What do we parse when we parse?

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(1)a. (Maymun) (elmayı yedi).

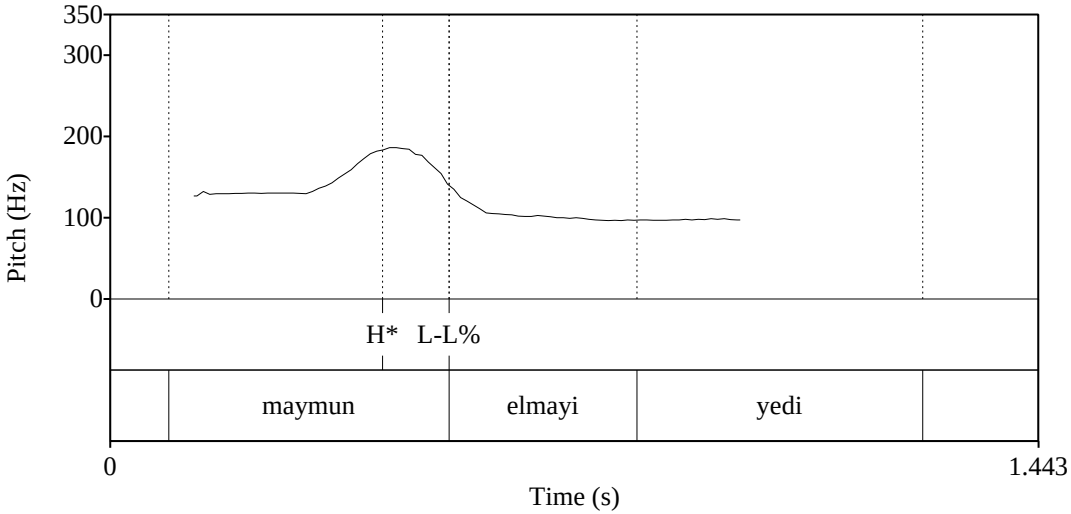
monkey.NOM apple-ACC ate

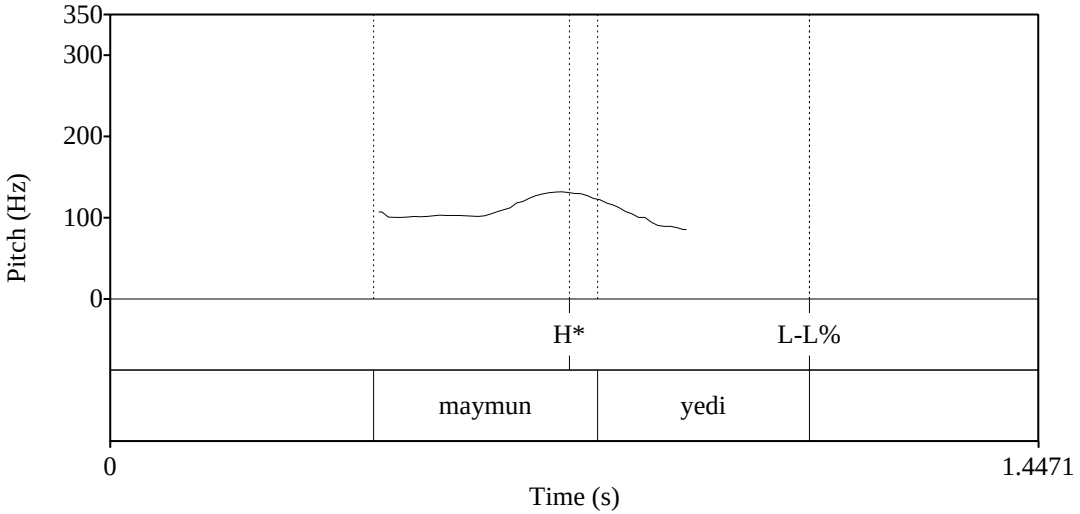
H* L-L%

‘The monkey ate the apple.’

b. (Maymun yedi). ‘The monkey ate (it).’

