HW2 COMS W4705

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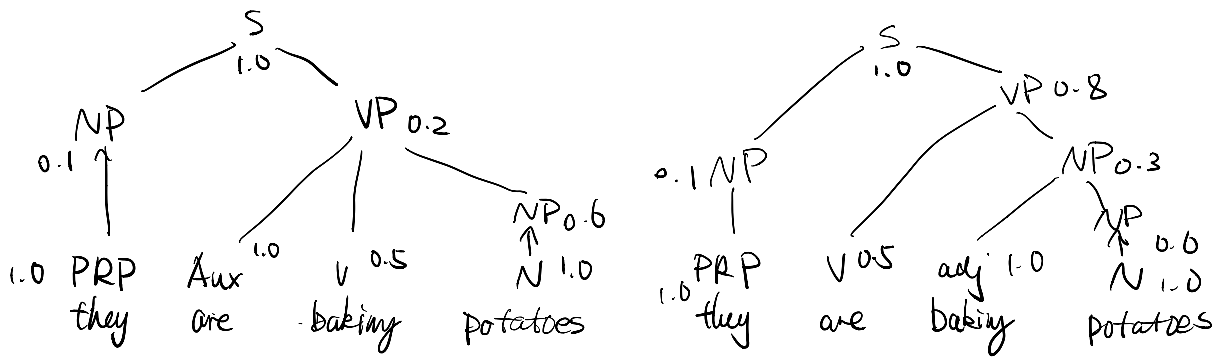
Problem 1.

a) $P(\text{tags}, \text{words}) = \left(\prod_{i=1}^{n} P(t_i \mid t_{i-1}) P(w_i \mid t_i)\right) \times P(\text{END} \mid t_n)$



PRP	Aux	V	N
~~PRP~~	~~Aux~~	~~adj~~	~~N~~
~~PRP~~	~~V~~	~~V~~	~~N~~
PRP	V	adj	N

$P(\text{PRP}, \text{Aux}, \text{V}, \text{N}, \text{they}, \text{are}, \text{baking}, \text{potatoes})$

$= 1.0 \times 0.1 \times 1.0 \times 0.2 \times 1.0 \times 0.5 \times 1.0 \times 0.6 =$

$= 0.02 \times 0.3 = 0.006$

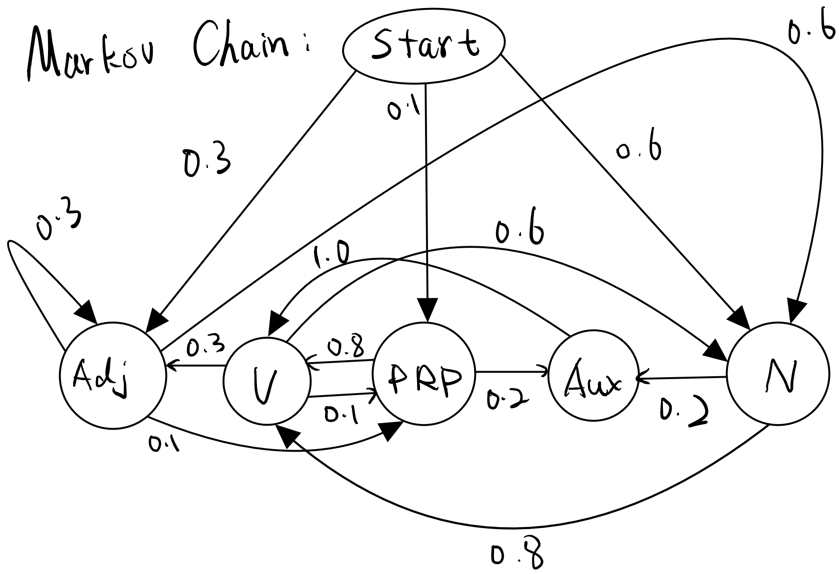
$P(\text{PRP}, \text{Aux}, \text{V}, \text{N}, \text{they}, \text{are}, \text{baking}, \text{potatoes})$

$= 1.0 \times 0.1 \times 1.0 \times 0.8 \times 0.5 \times 0.3 \times 1.0 \times 0.6 \times 1.0$

$= 0.04 \times 0.18$

$= 0.0072$

b) Markov Chain:



$$\begin{array}{ccccccccc} \text{Start} & \to & \text{PRP} & \to & \text{Aux} & \to & \text{V} & \to & \text{N} \\ & & \downarrow & & \downarrow & & \downarrow & & \downarrow \\ & & \text{they} & & \text{are} & & \text{baking} & & \text{potatoes} \end{array}$$

$P(PRP \mid start) = 1.0 \times 0.1$ $\quad P(they \mid PRP) = 1.0$

$P(Aux \mid PRP) = 0.2$ $\quad P(are \mid Aux) = 1.0$

$P(V \mid Aux) = 1.0$ $\quad P(baking \mid V) = 0.5$

$P(N \mid V) = 0.6$ $\quad P(potatoes \mid N) = 1.$

$1.0 \times 0.1 \times 1.0 \times 1.0 \times 0.2 \times 0.5 \times 0.6 \times 1.0$

