Semantic composition

Chris Potts, Ling 130a/230a: Introduction to semantics and pragmatics, Winter 2019

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1 Overview

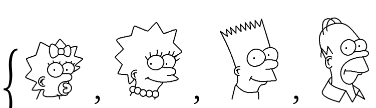
- This handout describes our theory of semantic composition. It's a bare-bones theory, but still powerful.
- The most important conceptual move is to interpret lexical items as functions. Meanings might not literally *be* functions, but, following Lewis's advice, functions at least *do what meanings do*.
- The grammar is defined by a set of rules for interpreting syntactic structures. Some of these rules come from the optional Heim & Kratzer reading, while others are new. My notation is slightly different (to more strongly suggest a computational perspective), but the underlying ideas are the same as in H&K. (I've set up these correspondences largely to try to build some bridges into this advanced optional reading.)
- We need a bunch of rules in order to respect the syntactic structures. However, all the rules just do *function application*.
- So, in essence, if you know the lexical meanings of your language and you can put them together according to the syntactic rules, then the only other concept you need to be a full-fledged interpreter is function application.

2 Basic semantic objects

2.1 Truth values

I use T for truth and F for falsity. (Heim & Kratzer use 1 and 0, respectively.)

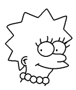
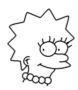
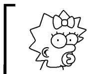
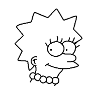
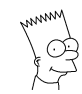
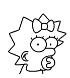
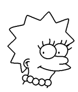
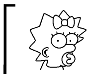
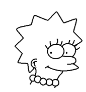
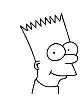
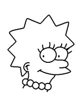
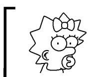
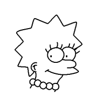
2.2 Universe

$U = \{$  $\}$

3 Characteristic sets and characteristic functions

Characteristic function of a set For a universe of entities U and any set $A \subseteq U$, the characteristic function for A is the function that maps every member of A to $\mathtt{T}$ and all members of $(U - A)$ to $\mathtt{F}$.

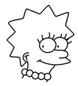
Characteristic set of a function If f is a function into truth values, the characteristic set of f is $\{x \mid f(x) = \mathtt{T}\}$

Set	Function	Set	Function
{  ,  ,  }	[ $\mapsto$ T  $\mapsto$ T  $\mapsto$ F  $\mapsto$ T]		[ $\mapsto$ T  $\mapsto$ F  $\mapsto$ F  $\mapsto$ F]
{  ,  }	[ $\mapsto$  $\mapsto$  $\mapsto$  $\mapsto$]		[ $\mapsto$ T  $\mapsto$ T  $\mapsto$ T  $\mapsto$ T]
$\emptyset$	[ $\mapsto$  $\mapsto$  $\mapsto$  $\mapsto$]		[ $\mapsto$ F  $\mapsto$ F  $\mapsto$ F  $\mapsto$ F]

4 Notation for describing functions

4.1 Functions

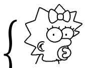
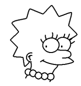
$\Big[$  $\mapsto$ T

 $\mapsto$ T

 $\mapsto$ T

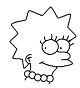
 $\mapsto$ F $\Big]$

CHILD(x)

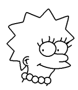
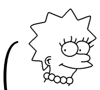
if $x \in \{$  ,  ,  $\}$

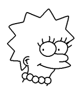
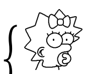
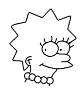
return T

else return F

λx (T if $x \in \{$  ,  ,  $\}$, else F)

4.2 Function application

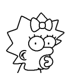
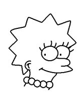
(λx (T if $x \in \{$  ,  ,  $\}$, else F)) () =

T if  $\in \{$  ,  ,  $\}$, else F =

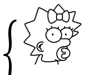
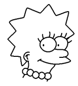
T

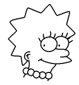
5 Semantic lexicon

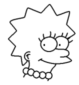
5.1 PNs

$[\![\textit{Maggie}]\!] =$  $[\![\textit{Lisa}]\!] =$  $[\![\textit{Bart}]\!] =$  $[\![\textit{Homer}]\!] =$ 

5.2 Ns

(1) $[\![\textit{Simpson}]\!] = \lambda x$ (T if $x \in \{$  ,  ,  ,  $\}$, else F)

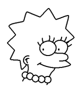
(2) $[\![\textit{child}]\!] = \lambda x$ (T if $x \in \{$  ,  ,  $\}$, else F)

