Q1:

1. a sandwich pickled every pickle in every pickle .
2. every perplexed perplexed chief of staff under every chief of staff on every sandwich with the delicious floor in every pickle with a delicious sandwich pickled a sandwich with every chief of staff under every pickle under the sandwich on a sandwich under a president under every pickle with every floor on every president with a sandwich on a sandwich on the delicious fine president with every perplexed pickled floor .
3. a chief of staff understood the delicious sandwich with every floor !
4. the pickle ate every fine pickle !
5. is it true that every floor pickled a pickle with every chief of staff ?
6. is it true that a chief of staff pickled a pickle on a floor on a president in every fine sandwich with a perplexed floor on every president with every delicious chief of staff with a sandwich with the president on a sandwich on every floor under every sandwich with a chief of staff on a chief of staff on every president under the floor on the floor in the pickle on the sandwich with a floor under the sandwich in a floor on every chief of staff in a president under a chief of staff in a sandwich in the floor on every sandwich in every chief of staff with every president in a pickle on the floor in a floor under the pickle in the sandwich under a chief of staff with every sandwich with the chief of staff with a pickle on every delicious president with a president under every president under the sandwich under the president with the sandwich in a pickle in the floor with every floor on the floor in the floor on every sandwich with the chief of staff under every president in the floor with a floor in every sandwich with every delicious sandwich under the president with every pickle on a president on the president under every president under every president under every fine pickle in every pickled pickle on a delicious chief of staff in the floor under every fine sandwich with the sandwich with the pickle in every pickle on the perplexed floor under a chief of staff with a chief of staff with the chief of staff with a pickle with a president with the pickle on a chief of staff under the chief of staff with the president under the sandwich in the sandwich ?
7. a sandwich under a sandwich under a president under the president with a fine floor under every chief of staff on a chief of staff kissed the pickle !
8. is it true that every floor ate a president ?
9. is it true that the pickle in the president in a president in the sandwich under the floor on every floor under the sandwich under a pickle on a president in every chief of staff with a president under the sandwich in the perplexed floor with every floor on the chief of staff in a president with the president in a floor on the sandwich on every pickle in a floor under a sandwich in the pickle with every president under every pickle with the sandwich with a chief of staff with the pickle with the floor in the sandwich in the chief of staff with the president on the sandwich under the president under a floor under every pickle under a chief of staff on a chief of staff in the pickle with every pickle under every pickle with every fine president with a chief of staff under every pickle in the floor on a pickle on a president in the pickle with every pickle in a pickle under every sandwich under every pickle under every floor with a sandwich on the fine president under the pickle under every sandwich in every chief of staff in a pickled chief of staff in the sandwich in every sandwich in a floor in the chief of staff on every floor with every floor on a chief of staff in a floor on a chief of staff in every pickle with a perplexed president with every sandwich under the fine perplexed chief of staff on the delicious sandwich in every sandwich on the chief of staff in every floor with a floor under every delicious pickle under the pickle under the chief of staff under the chief of staff on a president in a delicious pickle pickled every delicious president ?
10. is it true that every floor with every pickle ate every floor under a president ?

Q2:

1. Cause there is a loop in the grammar given and there Is a large chance to get into the loop again and again. As a result, the program generated long sentences.

The responsible grammars are:

1 NP NP PP

1 PP Prep NP

1 Noun Adj Noun

All these grammars have self-loops or loop with others. eg. NP may generate PP and PP may generate NP, this is a loop

1. Because of the probability to generate multiple adjectives is low. For example, we have a Noun. Then the probability to generate 1 adjective is 1/6, the probability of generating 2 adjectives are 1/(6 \* 6) = 1/36 …..therefore there is small chance to generate multiple adjectives.
2. See the program
3. By increase the weight of

1 Noun Adj Noun to 10 Noun Adj Noun

and decrease the weight of

1 NP NP PP to 0.1 NP NP PP

1 PP Prep NP to 0,1 PP Prep NP

The result becomes much shorter with more like:

the fine floor understood every sandwich .

a pickled floor wanted every delicious delicious pickle !

the perplexed pickle on the delicious fine pickled delicious delicious delicious fine perplexed pickle understood the fine fine chief of staff .

the floor understood a fine president !

a fine perplexed chief of staff wanted the pickled sandwich under the perplexed fine chief of staff .

every fine perplexed president kissed the delicious perplexed fine chief of staff !

every pickled pickled fine floor kissed every perplexed perplexed perplexed chief of staff !

every floor kissed the president !

a fine delicious pickled fine sandwich kissed the fine delicious floor .

every fine fine fine chief of staff wanted every sandwich .

e)See grammar2.gr

f)See the program

Q3. See grammar3.gr

Q4.