H* L-L%


350
300
200
100
0
Pitch (Hz)
H*
L-L%
maymun
elmayi
yedi
0
1.443
Time (s)


350
300
200
100
0
Pitch (Hz)
H*
L-L%
maymun
yedi
0
1.4471
Time (s)

Pitch accents and boundary tones are distinct prosodic events (Pierrehumbert, 1980)

H* : local maximum on stressed syllable

L- : Intermediate phrase boundary

L% : Intonational phrase boundary

Turkish has a pitch accent system:

(Demircan, 1996; Ergenç, 1989; Van Der Hulst and Van De Weijer, 1991; Johanson, 1998; Kornfilt, 1997; Levi, 2005; Lewis, 2000; Nash, 1973; Özsoy, 2004; Selen, 1973; Üçok, 1951; Underhill, 1976)

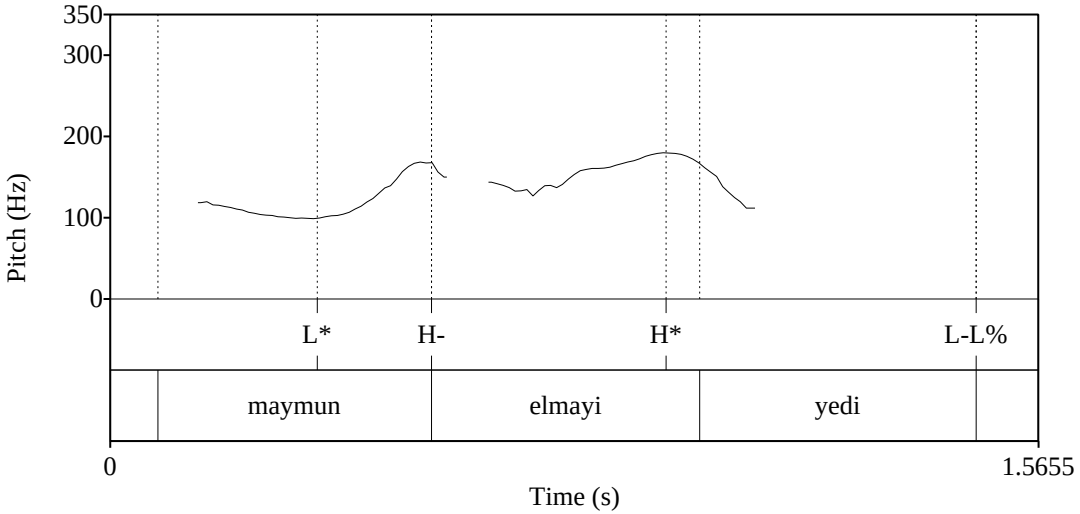
Pitch accent is different than stress: It is **movement** of pitch associated with stressed syllable.

H*, L*, L+H*, H*+L, L*+H

L+H*: *Marcel proved COMPLETENESS*

Word stress without high pitch accent:

(2) (Maymun) (elma-YI ye-di.)
L* H- H* L-L%


350
300
200
100
0
Pitch (Hz)
L*
H-
H*
L-L%
maymun
elmayi
yedi
0
1.5655
Time (s)

H*+L

(3)a. Siz-in-ki-ler nerede?

you-GEN-REL-PLU where

‘Where are your parents?’

b. *Theme* *Rheme*

(Annem) (ARABAYA biniyor.)

kontrast

H*+L H- H* L-L%

‘My mother is getting on the car.’

L+H*

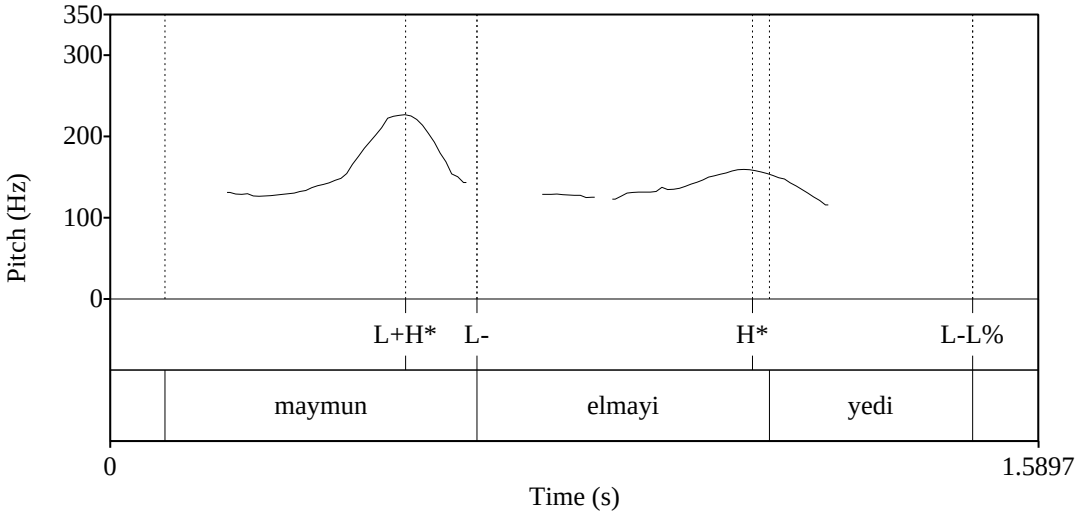
(4)a. (mayMUN) (elma-YI ye-di.)

