

24 Assignment 4

Sat

a4 q2: time (N) flies (V) like (P) an (D) arrow (N)
 time (N) flies (N) like (V) an (D) arrow (N)
 arrow (N) flies (V) like (P) time (N)
 flies (N) like (V) flies (N)
 an (D) arrow (N) like (V) flies (N)

(a) Conditional Probability Table for HMM model:

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q	counts for $\pi(q)$
D	1
N	4
P	0
V	0

\therefore Probability states =

q	$\pi(q)$
D	$1/5 = 0.2$
N	$4/5 = 0.8$
V	0
P	0

Counts of transactions :

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Counts for $a(p, q)$	D	N	P	V	Sum
D	0	3	0	0	3
N	0	1	0	5	6
P	1	1	0	0	2
V	1	2	2	0	5

\therefore Transition Probabilities =

$a(p, q)$	D	N	P	V
D	0	1	0	0
N	0	1/6	0	5/6
P	0.5	0.5	0	0
V	0.2	0.4	0.4	0

Generated Tables:

T_i	$P(T_i)$	T_{i-1}	T_i	$P(T_i T_{i-1})$
		D	N	1
N	0.8	N	N	$\frac{1}{6} \approx 0.166$
D	0.2	N	V	$\frac{5}{6} \approx 0.833$
		P	D	0.5
		P	N	0.5
		V	N	0.4
		V	P	0.4
		V	D	0.2

