Overview

• What we’re trying to do
• The pieces of our grammar
• Two extended examples
• Reflection on what we’ve done, what we still have to do
• Reading questions
What We’re Trying To Do

• Objectives
  • Develop a theory of knowledge of language
  • Represent linguistic information explicitly enough to distinguish well-formed from ill-formed expressions
  • Be parsimonious, capturing linguistically significant generalizations.

• Why Formalize?
  • To formulate testable predictions
  • To check for consistency
  • To make it possible to get a computer to do it for us
How We Construct Sentences

• The Components of Our Grammar
  • Grammar rules
  • Lexical entries
  • Principles
  • Type hierarchy (very preliminary, so far)
  • Initial symbol (S, for now)

• We combine constraints from these components.

• Q: What says we have to combine them?
An Example

A cat slept.

• Can we build this with our tools?

• Given the constraints our grammar puts on well-formed sentences, is this one?
Lexical Entry for $a$

- Is this a fully specified description?
- What features are unspecified?
- How many word structures can this entry license?
Lexical Entry for *cat*

- Which feature paths are abbreviated?
- Is this a fully specified description?
- What features are unspecified?
- How many word structures can this entry license?
Effect of Principles: the SHAC

\[
\begin{array}{l}
\text{word} \\
\hspace{1cm} \text{SYN} \\
\hspace{2cm} \langle \text{cat} \rangle \\
\hspace{3cm} \text{SEM} \\
\hspace{4cm} \langle \text{cat} \rangle \\
\end{array}
\]

\[
\begin{array}{l}
\text{word} \\
\text{HEAD} \\
\text{AGR} \begin{bmatrix} 3 \text{sing} \\ \text{GEND} \text{ neut} \end{bmatrix} \\
\text{AGR} \begin{bmatrix} 2 \\ \text{COUNT} + \\ \text{INDEX} \end{bmatrix} \\
\text{SPR} \left\langle \begin{bmatrix} \text{AGR} \\ \text{INDEX} \end{bmatrix} \right\rangle \\
\text{MOD} \left\langle \right\rangle \\
\text{MODE} \text{ ref} \text{ k} \\
\text{INDEX} \text{ k} \\
\text{RELN} \left\langle \begin{bmatrix} \text{RELN} \\ \text{INSTANCE} \end{bmatrix} \right\rangle \\
\end{array}
\]
Description of Word Structures for *cat*

```
word
  | HEAD
  | AGR 2
  | 3sing
  | GEND neut
  | noun

  | SYN
  | VAL
  | D
  | SPR
  | AGR 2
  | COUNT +
  | INDEX k
  | COMPS ⟨⟩
  | MOD ⟨⟩

  | SEM
  | MODE ref
  | INDEX k
  | RESTR ⟨ RELN cat ⟩
  | ⟨ INSTANCE k ⟩
```

*cat*
Description of Word Structures for $a$

$$\begin{align*}
\text{word} & \quad \text{SYN} & \quad \text{SEM} \\
\text{HEAD} & \quad \text{det} & \quad \text{MODE} & \quad \text{none} \\
\text{AGR} & \quad 3\text{sing} & \quad \text{INDEX} & \quad j \\
\text{COUNT} & \quad + & \quad \text{RESTR} & \quad \left\langle \left[ \text{RELN} \ a \right] \right\rangle \\
\text{COMPS} & \quad \langle \rangle & \quad \text{BV} & \quad j \\
\text{SPR} & \quad \langle \rangle & & \\
\text{MOD} & \quad \langle \rangle & & \\
\end{align*}$$
Building a Phrase

[ ]

[ ] [ ]
Constraints Contributed by Daughter Subtrees
Constraints Contributed by the Grammar Rule

[phrase
SYN [ VAL [ SPR ⟨⟩]]]
Constraints Contributed by the Grammar Rule

\[
\begin{array}{c}
\text{phrase} \\
\text{SYN [ VAL [ SPR ⟨ ⟩]]}
\end{array}
\]
Constraints Contributed by the Grammar Rule

[phrase
SYN [ VAL [ SPR ⟨⟩]]]

[word
SYN
VAL
SEM

7

word
SYN
VAL
SEM

[det
HEAD
AGR
COUNT +
COMPS ⟨⟩
SPR ⟨⟩
MOD ⟨⟩
MODE none
INDEX k
RESTR ⟨RELN a BV k ⟩]

