

CS 182

Sections 103 - 104

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with slides inspired by Eva Mok and Joe Makin

April 18, 2007

Announcements

- a8 out, due Tuesday, April 24th, in class
- BBS articles are assigned for the final paper

Schedule

- Last Week
 - Inference in Bayes Net
 - Metaphor understanding using KARMA
- This Week
 - Formal Grammar and Parsing
 - Construction Grammar, ECG
- Next Week
 - Psychological model of sentence processing
 - Grammar Learning

Questions

- What is top-down parsing? Using a plausible CFG grammar, what is the top down parse of “Pat ate the kiwi”?
- How well can CFGs represent English? What are some mechanisms for improvement?
- What are constructions?
- How does ECG use constructions?

Grammar

- A grammar is a set of rules defining a formal language
- an example is right-regular grammar
- a more common example is Context-Free Grammar

$$\alpha \rightarrow \beta$$

$\forall \alpha$: single non-terminal

- β : any combination of terminals and non-terminals

$S \rightarrow NP VP$

$NP \rightarrow Det Noun \mid ProperNoun$

$VP \rightarrow Verb NP \mid Verb PP$

$PP \rightarrow Preposition NP$

$Noun \rightarrow kiwi \mid orange \mid store$

$ProperNoun \rightarrow Pat \mid I$

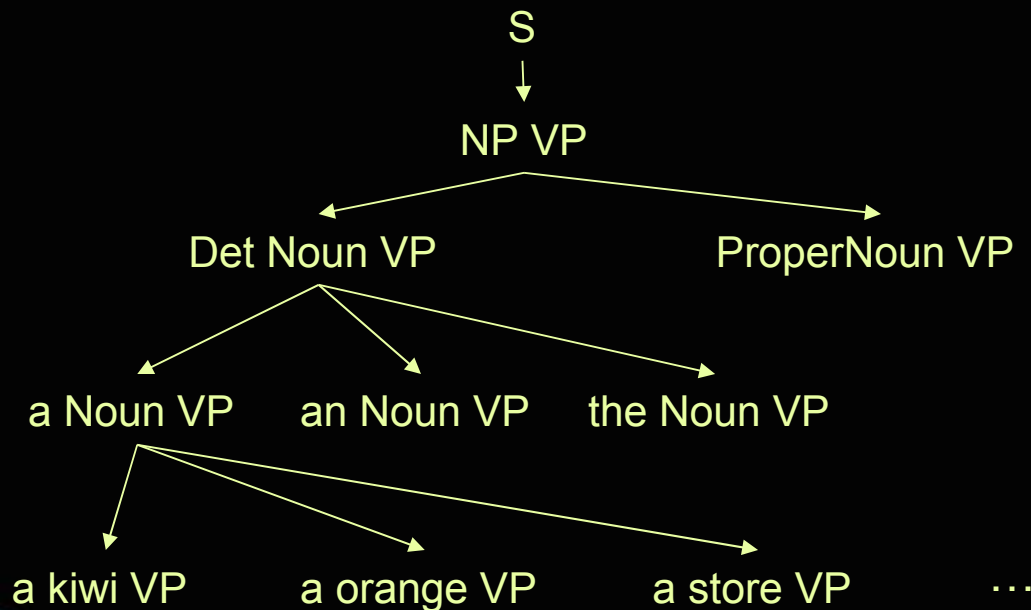
$Det \rightarrow a \mid an \mid the$

$Verb \rightarrow ate \mid went \mid shop$

$Preposition \rightarrow to \mid at$

Top Down Parsing: *Pat ate the kiwi*

- start from S and apply all applicable rules
- forward search (use your favorite search algorithm...)