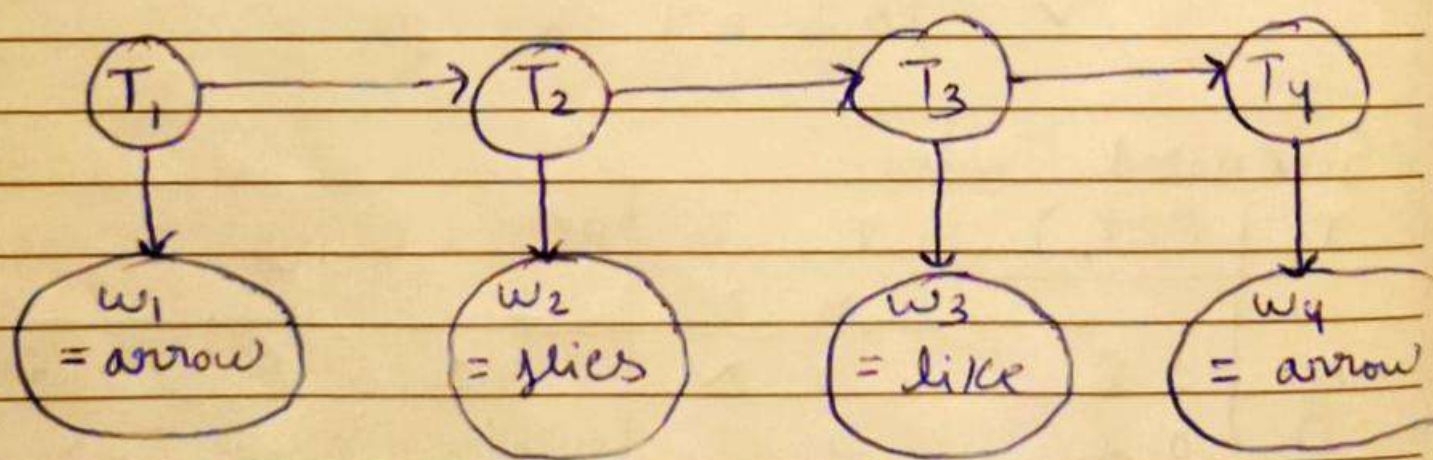
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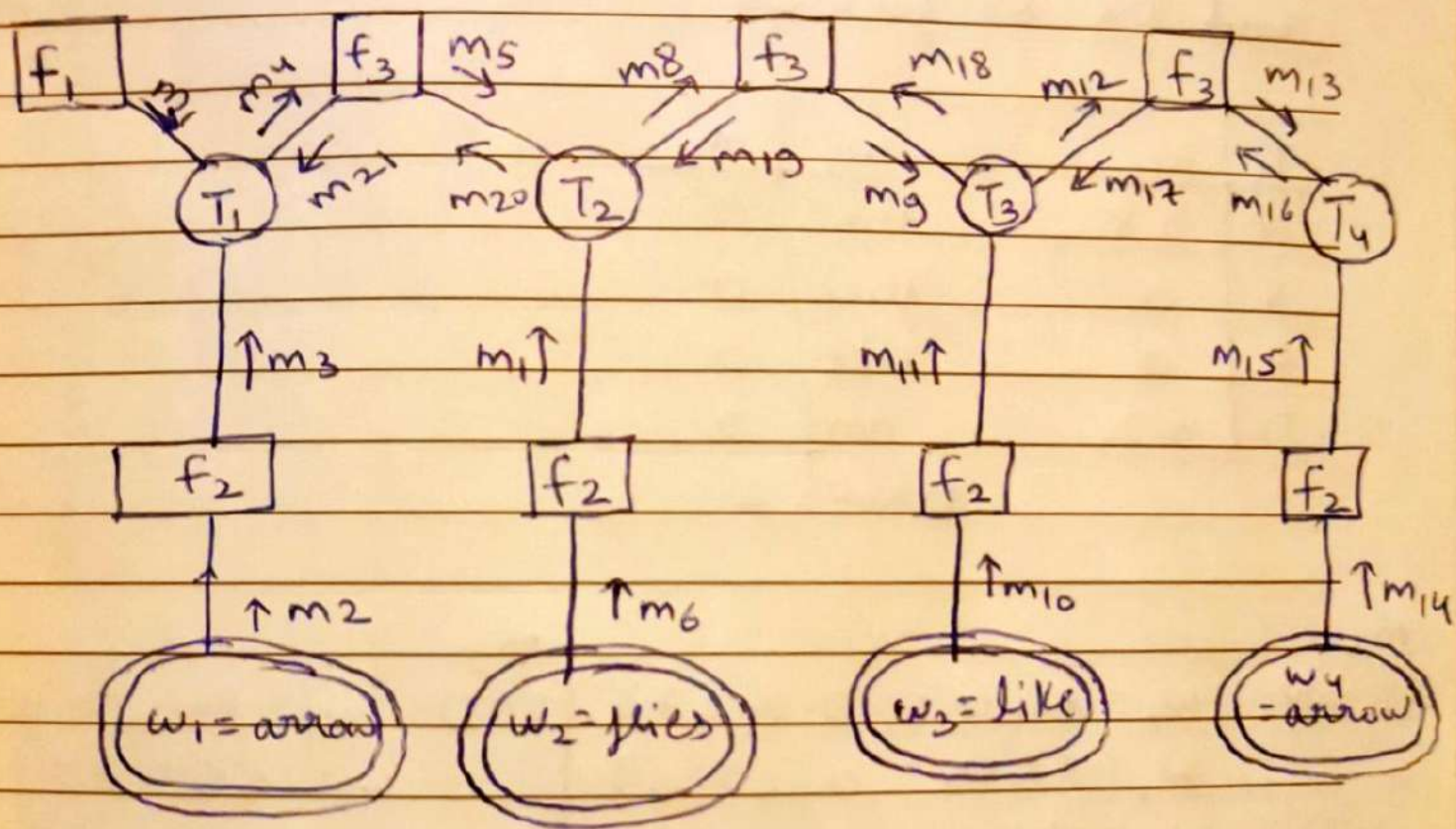
and, T_i w_i $P(w_i | T_i)$ \mathcal{D} an 1 N time $3/11 \approx 0.27$ N flies $4/11 \approx 0.36$ N arrow $4/11 \approx 0.36$ ~~no~~ P like 1 V like $3/5 = 0.6$ V flies $2/5 = 0.4$

6) Consider tagging the sentence,
 "arrow flies like arrow"

i.e. HMM =



Factor Graph for the tagged sentence Wed
is as follows:



c) Tables to calculate all the necessary messages and are as follows:

T_i	m_i	w_i	M_2
N	0.8	time	0
V	0	flies	0
P	0	like	0
D	0.2	am	0
		arrow	1

m_3		m_3	
$T_i = N$	$w_i = \text{time} = 0 \cdot (0.27)$	$T_i = D$	$w_i = \text{time} = 0 \cdot 0 = 0$
	$w_i = \text{flies} = 0 \cdot (0.36)$		$w_i = \text{flies} = 0 \cdot 0 = 0$
	$w_i = \text{like} = 0 \cdot 0$		$w_i = \text{like} = 0 \cdot 0 = 0$
	$w_i = \text{am} = 0 \cdot 0$		$w_i = \text{am} = 0 \cdot 1 = 0$
	$w_i = \text{arrow} = 1 \cdot (0.36)$		$w_i = \text{arrow} = 1 \cdot 0 = 0$
	$\text{max} = 0.36$		$\text{max} = 0$