[noun
HEAD
AGR
3sing
GEND neut
VAL
SPR ⟨⟩
MOD ⟨⟩
COUNT +
INDEX k
COMPS ⟨⟩
RESTR ⟨RELN cat INSTANCE k ⟩]

[noun
HEAD
AGR
3sing
GEND neut
VAL
SPR ⟨⟩
MOD ⟨⟩
COUNT +
INDEX k
COMPS ⟨⟩
RESTR ⟨RELN cat INSTANCE k ⟩]

[7D]
Constraints Contributed by the Grammar Rule

\[
\text{phrase} \quad \text{[SYN [ VAL [ SPR ⟨⟩]]]}
\]

\[
\begin{align*}
\text{word} &\quad \text{[DET [3sing GEND neut]} \text{]} \\
\text{HEAD} &\quad \text{AGR \{} \text{COUNT +} \text{]} \\
\text{VAL} &\quad \text{COMPS ⟨⟩} \\
\text{SEM} &\quad \text{MODE none INDEX} \quad k \quad \text{RESTR} ⟨\text{RELN a BV k}⟩
\end{align*}
\]

\[
\begin{align*}
\text{word} &\quad \text{[noun [3sing GEND neut]} \text{]} \\
\text{HEAD} &\quad \text{AGR \{} \text{]} \\
\text{VAL} &\quad \text{SPR ⟨⟩} \\
\text{SEM} &\quad \text{MODE ref INDEX} \quad k \quad \text{RESTR} ⟨\text{RELN cat INSTANCE k}⟩
\end{align*}
\]
Constraints Contributed by the Grammar Rule
Constraints Contributed by the Grammar Rule
Constraints Contributed by the Grammar Rule

```
phrase
  SYN [ VAL [ SPR ⟨⟩]]

word
  HEAD
  AGR [ 3sing
        GEND neut]
  COUNT +
  COMPS ⟨⟩
  SPR ⟨⟩
  MOD ⟨⟩
  MODE none
  INDEX k
  SEM
  INDEX k
  RESTR ⟨RELN a BV k⟩

word
  HEAD
  AGR [ 3sing
        GEND neut]
  COUNT +
  COMPS ⟨⟩
  MOD ⟨⟩
  MODE ref
  INDEX k
  SEM
  INDEX k
  RESTR ⟨RELN INSTANCE k⟩

7

7
```

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Constraints Contributed by the Grammar Rule

[phrase
SYN [ VAL [ SPR ⟨⟩]]]
Constraints Contributed by the Grammar Rule

[phrase
SYN [ VAL [ SPR ⟨⟩]]]

[word
HEAD
[det
AGR [3sing
GEND neut]]
COUNT +
COMPS ⟨⟩
SPR ⟨⟩
MOD ⟨⟩]

[SEM
MODE none
INDEX k
RESTR ⟨[RELN a BV k]⟩]

[7]

[word
HEAD
[noun
AGR [3sing
GEND neut]]
]

[SYN
VAL
SPR ⟨[COUNT + INDEX k]⟩
COMPS ⟨⟩
MOD ⟨⟩]

[SEM
MODE ref
INDEX k
RESTR ⟨[RELN cat INSTANCE k]⟩]
A Constraint Involving the SHAC

