CS-5340/6340, Written Assignment #2
DUE: Thursday, September 19, 2019 by 11:59pm
Submit your assignment on CANVAS in pdf format
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1. (20 pts) For each sentence below, indicate whether the main verb appears in an intransitive construction, a transitive construction, or a ditransitive construction. Only give the answer transitive if the usage is not ditransitive
.

(a) She solved the puzzle in two minutes.
Answer: transitive construction.

(b) Tom has read ten books by Stephen King.
Answer: ditransitive construction.

(c) Lee cooked Mary a steak for her birthday.
Answer: ditransitive construction.

(d) The boy dreamt about summer camp.
Answer: ditransitive construction

(e) The rabbit hopped up the stairs to its favorite room.
Answer: intransitive construction

(f) Jim sneezes often during allergy season.
Answer: intransitive construction.

(g) Susan lent her brother some money for his tuition.
Answer: ditransitive construction.

(h) Pat learned to ski by trial and error.
Answer: intransitive construction.

(i) A bird flew into the building.
Answer: intransitive construction.

(j) The reporter investigated the story thoroughly and carefully.
Answer: transitive construction.

2. (40 pts) Use the following tables of probabilities to answer this question. Note that these numbers are completely fictional and not necessarily realistic!

a) P(California=NOUN)

Answer: P(California | NOUN) * P(NOUN | *phi*)
= 0.04 * 0.75
= 0.03

b) P(California=VERB)

Answer: P(California | VERB) * P(VERB | *phi*)
= 0.008 * 0.25
= 0.002

c) P(seals= NOUN)

Answer : P(seals| NOUN) * max(P(NOUN | NOUN) * Score(NOUN, California) , P(NOUN | VERB) * Score(VERB, California))
= 0.05 * max(0.30 * 0.03 , 0.55 * 0.002)
= 0.05 * max(0.009, 0.0011)
= 0.05 * 0.009
= 4.5E-4

d) P(seals = VERB)

Answer: P(seals | VERB) * max(P(VERB | NOUN) * Score(NOUN, California) , P(VERB | VERB) * Score(VERB, California))
= 0.02 * max(0.015, 0.0007)
= 0.02 * 0.015
= 0.0003

Using the same network, compute the forward probabilities α word (tag) indicated below. You should assume that w0 = φ, w1 = California, w2 = seals, w3 = report, and w4 = Ω. Show all your work!

e) αw1(NOUN)

Answer: P(California | NOUN) * P(NOUN | *phi)*
= 0.04 * 0.75
= 0.03

f) αw1(VERB)

Answer: P(California | VERB) * P(VERB | *phi*)
= 0.008 * 0.25
= 0.002

g) αw2(NOUN)

Answer: αw1(N) * P(N | N) * P(seals | N) + αw1(V) * P(N | V) * P(seals | N)
= 0.03 * 0.30 * 0.05 + 0.002 * 0.55 * 0.05
= 5.05E-4

h) αw2(VERB)

Answer: αw1(N) * P(V | N) * P(seals | V) + αw1(V) * P(V | V) * P(seals | V)
= 0.03 * 0.50 * 0.02 + 0.002 * 0.35 * 0.02
= 3.55E-4

Using the previous forward probabilities, normalize them to estimate O(oi/tk | o0...oi) for the following cases. Show all your work!

i) P(w2/NOUN | w0...w2)

Answer : αw2(NOUN) / αw2(NOUN) + αw2(VERB)
= 5.05E-4 / (5.05E-4 + 3.55E-4)
= 0.5872

j) P(w2/VERB | w0...w2)

Answer: αw2(VERB) / αw2(NOUN) + αw2(VERB)
= 3.55E-4 / (5.05E-4 + 3.55E-4)
= 0.4128

Using the same network, compute the backward probabilities α word (tag) indicated below. You should assume that w0 = φ, w1 = California, w2 = seals, w3 = report, and w4 = Ω. Show all your work!