m_3		m_3	
$T_i = V$	$w_i = \text{time} = 0 \cdot 0 = 0$	$T_i = P$	$w_i = \text{time} = 0 \cdot 0 = 0$
	$w_i = \text{flies} = 0 \cdot (0.4) = 0$		$w_i = \text{flies} = 0 \cdot 0 = 0$
	$w_i = \text{like} = 0 \cdot (0.6) = 0$		$w_i = \text{like} = 0 \cdot 1 = 0$
	$w_i = \text{am} = 0 \cdot 0 = 0$		$w_i = \text{am} = 0$
	$w_i = \text{arrow} = 1 \cdot 0 = 0$		$w_i = \text{arrow} = 0$
	$\text{max} = 0$		$\text{max} = 0$

T_1	m_3	T_1	$m_4 (m_1 \cdot m_3)$
N	0.36	N	$(0.8) \cdot (0.36) = 0.288$
V	0	V	$0 \cdot 0 = 0$
P	0	P	$0 \cdot 0 = 0$
D	0	D	$(0.2) \cdot 0 = 0$

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T_2	m_5
N	0.046
V	0.24
P	0
D	0

m_5		$(m_4 \cdot f_3)$		m_5		$(m_4 \cdot f_3)$	
$T_2 = N$	T_1	N	$(0.288) \cdot (0.16) = 0.046$	$T_2 = D$	T_1	N	$(0.288) \cdot 0 = 0$
	T_1	V	$0 \cdot (0.4) = 0$		T_1	V	$0 \cdot (0.2) = 0$
	T_1	P	$0 \cdot (0.5) = 0$		T_1	P	$0 \cdot (0.5) = 0$
	T_1	D	$0.1 = 0$		T_1	D	$0 \cdot 0 = 0$
			$\max = 0.046$				$\max = 0$

m_5	$(m_4 \cdot f_3)$		
$T_2 = V$	T_1	N	$(0.288) \cdot (0.83) = 0.24$
	T_1	V	0
	T_1	P	0
	T_1	D	0
	<u>max = 0.24</u>		

m_5	$(m_4 \cdot f_3)$		
$T_2 = P$	T_1	N	$(0.288) \cdot (0) = 0$
	T_1	V	$0 \cdot (0.4) = 0$
	T_1	P	0
	T_1	D	0
	<u>max = 0</u>		

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m_6	w_2	m_6
time	0	
flies	1	
like	0	
an	0	
arrow	0	

m_7	w_2	time	$0 \cdot (0.27) = 0$	m_7	w_2	time	$0 \cdot 0$
$T_2 = N$	w_2	flies	$1 \cdot (0.36) = 0.36$	$T_2 = D$	w_2	flies	$0 \cdot 1$
	w_2	like	0		w_2	like	$0 \cdot 0$
	w_2	an	0		w_2	an	$1 \cdot 0$
	w_2	arrow	0		w_2	arrow	$0 \cdot 0$
			$\max = 0.36$				$\max = 0$

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Sun

m_7	w_2	time	$0 \cdot 0 = 0$	m_7	w_2	time	$0 \cdot 0$
$T_2 = V$	w_2	flies	$1 \cdot (0.4) = 0.4$	$T_2 = P$	w_2	flies	$1 \cdot 0$
	w_2	like	$0 \cdot (0.6) = 0$		w_2	like	$0 \cdot 1$
	w_2	an	$0 \cdot 0 = 0$		w_2	an	$0 \cdot 0$
	w_2	arrow	$0 \cdot 0 = 0$		w_2	arrow	$0 \cdot 0$
			$\max = 0.4$				$\max = 0$

T_2	m_2	T_2	$m_8 (m_5 \cdot m_2)$
N	0.36	N	$(0.046) \cdot (0.36) \approx 0.0165$
V	0.4	V	$(0.24) \cdot (0.4) = 0.096$
P	0	P	$0 \cdot 0 = 0$
D	0	D	$0 \cdot 0 = 0$

