

# CS151 - Written Problem 9

## Solutions

### 1. Exercise 23.3

a.

i.

result	rule
VP	
VP Adv	$VP \rightarrow VP \text{ Adv}$
VP Adv Adv	$VP \rightarrow VP \text{ Adv}$
VP Adv Adv Adv	$VP \rightarrow VP \text{ Adv}$
V the N Adv Adv Adv	$VP \rightarrow V \text{ the N}$
shoots the duck well well well	lexical

ii. No. The only way to get “the” into a sentence is with the rule  $VP \rightarrow V \text{ the N}$  and “seems” is not a verb.

iii. No. The only way to get “the” into a sentence is with the rule  $VP \rightarrow V \text{ the N}$  and “unwell” is not a noun.

b.

Two parses:

result	rule	prob
VP		
VP Adv	$VP \rightarrow VP \text{ Adv}$	0.2
VP Adv Adv	$VP \rightarrow VP \text{ Adv}$	0.2
V Adv Adv	$VP \rightarrow V$	0.1
is Adv Adv	$V \rightarrow \text{is}$	0.8
is well Adv	$\text{Adv} \rightarrow \text{well}$	0.5
is well well	$\text{Adv} \rightarrow \text{well}$	0.5
total		0.0008

result	rule	prob
VP		
VP Adv	$VP \rightarrow VP \text{ Adv}$	0.2
Copula Adj Adv	$VP \rightarrow \text{Copula Adj}$	0.2
is Adv Adv	$\text{Copula} \rightarrow \text{is}$	0.8
is well Adv	$\text{Adj} \rightarrow \text{well}$	0.5
is well well	$\text{Adv} \rightarrow \text{well}$	0.5
total		0.008

Total probability of the sentence is the sum: 0.0088

- c . We see two kinds of ambiguity at the word level with “is” and “well” each having two parts of speech. This then results in the two possible parses
  - d. Yes. One naive way to calculate this is to take all possible sequences of length 10 of the terminal symbols. We can then parse each of these. If we find one where we have a valid parse, then we know that we can generate a sequence of exactly 10 words. It is not efficient, but tractable: there will be  $T^{10}$  sequences where  $T$  is the number of terminal symbols and parsing is polynomial.
2. Exercise 23.17 (think about the first two questions)
  3. Exercise 23.15 (not required: just for fun)