k) β w3(NOUN)
Answer: P(report | N) * P(Ω | N)
= 0.07 * 0.20
= 0.014

l) β w3(VERB)
Answer: P(report | V) * P(Ω | V)
= 0.06 * 0.10
= 0.006

m) β w2(NOUN)
Answer: β w3(N) * P(N | N) * P(seals | N) + β w3(V) * P(N | V) * P(seals | N)
= 0.014 * 0.30 * 0.05 + 0.006 * 0.55 * 0.05
= 3.75E-4

n) β w2(VERB)
Answer: β w3(N) * P(V | N) * P(seals | V) + β w3(V) * P(V | V) * P(seals | V)
= 0.014 * 0.50 * 0.02 + 0.006 * 0.35 * 0.02
= 1.82E-4

Using the previous forward probabilities, normalize them to estimate O(oi/tk | o0...oi) for the following cases. Show all your work!

o) P(w2/NOUN | w2...w4)
Answer: β w2(NOUN) / β w2(NOUN) + β w2(VERB)
= 3.75E-4 / (3.75E-4 + 1.82E-4)
= 0.6732

p) P(w2/VERB | w2...w4)
Answer: β w2(VERB) / β w2(NOUN) + β w2(VERB)
= 1.82E-4 / (3.75E-4 + 1.82E-4)
= 0.3267

Using the previous forward and backward probabilities, normalize them together to estimate P(oi/tk | o0...oi) for the following cases. Show all your work!

q) P(w2/NOUN | w0...w4)

Answer: (αw2(NOUN) * β w2(NOUN)) / (αw2(NOUN) * β w2(NOUN)) + (αw2(VERB) * β w2(VERB))
= (5.05E-4 * 3.75E-4) / (5.05E-4 * 3.75E-4) + (3.55E-4 * 1.82E-4)
= 1.0000

r) P(w2/VERB | w0...w4)

Answer: (αw2(VERB) * β w2(VERB)) / (αw2(NOUN) * β w2(NOUN)) + (αw2(VERB) * β w2(VERB))
= (3.55E-4 * 1.82E-4) / (5.05E-4 * 3.75E-4) + (3.55E-4 * 1.82E-4)
= 1.0000

3) Consider the following four Verb Phrase (VP) grammars:

Answers:

a) adv = NONE
b) verb = G1
c) verb verb = NONE
d) adv verb adv = G1, G2, G3
e) adv adv adv verb = G1, G2
f) verb adv adv adv = G1, G3, G4
g) adv adv verb adv verb: NONE
h) adv adv verb adv adv adv = G1, G2, G3, G4

4.
a)

Grammar Rules without frequency:
Parse tree A
S -> NP VP

NP -> noun
VP -> verb NP1 NP2 PP
NP1 -> noun
NP2 -> art noun
PP -> prev NP3
NP3 -> noun

Parse tree B
S -> NP VP
NP -> noun
VP -> verb NP1 NP2
NP1 -> noun
NP2 -> art noun PP
PP -> prep NP3
NP3 -> noun

Parse tree C
S -> NP VP
NP -> noun
VP -> verb NP1 PP
NP1 -> art noun
PP -> prep NP2
NP2 -> noun

Parse tree D
S -> NP VP
NP -> noun
VP -> verb NP1 PP
NP1 -> art noun
PP -> prep NP2
NP2 -> noun

Grammar Rules	**Total Frequency**
S -> NP VP	- 4 times
NP -> noun	- 4 times
VP -> verb NP1 NP2 PP	- 1 time
NP1 -> noun	- 2 times
NP2 -> art noun	- 1 time
PP -> prep NP3	- 2 times

NP3 -> noun	- 2 times
VP -> verb NP1 NP2	- 1 time
NP2 -> art noun PP	- 1 time
VP -> verb NP1 PP	- 2 times
NP1 -> art noun	- 2 times
PP -> prep NP2	- 2 times
NP2 -> noun	- 2 times

b)

Answer:

i. John bought a car with cash **on Friday,**
Answer : VP

ii. John bought a car with cash **with his brother**
Answer: NP3

iii. John bought a car with cash **from his savings account**
Answer: NP3

iv. John bought a car with cash **with excitement**
Answer: NP1