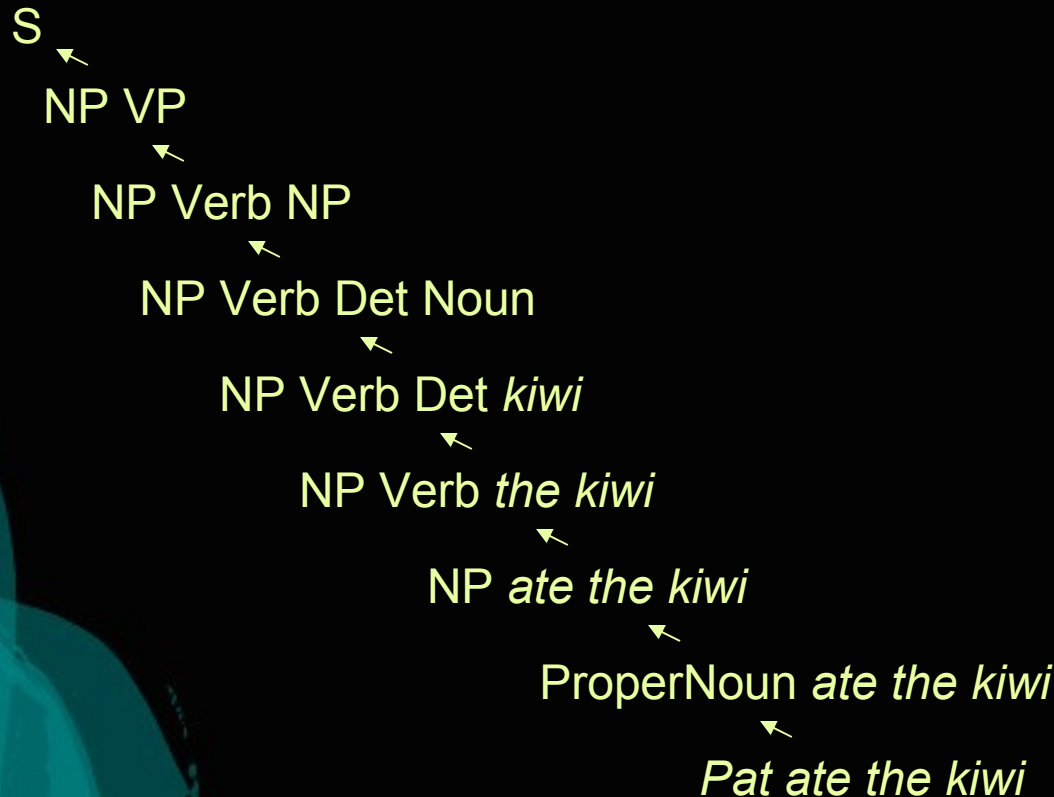


$S \rightarrow NP VP$
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 $Noun \rightarrow kiwi \mid orange \mid store$
 $ProperNoun \rightarrow Pat \mid I$
 $Det \rightarrow a \mid an \mid the$
 $Verb \rightarrow ate \mid went \mid shop$
 $Preposition \rightarrow to \mid at$

succeed when you encounter
Pat ate the kiwi
in a state without any non-terminals

Bottom Up Parsing: *Pat ate the kiwi*

- start from the sentence and try to match non-terminals to it
- backward search (use your favorite search algorithm...)



$S \rightarrow NP VP$
 $NP \rightarrow Det Noun \mid ProperNoun$
 $VP \rightarrow Verb NP \mid Verb PP$
 $PP \rightarrow Preposition NP$
 $Noun \rightarrow kiwi \mid orange \mid store$
 $ProperNoun \rightarrow Pat \mid I$
 $Det \rightarrow a \mid an \mid the$
 $Verb \rightarrow ate \mid went \mid shop$
 $Preposition \rightarrow to \mid at$

succeed when you encounter
S in a state by itself

Questions

- What is top-down parsing? Using a plausible CFG grammar, what is the top down parse of “Harry likes the cafe”?
- How well can CFGs represent English? What are some mechanisms for improvement?
- What are constructions?
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Notice the ungrammatical and/or odd sentences that we can generate?

