CS460/626 : Natural Language Processing/Speech, NLP and the Web
(Lecture 35– X-bar theory)

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(main text: Syntax by Andrew Carnie, Blackwell Publication, 2002)
How deep should a tree be?

- Is there a principle in branching
- When should the constituent give rise to children?
- What is the hierarchy building principle?
Deeper trees needed for capturing sentence structure

[The big book of poems with the Blue cover] is on the table.
Other languages

**English**

The big book of poems with the blue cover

**Hindi**

niil jilda vaalii kavita kii kitaab
Other languages: contd

English
- PP
  - with the blue cover

Bengali
- [niil malaat deovaa kavitar bai ti]
PPs are at the same level: *flat with respect to the head word “book”*

No distinction in terms of dominance or c-command

[The big book of poems with the Blue cover] is on the table.
“Constituency test of Replacement” runs into problems

- One-replacement:
  - I bought the big [book of poems with the blue cover] not the small [one]
  - One-replacement targets book of poems with the blue cover

- Another one-replacement:
  - I bought the big [book of poems] with the blue cover not the small [one] with the red cover
  - One-replacement targets book of poems
More deeply embedded structure

```
NP
  \--- N'₁
     \--- The
     \--- AP
          \--- big
          \--- N'₃
               \--- N
                   \--- book
               \--- PP
                   \--- of poems
       \--- N'₂
            \--- PP
                 \--- with the blue cover
```
To target $N_1$’

- I want \( [_{NP} \text{this } ]_{N'} \text{big book of poems with the red cover} ] \) and not \( [_{N} \text{that } ]_{None} ] \)
Bar-level projections

- Add intermediate structures
  - NP $\rightarrow$ (D) N'
  - N' $\rightarrow$ (AP) N' | N' (PP) | N (PP)
- () indicates optionality
New rules produce this tree

The

NP

N'-1

AP

big

N'-2

N'-3

N-book

PP

with the blue cover

PP

of poems
As opposed to this tree

```
NP
  /\  
AP  book  PP
  /\    /\ 
big  of  with the blue cover
  \    
  book

```

The big book of poems with the blue cover
V-bar

- What is the element in verbs corresponding to *one-replacement* for nouns
- *do-so* or *did-so*
As opposed to this tree
I [eat beans with a fork]

No constituent that groups together V and NP and excludes PP
Need for intermediate constituents

- I [eat beans] with a fork but Ram [does so] with a spoon.
How to target $V_1'$

- I [eat beans with a fork], and Ram [does so] too.

```
VP  →  V'
V'  →  V' (PP)
V'  →  V (NP)
```

V

```
NP
```

```
beans
```

```
with a fork
```
Case of conjunction

In the afternoon

eat beans

and

drink coffee
A-bar: adjectives

\[ \text{AP} \rightarrow A' \]
\[ A' \rightarrow (\text{AP}) A' \]
\[ A' \rightarrow A \ (\text{PP}) \]

**Tree Diagram:**

- AP
  - A'\[\text{Very}\]
    - AP
      - bright
    - blue
    - Conj and
      - AP
        - dull
      - A'\[\text{green}\]
So-replacement for adjectives

- Ram is very serious about studies, but less so than Shyam
P-bar: prepositions

\[ PP \rightarrow P' \]
\[ P' \rightarrow P' (PP) \]
\[ P' \rightarrow P (NP) \]

The tree diagram shows the syntactic structure of the sentence:

- **Root**: A$_1$'
  - **AP**: right
  - **PP**: into the trash
  - **NP**: the table
  - **Conj**: and
  - **NP**: the trash
So-replacement for Prepositions

- *Ram is utterly in debt, but Shyam is only partly so.*
Complements and Adjuncts

or

Arguments and Adjuncts
Rules in bar notation: Noun

- \( NP \rightarrow (D) N' \)
- \( N' \rightarrow (AP) N' \)
- \( N' \rightarrow N' (PP) \)
- \( N' \rightarrow N (PP) \)
Rules in bar notation: Verb

- $\text{VP} \rightarrow V'$
- $V' \rightarrow V' \ (\text{PP})$
- $V' \rightarrow V \ (\text{NP})$
Rules in bar notation: Adjective

- AP → A'  
- A' → (AP) A'  
- A' → A (PP)
Rules in bar notation: Preposition

- $PP \rightarrow P'$
- $P' \rightarrow P' \ (PP)$
- $P' \rightarrow P \ (NP)$
Introducing the “X factor”

- Let X stand for any category N, V, A, P
- Let XP stand for NP, VP, AP and PP
- Let X’ stand for N’, V’, A’ and P’
XP to X’

- Collect the first level rules
  - NP $\rightarrow$ (D) N’
  - VP $\rightarrow$ V’
  - AP $\rightarrow$ A’
  - PP $\rightarrow$ P’
- And produce
  - XP $\rightarrow$ (YP) X’
X’ to X’

- Collect the 2nd level rules
  - N’ → (AP) N’ or N’ (PP)
  - V’ → V’ (PP)
  - A’ → (AP) A’
  - P’ → P’ (PP)
- And produce
  - X’ → (ZP) X’ or X (ZP)
X’ to X

- Collect the 3\textsuperscript{rd} level rules
  - N’ → N (PP)
  - V’ → V (NP)
  - A’ → A (PP)
  - P’ → P (NP)
- And produce
  - X’ → X (WP)
Basic observations about $X$ and $X'$

- $X' \rightarrow X$ (WP)
- $X' \rightarrow X'$ (ZP)
- $X$ is called **Head**
- Phrases must have Heads: **Headedness** property
- Category of XP and $X$ must match: **Endocentricity**
Basic observations about X and X’

- X’→ X (WP)
- X’→ X’ (ZP)
- Sisters of X are **complements**
  - Roughly correspond to *objects*
- Sisters of X’ are **Adjuncts**
  - PPs and Adjectives are typical adjuncts
- We have *adjunct rules* and *complement rules*
Structural difference between complements and adjuncts
Complements and Adjuncts in NPs

NP
    /\     \
  N'    ZP
      /\      /
    N'  PP   N'
       / \    / \\
      N  book of poems

with red cover
Any number of Adjuncts

NP

N'

N'

NP

ZP

with red cover

from Oxford Press

N'

PP

book

of poems

of poems