$= 0.02 \times 0.3 = 0.006$

$$\begin{array}{ccccccccc} \text{Start} & \to & \text{PRP} & \to & \text{V} & \to & \text{Adj} & \to & \text{N} \\ & & \downarrow & & \downarrow & & \downarrow & & \downarrow \\ & & \text{they} & & \text{are} & & \text{baking} & & \text{potatoes} \end{array}$$

$P(PRP \mid start) = 1.0 \times 0.1$

$P(V \mid PRP) = 0.8$

$P(adj \mid V) = 0.3$

$P(N \mid adj) = 0.6$

$1.0 \times 0.1 \times 1.0 \times 0.8 \times 1.0 \times 0.3 \times 0.3 \times 0.6 \times 1.0$

$= 0.08 \times 0.09$

$= 0.0072$

c) It is not possible. PCFG can produe recursion when generatig tags. But, HMMs can not do recursion. So when PCFG generate a infite many tags, HMMs can not reproduce the process.

P2. a.

chart [0]

S → • NP VP [0,0] pred
NP → • Adj NP [0,0] pred
NP → • PRP [0,0] pred
NP → • N [0,0] pred
Adj → • baking [0,0] noth
PRP → • they [0,0] scan
N → • potatoes [0,0] noth

chart [1]

PRP → they • [0,1] comp
NP → PRP • [0,1] comp
S → NP • VP [1,1] pred
VP → • V NP [1,1] pred
VP → • Aux V NP [1,1] pred
V → • baking [1,1] noth
V → • are [1,1] scan
Aux → • are [1,1] scan

chart [2]

V → are • [1,2] comp
Aux → are • [1,2] comp
VP → V • NP [2,2] pred
VP → Aux • V NP [2,2] pred
NP → • Adj NP [2,2] pred
NP → • PRP [2,2] pred
NP → • N [2,2] pred
V → • baking [2,2] scan
V → • are [2,2] noth
Adj → • baking [2,2] scan
PRP → • they [2,2] noth
N → • potatoes [2,2] noth.

chart [3]

V → baking • [2,3] comp

Adj → baking • [2,3] comp

VP → Aux V • NP [3,3] pred

NP → Adj • NP [3,3] pred

NP → • Adj NP [3,3] pred

NP → • PRP [3,3] pred

NP → • N [3,3] pred

Adj → • baking [3,3] noth

PRP → • they [3,3] noth

N → • potatoes [3,3] scan

chart [4]

N → potatoes • [3,4] comp

NP → N • [3,4]

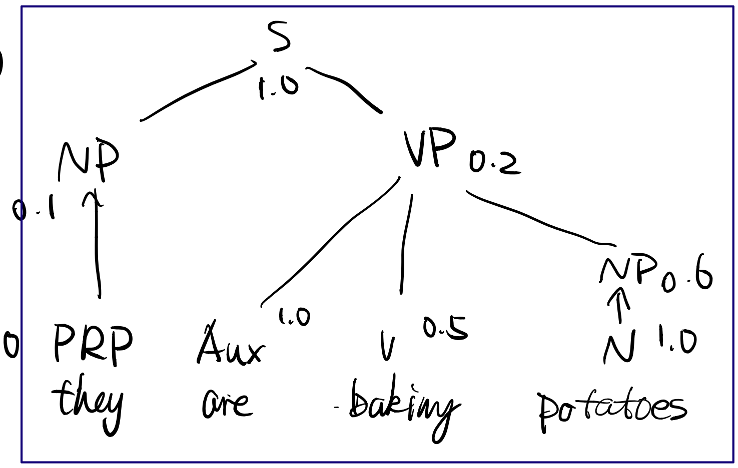
VP → Aux V NP • [1,4]

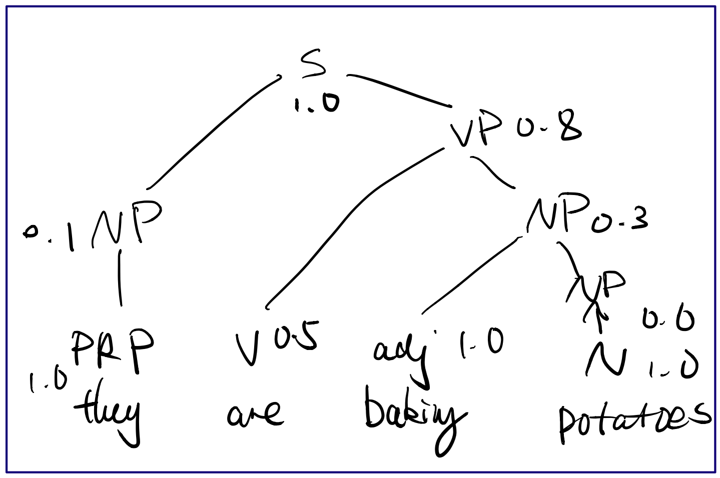
NP → Adj NP • [2,4]

VP → V NP • [1,4]

S → NP VP • [0,4]

b)





P (PRP , Aux , V , N , they , are , baking , potatoes)

= 1.0 × 0.1 × 1.0 × 0.2 × 1.0 × 0.5 × 1.0 × 0.6 =

= 0.02 × 0.3 = 0.006

P (PRP , Aux , V , N , they , are , baking , potatoes)

= 1.0 × 0.1 × 1.0 × 0.8 × 0.5 × 0.3 × 1.0 × 0.6 × 1.0

= 0.04 × 0.18

= 0.0072

P3. S → NP VP

NP → Adj NP

VP → V NP

b. 1) A → B . When B → b , then A → b.