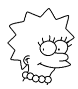
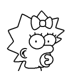
(3) $[\![student]\!] = \lambda x \left(\text{T if } x \in \{\right.$  ,  $\left.\}, \text{ else F} \right)$

(4) $[\![parent]\!] = \lambda x \left(\text{T if } x \in \{\right.$  $\left.\}, \text{ else F} \right)$

5.3 Intransitive Vs

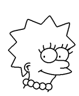
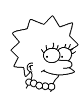
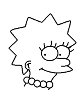
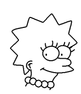
(5) $[\![skateboards]\!] = \lambda x \left(\text{T if } x \in \{\right.$  ,  $\left.\}, \text{ else F} \right)$

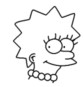
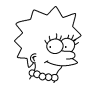
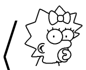
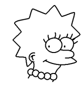
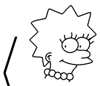
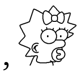
(6) $[\![studies]\!] = \lambda x \left(\text{T if } x \in \{\right.$  $\left.\}, \text{ else F} \right)$

(7) $[\![introspects]\!] = \lambda x \left(\text{T if } x \in \{\right.$  ,  $\left.\}, \text{ else F} \right)$

(8) $[\![speaks]\!] =$

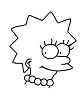
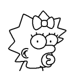
5.4 Transitive Vs

(9) $[\![tease]\!] = \lambda y \left(\lambda x \left(\text{T if } \langle x, y \rangle \in \{\right.\right.$
$\langle$  ,  $\rangle$, $\langle$  ,  $\rangle$,
$\langle$  ,  $\rangle$, $\langle$  ,  $\rangle$,
$\langle$  ,  $\rangle$, $\langle$  ,  $\rangle$
$\left.\left.\}, \text{ else F} \right)\right)$

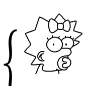
(10) $[\![admires]\!] = \lambda y \left(\lambda x \left(\texttt{T} \text{ if } \langle x, y \rangle \in \left\{ \langle$  ,  $\rangle, \langle$  ,  $\rangle, \langle$  ,  $\rangle, \langle$  ,  $\rangle \right\}, \text{ else } \texttt{F} \right) \right)$

(11) $[\![loves]\!] =$

5.5 Adjectives

(12) $[\![female]\!] = \lambda f \left(\lambda x \left(\texttt{T} \text{ if } x \in \left\{\right.$  ,  $\left.\right\} \text{ and } f(x) = \texttt{T}, \text{ else } \texttt{F} \right) \right)$

(13) $[\![male]\!] = \lambda f \left(\lambda x \left(\texttt{T} \text{ if } x \in \left\{\right.$  ,  $\left.\right\} \text{ and } f(x) = \texttt{T}, \text{ else } \texttt{F} \right) \right)$

(14) $[\![hungry]\!] = \lambda f \left(\lambda x \left(\texttt{T} \text{ if } x \in \left\{\right.$  ,  $\left.\right\} \text{ and } f(x) = \texttt{T}, \text{ else } \texttt{F} \right) \right)$

(15) $[\![alleged]\!] = \lambda f \, (\lambda x \, (\texttt{T} \text{ if someone claimed that } f(x) = \texttt{T}, \text{ else } \texttt{F}))$

(16) $[\![Springfieldian]\!] =$

5.6 Negation

To be completed:

(17) $\lambda f\Bigg(\lambda x\Bigg(\qquad\qquad\qquad\qquad \Bigg)\Bigg)$

5.7 Quantificational determiners

(18) $[\![\textit{every}]\!] = \lambda f\Big(\lambda g\Big(\texttt{T} \text{ if } \{x \mid f(x) = \texttt{T}\} \subseteq \{x \mid g(x) = \texttt{T}\}, \text{ else } \texttt{F}\Big)\Big)$

(19) $[\![\textit{some}]\!] = \lambda f\Big(\lambda g\Big(\texttt{T} \text{ if } \{x \mid f(x) = \texttt{T}\} \cap \{x \mid g(x) = \texttt{T}\} \neq \emptyset, \text{ else } \texttt{F}\Big)\Big)$

(20) $[\![\textit{no}]\!] = \lambda f\Big(\lambda g\Big(\texttt{T} \text{ if } \{x \mid f(x) = \texttt{T}\} \cap \{x \mid g(x) = \texttt{T}\} = \emptyset, \text{ else } \texttt{F}\Big)\Big)$