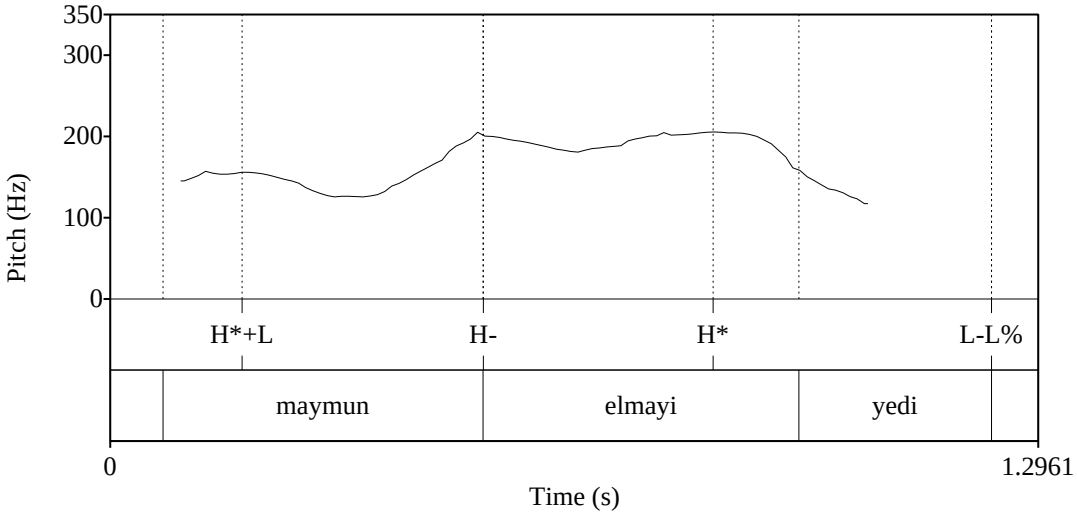
L+H* L- H* L-L%

b. (MAYmun) (elma-YI ye-di.)

H*+L H- H* L-L%

Not truth-conditionally equivalent.


350
300
200
100
0
Pitch (Hz)
L+H*
L-
H*
L-L%
maymun
elmayi
yedi
0
1.5897
Time (s)

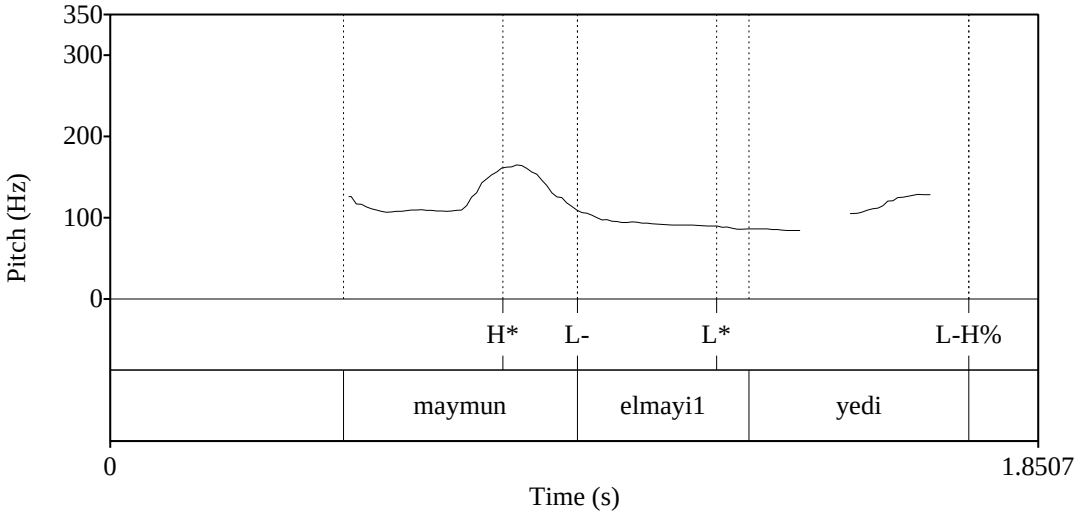

350
300
200
100
0
Pitch (Hz)
H*+L
H-
H*
L-L%
maymun
elmayi
yedi
0
1.2961
Time (s)

When do we complete an utterance?

(5) (Maymun) (elmayı yedi.)

H* L- L* L-H%

Main predicate is *and′*, not *eat′*.


350
300
200
100
0
Pitch (Hz)
H*
L-
L*
L-H%
maymun
elmayi1
yedi
0
1.8507
Time (s)

L-, H-, L% are autonomous strings.

H*, L* are not. They align with syllables of words (segmental).

H*, L* bear on information structure of the words (rheme, theme).