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(Noun (Adj delicious)

(Noun president)))))

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(NP (NP (NP (Det the)

(Noun floor))

(Conj or)

(NP (NP (Det the)

(Noun chief

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(Noun sandwich))

(PP (Prep with)

(NP (Det the)

(Noun floor))))))))

(VP (Vi sighed)

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(Noun (Adj delicious)

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(Adj pickled))

(Noun pickle))))))))

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(NP (Pnoun Sally))))

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(Noun pickle))

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(Noun sandwich))

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(Noun sandwich))

(Conj and)

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(Noun floor)))

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(Noun pickle))

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(Noun sandwich))

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(Noun sandwich))

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(NP (Det the)

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(Noun sandwich))

(Conj or)

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(Vi worked)))))

(VP (Vi sighed)))

Q5.

Q6.

6(a).No, the parser does not always recover the original derivation. Instead, it sometimes finds an alternative derivation. This is because the same sentence can be generated by different grammars, and parser will only find one of them, which is why alternative derivation appear.

13.6(b)There is only one way to derive the string. Since there is a ‘with’, NP -> NP PP is necessary here. And since ‘every’ is one part of the determiner， NP -> Det Noun must be used for the first NP above. And because of ‘a’ in the next place, NP -> Det Noun must be be used here. …… After all these analysis, I find out there is only one way to generate that noun phrase. It is mainly because of the restriction of determiner and preposition. There is only 1 rule to generate determiner and 1 rule to generate preposition. Therefore , there is only one way.

6(c).Yes, I find out that sentences with many noun phrase have more parse than other sentence. It is because that noun phrase can be generated by many different rules, which makes it have more parse than others.

6(d).i.(1)

All used grammar rules are below:

1 ROOT S . 1/3

1 S NP VP 1/1

1 NP Det Noun 1/2

1 Det the 1/3

1 Noun president 1/5

1 VP Verb NP 1/1

1 Verb ate 1/5

1 NP Det Noun 1/2

1 Det the 1/3

1 Noun sandwich 1/5

The last part of each line is the probability to use this line of grammar. The p(sentence) is the product of all the grammars above, which is 5.144032922e-05.

6(d).i.(2)It is because that there is only one way to generate this sentence. The best parse is the only parse. They both use grammar rules below.

1 ROOT S . 1/3

1 S NP VP 1/1

1 NP Det Noun 1/2

1 Det the 1/3

1 Noun president 1/5

1 VP Verb NP 1/1

1 Verb ate 1/5

1 NP Det Noun 1/2

1 Det the 1/3

1 Noun sandwich 1/5

Since they share the same grammar rules, the probability must be the same.

6(d).i.(3)It is because that there is only one way to generate this sentence. The best parse is the only parse. Therefore the probability that use this best parse to generate this sentence is 1.

6(d).ii.

The 0.5 means that there are two ways to generate this sentence. The best parse is one of the two ways.

6(d).iii.

6(d).iv.

The perplexity is equal to the E power of 2, in which E is the cross entropy. Therefore the perplexity is 22.435185067 = 5.40833706189742

6(d).v.

It is because that compress the corpus into the smallest size is only ideal. It is based the compress every information into exact several bits. However, the fact is that it is nearly impossible to compress terminal word into exact several bits. Therefore the ideal compress does not exist.

6(e)

For grammar2, after I use the command below:

./randsent grammar2.gr 10 |./parse -P -g grammar2.gr | ./prettyprint

It turns out that entropy is 1.796371671 bits

(# cross-entropy = 1.796371671 bits = -(-194.0081405 log-prob. / 108 words))

For grammar3, after I use the command below:

./randsent grammar3.gr 10 |./parse -P -g grammar3.gr | ./prettyprint

It turns out that entropy is 2.462806611 bits

(# cross-entropy = 2.462806611 bits = -(-918.626866 log-prob. / 373 words))

So the entropy of grammar3 is bigger than the entropy of grammar2

It is because that grammar 3 can present more sentences than grammar2, so its entropy in bigger.

For grammar, after I use the command below:

./randsent grammar.gr 10 |./parse -P -g grammar.gr | ./prettyprint

It turns out that entropy is 1.986691222 bits

(# cross-entropy = 1.986691222 bits = -(-480.7792757 log-prob. / 242 words))

It proves that grammar 3 can present more sentences than grammar 1,and grammar 1 can present more sentences than grammar2.

6(f)

If I use grammar3 to predict grammar2, after I use the command below:

./randsent grammar2.gr 10 |./parse -P -g grammar3.gr | ./prettyprint

It turns out that entropy is 2.607252847 bits

(# cross-entropy = 2.607252847 bits = -(-237.2600091 log-prob. / 91 words))

Since the entropy of grammar2 is 1.796371671 , which is smaller than cross entropy. It proves that entropy is lower than cross entropy, which means that the same grammar predict better than different grammar.