S → NP VP

NP → Det Noun | ProperNoun

VP → Verb NP | Verb PP

PP → Preposition NP

Noun → kiwi | orange | store

ProperNoun → Pat | I

Det → a | an | the

Verb → ate | went | shop

Preposition → to | at

- * Pat ate a orange
- * Pat shop at the store
- * Pat went a store
- ? Pat ate a store
- ? The kiwi went to an orange

need to capture agreement,
subcategorization, etc

you could make many versions
of verbs, nouns, dets
→ cumbersome

Unification Grammar

- Basic idea: capture these agreement features for each non-terminal in feature structures

I $\left(\begin{array}{l} \text{agreement} \left(\begin{array}{l} \text{number : SG} \\ \text{person : 1st} \end{array} \right) \end{array} \right)$

Pat $\left(\begin{array}{l} \text{agreement} \left(\begin{array}{l} \text{number : SG} \\ \text{person : 3rd} \end{array} \right) \end{array} \right)$

Went $\left(\begin{array}{l} \text{agreement} \end{array} \right)$

Shop $\left(\begin{array}{l} \text{agreement} \left(\begin{array}{l} \text{number :} \\ \text{person : 1st} \end{array} \right) \end{array} \right)$

- Enforce constraints on these features using unification rules

$VP \rightarrow \text{Verb NP}$

$VP.\text{agreement} \leftrightarrow \text{Verb}.\text{agreement}$

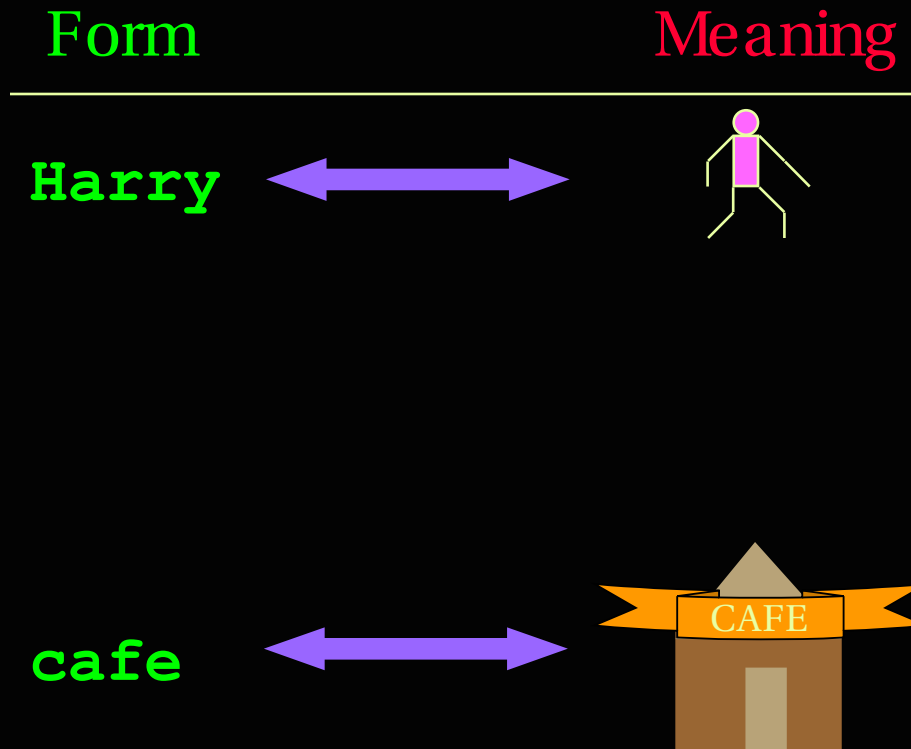
$S \rightarrow \text{NP VP}$

$\text{NP}.\text{agreement} \leftrightarrow \text{VP}.\text{agreement}$

Questions

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Embodied constructions



ECG Notation

construction HARRY
form : /hEriy/
meaning : Harry

construction CAFE
form : /k^haefej/
meaning : Cafe

Constructions have **form** and **meaning** poles that are subject to type constraints.

Questions

1. What is top-down parsing? Using a plausible CFG grammar, what is the top down parse of “Harry likes the cafe”?
2. How well can CFGs represent English? What are some mechanisms for improvement?
3. What are constructions?
 - How does ECG use constructions?