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m_3	T_2	$m_8 \cdot f_3$
$T_3 = N$	N	$(0.0165) \cdot (0.16) \approx 0.0026$
	V	$(0.096) \cdot (0.4) = 0.0384$
	P	$0 \cdot (0.5) = 0$
	D	$0 \cdot 1 = 0$
$\max = 0.0384$		

m_3	T_2	$m_8 \cdot f_3$
$T_3 = D$	N	$(0.0165) \cdot 0 = 0$
	V	$(0.096) \cdot (0.2) = 0.19$
	P	$0 \cdot (0.5) = 0$
	D	$0 \cdot 0 = 0$
$\max = 0.19$		

m_3	T_2	$m_8 \cdot f_3$
$T_3 = V$	N	$(0.0165) \cdot (0.83) \approx 0.013$
	V	$(0.096) \cdot 0 = 0$
	P	$0 \cdot 0$
	D	$0 \cdot 0$
$\max = 0.013$		

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 m_g (m_g, f_3)

Tue

 $T_3 = P$ T_2

N

$(0.0165) \cdot 0 = 0$

 T_2

V

$(0.096) \cdot (0.4) = 0.0384$

 T_2

P

$0 \cdot 0 = 0$

 T_2

D

$0 \cdot 0 = 0$

$\text{Max} = 0.0384$

T_3	m_g	w_3	m_{10}
N	0.0384	time	0
V	0.013	flies	0
P	0.0384	like	1
D	0.19	an	0
		arrow	0

 m_H $T_3 = N$ w_3

time

$0 \cdot (0.27)$

 m_H $T_3 = D$ w_4

time

$0 \cdot 0$

 w_3

flies

$0 \cdot (0.36)$

 w_4

flies

$0 \cdot 0$

 w_3

like

$1 \cdot 0$

 w_4

like

$1 \cdot 0$

 w_3

an

$0 \cdot 0$

 w_4

an

$0 \cdot 1$

 w_3

arrow

$0 \cdot 0$

 w_4

arrow

$0 \cdot 0$

$\text{max} = 0$

$\text{max} = 0$

m_{11}

$T_3 = V$	w_3	Time	$0.0 = 0$
	w_3	flies	$0. (0.4) = 0$
	w_3	like	$1 - (0.6) = 0.6$
	w_3	an	0.0
	w_3	arrow	0.0

$\max = 0.6$

m_{11}

$T_3 = P$	w_3	time	$0.0 = 0$
	w_3	flies	$0.0 = 0$
	w_3	like	$0.1 = 1$
	w_3	an	$0.0 = 0$
	w_3	arrow	$0.0 = 0$

$\max = 1$

T_3	m_{11}
N	0
V	0.6
P	1
D	0

T_3	$m_{12} (m_9 \cdot m_{11})$
N	$(0.0384) \cdot 0 = 0$
V	$(0.013) \cdot (0.6) = 0.0078$
P	$(0.0384) \cdot 1 = 0.0384$
D	$(0.19) \cdot 0 = 0$

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 m_{13}

T_4	m_{13}
N	0.019
V	0
P	0.003
D	0.0192

 m_{13} $T_4 = N$ T_3

N

 $(m_{12} \cdot f_3)$

$$0 \cdot (0.16) = 0$$

 T_3

V

$$(0.0078) \cdot (0.4) \approx 0.003$$

 T_3

P

$$(0.0384) \cdot (0.5) = 0.019$$

 T_3

D

$$0 \cdot 1 = 0$$

$$\text{Max} = 0.019$$

 m_{15} $(m_{12} \cdot f_3)$ $T_4 = D$ T_3

N

$$(\cancel{0.0078}) \cdot (\cancel{0.2}) \approx 0.020$$

 T_3

V

$$(0.0078) \cdot (0.2) \approx 0.0015$$

 T_3

P

$$(0.0384) \cdot (0.5) = 0.0192$$

 T_3

D

$$0 \cdot 0 = 0$$

$$\text{max} = 0.0192$$

M_{13}		(m_{12}, f_3)
$T_4 = V$	$T_3 = N$	$0 \cdot (0.83) = 0$
	$T_3 = V$	$(0.0078) \cdot 0 = 0$
	$T_3 = P$	$(0.0384) \cdot 0 = 0$
	$T_3 = D$	$0 \cdot 0 = 0$
		$\max = 0$

