FLIGHT-NP □ FLIGHT-N NUMBER (flight 457)
CITY-NP □ CITY-NAME (Boston) CITY-NP □ DET CITY-CNP (the city)
CITY-CNP □ CITY-N (city)
CITY-CNP □CITY-MOD CITY-CNP CITY-MOD-AGR(nearest city to Dallas)

Other Strategies for Semantic Interpretation

10.2 Semantic Grammars

Of course, many other rules are needed, but these use semantic categories as well. For instance, the FLIGHT-DEST category allows prepositional phrases that specify the destination cities of flights:

FLIGHT – DEST □ to CITY – NP
FLIGHT –SOURSE □ from CITY – NP

Higher level syntactic structures can be similarly tailored to these categories, such as the rule:

TIME – QUERY □ When does FLIGHT – NP FLIGHT – VP

A grammar that is cast in terms of the major semantic categories of the domain is called a **semantic grammar**.

Other Strategies for Semantic Interpretation

10.2 Semantic Grammars

- We can augment a semantic grammar to produce a logical form in the normal way.
- An alternative method, however it is simply to use the parse tree itself as the logical form.

Example: Figure.10.4 shows the parse tree for the query:

Does the flight to Chicago leave ?

The tree structure in figure 10.4, might be represented as

```
( TIME – QUERY
    ( FLIGHT – NP
     ( DET the
     ( FLIGHT – CNP
         ( FLIGHT – CNP flight )
         ( FLIGHT – DEST to ( CITY – NP Chicago ))))
    ( FLIGHT – EVENT  leave ))
```

Other Strategies for Semantic Interpretation

11.2 Semantic Grammars

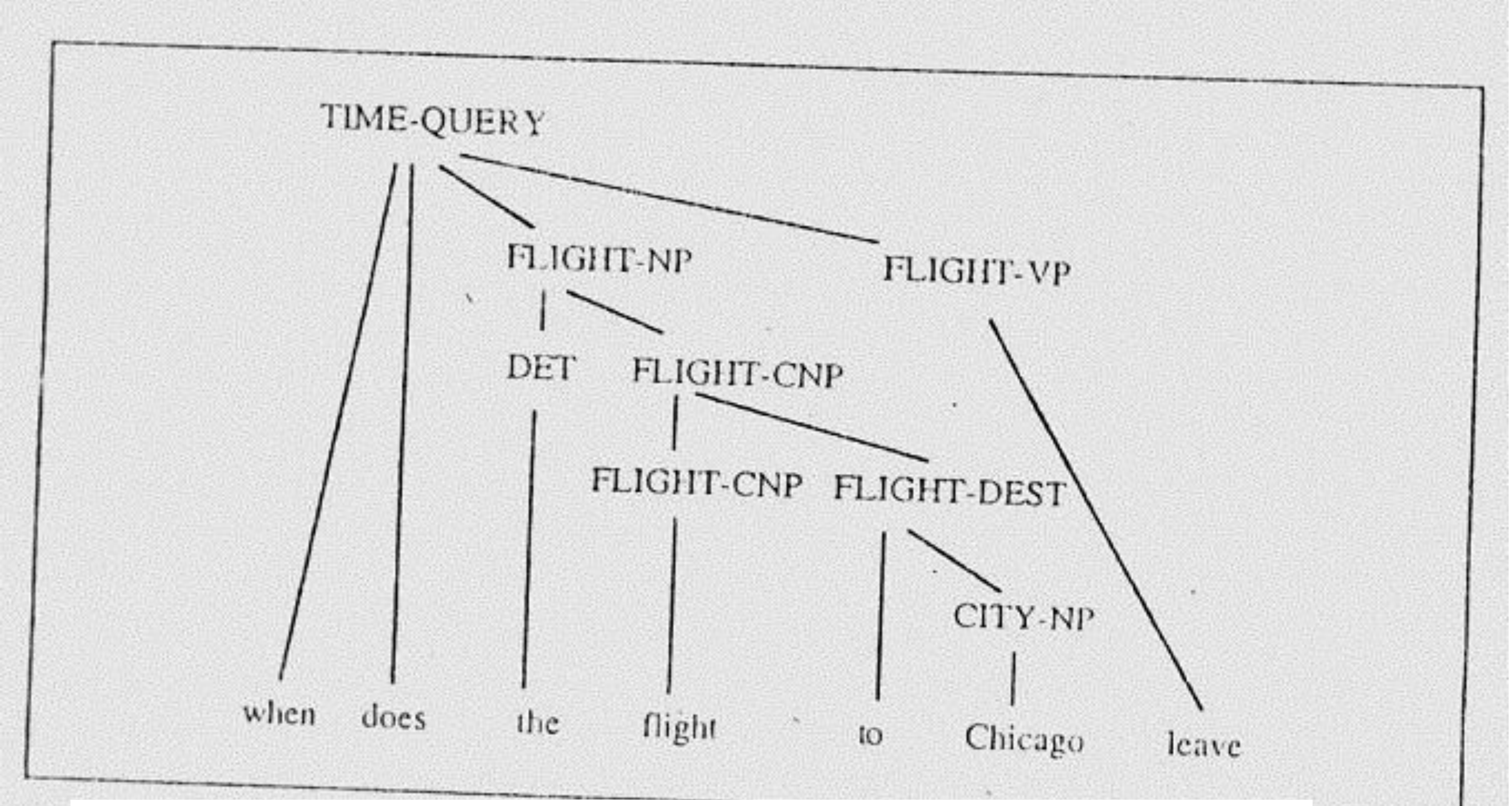

Figure 10.4: The parse tree for “When does the flight to Chicago leave ?”

Other Strategies for Semantic Interpretation

10.2 Semantic Grammars

- This structure would be at least as easy to convert to the database query as the full logical form for the sentence.
- So there is no advantage to further semantic analysis.

Semantic grammars combine aspects of the syntax, semantics and selectional restriction in the simple uniform framework.

- The results of semantic grammar have proven useful for the rapid development of the parsers in the limited application domain.
- The down side, however, is that they do not port well to new domains and can not handle applications in broad domains.
- A new domain will require a completely new semantic grammar, whereas most of syntactic grammar for one domain will apply to another domain

Other Strategies for Semantic Interpretation

10.3 Template Matching

(Study oneself)

10.4 Semantically driven Parsing Techniques

(Study oneself)

EXERCISE OF CHAPTER 10

1) Show the logical form generated from the grammatical dependency representation of the sentence *A ticket was bought at the theater,* using the data shown in figure 10.1, 10.2 and 10.3.
2) Draw the parse tree produced by the semantic grammar described in section 10.2 for the query *When does the 8 pm train from Boston arrive in Chicago ?.* Show additional rules that you have to add to the grammar so that it will accept this sentence.
3) Extend the treatment based on grammatical relations described in section 10.1 so that it handles the beneficiary case as in:

   Jack bought me a ticket.

   Jack bought a ticket for me