[phrase
[SYN [ VAL [ SPR ⟨⟩]]]]
Effects of the Valence Principle

```
phrase
  SYN
  VAL
    COMPS 3
    MOD 4

word
det
  HEAD
    AGR 2
    COUNT +
    COMPS 〈 〉
    SPR 〈 〉
    MOD 〈 〉
  MODE none
  INDEX k
  RESTR 〈 [RELN a BV k] 〉

word
nou
  HEAD
    AGR 2
    3sing
    GEND neut
  MODE ref
  INDEX k
  RESTR 〈 [RELN INSTANCE cat k] 〉
```
Effects of the Head Feature Principle

```
phrase

<table>
<thead>
<tr>
<th>HEAD 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYN</td>
</tr>
<tr>
<td>VAL</td>
</tr>
<tr>
<td>COMPS 3</td>
</tr>
<tr>
<td>MOD 4</td>
</tr>
</tbody>
</table>

word

<table>
<thead>
<tr>
<th>det</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAD 6</td>
</tr>
<tr>
<td>AGR 2</td>
</tr>
<tr>
<td>COUNT +</td>
</tr>
<tr>
<td>COMPS 3</td>
</tr>
<tr>
<td>SPR 7</td>
</tr>
<tr>
<td>SPR 7</td>
</tr>
<tr>
<td>MOD 4</td>
</tr>
</tbody>
</table>

word

<table>
<thead>
<tr>
<th>noun</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAD 6</td>
</tr>
<tr>
<td>AGR 2</td>
</tr>
<tr>
<td>3sing</td>
</tr>
<tr>
<td>GEND neut</td>
</tr>
<tr>
<td>COMPS 3</td>
</tr>
<tr>
<td>SPR 7</td>
</tr>
<tr>
<td>SPR 7</td>
</tr>
<tr>
<td>MOD 4</td>
</tr>
</tbody>
</table>

word

<table>
<thead>
<tr>
<th>MODE ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDEX k</td>
</tr>
<tr>
<td>RELN cat</td>
</tr>
<tr>
<td>INSTANCE k</td>
</tr>
<tr>
<td>MODE ref</td>
</tr>
<tr>
<td>INDEX k</td>
</tr>
<tr>
<td>RELN a</td>
</tr>
<tr>
<td>BV k</td>
</tr>
</tbody>
</table>
```

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Effects of the Semantic Inheritance Principle
Effects of the Semantic Compositionality Principle
Is the Mother Node Now Completely Specified?
Lexical Entry for *slept*

\[
\langle \text{slept,} \rangle
\]

\[
\begin{align*}
\text{word} & : \text{*slept*} \\
\text{SYN} & : \begin{cases}
\text{HEAD} & : \text{verb} \\
\text{VAL} & : \begin{cases}
\text{SPR} & : \langle \text{AGR} \ [9] \ \text{CASE} \ \text{nom} \rangle \\
\text{COMPS} & : \langle \rangle \\
\text{MOD} & : \langle \rangle
\end{cases} \\
\text{INDEX} & : s_1 \\
\text{MODE} & : \text{prop}
\end{cases} \\
\text{SEM} & : \begin{cases}
\text{RESTR} & : \langle \text{RELN} \ [\text{sleep}] \ SIT s_1 \ \text{SLEEPER} m \rangle, \ldots \rangle
\end{cases}
\end{align*}
\]
Another Head-Specifier Phrase

Key
- HSR
- SHAC
- Val Prin
- HFP
- SIP
- SCP

```
[phrase
  [HEAD 11
   SYN
   [SPR ⟨⟩]
   VAL
   [COMPS 12]
   MOD 13
   ]
  SEM
  [MODE 10 prop
   INDEX s₁
   RESTR A ⊕ B ⊕ C
   ]
]

[noun
  [HEAD 6
   AGR
   [3sing
    GEND neut]
   CASE nom
   ]
  SPR ⟨⟩
  COMPS 12
  MOD 13
]

[word
  [HEAD 11
   [verb
    AGR 9
    ]
   SYN
   [SPR ⟨14NP_k{ AGR 9, CASE nom}⟩]
   VAL
   [COMPS 12⟨⟩]
   MOD 13⟨⟩
   ]
  MODE 10 prop
  INDEX s₁
  RESTR [RELN sleep
  SIT s₁, ...]
  [SLEEPER k]
  ]
```
Another Head-Specifier Phrase

Key

- HSR
- SHAC
- Val Prin
- HFP
- SIP
- SCP

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Another Head-Specifier Phrase

Key

- HSR
- SHAC
- Val Prin
- HFP
- SIP
- SCP

Phrase:

\[
\begin{align*}
\text{HEAD} & \quad \text{11} \\
\text{SPR} & \quad \langle \rangle \\
\text{COMPS} & \quad \text{12} \\
\text{MOD} & \quad \text{13}
\end{align*}
\]

Val:

\[
\begin{align*}
\text{SPR} & \quad \langle \rangle \\
\text{COMPS} & \quad \text{3} \\
\text{MOD} & \quad \text{4}
\end{align*}
\]

Sem:

\[
\begin{align*}
\text{MODE} & \quad \text{10} \quad \text{prop} \\
\text{INDEX} & \quad s_1 \\
\text{RESTR} & \quad A \oplus B \oplus C
\end{align*}
\]