L-, H-, L% are lexical items. They carry theme/rheme to complete intonational phrases.

Words and affixes

(6)a. [*Ziyaretçi ve misafir*]*-ler-de-ki* *hediye-ler*

Visitor and guest-PLU-LOC-REL gift-PLU

lit. The gifts, the ones at the visitors and of the guests
'the gifts at the visitors and at the guests'

b. **Ziyaretçi hediyeler*

c. *Çocuk-lar-ın* *ziyaretçi ve misafir-ler-de-ki* *hediye-ler-i*

child-PLU-GEN.3s visitor and guest-PLU-LOC-REL gift-PLU-COMP.3s

'the gifts of the children at the visitors and the guests'

Clitics

(7)a. [*Sinema-ya* *gid-er*
kitap *oku-y-abil-ir*
ya da *dans* *ed-ebil-ir*]*-mi-y-di-k*?
Cinema-DAT go-AOR
book read-COP-ABIL-AOR
or dance do-ABIL-AOR-QUES-COP-PAS
'Could we go to a movie, read a book or dance?' (Kabak, 2006, ex.20)

Annen kitap, sen de dergi okudun bütün gün.

**Annen kitap, sen dergi de okudun bütün gün.*

**Annen kitap, sen dergi okudun da bütün gün.*

Arabalarla

**Arabalalar*

Evdeler mi? Evde miler?

Constituencies

(8)a. Ben, kapı-yı ALİ kır-dı zanned-iyor-du-m.
I door-ACC A break-PAST think-PROG-PAST-1sg
'I thought Ali crashed the door.'

b. Hayır, (PENCERE-Yİ Ali), (kapı-yı) (MEHMET kır-dı.)
No window-ACC A door-ACC M break-PAST
'No, Ali crashed the window, and Mehmet, the door.'

(9)a. Ben, kapı-yı ALİ kır-dı zanned-iyor-du-m.
I door-ACC A break-PAST think-PROG-PAST-1sg
'I thought Ali crashed the door.'

b. Hayır, (PENCERE-Yİ) (Ali kır-dı), (kapı-yı) (MEHMET)
No window-ACC A break-PAST door-ACC M
'No, Ali crashed the window, and Mehmet, the door.'

Interjections

The man, I claim, works for the government.

**The, I can claim with confidence, man works for the government.*

**This man I, claim works for the government.*

Tüm hayallerimizin, biraz düşününce, gerçekleşemeyeceğini anladık.

**Tüm, biraz uyuyup düşününce, hayallerimizin gerçekleşemeyeceğini anladık.*

CCG

Combinatory Categorial Grammar: Steedman (1996, 2000).

Steedman and Baldridge (2007): summary of recent advances.

Hockenmaier and Steedman (2007): wide-coverage parsing.

Çakıcı (2008): Turkish WCP.

All constraints on grammatical meaning composition must bear on a single dynamic aspect of grammar: Its **syntactic types**.

Syntactic derivation is purely syntactic type-driven.

Lexicalizing a Surface Grammar: A Game of Algebra

PSGs encode constituency and order, but some information will be redundantly specified:

S	$\rightarrow$	**NP VP**	
VP	$\rightarrow$	$\mathbf{V}_{\mathrm{iv}}$	
VP	$\rightarrow$	$\mathbf{V}_{\mathrm{tv}}$ **NP**	
$\mathbf{V}_{\mathrm{iv}}$	$\rightarrow$	*slept*	$e \mapsto t$
$\mathbf{V}_{\mathrm{tv}}$	$\rightarrow$	*read*	$e \mapsto (e \mapsto t)$

read's subcategorization for an object **NP** is defined twice: in its lexical category ($\mathbf{V}_{\mathrm{tv}}$) and in the **VP** rule.

NB. Its (normalized) semantic type is non-redundantly specified.

VP is the functor, which, applied to a leftward **NP**, yields an **S**; i.e. **VP = (S\NP)**

$\mathbf{V}_{\mathrm{iv}}$ **= VP = (S\NP)** $\mathbf{V}_{\mathrm{tv}}$ **= VP/NP = (S\NP)/NP**

Therefore, the only ineliminable parts of the grammar above are *slept* and *read*:

slept $\stackrel{\text{def}}{=}$ $\mathbf{V}_{\text{iv}}$ **= (S\NP)**

read $\stackrel{\text{def}}{=}$ $\mathbf{V}_{\text{tv}}$ **= (S\NP)/NP**

Assuming **S** to be of semantic type t, and **NP** to be e, a fully interpretable equivalent of the grammar above is

$$\begin{array}{lcll} slept & := & \mathbf{S\backslash NP} & e \mapsto t \\ read & := & (\mathbf{S\backslash NP})/\mathbf{NP} & e \mapsto (e \mapsto t) \end{array}$$

This much type-dependence can explain Ross's (1967) ATB constraints,

their exceptions,

and exceptions to exceptions (Steedman, 2000, 2008:p.c.).