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Fri

m_{13}		(m_{12}, f_3)
$T_4 = P$	$T_3 = N$	$0 \cdot 0 = 0$
	$T_3 = V$	$(0.0078) \cdot (0.4) \approx 0.003$
	$T_3 = P$	$(0.0384) \cdot 0 = 0$
	$T_3 = D$	$0 \cdot 0 = 0$
		$\max = 0.003$

w_4	m_{14}	M_{15}	
time	0	$T_4 = N$	$w_4 = \text{time}$
flies	0		flies
like	0		like
an	0		an
arrow	1		arrow
			$\max = 0.36$

M_{15}		M_{15}
$T_4 = D$	$w_4 = \text{time}$	$T_4 = V$
	flies	
	like	
	an	
	arrow	
		$\max = 0$

m₁₅

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 $T_4 = P$ $w_4 = \text{time} \quad 0.0$ $w_4 = \text{flies} \quad 0.0$ $w_4 = \text{like} \quad 0.1$ $w_4 = \text{am} \quad 0.0$ $w_4 = \text{arrow} \quad 1.0$

max = 0

T_4	m_{15}
N	0.36
V	0
P	0
D	0

T_4	$(m_{13} \cdot m_{15})$
N	$(0.019) \cdot (0.36) = 0.00684$
V	$0.0 = 0$
P	$(0.003) \cdot 0 = 0$
D	$(0.0192) \cdot 0 = 0$

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$$\therefore T_4^* = N$$

T_4	m_{16}
N	0.36
V	0
P	0
D	0

T_3	m_{17}
N	0.57
V	0.144
P	0.18
D	0.36

For m_{17} , only $T_4 = N$ will be used in $m_{16} \cdot f_3$
(For $T_4 = N$)

T_3	$m_{17} \cdot m_{16} \cdot f_3$
N	$(0.36) \cdot (0.16) = 0.057$
V	$(0.36) \cdot (0.4) = 0.144$
P	$(0.36) \cdot (0.5) = 0.18$
D	$(0.36) \cdot 1 = 0.36$

For optimal T_3 ,

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T_3	$m_{17} \cdot m_{11} \cdot m_9$
N	$(0.057) \cdot 0 \cdot (0.0384) = 0$
V	$(0.144) \cdot (0.6) \cdot (0.013) = 0.00123$
P	$(0.18) \cdot 1 \cdot (0.0384) = 0.006912$
D	$(0.36) \cdot 0 \cdot (0.19) = 0$

$$\therefore T_3^* = P$$

T_3	$m_{18} (m_{17} \cdot m_{11})$	T_2	$m_{11} (m_{18} \cdot f_3)$ For $T_3 = P$
N	$(0.057) \cdot 0 = 0$	N	$(0.018) \cdot 0 = 0$
V	$(0.144) \cdot (0.6) = 0.0864$	V	$(0.018) \cdot (0.4) = 0.0072$
P	$(0.18) \cdot 1 = (0.018)$	P	$(0.018) \cdot 0 = 0$
D	$(0.36) \cdot 0 = 0$	D	$(0.018) \cdot 0 = 0$

For optimal value of T_2 ,

T_2	$m_{19} \cdot m_5 \cdot m_7$
N	$0 \cdot (0.046) \cdot (0.36) = 0$
V	$(0.0072) \cdot (0.24) \cdot (0.4) = 0.0006912$
P	$0 \cdot 0 \cdot 0 = 0$
D	$0 \cdot 0 \cdot 0 = 0$

$$\therefore T_2^* = V$$

3	T_2	$m_{20}(m_7 \cdot m_{10})$
Tue	N	$(0.036) \cdot 0$
	V	$(0.0072) \cdot (0.4) = 0.00288$
	P	0.020
	D	0.020

T_2	$m_{21}(m_{20} \cdot f_3)$ for $T_2 = V$
N	$(0.00288) \cdot (0.83) = 0.0023904$
V	$(0.00288) \cdot 0 = 0$
P	$(0.00288) \cdot 0 = 0$
D	$(0.00288) \cdot 0 = 0$

For the optimal value of T_1 ,

T_1	$m_1 \cdot m_3 \cdot m_{21}$
N	$(0.8) \cdot (0.36) \cdot (0.0024) = 0.0006912$
V	$0.0 \cdot 0.020$
P	$0.0 \cdot 0.020$
D	$(0.2) \cdot 0.020$

$\therefore T_1^* = N$

So, the most optimal values for T_1, T_2, T_3 & T_4 are calculated to be:

$$T_1^* = N, T_2^* = V, T_3^* = P, T_4^* = N$$