Word:

\[
\begin{align*}
\text{HEAD} & \quad \text{11} \\
\text{AGR} & \quad \text{9} \\
\text{3sing} & \quad \text{GEND neut} \\
\text{CASE} & \quad \text{nom}
\end{align*}
\]

Val:

\[
\begin{align*}
\text{SPR} & \quad \langle \rangle \\
\text{COMPS} & \quad \text{12} \langle \rangle \\
\text{MOD} & \quad \text{13} \langle \rangle
\end{align*}
\]

Sem:

\[
\begin{align*}
\text{MODE} & \quad \text{10} \quad \text{prop} \\
\text{INDEX} & \quad s_1 \\
\text{RESTR} & \quad C \\
\text{RELN} & \quad \text{sleep} \\
\text{SIT} & \quad s_1 \\
\text{SLEEPER} & \quad k, \ldots
\end{align*}
\]

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Another Head-Specifier Phrase

**Key**

<table>
<thead>
<tr>
<th>Color</th>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>yellow</td>
<td>HSR</td>
<td>Head-Specifier Rule</td>
</tr>
<tr>
<td>orange</td>
<td>SHAC</td>
<td>Specifier Head Adjunction Category</td>
</tr>
<tr>
<td>cyan</td>
<td>Val Prin</td>
<td>Valuation Principle</td>
</tr>
<tr>
<td>blue</td>
<td>HFP</td>
<td>Head-Full Principle</td>
</tr>
<tr>
<td>green</td>
<td>SIP</td>
<td>Specifier Insertion Principle</td>
</tr>
<tr>
<td>red</td>
<td>SCP</td>
<td>Specifier Capture Principle</td>
</tr>
</tbody>
</table>

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Another Head-Specifier Phrase
Another Head-Specifier Phrase

Key

- HSR
- SHAC
- Val Prin
- HFP
- SIP
- SCP
Another Head-Specifier Phrase

Key

<table>
<thead>
<tr>
<th>Code</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSR</td>
<td>Head-Specifier Relation</td>
</tr>
<tr>
<td>SHAC</td>
<td>Specified Head AGR</td>
</tr>
<tr>
<td>Val Prin</td>
<td>Val Particle</td>
</tr>
<tr>
<td>HFP</td>
<td>Head-Foot Point</td>
</tr>
<tr>
<td>SIP</td>
<td>Specified Intensifiers</td>
</tr>
<tr>
<td>SCP</td>
<td>Specified Complements</td>
</tr>
</tbody>
</table>

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Is this description fully specified?
Does the top node satisfy the initial symbol?
RESTR of the S node

\[ \langle \left[ \text{RELN} \ a \right], \left[ \text{RELN} \ \text{cat} \right], \left[ \text{RELN} \ \text{sleep} \right] \rangle, \ldots \]
Another Example

```
S
  NP      VP
    D      NOM      V      ADV
      the    NOM    disappeared  yesterday

      photos    PP
      of

      of    NP
        D    NOM
          the  suspect
```
Head Features from Lexical Entries

S

NP

[HEADdet] the

NOM photos

PP of

VP disappeared

[HEADadverb] yesterday

NP

[HEADdet] the

[HEADnoun] suspect
Head Features from Lexical Entries, plus HFP

```
[HEAD[4]]
  │             │             │             │             │
  └─ [HEADdet]  └─ [HEAD[1]noun]  └─ disappeared  └─ yesterday
               │                     │                     │
                   │                     │                     │
                   └─ of ── [HEADdet] ── the
                                   │                     │
                                   └─ suspect
```
Head Features from Lexical Entries, plus HFP

[HEAD4]
  /   \
 [HEAD1]     [HEAD4]
     /       /   \
 [HEADdet] [HEAD1] [HEADVerb] [HEADAdv]
           /    |     |       |
    the   [HEAD1noun] disappeared yesterday
           /    |       |
      photos [HEAD2prep]     |
             /    |
           of [HEAD3]
             /    |
            the [HEAD3noun]
             /    |
            the suspect
Head Features from Lexical Entries, plus HFP

[HEAD[4]]

[HEAD1]

Head Features from Lexical Entries, plus HFP

[HEAD4]

[HEAD1] [HEAD2] [HEAD3] [HEAD4]

[HEADdet] [HEAD1noun] [HEAD2prep] [HEADdet] [HEAD3noun]

[the] [photos] [of] [the] [suspect]