(10) a. The cat that [John admires]$_{\mathbf{S/NP}}$ and [Mary hates]$_{\mathbf{S/NP}}$

b. *The cat that [John admires]$_{\mathbf{S/NP}}$ and [bites Mary]$_{\mathbf{S\backslash NP}}$

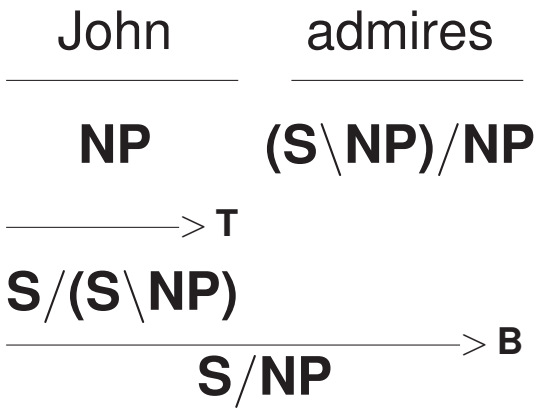
c. *The man that [admires John]$_{\mathbf{S\backslash NP}}$ and [Mary detests]$_{\mathbf{S/NP}}$

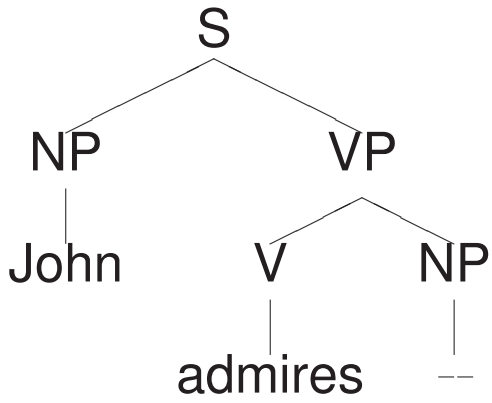
d. The man [that admires John]$_{\mathbf{N\backslash N}}$ and [(that) Mary detests]$_{\mathbf{N\backslash N}}$

e. *The cat that [John admires]$_{\mathbf{S/NP}}$ and [Mary hates it]$_{\mathbf{S}}$

f. *The cat that [John admires it]$_{\mathbf{S}}$ and [Mary hates]$_{\mathbf{S/NP}}$

John admires as a constituent:





CCG's universal syntax

Application

$$\mathbf{X/Y}: f \quad \mathbf{Y}: a \quad \Rightarrow \quad \mathbf{X}: fa \qquad\qquad \mathbf{Y}: a \quad \mathbf{X\backslash Y}: f \quad \Rightarrow \quad \mathbf{X}: fa$$

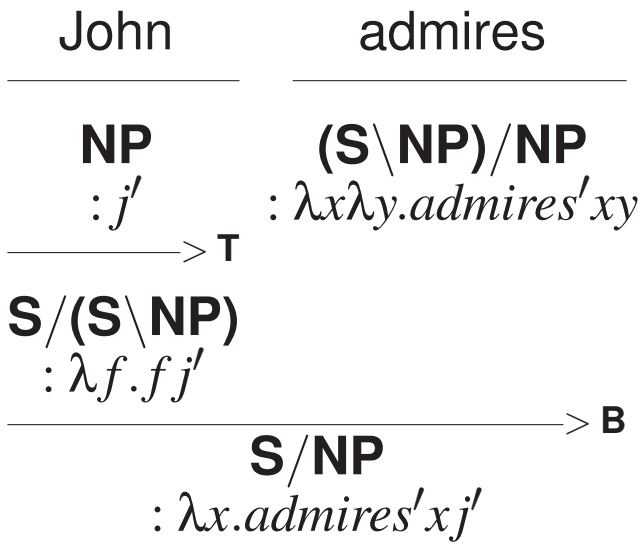
Type Raising

$$\mathbf{A}: a \quad \Rightarrow \quad \mathbf{T/(T\backslash A)}: \lambda f.fa \qquad\qquad \mathbf{A}: a \quad \Rightarrow \quad \mathbf{T\backslash(T/A)}: \lambda f.fa$$

Composition

$$\mathbf{X/Y}: f \quad \mathbf{Y/Z}: g \quad \Rightarrow \quad \mathbf{X/Z}: \lambda x.f(gx) \qquad \mathbf{Y\backslash Z}: g \quad \mathbf{X\backslash Y}: f \quad \Rightarrow \quad \mathbf{X\backslash Z}: \lambda x.f(gx)$$