A schema hierarchy of objects (Nomi)


schema Entity

schema Place

schema Object
subcase of Entity

schema Referent
subcase of Entity
roles
category
distribution
boundedness
number
gender
accessibility
resolved-ref

schema Physical-Object
subcase of Object, Place

schema Animate
subcase of Physical-Object
roles
animacy
constraints  slot filler
animacy ← true

schema Manipulable-Object
subcase of Physical-Object

schema Cup
subcase of Manipulable-Object

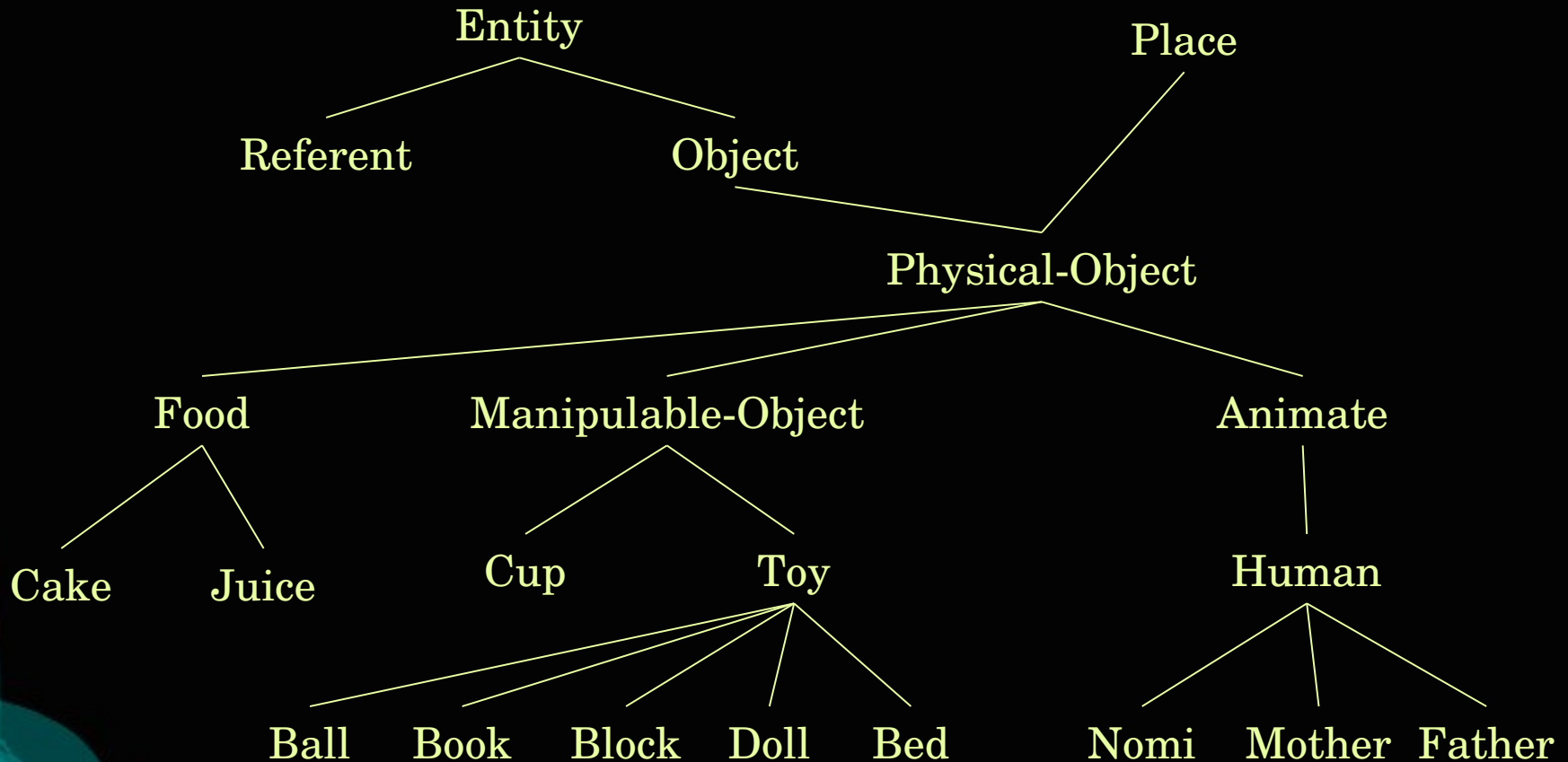
schema Human
subcase of Animate
roles
sex

schema Nomi
subcase of Human
sex ← female

schema Toy
subcase of
Manipulable-Object

schema Ball
subcase of Toy

The schemas we just defined



A schema hierarchy of actions (Nomi)