(21) $[\![\textit{most}]\!] =$

(22) $[\![\textit{three}]\!] =$

(23) $[\![\textit{few}]\!] =$

6 Semantic grammar

(NB) Given a syntactic structure $\begin{array}{c}\text{X}\\ |\\ \text{Y}\end{array}$, $\llbracket \text{X} \rrbracket = \llbracket \text{Y} \rrbracket$

(S) Given a syntactic structure $\begin{array}{c}\text{S}\\ \text{PN}\quad \text{VP}\end{array}$, $\llbracket \text{S} \rrbracket = \llbracket \text{VP} \rrbracket(\llbracket \text{PN} \rrbracket)$

(A) Given a syntactic structure $\begin{array}{c}\text{NP}_j\\ \text{AP}\quad \text{NP}_i\end{array}$, $\llbracket \text{NP}_j \rrbracket = \llbracket \text{AP} \rrbracket(\llbracket \text{NP}_i \rrbracket)$

(N) Given a syntactic structure $\begin{array}{c}\text{VP}_j\\ \textit{not}\quad \text{VP}_i\end{array}$, $\llbracket \text{VP}_j \rrbracket = \llbracket \textit{not} \rrbracket(\llbracket \text{VP}_i \rrbracket)$

(With apologies to the morphosyntax of English for providing no *do* support.)

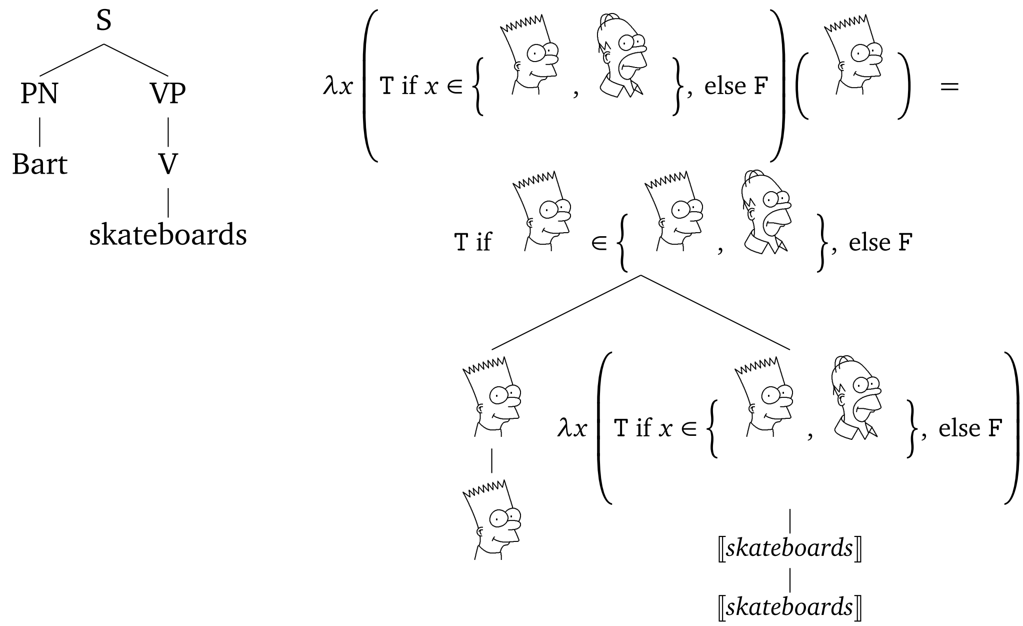
(TV) Given a syntactic structure $\begin{array}{c}\text{VP}\\ \text{V}\quad \text{PN}\end{array}$, $\llbracket \text{VP} \rrbracket = \llbracket \text{V} \rrbracket(\llbracket \text{PN} \rrbracket)$

(Q1) Given a syntactic structure $\begin{array}{c}\text{QP}\\ \text{D}\quad \text{NP}\end{array}$, $\llbracket \text{QP} \rrbracket = \llbracket \text{D} \rrbracket(\llbracket \text{NP} \rrbracket)$