[HEAD1] [HEAD2] [HEAD3] [HEAD4verb] [HEADadverb]

disappeared yesterday
Head Features from Lexical Entries, plus HFP

[HEAD[1]

[HEAD[1]

[HEAD[1]noun]

[HEAD[2]

[HEAD[2]prep]

[HEAD[3]

[HEAD[3]noun]

[HEAD[4]

[HEAD[4]verb]

[HEADadverb]

disappeared

yesterday

the

photos

of

the

suspect
Valence Features: Lexicon, Rules, and the Valence Principle

Key

- Lexicon
- Val.
- Rules

Example: "the photos disappeared yesterday of the suspect"
Valence Features:
Lexicon, Rules, and the Valence Principle

Key
- Lexicon
- Val. Prin.
- Rules

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Valence Features:
Lexicon, Rules, and the Valence Principle

The

Photos

Disappeared

Yesterday

Key

Lexicon

Val. Prin.

Rules

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Valence Features:
Lexicon, Rules, and the Valence Principle

Key
- Lexicon
- Val.
- Rules

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Valence Features: Lexicon, Rules, and the Valence Principle

Key
Lexicon
Val.
Rules

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Valence Features: Lexicon, Rules, and the Valence Principle

Key
- Orange: Lexicon
- Yellow: Rules

Example:
- The lexicon entry for "photos" is marked as Lexicon.
- The valence feature for "photos" is marked as Val. Prin.
- The rules feature for "photos" is marked as Rules.
Valence Features:
Lexicon, Rules, and the Valence Principle

Key

Lexicon
Val.
Rules

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Valence Features:
Lexicon, Rules, and the Valence Principle
Required Identities: Grammar Rules

\[
S \rightarrow [SPR \langle 1 \rangle] NP \rightarrow [SPR \langle 2 \rangle] D \rightarrow \text{the} NP \rightarrow [SPR \langle 2 \rangle] N \rightarrow \text{photos} PP \rightarrow [COMPS \langle 3 \rangle] P \rightarrow \text{of} NP \rightarrow [SPR \langle 5 \rangle] D \rightarrow \text{the} NP \rightarrow [SPR \langle 5 \rangle] N \rightarrow \text{the suspect} V \rightarrow \text{disappeared} ADV \rightarrow \text{yesterday}
\]
Required Identities: Grammar Rules

S

1NP

2D

the

[COMPS ⟨3⟩]

N

photos

[COMPS ⟨4⟩]

P

of

4NP

5D

[SPR ⟨5⟩]

the

[SPR ⟨2⟩]

NOM

[SPR ⟨2⟩]

[PP ⟨3⟩]

[COMPS ⟨3⟩]

[SPR ⟨1⟩]

VP

6V

disappeared

[MOD ⟨6⟩]

yesterday

[SPR ⟨1⟩]
the photos of the suspect disappeared yesterday
Required Identities: Grammar Rules

S

1. NP
   2. D
      3. N
         4. PP
             5. P
                6. NP
                   7. N

2. NOM
   [SPR ⟨2⟩]

3. [COMPS ⟨3⟩]
   photos

4. [COMPS ⟨4⟩]
   of

5. [SPR ⟨5⟩]
   the

6. V
   disappeared
   [MOD ⟨6⟩]

7. [SPR ⟨1⟩]
   yesterday
the photos of the suspect disappeared yesterday
Required Identities: Grammar Rules

S

1 NP

2 D

3 PP

4 NP

5 D

6 V

NOM

[SPR 2]

[COMPS 3]

photos

[SPR 5]

[SPR 6]

the

suspect

the

disappeared

of

yesterday

of

the

national

adv

P

N

[SPR]

[SPR 1]

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Required Identities: Grammar Rules

S

[1] NP

[2] D

the

[SPR [2]]

NOM

[SPR [2]]

[3] PP

photos

[SPR [3]]

P

of

[SPR [4]]

[COMPS [4]]

[5] D

of

[SPR [5]]

[COMPS [5]]

N

the

[SPR [5]]

[6] V

disappeared

[SPR [1]]

VP

[SPR [1]]

[COMPS [1]]

ADV

yesterday
Two Semantic Features: the Lexicon & SIP

[MODE prop] [INDEX s3]

[MODE ref] [INDEX j]

[MODE none] [INDEX j]

[MODE ref] [INDEX j]

[MODE prop] [INDEX s3]

[MODE prop] [INDEX s4]

