Homework 2

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Question 1. Chomsky Normal Form (CNF)

Answer a): The converted grammar is:

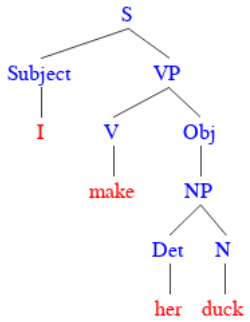
$S \rightarrow NP\ VP$
$S \rightarrow I\_VP\ PP$. We make the rule binary
$I\_VP \rightarrow I\ VP$
$I \rightarrow i$. When we make terminal symbols we do not make non-terminal symbols
$NP \rightarrow Det\ N$
$VP \rightarrow V\ NP$. We use the fact that $V \rightarrow ate$ instead of creating a new rule which does exactly the same
$VP \rightarrow ate$. We eliminate unit rules
$PP \rightarrow Pre\ NP$
$V \rightarrow ate$
$Det \rightarrow the \mid a$
$N \rightarrow fork \mid salad$
$Pre \rightarrow with$

Question 2. PCFGs and the CYK algorithm

Answer a): For any given parse, we compute the probability of that parse by; $p(rule) * p(element\,of\,rule) * p(element\,of\,rule)$ Lets start with the cell marked B:
$VP \rightarrow V\,Obj\,Obj$, we get: 0.3*0.6*0.2*0.2=0.0072
$VP \rightarrow V\,Obj$, we get: 0.5*0.6*0.2=0.06
$VP \rightarrow V\,small$, we get: 0.2*0.6*0.08=0.0096
As we have three rules representing VP we select the one which has the highest probability as the representatitve, namely $VP \rightarrow V\,Obj$.

For the cell marked A we essentially get the probabilities of B times 0.3:
$S \rightarrow Subj\,VP$, we get: 1.0*0.3*0.06=0,018

Answer b): The most probable parse:



Question 3. Dependency parsing /MST

Answer a): CLE

I denote each node as the first letter in the corresponding word, $John = j$, $likes = l$, $plain = p$ and $bagles = b$ and for the root, $root = r$. A directed edge from i to j is denoted by (i, j). An edge with weight k is denoted by $w((i, j)) = k$.

After applying the first step of the algorithm we are left with the edges:
$E = \{(l, j), (p, l), (b, p), (l, b)\}$
And corresonding weights:
$w((l, j)) = 20$, $w((p, l)) = 20$, $w((b, p)) = 15$, $w((l, b)) = 30$
There is clearly three node a circle: $C = \{(p, l), (l, b), (b, p)\}$

Answer b): Final step

The final result is:
$E = \{(r, l), (l, j), (l, b), (b, p)\}$
And corresonding weights:
$w((r, l)) = 15$, $w((l, j)) = 20$, $w((l, b)) = 30$, $w((b, p)) = 15$
Total span is 80.

Question 4. Dependency parsing / Transistion based

Answer a): Arc-standard system

Table 1: Configurations

Transition	Stack	Buffer	Arcs
/	[root]	[A koala eats leafs and barks]	$\emptyset = A$
SHIFT	[root A]	[koala eats leafs and barks]	A
SHIFT	[root A koala]	[eats leafs and barks]	A
LEFT-ARC (det)	[root koala]	[eats leafs and barks]	$A \cup \{koala \rightarrow A\}$
SHIFT	[root koala eats]	[leafs and barks]	A
LEFT-ARC (nsubj)	[root eats]	[leafs and barks]	$A \cup \{eats \rightarrow koala\}$
SHIFT	[root eats leafs]	[and barks]	A
SHIFT	[root eats leafs and]	[barks]	A
RIGHT-ARC (cc)	[root eats leafs]	[barks]	$A \cup \{leafs \rightarrow and\}$
SHIFT	[root eats leafs barks]	[]	A
RIGHT-ARC (conj)	[root eats leafs]	[]	$A \cup \{leafs \rightarrow barks\}$
RIGHT-ARC (dobj)	[root eats]	[]	$A \cup \{eats \rightarrow leafs\}$
RIGHT-ARC (root)	[root]	[]	$A \cup \{root \rightarrow eats\}$