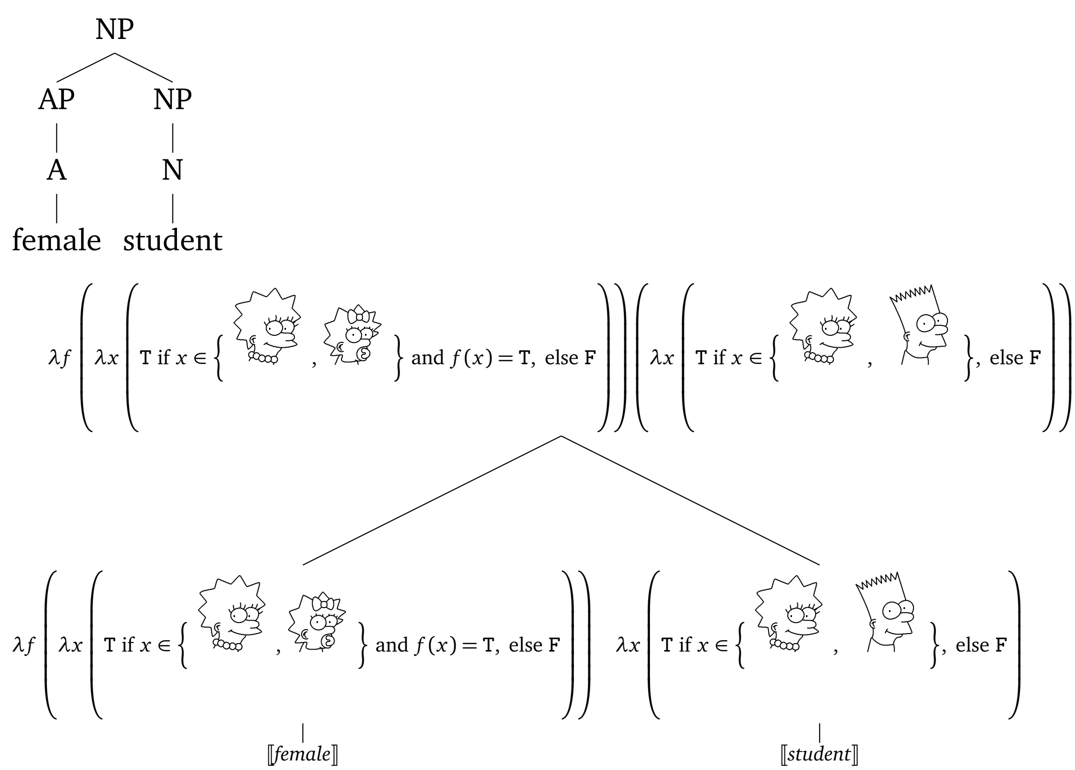
(Q2) Given a syntactic structure $\begin{array}{c}\text{S}\\ \text{QP}\quad \text{VP}\end{array}$, $\llbracket \text{S} \rrbracket = \llbracket \text{QP} \rrbracket(\llbracket \text{VP} \rrbracket)$