[MODE ref] [INDEX j]

[MODE ref] [INDEX j]

[MODE ref] [INDEX j]

[MODE ref] [INDEX j]

[MODE none] [INDEX k]

[MODE ref] [INDEX k]

[MODE ref] [INDEX k]

[MODE ref] [INDEX k]

[MODE ref] [INDEX k]

[MODE ref] [INDEX k]

[MODE none] [INDEX k]

[MODE ref] [INDEX k]

[MODE ref] [INDEX k]

[MODE ref] [INDEX k]

[MODE prop] [INDEX s3]

disappeared

yesterday

the

photos

of

the

suspect
Two Semantic Features: the Lexicon & SIP

```
[MODE prop] s3

[MODE ref] j
[INDEX j]

[MODE ref] j
[INDEX j]

[MODE ref] j
[INDEX j]

[MODE prop] s3

[MODE ref] j
[INDEX j]

[MODE prop] s3

[MODE none] k
[INDEX k]

[MODE prop] s4

[MODE none] k
[INDEX k]

[MODE prop] s3

[MODE none] k
[INDEX k]

[MODE prop] s3

[MODE ref] k
[INDEX k]

[MODE ref] k
[INDEX k]

[MODE prop] s3

[MODE none] k
[INDEX k]

[MODE ref] k
[INDEX k]

[MODE none] k
[INDEX k]

the

photos

of

disappeared

yesterday

the

suspect
```
Two Semantic Features: the Lexicon & SIP

```
[MODE prop]
[INDEX s3]

[MODE ref]
[INDEX j]

[MODE none]
[INDEX j]

[MODE ref]
[INDEX j]

MODE prop INDEX s3

[MODE prop]
[INDEX j]

MODE none INDEX j

the

[MODE ref]
[INDEX j]

photos

[MODE ref]
[INDEX k]

of

[MODE none]
[INDEX k]

the

[MODE ref]
[INDEX k]

disappeared

yesterday

[MODE prop]
[INDEX s3]

[MODE prop]
[INDEX s4]

[MODE none]
[INDEX s]

[MODE none]
[INDEX k]

suspect
```
Two Semantic Features: the Lexicon & SIP

\[
\begin{align*}
\text{the} & \quad \text{INDEX } j \\
\text{photos} & \quad \text{INDEX } j \\
\text{of} & \quad \text{INDEX } k \\
\text{the} & \quad \text{INDEX } k \\
\text{disappeared} & \quad \text{INDEX } s_3 \\
\text{yesterday} & \quad \text{INDEX } s_4 \\
\end{align*}
\]
Two Semantic Features: the Lexicon & SIP

the photos of the suspect disappeared yesterday.
Two Semantic Features: the Lexicon & SIP

- **the**
- **MODE ref**
- **INDEX j**
- **photos**
- **MODE ref**
- **INDEX k**
- **of**
- **MODE none**
- **INDEX k**
- **of**
- **MODE ref**
- **INDEX k**
- **disappeared**
- **MODE none**
- **INDEX s_{3,4}**
- **yesterday**
- **MODE prop**
- **INDEX s_{3,4}**
- **the**
- **MODE prop**
- **INDEX s_{3,4}**
- **suspect**
RESTR Values and the SCP

A ⊕ B ⊕ C ⊕ D ⊕ E ⊕ F ⊕ G

A ⊕ B ⊕ C ⊕ D ⊕ E

B ⊕ C ⊕ D ⊕ E
disappeared

disappeared

D ⊕ E

photos

of

the

C()

RELN the BV j

RELN the BV k

RELN suspect INST k

RELN yest. ARG s3

RELN disap. SIT s3 D-ER j

RELN the BV j

RELN photo INST j CONTENT k

RELN yest. ARG s3

RELN photos

of

RELN the

RELN suspect

RELN the

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An Ungrammatical Example

* $S$

$NP$

them

$VP$

$V$

sent

$NP$

us

$NP$

$D$

a

$N$

letter
An Ungrammatical Example

What's wrong with this sentence?
An Ungrammatical Example

What's wrong with this sentence?

```
* S
   NP [CASE acc] them
   VP
      V [SPR ⟨ NP[nom] ⟩]
      sent
      NP us
      NP NP
```
An Ungrammatical Example

What’s wrong with this sentence?