John likes's compositional semantics is immediate:



Strings and Categories

(11)a. *admires* := $\mathbf{(S\backslash NP_{3s})/NP} : \lambda x \lambda y.admire' \, xy$

b. $\overbrace{\overbrace{admires}^{string} \underbrace{:=}_{\substack{string\\type\\descriptor}} \overbrace{\overbrace{\mathbf{(S\backslash NP_{3s})/NP}}^{syn.type} : \overbrace{\underbrace{\lambda x \lambda y.}_{correspondence} \underbrace{admire' \underbrace{(e,(e,t))}_{sem.type} xy}^{logical\,form}}^{lambda\ term}}^{category}$

Any contiguous string can bear a type. CCG does not commit itself to morphemic morphology or word-based syntax.

Learning which (sub)strings go with which meanings is a learning problem.

(Zettlemoyer and Collins, 2005; Steedman, 2005; Steedman and Hockenmaier, 2007; Coltekin and Bozsahin, 2007)

Constituent structure, intonational structure, information structure

H*L- seems to be the rheme contour in Turkish.

Declarative tune is H*L-L%

(Ali) $\overbrace{\text{(AYNUR-U gördü)}}^{\textit{Rheme}}$ dün gece.

L* H- H* L-L%

‘Ali saw Aynur last night.’

Rheme does not always include the verb, or L%.

(12)a. Ali kim-i gör-dü?
Ali who-ACC see-PAST
‘ Whom did Ali see?’

b. $\overbrace{\text{(AYNUR-U}}^{\textit{Rheme}}\ \overbrace{\text{gördü.)}}^{\textit{Theme}}$
H* L-L%
Aynur-ACC saw

Grammaticizing Turkish tunes and information structure

(13)a. The categories of boundary tones: L- := $\mathbf{S\$}_{\iota}\backslash\mathbf{S\$}_{\rho} : \lambda f.\rho' f$

H- := $\mathbf{S\$}_{\iota}\backslash\mathbf{S\$}_{\theta} : \lambda f.\theta' f$

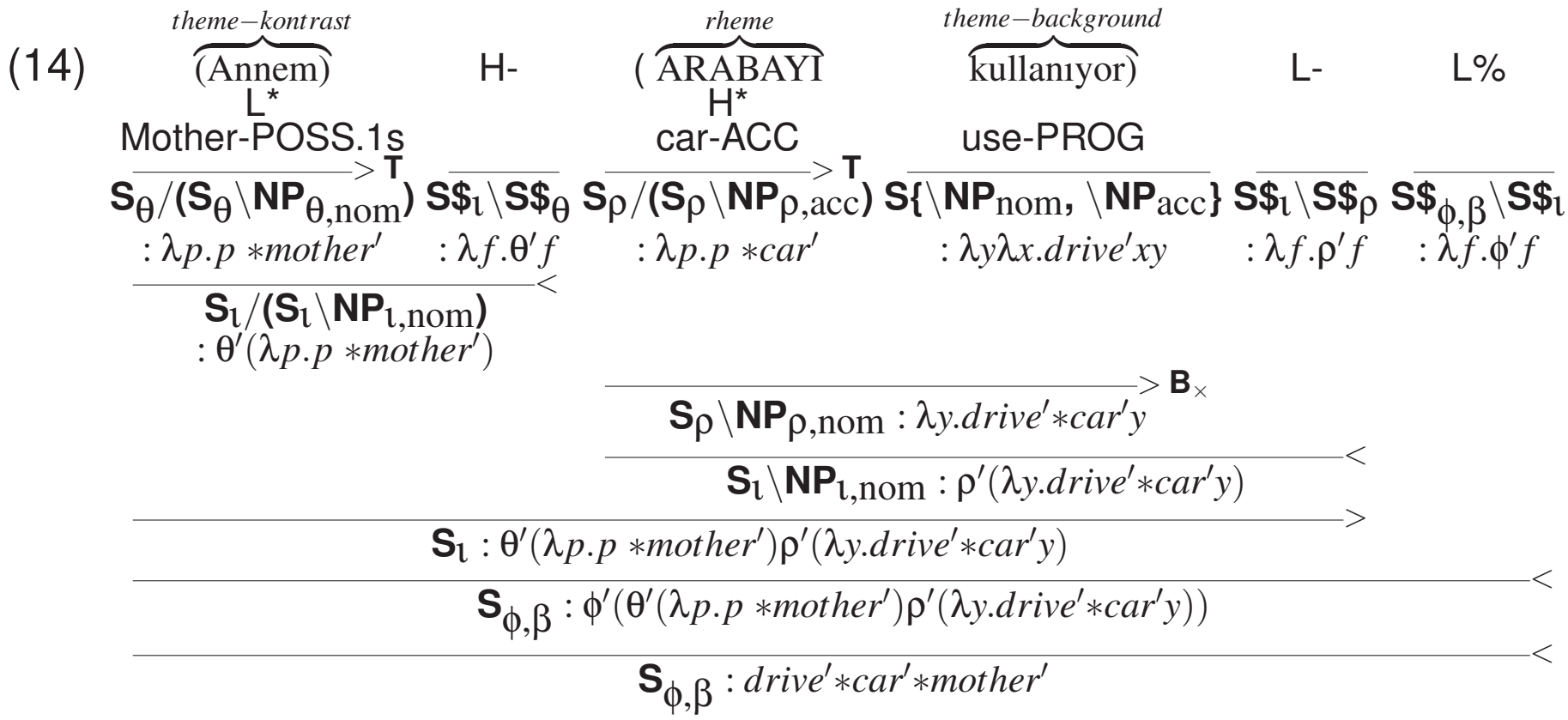
L% := $\mathbf{S\$}_{\phi,\beta}\backslash\mathbf{S\$}_{\iota} : \lambda f.\phi' f$

