

Ans. 1.

q)

I eat sushi with chopsticks with you.

0,1	NP	0,2	S	0,3	·	0,4	S	0,5	·	0,6	S	0,7
	Verb		VP	1,3	·	1,4	VP	1,5	·	1,6	VP	1,7
1,2			NP		·	2,4	NP	2,5	·	2,6	NP	2,7
		2,3	P ₄ eP				PP	3,5	·	3,6	PP	3,7
				3+			NP		·	4,6	NP	4,7
					4,5		P ₄ eP	5,			PP	5,7
						6					NP	6,7

$S \rightarrow NP VP$

$VP \rightarrow V_{verb} NP$

$NP \rightarrow you$

$NP \rightarrow NP PP$

$VP \rightarrow VP PP$

$PP \rightarrow P_{4eP} NP$

$NP \rightarrow Sushi$

$NP \rightarrow chopsticks$

$V_{verb} \rightarrow eat$

$NP \rightarrow I$

$P_{4eP} \rightarrow with$

\rightarrow for all diagonal

cells $chauf[i][j]$:

for rules $x \rightarrow w^{(i)}$

add an entry x to
 $chauf[i][j]$

Ans. 1 b)

$$S \rightarrow ASB$$

$$A \rightarrow aASA | a | G$$

$$B \rightarrow SBS | a | bb$$

1) remove ϵ productions

$$S \rightarrow ASB | SB$$

$$A \rightarrow a | as | aASA | aAS | ASA$$

$$B \rightarrow SBS | bb | A$$

$$S \rightarrow SB | ASB | AS$$

$$A \rightarrow a | as | aASA | aAS | ASA$$

$$B \rightarrow SBS | bb | A$$

2) remove unit prod.

$$S \rightarrow ASB | SB \checkmark$$

$$A \rightarrow \checkmark a | as | aASA | aAS | ASA$$

$$B \rightarrow SBS | bb | a | as | aASA | aAS | ASA$$

$$\bar{t}_a \rightarrow a$$

$$\bar{t}_b \rightarrow b$$

$$S \rightarrow ASB | SB \checkmark$$

$$A \rightarrow \checkmark a | \bar{t}_a s | \bar{t}_a ASA | \bar{t}_a AS | \bar{t}_a SA$$

$$B \rightarrow S\bar{t}_b s | \bar{t}_b \bar{t}_b | a | \bar{t}_a s | \bar{t}_a ASA | \bar{t}_a AS | \bar{t}_a SA$$

$$\bar{t}_a \rightarrow a$$

$$\bar{t}_b \rightarrow b$$

$S \rightarrow AT_{sb} | SB$
 $T_{sb} \rightarrow SB$
 $A \rightarrow a | TqS | TqTasq | TaTas | TqTsq$
 $Tasq \rightarrow ASA$
 $Tas \rightarrow AS$
 $Tsq \rightarrow SA$
 $B \rightarrow STbs | TbTb | a | TqS | TqTasq | TaTas | TqTsq$
 $Tbs \rightarrow TbS$
 $Tq \rightarrow q$
 $Tb \rightarrow b$

Ans. 2(a)

lesk Algorithm:

correct meaning of each word context is found by getting the sense which overlaps the most among given context & it's dictionary Meaning.

Overlapping words:

Ash ~~wild small~~ Coal

Sense1: ~~solid~~ burn

Sense2 Solid ~~ash~~ ash burn

combustible solid combustible

burn ~~wild~~ ~~ash~~ ~~solid~~ burn

Sense3: — ~~wild~~ ~~ash~~ ~~solid~~ ~~ash~~

Sense2 of Ash or

Sense3 of coal is winner.

Ans. 2 b)

Main goal of question processing phase is to extract query.

Query contains keywords passed to IR system to match potential documents.

along with query other further informations to be extracted are:

1. Answer type : entity (Person, location, time)
2. Focus : main emphasis
3. Question type : what will be potential answer

- Numerical
- objective
- Subjective

Q1

question: What is the capital of India?