So what?
An Ungrammatical Example

The Valence Principle

*\( S \)

\[
\begin{array}{c}
\text{NP} \\
\text{[CASE acc]} \\
\text{\textit{them}} \\
\text{\textit{sent}} \\
\text{NP[nom]} \\
\text{D} \\
\text{N} \\
\text{a} \\
\text{letter}
\end{array}
\]
An Ungrammatical Example

The Valence Principle

*S

NP
[CASE acc]

them

VP
[SPR ⟨1⟩]

V

sent

NP
[SPR ⟨1⟩NP[nom]]

us

NP

D

a

N

letter
An Ungrammatical Example

Head Specifier Rule

*\(S\)

\[\begin{array}{c}
\Box \text{NP} \\
\text{[CASE acc]} \\
\text{them}
\end{array}\]

\[\begin{array}{c}
\Box \text{VP} \\
\text{[SPR \langle \Box \rangle ]} \\
\text{sent} \\
\end{array}\]

\[\begin{array}{c}
\Box \text{NP} \\
\text{[SPR \langle \Box \text{NP[nom]} \rangle ]} \\
\text{us} \\
\end{array}\]

\[\begin{array}{c}
\Box \text{NP} \\
\text{a} \\
\text{letter}
\end{array}\]
An Ungrammatical Example

Head Specifier Rule

*S

[CASE acc]

them

[SPR ⟨[1]⟩]}

V

sent

[SPR ⟨[1]NP[nom]]⟩]

us

NP

NP

D

N

a

letter
An Ungrammatical Example

Head Specifier Rule

*S

[CASE acc]
them

[SPR ⟨⟩]

V

sent

[SPR ⟨⟩]

NP

us

[SPR ⟨⟩]

NP

NP

a

letter
Exercise in Critical Thinking
Exercise in Critical Thinking

- Our grammar has come a long way since Ch 2, as we've added ways of representing different kinds of information:
  - generalizations across categories
  - semantics
  - particular linguistic phenomena: valence, agreement, modification
Our grammar has come a long way since Ch 2, as we've added ways of representing different kinds of information:

- generalizations across categories
- semantics
- particular linguistic phenomena: valence, agreement, modification

What else might we add? What facts about language are as yet unrepresented in our model?
Overview

• What we’re trying to do
• The pieces of our grammar
• Two extended examples
• Reflection on what we’ve done, what we still have to do
• Reading questions
Reading Questions

- Do we have to understand 6.3 (the squiggly bits)?

- I am wondering what exactly $\omega$ and $\Phi$ stand for in 6.1. From the context, it looks like $\omega$ may stand for the surface word, whereas $\Phi$ stands for the specified features of a given interpretation of that word. 'F' is specified as a "resolved feature structure", but the other symbols do not have explicit definitions.
First, each lexical entry licenses a family of word structures – each of which is a nonbranching tree. More precisely, a lexical entry \( \langle \omega, \Phi \rangle \) licenses any word structure of the form:

\[
\begin{array}{c}
  F \\
  \quad \downarrow \\
  \omega
\end{array}
\]

if and only if \( F \) is a resolved feature structure that satisfies \( \Phi \). A resolved feature structure \( F \) satisfies \( \Phi \) if and only if it assigns values to all features appropriate for feature structures of its type, and those values are consistent with all of the information specified in \( \Phi \).
Reading Questions

• In the appendix it mentions that feature structures have a recursive definition. Why do they need to have a recursive definition and which part of the definition is recursive?

• What is the difference between sequences $\phi$ and description sequences $d$?
Reading Questions

• In 6.3.5, a requirement of a tree structure is: 3. sister nodes are ordered with respect to each other. Is this the same as saying there can only be one possible ordering of nodes in a given structure?

• And another requirement is: 4. it has no crossing branches What's an example of a spurious structure that would have crossing branches?
• From the examples in the chapter, it appears we can arbitrarily choose a gender value for word structures corresponding to proper nouns (names). How about cases when other words within the sentence (i.e. gender specific pronouns) give some indication of gender--would we then simply choose the gender based on that context?
Reading Questions

• Earlier in the class, we discussed how the book states that feature structures need to be fully resolved. In this chapter, though, example 8 states that the addressee field does not need to reference anything. Is it still a fully resolved tree, even if the addressee is not referencing anything? What's the difference between this case, and a case that would not accept a tree because it isn't fully resolved?
Reading Questions