b. Pitch accents: H* decorates the item in the string with ρ (rheme) feature.

L* decorates the item in the string with θ (theme) feature.

ι: Intermediate phrase. β: background ϕ: Intonational phrase.

(14)



Autosegmental-metrical component aligns pitch accents with syllables (Ladd, 1996; Liberman, 1975; Pierrehumbert, 1980).

Postfocal deaccenting

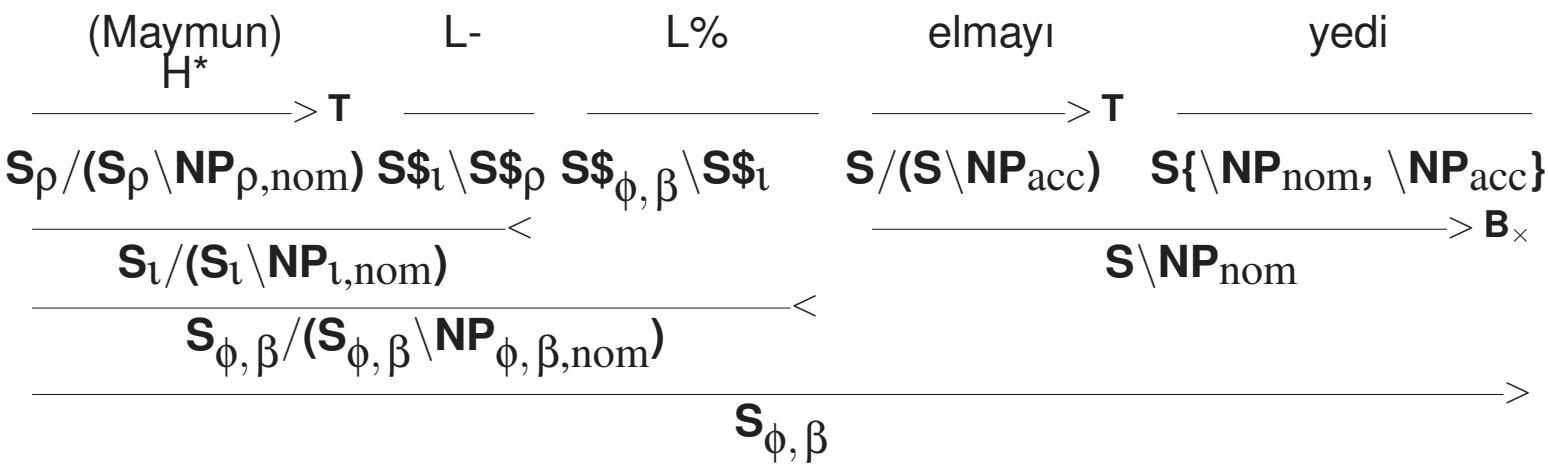
Follows from lexicalized syntactic types.

