CS 662- AI Programming

HW4: First Order Logic, Probabilities and NLP

Wei Fang

1.

1.∀ x mortal(x) ∧ holding(x,Ring) ⇒ tempted(x)
2.hobit(Frodo)
3.∀ x hobbit(x) ⇒ mortal(x)
4.∀ x tempted(x) ⇒ putOn(x,Ring)
5.~holding(Frodo,Ring)⇒ holding(Gandalf,Ring)
6.~holding(Gandalf,Ring)

2.

7.mortal(Frodo) 2*3 {x/Frodo}
8. ~holding(Gandalf,Ring) ⇒ holding(Frodo,Ring) 5
9.holding(Frodo,Ring) 6*8
10.tempted(Frodo) 1*7*9 {x/Frodo}
11.putOn(Frodo,Ring) 4*10 {x/Frodo}

3.

To prove:7.putOn(Frodo,Ring)
7 unifies with 4{x/Frodo}. To prove:
8.tempted(Frodo)
8 unifies with 1{x/Frodo}. To prove:
9.mortal(Frodo) 10.holding(Frodo,Ring)
9 unifies with 3{x/Frodo}. To prove:
11.hobbit(Frodo) 10.holding(Frodo,Ring)
11 unifies with 2. To prove:
10.holding(Frodo,Ring)
10 unifies with 5. To prove:
12.~holding(Gandalf,Ring)
12 unifies with 6
The list of goals is empty, so we are done.

4.

1.~mortal(x)∨ ~holding(x,Ring)∨ tempted(x)
2.hobbit(Frodo)
3.~hobbit(x)∨ mortal(x)
4.~tempted(x)∨ putOn(x,Ring)
5.holding(Frodo,Ring)∨ holding(Gandalf,Ring)
6.~holding(Gandalf,Ring)
7.~putOn(Frodo,Ring) (added)

8.~tempted(Frodo) 3*7 {x/Frodo}
9.~mortal(Frodo)∨ ~holding(Frodo,Ring) 1*8 {x/Frodo}
10.~hobbit(Frodo)∨ ~holding(Frodo,Ring) 3*9 {x/Frodo}
11.~holding(Frodo,Ring) 2*10
12.~holding(Gandalf,Ring) 5*11
13.Contradiction 6*12

5.

	toothache		*¬toothache*	
	catch	*¬catch*	*catch*	*¬catch*
cavity	0.108	0.012	0.072	0.008
¬cavity	0.016	0.064	0.144	0.576

Figure 13.3 A full joint distribution for the *Toothache*, *Cavity*, *Catch* world.

a. P(toothache) = 0.108+0.012+0.016+0.064= 0.2
b. P(Cavity) = 0.108+0.012+0.072+0.008=0.2
c. P(Toothache | cavity) = P(toothache ∧ cavity) / P(cavity)=(0.108+0.012)/0.2=0.6
d. P(cavity | toothache ∨ catch) = P(cavity ∧(toothache ∨ catch)) / P(toothache ∨ catch)
=(0.108+0.012+0.072) /(0.108+0.012+0.072+0.016+0.064+0.144)
=0.4615

6.

Forget:F Complete:C
P(F | C) = 0.01
P(F | ~C) = 0.5
P(C)=0.9

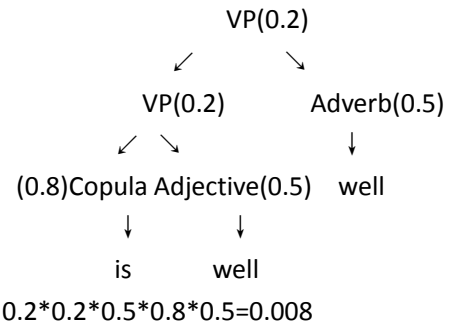
so P (F ∧ C) = P(F | C)*P(C) = 0.009
P(~F ∧ C) = P(C) - P (F ∧ C)=0.891
P(~C) = 1-P(C) = 0.1
P(F ∧ ~C) = P(~C) * P(F | ~C) =0.05
P(~F ∧ ~C)=P(~C) - P(F ∧ ~C) =0.05