• Because of the change on the morphology of the word, it makes sense why we have to create two separate lexical entries for the same verb based on the tense (*send* vs. *sent*). And it also makes sense why we have to make a case for agreement for the present tense of the verb (*send* vs. *sends*). However, for the past tense (*sent*), the word isn’t morphologically affected when it is used with either 3rd, 2nd, 1st, plural or single NPs, thus it seems unnecessary to have to specify AGR for the verb *sent*. 
Reading Questions

• The verb sent in example (13), the COMPS list includes two NPs both with [CASE acc]. I understand the CASE constraint on the first NP, but don't quite understand why the second NP also has a CASE constraint. At least in English, I haven't been able to think of an example using sent where the second NP would be a pronoun where CASE would be meaningful. In our example it is *a letter*.

• Why do we put CASE outside of AGR? (as in pg. 167 (2a))
Reading Questions

• Are prepositions always semantically empty? What about *This is for you*?

• (28) shows the phrase *to Lee*, and points out that the preposition *to* has no semantics on its own. I get the feeling that this isn't a necessary consequence of the grammar so far, but instead is something of a stylistic choice. Would it be straightforward to get the same semantics in the end, if prepositions like *to* have their own semantic interpretation?
Reading Questions

• I'd like to know how we define the meaning of the RELN values. It seemed like we made use of a times relation to crate two hundred from two and hundred. Yet we didn't explicitly define what that means. Is it just a place marker?

• I was a bit surprised to see RESTR values for "two" and "letters" that where called two and letter. Perhaps I shouldn't be -- since we obviously have to have some grasp of the language used in our formalisms (and it just so happens that it's the same language we're analyzing) and since all of the SEM structures up until now have involved English words -- but it nevertheless struck me as circular in these cases. Why is that seeming circularity not considered a problem for the grammar, especially when one gets to the point of trying to implement NLP?
Reading Questions

• The RESTR value of "us" contains three predications; send, group, and speaker. In the sentence "they sent us a letter" the INST of group is identified with the SENDEE feature of "send" but the other two predications don't show up again. So I was wondering what purpose those predications serve? Are there sentences where they are connected to other semantic entries?
Reading Questions

• Since there seem to be various different ways to define the SEM RESTR values how to you know when you have enough predications?

• On the phrase level, the RESTR value order appears to be determined by word order within the phrase. How does this apply to the word level? How do we know RESTR value predication order for a lexical entry?
Reading Questions

- We don't, however, actually know the specific identities of *they* or *us* without more context. Imagine the sentence, *They sent us a letter* occurred in the context, *My sister and I emailed our grandparents. They sent us a letter.* Could we use the indices already described to connect *my sister and I* with *us* and *our grandparents* with *they*? Perhaps we could extrapolate the Semantic Compositionality Principle to a wider scope? This seems related to issues like anaphora resolution.
Reading Questions

• In a sentence, it seems that the RESTR value of the verb is a good indicator of how many semantic indices there will be. However, I'm not 100% certain how to annotate more complicated NP's which contain NP's such as Jake's friend or the cat on the mat in the house. It seems that the Semantic Inheritance principle would reduce each of those NP's into a single index as in two letters to Lee on page 190; this would lead me to believe that every noun should have its own index.
Reading Questions

• In languages that use complex case systems, it seems to me that there would be certain overlap between semantic and syntactic features. How could redundancy be avoided (or should it be)?
Reading Questions

• Which is used more frequently in real-life computational linguistics, and what are the qualities that might make one sentence more amenable to a given methodology?

• In the book, I felt that for the top down approach, a list of RESTR predications are immediately introduced, but is there a good technique / approach / advice on how to come up with such predications at the first step? It just seems counter-intuitive to do it this way because it feels like a process of dividing up the list of RESTR, instead of summing up the RESTR.
Reading Questions

• It says the top-down approach could be used equally well, but in the example, starts immediately with RESTR lists that only could have been generated with a human understanding of the sentence, and tree that is already constructed. I understand that trees can be analyzed top-down and rules can be applied to license its parts from the top-down, but I don't understand how the tree could actually be constructed from the top down. (Or, if it can be done more intelligently than brute force, what reason there would be to do so.)
Reading Questions

- Could top-down and bottom-up parsing be combined (in computational applications) in an effort to disambiguate structural/word sense/etc ambiguity? There would obviously need to be some probabilistic weights involved from both ends.