schema Action
roles
agent : Entity

type constraint

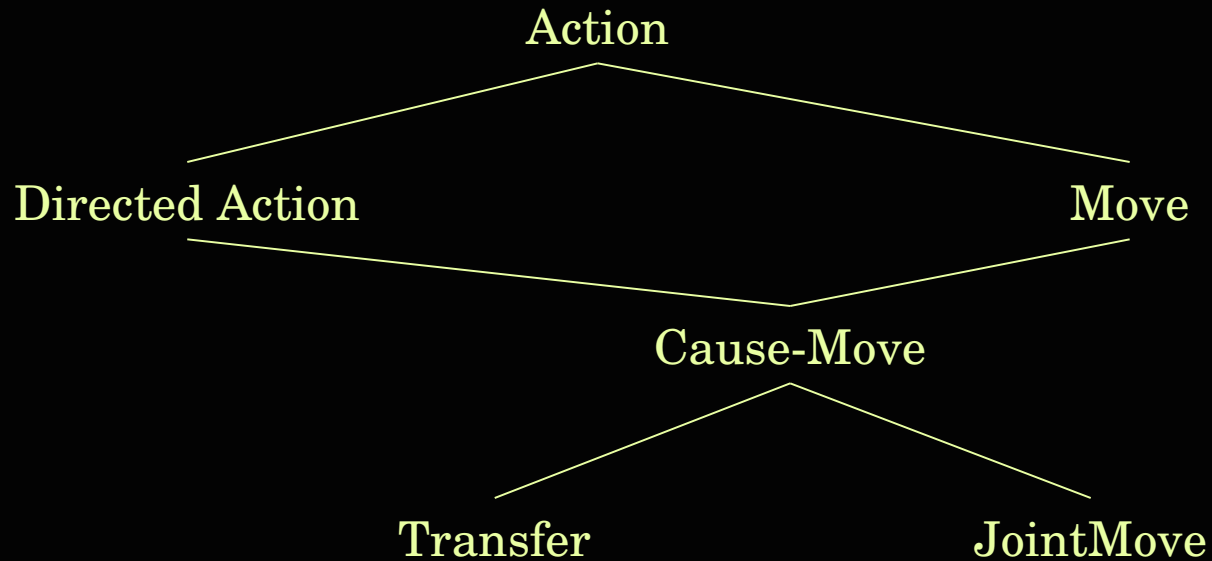
schema DirectedAction
subcase of Action
roles
patient : Entity

schema Move
subcase of Action
roles
mover : Entity
direction : Place

schema CauseMove
subcase of DirectedAction, Move
roles
causer : Human
mover : Physical-Object
motion : Move
constraints
motion.mover ↔ mover
motion.agent ↔ causer
agent ↔ causer
patient ↔ mover

identification constraint

The schemas we just defined



Constructions, finally (Nomi)

construction Ref-Expr
form : Schematic-Form
meaning : Referent

construction Nomi-Cn
level 0
subcase of Ref-Expr
form : Word
self.f.orth ← "Nomi"
meaning
evokes Nomi as n
self.m.category ↔ n
self.m.resolved-ref ↔ n

local name

fancy way of saying
that the category of
the referent is Nomi

construction Cup-Cn
level 0
subcase of Ref-Expr
form : Word
self.f.orth ← "cup"
meaning
evokes Cup as n
self.m.category ↔ n
self.m.resolved-ref ↔ n

Constructions, finally (Nomi)

construction Motion-Verb
meaning : Move

construction Cause-Motion-Verb
subcase of Motion-Verb
meaning : CauseMove

construction Get-Cn
level 0
subcase of Cause-Motion-Verb
form : Word
self.f.orth ← "get"

lexical
construction



Constructions, finally (Nomi)

construction Transitive-Cn

level 2

constructional

constituents

agt : Ref-Expr

v : Cause-Motion-Verb

obj : Ref-Expr

form

agt.f before v.f

v.f before obj.f

meaning

v.m.agent \leftrightarrow agt.m.resolved-ref

v.m.patient \leftrightarrow obj.m.resolved-ref

smaller constructions that it takes

ordering constraints on the constituents

Traditional Levels of Analysis

Pragmatics

Semantics

Syntax

Morphology

Phonetics