7 Illustrations

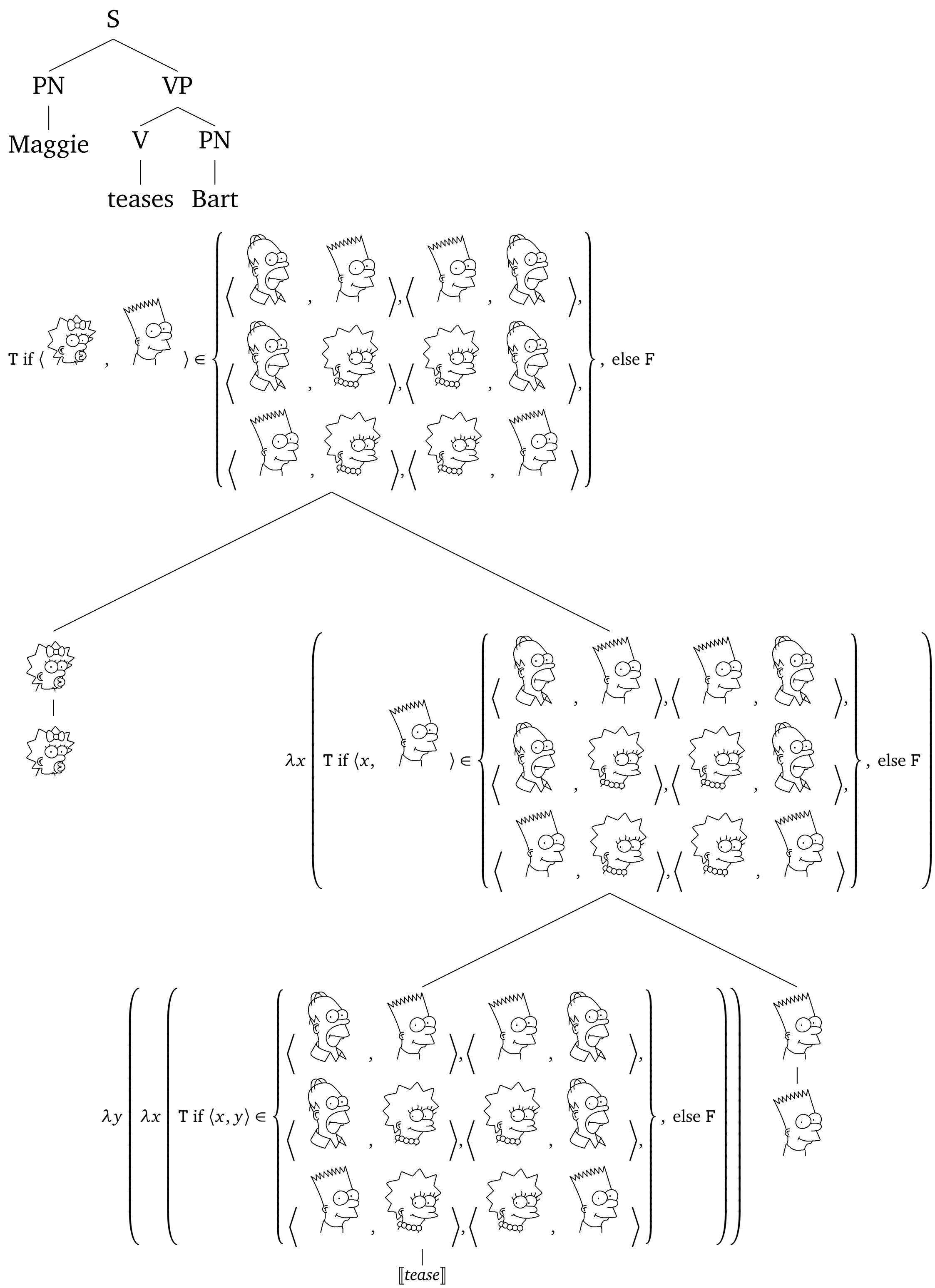
(24)



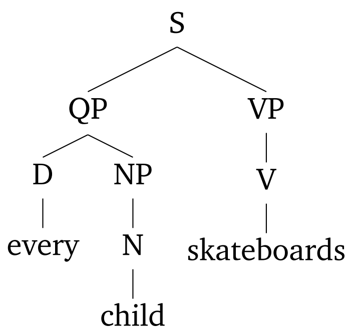
(25)

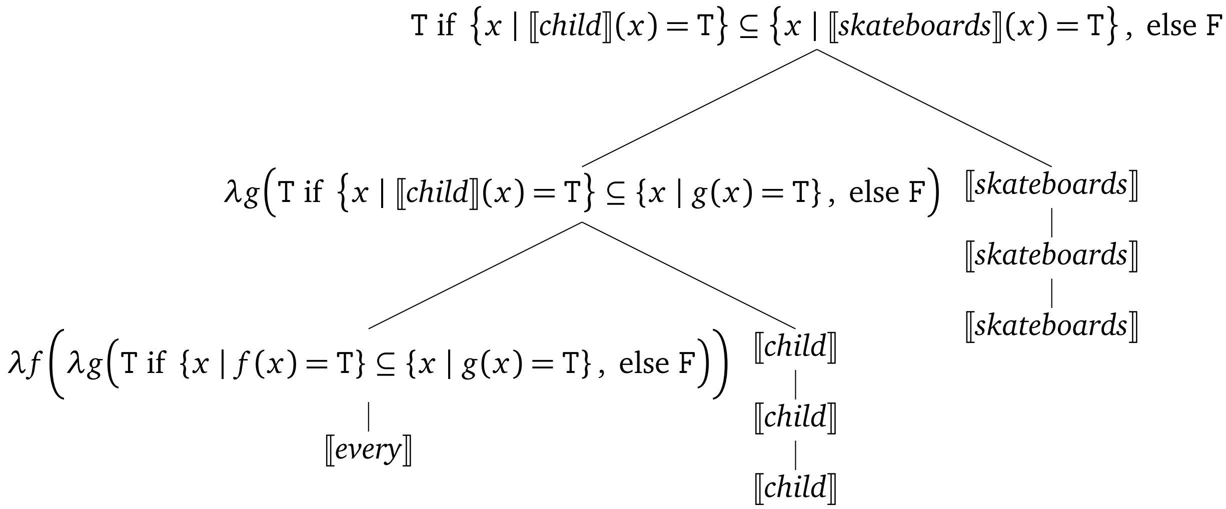


(26)

