1 Practice with set abstraction notation
Do the exercise on pp. 9-10 of Heim and Kratzer.

2 Semantic composition and linear order
The toy semantics we built in class this week has a couple of interesting properties. The following are particularly relevant:

UNIQUENESS: No input receives more than one interpretation. Our lexical entries provide a unique denotation for each word, and the composition rules are all written in such a way that if they apply to a given constituent at all, they will yield a unique denotation for that constituent.

INSENSITIVITY TO LINEAR ORDER: The composition rules make reference to ‘the immediate subconstituents of’ the phrase to be interpreted (i.e., its daughters), but they do not care about the linear ordering of these constituents. That is, when we say ‘α is a constituent whose immediate subconstituents are β and γ’, we could be talking about constituents of either the form (1a) or (1b).

(1) a. α b. α

\[ \beta \gamma \gamma \beta \]

This means that any two syntactic representations that differ only in permutations of linear order in (one or more of) their subtrees, but not in hierarchical relations, are semantically equivalent (have denotations that lead to the same truth conditions).

A. Given the insensitivity to linear order of the composition rules, it is not clear that our system is actually coherent. Why not? To answer this question, consider the hypothetical connective \textit{twithout}, whose extension is the operation of set difference (see PTW p. 15), which is defined in (2):

(2) For any two sets A, B, \([\text{twithout}](A,B) = \{x | x \in A \text{ and } x \notin B\}\)

Assume that structures with \textit{twithout} are syntactically identical to those with \textit{and}, i.e., they are ternary branching, as shown in (3) for ‘Kim runs twithout smoking’. (For now, we will continue to ignore verbal morphology.) What is the crucial property of \textit{twithout} that makes it a problem for order-insensitive composition rules?

(3) Kim run twithout smoke

B. One way to fix this problem would be to introduce order-sensitive composition
rules. Formulate an appropriate rule to handle the hypothetical word *twithout*.

C. Another way to fix the problem would be to revise the syntax and assume (along with most work in modern syntactic theory) that all structures are binary branching. Spell out the necessary revisions to our composition rules and lexical entries that this solution would require, assuming that the truth conditions that we want to end up with are the same as the ones we derive in a system that assumes ternary branching and order-sensitive rules, as in Part B. Show how your proposals work by deriving the truth conditions of (4). (I.e., do a ‘proof’ like the one on the ‘toy semantics’ handout.)

![Diagram](image)

D. How does the real English word *without* compare to the hypothetical *twithout*? Can the real *without* be treated adequately in a theory that has no order-sensitive rules? Is the denotation in (2) or your modified denotation for binary-branching structures sufficient to capture the meaning of *without*?

For the purposes of this assignment, you should just worry about examples in which *without* is followed by a verb or VP, not examples in which it is followed by a noun or NP or any other constituent. It is probably best to stick to examples involving intransitive verbs (these should be sufficient to answer the question), but if you want to consider more complex VPs, you can also assume for simplicity that they also denote sets, so that *like tea*, for example, denotes the set of individuals that like tea. (Don’t worry about how the direct object and other internal arguments are interpreted for now.)

In thinking about the last question, you should be aware of the fact that verbs like *smoke* and *run* exhibit an ambiguity between so-called ‘episodic’ and ‘habitual’ interpretations. For example, *Kim smoked* can mean either that Kim smoked on some occasion, or that Kim was a habitual smoker. For reasons that we won’t go into (though it’s an interesting topic!), this ambiguity disappears in the simple present tense, and only the habitual interpretation remains. Be sure that you keep the interpretations of the verbs you use constant in any examples you compare, since comparing habitual uses with episodic uses may introduce additional factors that are orthogonal to the question under consideration here.