National University of Singapore
School of Computing
CS3243: Foundations of Artificial Intelligence
Tutorial 8

Readings: AIMA Chapter 22

1. Given the following grammar:

   S ⇒ NP VP
   NP ⇒ Noun | Article Noun | NP PP
   VP ⇒ Verb | VP NP | VP PP
   PP ⇒ Preposition NP
   Article ⇒ the
   Noun ⇒ agent | wumpus | [1,2]
   Verb ⇒ detects
   Preposition ⇒ at

   Consider the sentence "the agent detects the wumpus at [1,2]". Show two different parse trees of this sentence based on the above grammar, and give the interpretation (in English) of each parse tree.

2. (Modified from Question 22.9 of the textbook) Consider the sentence "someone walked slowly to the supermarket" and the following lexicon:

   Pronoun ⇒ someone
   Verb ⇒ walked
   Adv ⇒ slowly
   Prep ⇒ to
   Article ⇒ the
   Noun ⇒ supermarket

   Which of the following three grammars, combined with the lexicon, generates the given sentence? Show the corresponding parse tree(s).

   Grammar A:
   S ⇒ NP VP
   NP ⇒ Pronoun
   NP ⇒ Article Noun
   VP ⇒ VP PP
   VP ⇒ VP Adv Adv
   VP ⇒ Verb
   PP ⇒ Prep NP
   NP ⇒ Noun

   Grammar B:
   S ⇒ NP VP
   NP ⇒ Pronoun

NP ⇒ Noun
NP ⇒ Article NP
VP ⇒ Verb Vmod
Vmod ⇒ Adv Vmod
Vmod ⇒ Adv
Adv ⇒ PP
PP ⇒ Prep NP

Grammar C:
S ⇒ NP VP
NP ⇒ Pronoun
NP ⇒ Article NP
VP ⇒ Verb Adv
Adv ⇒ Adv Adv
Adv ⇒ PP
PP ⇒ Prep NP
NP ⇒ Noun

3. Consider the following context-free grammar that generates sequences of letters:

   S ⇒ a X c
   S ⇒ b X c
   S ⇒ b X e
   S ⇒ c X e
   X ⇒ f X
   X ⇒ g

   (a) Give a trace of the top-down parse on the input bfge
   (b) Give a trace of the bottom-up parse on the same input bfge
   (c) Which approach is better in this case?

4. Give context-free grammars for

   (a) The set of all strings of the form: n occurrences of as, followed by any number of bs, followed by any number of cs, followed by n occurrences of d
   (b) The set of palindromes (strings that read the same forward as backward) over alphabet $\{a, b\}$