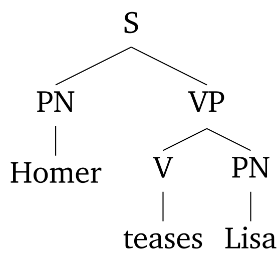

S
PN
VP
Maggie
V
PN
teases
Bart
T if ⟨ , ⟩ ∈ , else F
λx T if ⟨x, ⟩ ∈ , else F
λy λx T if ⟨x, y⟩ ∈ , else F
⟦tease⟧

(27)

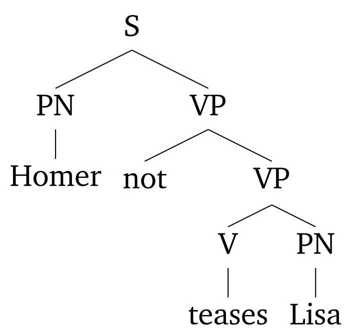

S
QP
VP
D
NP
V
every
N
skateboards
child


$\texttt{T}$ if $\{x \mid [\![child]\!](x) = \texttt{T}\} \subseteq \{x \mid [\![skateboards]\!](x) = \texttt{T}\}$, else $\texttt{F}$
$\lambda g\big(\texttt{T}$ if $\{x \mid [\![child]\!](x) = \texttt{T}\} \subseteq \{x \mid g(x) = \texttt{T}\}$, else $\texttt{F}\big)$
$[\![skateboards]\!]$
$[\![skateboards]\!]$
$[\![skateboards]\!]$
$\lambda f\Big(\lambda g\big(\texttt{T}$ if $\{x \mid f(x) = \texttt{T}\} \subseteq \{x \mid g(x) = \texttt{T}\}$, else $\texttt{F}\big)\Big)$
$[\![every]\!]$
$[\![child]\!]$
$[\![child]\!]$
$[\![child]\!]$

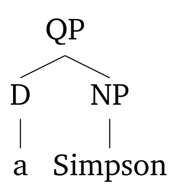
(28)


S
PN
VP
Homer
V
PN
teases
Lisa

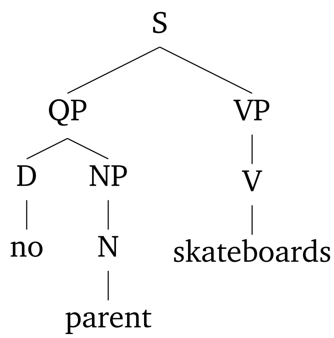
(29)


S
PN
VP
Homer
not
VP
V
PN
teases
Lisa

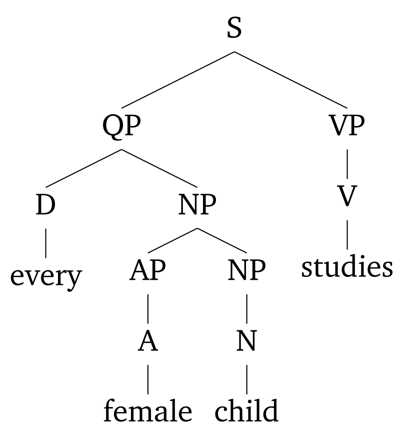
(30)


QP
D
NP
a
Simpson

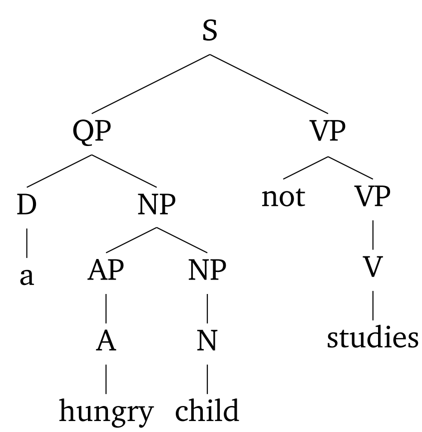
(31)


S
QP
VP
D
NP
V
no
N
skateboards
parent

(32)


S
QP
VP
D
NP
V
every
AP
NP
studies
A
N
female
child

(33)


S
QP
VP
D
NP
not
VP
a
AP
NP
V
A
N
studies
hungry
child