	C	~C
F	0.009	0.050
~F	0.891	0.050

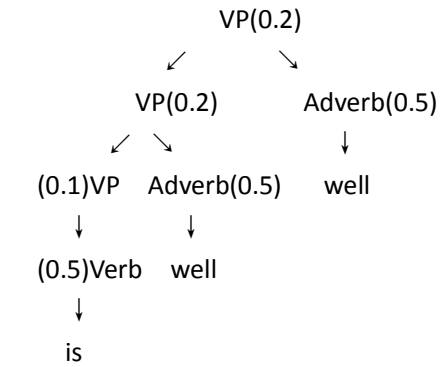
P(C | F)= P(F ∧ C) / P(F)=0.009/(0.009+0.05)=0.153

7.

a.(i)shoots the duck well well well
b. There are two parses to generate that phrase.
First parse:



0.2*0.2*0.5*0.8*0.5=0.008
Second parse:

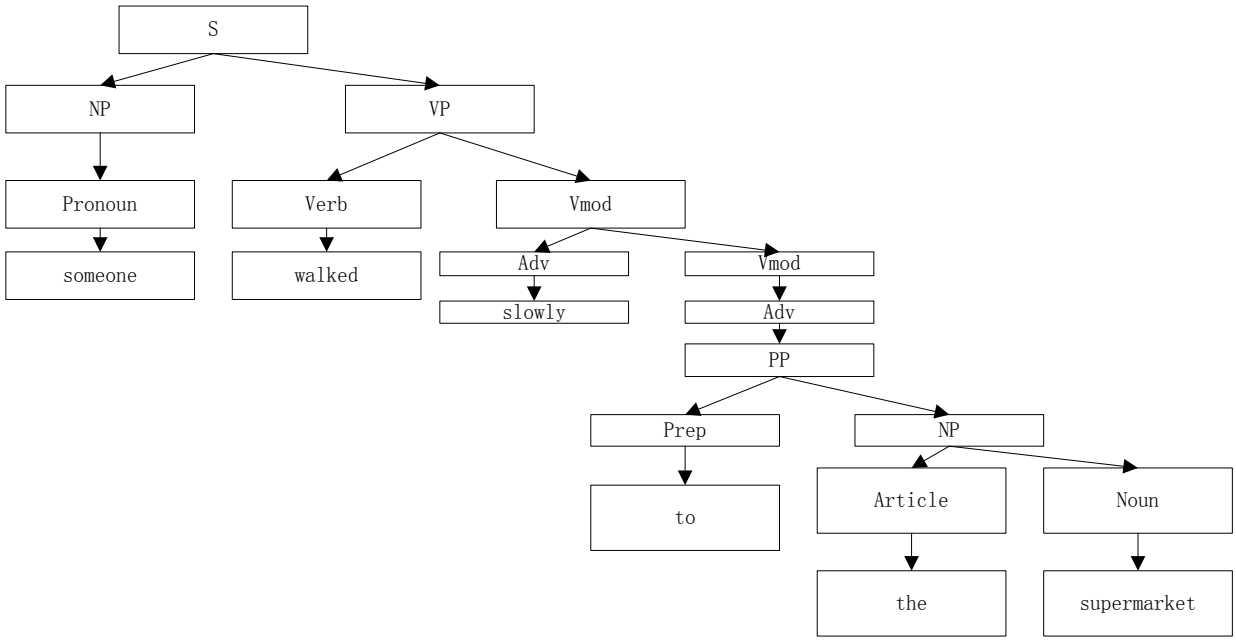


0.2*0.2*0.5*0.1*0.5*0.5=0.0005
total = 0.0085
The probability of generating “is well well” is 0.0085.
c. Its type of ambiguity is Syntactic ambiguity, because the Syntactic ambiguity refers to a phrase that has multiple parses and we have two parses to generating the phrase.
d. Yes. If I generate all strings not longer than 10 words using the PCFG, I will check the length of string.

