1. Determine the set of properties of the following relations on the set of all people. In each case, make the strongest possible statement, e.g., call a relation irreflexive whenever possible instead of nonreflexive.¹

(a) is a child of
(b) is a brother of
(c) is a descendant of
(d) is an uncle of

2. Using section 12.3.4 as a help and using what you know about English pronouns, write out all the CFG rules you need to capture the following sentences, where * indicates an ungrammatical sentence:

(1) a. I eat.                h. *Him/Her eats.
b. *I/Me eats.            i. We eat.
e. *You eats.     l. They eat.
f. He/She eats.          m. *They/Them eats.

3. Using the grammar in figure 13.1 on page 428, provide the following:

(a) A top-down, depth-first search for I prefer a meal.
(b) A top-down, breadth-first search for I prefer a meal.
(c) A left-corner search for I prefer a meal.

The bottom-up search is given for Book that flight in figure 13.4 on page 431, which might help you in your answer.

4. [Moved to next assignment:] The CYK algorithm can only be used with rules in Chomsky Normal Form (CNF)—i.e., where rules are only of the form $X \to AB$ or $X \to w$ ($A, B, X \in N$ and $w \in \Sigma$). Explain where exactly the CYK algorithm would change and how it would be more inefficient if arbitrary CFG rules were allowed.

¹Question adapted from Partee et al (1993), Mathematical Methods in Linguistics, ch. 3