2) A → B C D E . Creat X → B C and Y → D E . A → X Y.

VP → Aux B

B → V NP

Adj → baking

V → baking

V → are

Aux → are

NP → they

NP → potatoes

b)

		they	are	baking	potatoes 4
0		NP			S
1			Aux, V		VP, B
2				V, Adj	NP, VP, B
3					NP
4					

$NP_{[2,4]} \to Adj_{[2,2]}\ NP_{[3,4]}$

$VP_{[2,4]} \to V_{[2,2]}\ NP_{[3,4]}$

$B_{[2,4]} \to V_{[2,2]}\ NP_{[3,4]}$

$VP_{[1,4]} \to V_{[1,1]}\ NP_{[2,4]}$

$VP_{[1,4]} \to Aux_{[1,1]}\ VP_{[2,4]}$

$B_{[1,4]} \to V_{[1,1]}\ NP_{[2,4]}$

$S_{[0,4]} \to NP_{[0,1]}\ VP_{[1,4]}$

P4. I only write A down, when A gets changed

$(\sigma|\text{root}, \text{he}|\beta, \{\}_A) \xrightarrow{\text{shift}} (\sigma|\text{he}, \text{sent}|\beta, \{\}_A)$

$\xrightarrow{\text{L-Arc nsubj}} (\sigma|\text{root}, \text{sent}|\beta, \{(\text{sent}, \text{nsubj}, \text{he})\}) \xrightarrow{\text{shift}} (\sigma|\text{sent}, \text{her}|\beta, A)$

$\xrightarrow{\text{R-Arc jobj}} (\sigma|\text{root}, \text{sent}|\beta, \{(\text{sent}, \text{nsubj}, \text{he}), (\text{sent}, \text{jobj}, \text{her})\}) \xrightarrow{\text{shift}}$

$(\sigma|\text{sent}, \text{a}|\beta, A) \xrightarrow{\text{shift}} (\sigma|\text{a}, \text{funny}|\beta, A) \xrightarrow{\text{shift}}$

$(\sigma|\text{funny}, \text{meme}|\beta, A) \xrightarrow{\text{L-Arc amod}}$

$(\sigma, \text{meme}|\beta, \{(\text{sent}, \text{nsubj}, \text{he}), (\text{sent}, \text{jobj}, \text{her}), (\text{meme}, \text{amod}, \text{funny})\}) \xrightarrow{\text{L-Arc det}}$

$(\sigma|\text{sent}, \text{meme}|\beta, \{(\text{sent}, \text{nsubj}, \text{he}), (\text{sent}, \text{jobj}, \text{her}), (\text{meme}, \text{amod}, \text{funny}), (\text{meme}, \text{det}, \text{a})\}) \xrightarrow{\text{R-Arc dobj}}$

$(\sigma|\text{root}, \text{sent}|\beta, \{(\text{sent}, \text{nsubj}, \text{he}), (\text{sent}, \text{jobj}, \text{her}), (\text{meme}, \text{amod}, \text{funny}), (\text{meme}, \text{det}, \text{a}), (\text{sent}, \text{dobj}, \text{meme})\}) \xrightarrow{\text{shift}} (\sigma|\text{sent}, \text{today}|\beta, A) \xrightarrow{\text{R-Arc advmod}}$

$(\sigma | root, sent | \beta, \{(sent, nsubj, he), (sent, jobj, her), (meme, amod, funny), (meme, det, a),$
$(sent, dobj, meme), (sent, advmod, today)\}) \xrightarrow{\text{R-Arc pred}}$

$(\alpha, root | \beta, \{(sent, nsubj, he), (sent, jobj, her), (meme, amod, funny), (meme, det, a),$
$(sent, dobj, meme), (sent, advmod, today), (root, pred, sent)\})$

$\xrightarrow{\text{shift}} (root, [], A).$

So the final A is

$\{(sent, nsubj, he), (sent, jobj, her), (meme, amod, funny), (meme, det, a),$
$(sent, dobj, meme), (sent, advmod, today), (root, pred, sent)\}$

And transitions are :

(shift, left-Arc$_{nsubj}$, shift, Right-Arc$_{jobj}$, shift, shift, shift,
left-Arc$_{amod}$, left-Arc$_{det}$, Right-Arc$_{dobj}$, shift, Right-arc$_{advmod}$,
right-Arc$_{pred}$)