

National University of Singapore
 School of Computing
 CS3243: Introduction to Artificial Intelligence
 Tutorial 10

Readings: AIMA Chapter 23 (Sections 1-3)

1. Given the following grammar:

$S \Rightarrow NP VP$
 $NP \Rightarrow \text{Noun} \mid \text{Article Noun} \mid NP PP \mid \text{Noun Noun}$
 $VP \Rightarrow \text{Verb} \mid VP NP \mid VP PP$
 $PP \Rightarrow \text{Preposition NP}$
 $\text{Article} \Rightarrow \text{the}$
 $\text{Noun} \Rightarrow \text{agent} \mid \text{wumpus} \mid [1,2]$
 $\text{Verb} \Rightarrow \text{detects}$
 $\text{Preposition} \Rightarrow \text{at}$

Consider the sentence “the agent detects the wumpus at [1,2]”.

- (a) Show two different parse trees of this sentence based on the above grammar, and give the interpretation (in English) of each parse tree.
- (b) Now consider the same probabilistic grammar below (identical to the grammar in (a)) but with probability values as above. Calculate the probability of each of the two parses.

$S \Rightarrow NP VP [1.0]$
 $NP \Rightarrow \text{Noun} [.1] \mid \text{Article Noun} [.4] \mid NP PP [.3] \mid \text{Noun Noun} [.2]$
 $VP \Rightarrow \text{Verb} [.5] \mid VP NP [.3] \mid VP PP [.2]$
 $PP \Rightarrow \text{Preposition NP} [1.0]$
 $\text{Article} \Rightarrow \text{the} [1.0]$
 $\text{Noun} \Rightarrow \text{agent} [.4] \mid \text{wumpus} [.2] \mid [1,2] [.4]$
 $\text{Verb} \Rightarrow \text{detects} [1.0]$
 $\text{Preposition} \Rightarrow \text{at} [1.0]$

- (c) If the probability of the rule

$$NP \Rightarrow \text{Noun} [.1] \mid \text{Article Noun} [.4] \mid NP PP [.3] \mid \text{Noun Noun} [.2]$$

was changed to:

$$NP \Rightarrow \text{Noun} [.1] \mid \text{Article Noun} [.5] \mid NP PP [.3] \mid \text{Noun Noun} [.1]$$

would the parsing results change? Why or why not?

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

$\text{Pronoun} \Rightarrow \text{someone}$
 $\text{Verb} \Rightarrow \text{walked}$
 $\text{Adv} \Rightarrow \text{slowly}$
 $\text{Prep} \Rightarrow \text{to}$

Article \Rightarrow the
 Noun \Rightarrow supermarket

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

Grammar A:

$S \Rightarrow NP VP$
 $NP \Rightarrow$ Pronoun
 $NP \Rightarrow$ Article Noun
 $VP \Rightarrow VP PP$
 $VP \Rightarrow VP Adv Adv$
 $VP \Rightarrow$ Verb
 $PP \Rightarrow$ Prep NP
 $NP \Rightarrow$ Noun

Grammar B:

$S \Rightarrow NP VP$
 $NP \Rightarrow$ Pronoun
 $NP \Rightarrow$ Noun
 $NP \Rightarrow$ Article NP
 $VP \Rightarrow$ Verb Vmod
 $Vmod \Rightarrow$ Adv Vmod
 $Vmod \Rightarrow$ Adv
 $Adv \Rightarrow PP$
 $PP \Rightarrow$ Prep NP

Grammar C:

$S \Rightarrow NP VP$
 $NP \Rightarrow$ Pronoun
 $NP \Rightarrow$ Article NP
 $VP \Rightarrow$ Verb Adv
 $Adv \Rightarrow Adv Adv$
 $Adv \Rightarrow PP$
 $PP \Rightarrow$ Prep NP
 $NP \Rightarrow$ Noun

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

$S \Rightarrow a X c$
 $S \Rightarrow b X c$
 $S \Rightarrow b X e$
 $S \Rightarrow c X e$
 $X \Rightarrow f X$
 $X \Rightarrow g$

(a) Give a trace of the top-down parse on the input *bfgc*

- (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 $\{a, b\}$
5. Show the CYK chart and most likely parse of the sentence “the girl saw the man with the telescope”, given the following grammar and lexicon.
- $S \Rightarrow NP VP [1.0]$
 $NP \Rightarrow NP PP [.3] \mid \text{Article Noun} [.7]$
- $VP \Rightarrow VP PP [.4] \mid \text{Verb NP} [.6]$
 $PP \Rightarrow \text{Prep NP} [1.0]$
- $\text{Article} \Rightarrow \text{the} [1.0]$
 $\text{Noun} \Rightarrow \text{girl} [.4] \mid \text{man} [.2] \mid \text{telescope} [.4]$
 $\text{Verb} \Rightarrow \text{saw} [1.0]$
 $\text{Preposition} \Rightarrow \text{with} [1.0]$