Comp24412 Symbolic AI
Lecture 11: Natural Language Grammar II

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Outline

Phrases in X-bar theory

Movement in X-bar theory
• The sentences we have parsed so far contain no auxiliary verbs (auxiliaries):
  John loves Mary
  Every boy kissed a girl
  The cat sat on the mat

• But many sentences do:
  John will telephone Mary
  John can see Mary
  John is stalking Mary

• What is the phrase-structure of sentences with auxiliaries?
• The standard analysis takes the auxiliaries to be **inflections** (I)
• Sentences containing them are said to be **inflection phrases** (IPs)
• This is the analysis we shall assume in this course.
Here is the standard picture of an IP: . . .

[np]

[Maximal projection of head]

[IP]

[Intermediate projection of head]

[Specifier]

[NP]

[Complement]

[IP]

[I']

[VP]

[Head]

[Specifier]

[NP]

[Specifiers]

[Head]

[Specifier]

[Maximal projection of head]

[Intermediate projection of head]

[Specifier]

[Maximal projection of head]

[Intermediate projection of head]

[Specifier]

[Maximal projection of head]

[Intermediate projection of head]

[Specifier]

[Maximal projection of head]

[Intermediate projection of head]

[Specifier]

[Maximal projection of head]

[Intermediate projection of head]

[Specifier]
According to the **X-bar theory** of natural language syntax, there are three levels of phrase:

- The **head** ($I$)
- An **intermediate projection** ($I'$ or $\bar{I}$)
- A **maximal projection** ($IP$)
The head combines with its **complement** to form the intermediate projection.

The intermediate projection combines with a **specifier** to form the maximal projection.
• The VP (the complement of the IP) has a similar internal structure . . .
• So does the NP (the complement of the VP)
• Well, you may have noticed a difference here.
• This NP has **three** intermediate projections (and no complements)
• Intermediate projections combine with **adjuncts** to produce further intermediate projections
• These can also combine with adjuncts . . .
- The **preposition-phrase** (PP) has the same structure, but there is no specifier (and no adjuncts). . . .
• ... This NP has no complement (and no adjuncts) ...
Altogether now:

```
IP
  NP
    Det N'    I' VP
       |       |    V' NP
          |       |    Adv V
             |       |    V
                |       |    N' NP
                   |       |    PP N' P' NP
                      |       |    Adj N' P
                          |       |    Adj N' P
                              |       |    the N' P NP
                                  |       |    body in Det N' NP
                                      |       |    the N
                                          |       |    kitchen
```

Phrases in X-bar theory

Movement in X-bar theory
• On this analysis, all phrases are the same!
• The general structure of this phrase is:

```
XP
   X
  specifier
     X
    X
     X
      X
       X
         X
           X
```

• In general, complements are obligatory, adjuncts are not
There are three levels of phrase:

- Heads X
- Intermediate projections (X’ or X)
- Maximal projections (XP)
• Heads combine with complements to form intermediate projections
• Intermediate projections combine with zero or more adjuncts to form more intermediate projections
• Intermediate projections combine with specifiers to form maximal projections
Outline

Phrases in X-bar theory

Movement in X-bar theory
• This IP analysis leaves us with a problem
• We know how to analyse sentences containing auxiliary verbs:
  John will telephone Mary
  John can see Mary
  John is stalking Mary

• But how do we analyse sentences containing no auxiliary verbs?
  John loves Mary
  John saw Mary
• When there is an auxiliary, the auxiliary is **finite** (will, can, is) and the verb is **infinite** (telephone, see, stalking)

• When there is no auxiliary, the verb is finite (loves, saw). (In particular, it has **tense**.)
• One way to think about what is going on here is to suppose that, when no auxiliary is present, the verb migrates upwards to join the inflection.

```
Deep structure                              Surface structure
IP                                            IP
  NP                                          NP
    I'                                          I'
      John                                      John
      s                                          s
       V                                          loves
        NP                                        V
         love Mary                               NP
```

• This operation is known as (head) movement.
Thus, there are two levels of structure to worry about:

- **Deep structure**— the initial structure generated by the underlying grammar
- **Surface structure**— the structure that results after movement

The approach to syntax which posits such movement operations is sometimes called **transformational grammar**.
Consider how sentences with auxiliaries are negated

John will telephone Mary
John can see Mary
John is stalking Mary

John will not telephone Mary
John can not see Mary
John is not stalking Mary
• Of course, this form of negation is not available (in modern English) for sentences without auxiliaries:

John loves Mary
John saw Mary

* John loves not Mary
* John saw not Mary
• Instead, **do-support** is required.

• First, a vacuous auxiliary *do* is introduced . . .

  John loves Mary   John *does* love Mary  
  John saw Mary  ⇒  John *did* see Mary

• . . . at which point negation is possible:

  John *does not* love Mary
  John *did not* see Mary
**Phrases in X-bar theory**

**Movement in X-bar theory**

- We propose that *not* heads a **negation phrase** (NP), having the standard X-bar pattern.

- With an auxiliary present, this is the structure we get:

```
  IP
   NP       I'
     Mary    I          NegP
        does   Neg'  
          Neg    VP
             not  V'  
               V  NP
                  love John
```
Now the requirement for do-support can be imposed by decreeing that a verb cannot move out of a NegP to join with the I:
Summary

- We have introduced the X-bar theory of phrase-structure
- We have introduced the notion of movement and the distinction between deep structure and surface structure
- In the next lecture, we will see how deep structure can be assigned to sentences using dcg's