1. (a) Draw a tree for the following sentence, using whatever features are necessary to make subcategorization and the long-distance dependency work out:

   (1) Kim, Dana believes Chris knows Sandy trusts

   (b) Describe how subcategorization is handled here.

   (c) Describe how the trace is linked to Kim.

2. Here’s a set of CFG rules that don’t use feature structures:

   \[ NP_{1sg} \rightarrow \text{Det} \ N_{1sg} \]
   \[ NP_{3sg} \rightarrow \text{Det} \ N_{3sg} \]
   \[ NP_{2pl} \rightarrow \text{Det} \ N_{2pl} \]
   \[ NP_{2sg} \rightarrow \text{Det} \ N_{2sg} \]
   \[ NP_{1pl} \rightarrow \text{Det} \ N_{1pl} \]
   \[ NP_{3pl} \rightarrow \text{Det} \ N_{3pl} \]

   And here’s the same set using a feature structure notation:

   \[
   \begin{align*}
   \text{NP} & \rightarrow \text{Det} \ N \\
   <\text{NP PERSON}> & = <\text{N PERSON}> \\
   <\text{NP NUMBER}> & = <\text{N NUMBER}> \\
   \end{align*}
   \]

   Assume we’re using the Earley parser, and we’ve already processed the input from position 0 to position 1, using the rule \( \text{Det} \rightarrow \text{the} \).

   (a) Describe the current state of the Earley parser for the CFG rules without feature structures.

   (b) Describe the current state of the Earley parser for the CFG rules with feature structures.

3. Is the language \( a^n b^2 a^n \) context-free? (Jurafsky and Martin, question 16.1)

4. Assuming that the parser finds the correct dependency analysis for the German sentence in (2), walk through the steps of how Nivre’s parser produces a parse.

   (2) Die Wirtschaftspolitik läßt auf sich warten.

   ‘Economic policy is a long time coming.’

5. Do question 17.5, p. 582 of Jurafsky and Martin (involving vegetarians at McDonald’s).