(15) (Annem kullanıyor) L- L% arabayı.
H*

$$\frac{\dfrac{\dfrac{\dfrac{\dfrac{\mathbf{S}_{\rho}/(\mathbf{S}_{\rho}\backslash\mathbf{NP}_{\rho,nom})\quad \mathbf{S}\{\backslash\mathbf{NP}_{nom},\ \backslash\mathbf{NP}_{acc}\}}{\mathbf{S}_{\rho}\backslash\mathbf{NP}_{\rho,acc}}\,>\mathbf{B}_{\times}\quad \mathbf{S\$}_{\iota}\backslash\mathbf{S\$}_{\rho}}{\mathbf{S}_{\iota}\backslash\mathbf{NP}_{\iota,acc}}<\quad \mathbf{S\$}_{\phi,\beta}\backslash\mathbf{S\$}_{\iota}}{\mathbf{S}_{\phi,\beta}\backslash\mathbf{NP}_{\phi,\beta,acc}}<\quad \mathbf{S}_{\beta}\backslash(\mathbf{S}_{\beta}\backslash\mathbf{NP}_{\beta,acc})\,>\mathbf{T}_{\times}}{\mathbf{S}_{\phi,\beta}}<$$

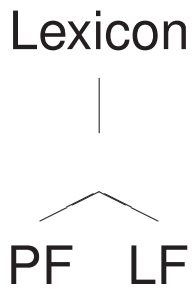
'My mother drives the car.'

It's not always the verb that does this. **Always** the rheme!



'The monkey ate the apple.'

Training the CCG lexical types



No intermediaries between Lexicon and interfaces.

No multiple structures.

Everything projects from the lexicon, led by syntactic types.

Learning algorithms easily apply to annotated data.

Conclusion

Information structure and intonation structure has compositional semantics.

Just like constituent structure.

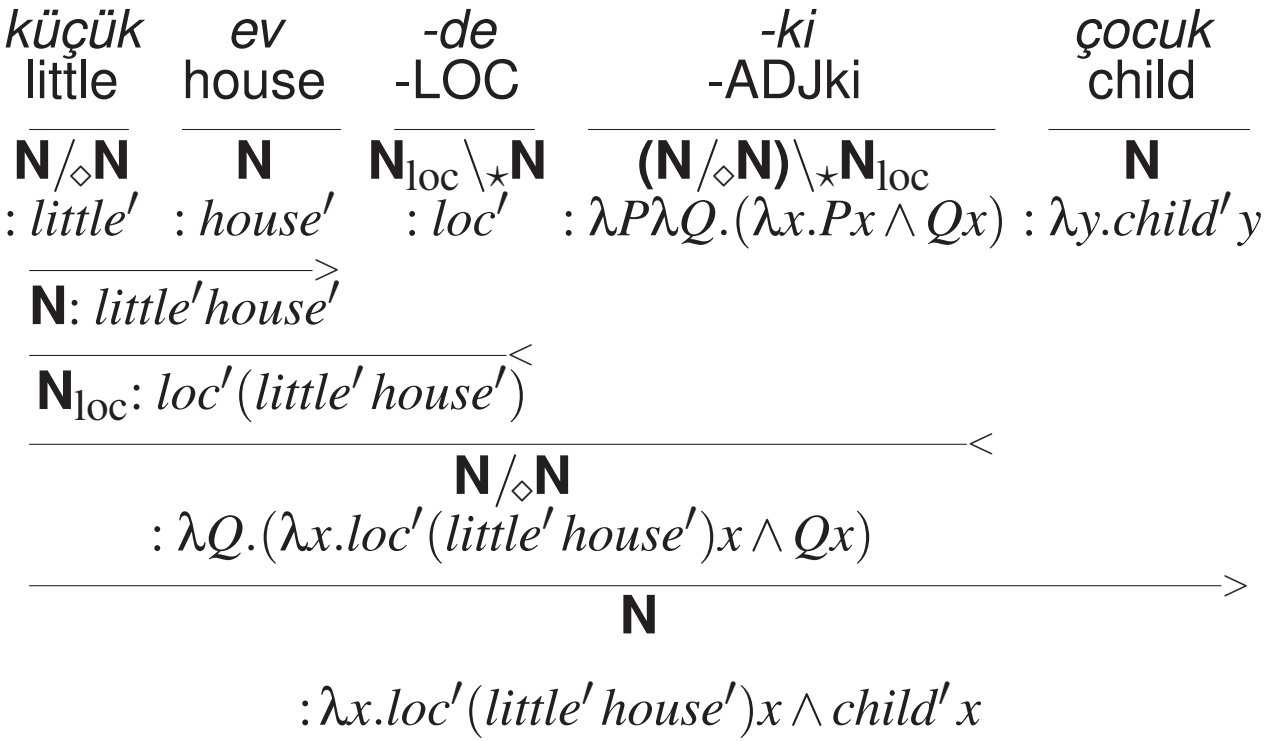
One syntax is good enough for all this

If syntactic type assignments are liberated from words.

Constraint interaction shapes the lexical syntactic types.

Grammar development is setting the constraints right.

The rest is history for the parser; it does not care about the nature of the string, and LF and IS is immediate.



'The child$_i$, the one$_i$ in the little house'

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