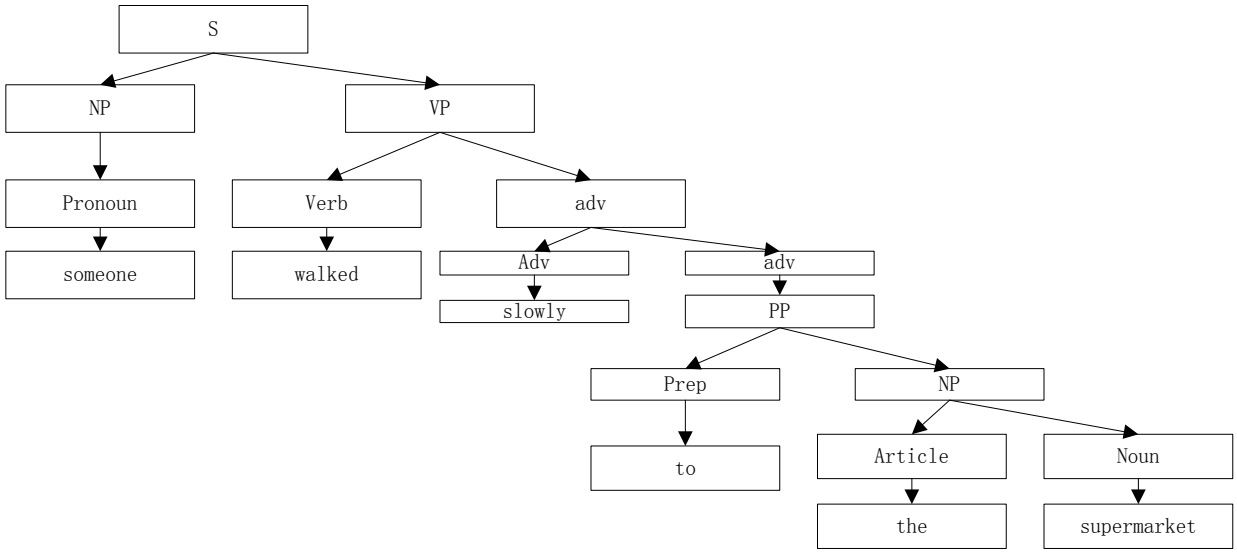
If the string is composed by exactly 10 words, I will calculate the probability of it and add to the probability of answer.

8.

(B) and (C) can generate the given sentence. The corresponding parse trees are shown below.



(B) Corresponding Parse Tree



(C) Corresponding Parse Tree

Pronoun→someone
Verb→goes, stays, fly, walked
Adv→ very, early, quietly ,slowly
Noun→student, classroom, baby, bed, birds, tree, supermarket
Prep → in, to, on, from, with

Article → the

(A)Three sentences of English
The student goes to the classroom very early.
The baby stays in the bed very quietly.
The birds fly to the tree.

Three sentences of non-English
The student stays to the tree very early.
The baby fly to the classroom quietly early very.
The birds goes in the bed to the student.

(B) Three sentences of English
Someone goes to bed very early.
The student walked from the classroom to the supermarket quietly.
The birds fly to the supermarket early.

Three sentences of non-English
The birds goes to the bed to the supermarket.
The student goes quietly early slowly.
Someone stays quietly in supermarket slowly.

(C) Three sentences of English
Someone walked to the classroom early with the baby.
The birds stays on the tree quietly.
The student goes to bed quietly.

Three sentences of non-English
The someone walked to the supermarket slowly.
The baby fly to the classroom in the supermarket.
The student goes to the someone.

Suggest ways to improve each grammar to avoid generating the non-English sentences:
1. Pay attention to the idiomatic usage.
2. Be careful about the third person singular form of the verb.
3. It's seldom that there are two prepositional phrase except for 'from' and 'to'.
4. The pronoun don't need the article.
5.Only some degree adverbials can qualify other adverbials.

Here is the way I suggest:
S → NP VP
NP → Article normal_Noun
NP → Proper_Noun
NP → Pronoun

VP → VP1 adv
VP1 → Intransitive_Verb
VP1 → Intransitive_Verb PP
VP1 → Transitive_Verb NP
Adv → degree_Adv Adv
PP → Prep NP