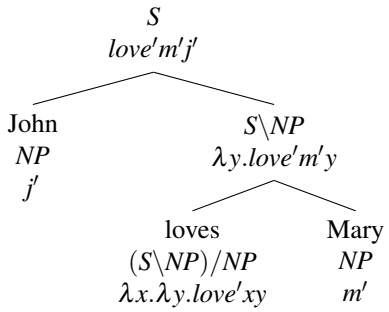
Here is how we define lexical signs — as a triple of phonetic form, syntactic type, semantic interpretation (with or without the semantic type):

$$\begin{array}{rlll}
\text{sleeps} := & S\backslash NP & :\lambda x.sleep'x & ::\langle e,t\rangle \\
\text{loves} := & (S\backslash NP)/NP & :\lambda x\lambda y.love'xy & ::\langle e,\langle e,t\rangle\rangle \\
\text{John} := & NP & :j' & ::e \\
\text{Mary} := & NP & :m' & ::e \\
\text{woman} := & S\backslash NP & :\lambda x.woman'x & ::\langle e,t\rangle \\
\text{a} := & (S/(S\backslash NP))/(S\backslash NP) & :\lambda p\lambda q.\exists x.px\wedge qx & ::\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle \\
\text{every} := & (S/(S\backslash NP))/(S\backslash NP) & :\lambda p\lambda q.\forall x.px\rightarrow qx & ::\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle
\end{array}$$

A strange thing here is that *sleeps* and *woman* look indistinguishable categorially. They have the same syntactic type, same semantic type and very similar interpretations. Don't worry about it at the moment. Both expressions define sets, therefore they are expected to be similar in their semantics. Their syntax must differ — you cannot substitute *sleeps* and *woman* in place of each other keeping sentences grammatical. We will ignore this fault in our syntax at the moment.

We derive the meaning of a sequence of words by function application of two items at a time. Here is how *John loves Mary* is interpreted.



Q1.

An alternative way of writing semantic types is omitting the angle brackets and adopting left associative parentheses elimination, as we did in lambda terms. In this regime we write $\langle e,t\rangle$ as et, $\langle e,\langle e,t\rangle\rangle$ as $e(et)$. The same goes for syntactic types. Under left associativity *loves* becomes $S\backslash NP/NP$

(a) Write the semantic type of *every* in left associative format.

(b) Write the syntactic type of *every* in left associative format.

Solution:

(a) $et(ett)$

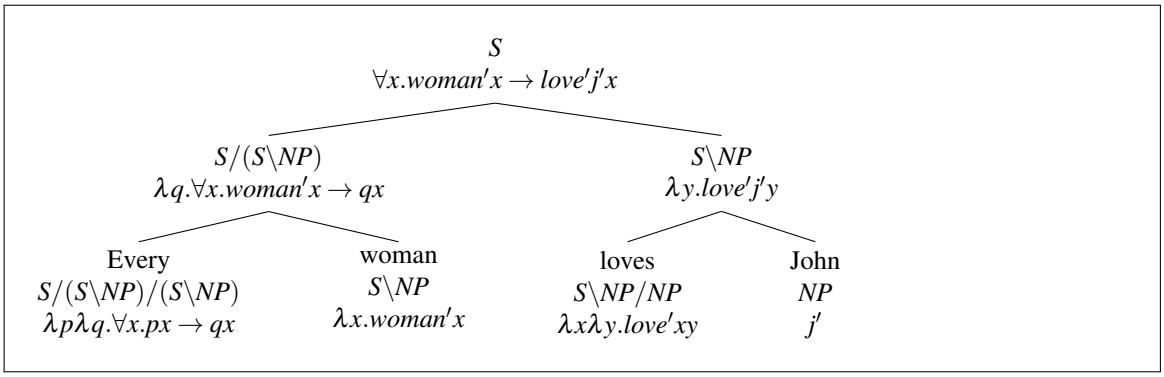
(b) $S/(S\backslash NP)/(S\backslash NP)$

Q2.

Draw the derivation tree of:

(1) Every woman loves John.

Solution:



Q3.

Draw the derivation tree for,

(2) John loves every woman.

Note that this will not work with the lexical definitions above. You need to alter the definition of *every*.

Solution: