

NLP Homework 4– Itay Itzhak, 305685877, Eytan Chamovitz, 203486550

Question 1

(a)

Let's take a look at the basic grammar rules:

```
# The basic grammar rules. Here's what the abbreviations stand for:
# S = sentence
# NP = noun phrase
# VP = verb phrase
# PP = prepositional phrase
# Det = determiner (sometimes called "article")
# Prep = preposition
# Adj = adjective

1 S NP VP
1 VP Verb NP
1 NP Det Noun
1 NP NP PP
1 PP Prep NP
1 Noun Adj Noun
```

The fourth rule $NP \rightarrow NP PP$ is very powerful one and he's the one causing those long sentences.

NP is an influential nonterminal since it appears in the left side of 2 basic rules and on the right side of 5 basic rules. Meaning once there is NP in the sentence the sentence is likely to become longer.

The fourth rule $NP \rightarrow NP PP$ creates a NP and a PP . As we said NP has chance of making the sentence longer, but furthermore if we look at basic rule five we'll see that PP itself create another NP ! So if the forth rule is activated it creates immediately 2 NP 's.

(b)

There's one rule that adds adjectives to nouns $Noun \rightarrow Adj Noun$ but there are 5 more rules that turns $Noun \rightarrow nonterminal$ with the same weight 1. So whenever a $Noun$ appears in the sentence it's 5 times more likely to become a terminal than to an adjective and a noun.

(c)

The rules we changed are marked in red:

```
1 S NP VP
1 VP Verb NP
1 NP Det Noun
0.1 NP NP PP
1 PP Prep NP
2 Noun Adj Noun
```

These changes stem directly from our explanation in (a) and (b). The rule $NP \rightarrow NP PP$ created very longs sentences so we lowered it's weight substantially and the in order to create more adjectives we raised the weight of the rule $Noun \rightarrow Adj Noun$ to make adjectives more likely. We fined tuned these particular values through trial and error on the grammar generator.

Question 2

- (a) in code
- (b) In code

Question 3

- (a) Grammar in zip
- (b) Grammar in zip
- (c) Test Results:

Run on Grammar3-CNF:

the chief of staff ate a sandwich .

```
(ROOT (S (NP (Det the) (Noun (Chief chief) (OfStaff (Of of) (Staff staff)))) (VP (VerbT ate) (NP (Det a) (Noun sandwich)))) (End .))
```

```
(ROOT (S (NP (Det the) (Noun (Chief chief) (OfStaff (Of of) (Staff staff)))) (VP (VerbT ate) (NP (Det a) (Noun sandwich)))) (End .))
```

Sally and the president wanted and ate a sandwich .

```
(ROOT (S (Name (Name Sally) (CC.NP (CC and) (NP (Det the) (Noun president)))) (VP (VerbT (VerbT wanted) (CC.VerbT (CC and) (VerbT ate))) (NP (Det a) (Noun sandwich)))) (End .))
```

```
(ROOT (S (Name (Name Sally) (CC.NP (CC and) (NP (Det the) (Noun president)))) (VP (VerbT (VerbT wanted) (CC.VerbT (CC and) (VerbT ate))) (NP (Det a) (Noun sandwich)))) (End .))
```

the president sighed .

```
(ROOT (S (NP (Det the) (Noun president)) (VerbI sighed)) (End .))
```

```
(ROOT (S (NP (Det the) (Noun president)) (VerbI sighed)) (End .))
```

the president thought that a sandwich sighed .

```
(ROOT (S (NP (Det the) (Noun president)) (VP (Verb5 thought) (SBAR (Comp that) (S (NP (Det a) (Noun sandwich)) (VerbI sighed)))))) (End .))
```

```
(ROOT (S (NP (Det the) (Noun president)) (VP (Verb5 thought) (SBAR (Comp that) (S (NP (Det a) (Noun sandwich)) (VerbI sighed)))))) (End .))
```

it perplexed the president that a sandwich ate Sally .

```
(ROOT (S (It it) (VP (Verb6 perplexed) (NP.SBAR (NP (Det the) (Noun president)) (SBAR (Comp that) (S (NP (Det a) (Noun sandwich)) (VP (VerbT ate) (Name Sally))))))) (End .))
```

```
(ROOT (S (It it) (VP (Verb6 perplexed) (NP.SBAR (NP (Det the) (Noun president)) (SBAR (Comp that) (S (NP (Det a) (Noun sandwich)) (VP (VerbT ate) (Name Sally))))))) (End .))
```

the very very very perplexed president ate a sandwich .

```
(ROOT (S (NP (Det the) (Noun (Quan very) (Adj.Noun (Quan very) (Adj.Noun (Quan very) (Adj.Noun (Adj perplexed) (Noun president)))))) (VP (VerbT ate) (NP (Det a) (Noun sandwich)))) (End .))
```

```
(ROOT (S (NP (Det the) (Noun (Quan very) (Adj.Noun (Quan very) (Adj.Noun (Quan very) (Adj.Noun (Adj perplexed) (Noun president)))))) (VP (VerbT ate) (NP (Det a) (Noun sandwich)))) (End .))
```

the president worked on every proposal on the desk .

```
(ROOT (S (NP (Det the) (Noun president)) (VP (VerbT worked) (NP (Prep on) (NP (Det every) (Noun (Noun proposal) (PP (Prep on) (NP (Det the) (Noun desk)))))))) (End .)))
```

```
(ROOT (S (NP (Det the) (Noun president)) (VP (VerbT worked) (NP (Prep on) (NP (Det every) (Noun (Noun proposal) (PP (Prep on) (NP (Det the) (Noun desk)))))))) (End .)))
```

Sally is lazy .

```
(ROOT (S (Name Sally) (VP (Is is) (Adj lazy))) (End .))
```

```
(ROOT (S (Name Sally) (VP (Is is) (Adj lazy))) (End .))
```

Sally is eating a sandwich .

```
(ROOT (S (Name Sally) (VP (VbTing (Is is) (VerbTing eating)) (NP (Det a) (Noun sandwich)))) (End .))
```

```
(ROOT (S (Name Sally) (VP (VbTing (Is is) (VerbTing eating)) (NP (Det a) (Noun sandwich)))) (End .))
```

the president thought that Sally is a sandwich .

```
(ROOT (S (NP (Det the) (Noun president)) (VP (Verb5 thought) (SBAR (Comp that) (S (Name Sally) (VP (VerbT is) (NP (Det a) (Noun sandwich)))))) (End .)))
```

```
(ROOT (S (NP (Det the) (Noun president)) (VP (Verb5 thought) (SBAR (Comp that) (S (Name Sally) (VP (VerbT is) (NP (Det a) (Noun sandwich)))))) (End .)))
```

the pickle kissed the president that ate the sandwich .

```
(ROOT (S (NP (Det the) (Noun pickle)) (VP (VerbT kissed) (NP (NP (Det the) (Noun president)) (Comp.SV (Comp that) (SV (VerbT ate) (NP (Det the) (Noun sandwich)))))) (End .)))
```

```
(ROOT (S (NP (Det the) (Noun pickle)) (VP (VerbT kissed) (NP (NP (Det the) (Noun president)) (Comp.SV (Comp that) (SV (VerbT ate) (NP (Det the) (Noun sandwich)))))) (End .)))
```

the pickle kissed the sandwich that the president ate .

```
(ROOT (S (NP (Det the) (Noun pickle)) (VP (VerbT kissed) (NP (Det the) (Noun (Noun sandwich) (PP (Comp that) (S (NP (Det the) (Noun president)) (VerbI ate)))))) (End .)))
```

```
(ROOT (S (NP (Det the) (Noun pickle)) (VP (VerbT kissed) (NP (Det the) (Noun (Noun sandwich) (PP (Comp that) (S (NP (Det the) (Noun president)) (VerbI ate)))))) (End .)))
```

the pickle kissed the sandwich that the president thought that Sally ate .

```
(ROOT (S (NP (Det the) (Noun pickle)) (VP (VerbT kissed) (NP (Det the) (Noun (Noun sandwich) (PP (Comp that) (S (NP (Det the) (Noun president)) (VP (Verb5 thought) (SBAR (Comp that) (S (Name Sally) (VerbI ate)))))) (End .)))
```

```
(ROOT (S (NP (Det the) (Noun pickle)) (VP (VerbT kissed) (NP (Det the) (Noun (Noun sandwich) (PP (Comp that) (S (NP (Det the) (Noun president)) (VP (Verb5 thought) (SBAR (Comp that) (S (Name Sally) (VerbI ate)))))) (End .)))
```

the citizens choose the president .

```
(ROOT (S (NPPP (PlurDet the) (PlurNoun citizens)) (VPPP (VerbTPP choose) (NP (Det the) (Noun president))) (End .))
```

```
(ROOT (S (NPPP (PlurDet the) (PlurNoun citizens)) (VPPP (VerbTPP choose) (NP (Det the) (Noun president))) (End .))
```

the president chooses the chief of staff .

```
(ROOT (S (NPPS (SingDet the) (SingNoun president)) (VPPS (VerbTPS chooses) (NP (Det the) (Noun (Chief chief) (OfStaff (Of of) (Staff staff)))))) (End .))
```

```
(ROOT (S (NPPS (SingDet the) (SingNoun president)) (VPPS (VerbTPS chooses) (NP (Det the) (Noun (Chief chief) (OfStaff (Of of) (Staff staff)))))) (End .))
```

the president chooses the desk .

```
(ROOT (S (NPPS (SingDet the) (SingNoun president)) (VPPS (VerbTPS chooses) (NP (Det the) (Noun desk)))) (End .))
```

```
(ROOT (S (NPPS (SingDet the) (SingNoun president)) (VPPS (VerbTPS chooses) (NP (Det the) (Noun desk)))) (End .))
```

the president and the chief of staff choose the sandwich .

```
(ROOT (S (NPPP (NP (Det the) (Noun president)) (CC.NP (CC and) (NP (Det the) (Noun (Chief chief) (OfStaff (Of of) (Staff staff)))))) (VPPP (VerbTPP choose) (NP (Det the) (Noun sandwich)))) (End .))
```

```
(ROOT (S (NPPP (NP (Det the) (Noun president)) (CC.NP (CC and) (NP (Det the) (Noun (Chief chief) (OfStaff (Of of) (Staff staff)))))) (VPPP (VerbTPP choose) (NP (Det the) (Noun sandwich)))) (End .))
```