Query: Capital of India

Answer type: city

Question type

Focus: capital

Cy.②.

question: Who won Highest No. of Gold Medals in Tokyo Olympic?

query: Highest No. of Gold Medals

Answer type: Country Name

focus: Gold Medals in Tokyo Olympic

Ans. 3.)

a.)

Q.No.	1	2	3	4	5	6	7
Ans. No.	4	3	6	2	8	1	2

Mean using formula

$$\text{Mean} = \frac{1}{181} \sum_{i=1}^{181} \text{Yanki}$$

$$\frac{1}{7} \left(\frac{1+1+1+1+1+1+1}{4+3+6+2+8+2} \right)$$

$$\frac{1}{7} \left(\frac{69}{24} \right)$$

$$\frac{23}{56}$$

~~Ans.~~

3 b.)

Rouge-2 score

Human Bigrams : 9

System Bigrams : 12

$$\begin{array}{l} \text{Precision} \quad \text{Recall} \quad F_1\text{-score} \\ \frac{6}{12} \quad \frac{6}{9} \quad \frac{2 \times \frac{6}{12} \times \frac{6}{9}}{\frac{6}{12} + \frac{6}{9}} \end{array}$$

$$\Rightarrow \frac{\frac{2}{3}}{\frac{1}{2} + \frac{2}{3}} \Rightarrow \frac{\frac{2}{3}}{\frac{7}{6}} \Rightarrow \frac{12}{21} \Rightarrow \frac{4}{7}$$

Watery spinach

Spinach is

is 9

common eaten

leaf veg.
of 98%Yogurt

$$\begin{array}{l} \text{Prc.} \quad \text{Recall} \quad F_1 \\ \frac{10}{13} \quad \frac{10}{10} \quad \frac{2 \times \frac{10}{13} \times \frac{10}{10}}{1 + \frac{10}{13}} \end{array}$$

$$\frac{20}{23}$$

Ans. 4.)

Sentences: Query

$$\lambda = 0.4$$

Similarity Matrix

	D ₁	D ₂	D ₃	D ₄	Q
D ₁	1	0.4	0.316	0.6	0.4
D ₂	.	1	0.79	0.8	0.4
D ₃	.	.	1	0.474	0.316
D ₄	.	.	.	1	0.4
Q	1

calculating cosine similarity

Sim(D₁, D₂) ↗

- D₁ New home sales top forecasts.
- D₂ Home sales rise in july
- D₃ Increase in home sales in july
- D₄ July new home sales rise

D_{5/Q} Sales home is very bad

New Home sales top fore rise in July Inc. is very bad

D ₁	1	1	1	1	1	0	0	0	0	0	0	0
D ₂	0	1	1	0	0	1	1	1	0	0	0	0
D ₃	0	1	1	0	0	0	0	2	1	0	0	0
D ₄	1	1	1	1	0	0	0	1	0	1	0	0
D _{5/Q}	0	1	1	0	0	0	0	0	0	1	1	0

1st iteration

result set 's' is empty.

$$\max_{d_j \in S} \text{sim}(d_i, d_j) = 0$$

$$\text{MMR} = \arg\max_{d_j} (0.4 \times 0.4) \\ \Rightarrow 0.16$$

d_1, d_2, d_3 all have
same similarity with d_i

Picking $d_1 \in S$ randomly

$$S = \{d_1\}$$

2nd iteration:

$$S = \{d_1\}$$

for d_2 :

$$\text{sim}(d_1, d_2) = 0.316 \cdot 0.4$$

$$\text{sim}(d_2, d_i) = 0.4$$

$$\text{MMR} = 0.4 \times 0.4 - 0.6 \times 0.4 \\ \Rightarrow -0.08$$

MMR_{d₃}:

$$0.4 \times 0.316 - 0.6 \times 0.316$$

$$\Rightarrow -0.0632$$

$$\text{MMR}_{d_4} : 0.4 \times 0.4 - 0.6 \times 0.6 \\ \Rightarrow -0.2$$

(d2) is Maximum MMR

$$S = \{d_1, d_2\}$$

3rd iteration:

$$S = \{d_1, d_2\}$$

Now;

$$\text{MMR}_{d_3} : 0.4 \times 0.316 - 0.6 \times \max(0.316, 0.79) \\ \Rightarrow 0.4 \times 0.316 - 0.6 \times 0.79 \\ \Rightarrow -0.3476$$

$$\text{MMR}_{d_4} : 0.4 \times 0.4 - 0.6 \times \max(0.6, 0.8) \\ \Rightarrow 0.16 - 0.48 \\ \Rightarrow -0.32$$

d_4 has Max. MMR

$$\text{So; } S = \{d_1, d_2, d_4\}$$

These are 3 sentences in
summary set.

Ans. 5:

a)

English play cricket
French jouey croquet

the cricket
la gerillon

cricket team
croquet equip

play cricket the cricket cricket team
jouey croquet la gerillon croquet equip
 $\frac{1}{3}, \frac{1}{3}, \frac{1}{9} \rightarrow \frac{1}{2}$ $\frac{1}{3}, \frac{1}{3}, \frac{1}{9} \rightarrow \frac{1}{2}$ $\frac{1}{3}, \frac{1}{3}, \frac{1}{9} \rightarrow \frac{1}{2}$

play cricket the cricket cricket team
jouey croquet la gerillon croquet equip
 $\frac{1}{3}, \frac{1}{3}, \frac{1}{9} \rightarrow \frac{1}{2}$ $\frac{1}{3}, \frac{1}{3}, \frac{1}{9} \rightarrow \frac{1}{2}$ $\frac{1}{3}, \frac{1}{3}, \frac{1}{9} \rightarrow \frac{1}{2}$

initial trans. prob.

	jouey	croquet	la	gerillon	equip
play	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
the	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
cricket	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
team	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$

~~P(A, F | E) :~~

$P(A/F, E) :$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$
 $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$

Q1

	jouey croquet	19	guillion	equipe
play	$\frac{1}{2}$	$\frac{1}{2}$	0	0
the	0	0	$\frac{1}{2}$	$\frac{1}{2}$
croquet	$\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{1}{2}$
team	0	$\frac{1}{2}$	0	$\frac{1}{2}$

Normalizing row

	jouey croquet	19	guillion	equipe
play	$\frac{1}{2}$	$\frac{1}{2}$	0	0
the	0	0	$\frac{1}{2}$	$\frac{1}{2}$
croquet	$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{6}$	$\frac{1}{6}$
team	0	$\frac{1}{2}$	0	$\frac{1}{2}$

after 1st iteration
Normalization Prob.

Alignment
Probability

$$\frac{1}{2} \cdot \frac{1}{3} = \frac{1}{6} \quad \frac{1}{2} \cdot \frac{1}{6} = \frac{1}{12} \quad \frac{1}{3} \cdot \frac{1}{2} = \frac{1}{6}$$

$$\frac{1}{2} \cdot \frac{1}{6} = \frac{1}{12} \quad \frac{1}{2} \cdot \frac{1}{6} = \frac{1}{12} \quad \frac{1}{6} \cdot \frac{1}{2} = \frac{1}{12}$$

Ans. 6)

Rahul can play chess
 <S> N M V N <E>

Kayan should clean table

<S> N M V N <E>

Will Shyam play chess

<S> M N V N <E>

Kayan should beat Rahul

<S> N M V N <E>

using HMM

$P(N M V N / \text{Rahul should beat})$
 Kayan

N M V <E>

<S> $\frac{3}{4}$ $\frac{1}{4}$ 0 $\frac{1}{4}$

N 0 $\frac{1}{4}$ $\frac{3}{8}$ $\frac{1}{8}$ $\frac{4}{8}$

M $\frac{1}{4}$ 0 $\frac{1}{4}$ $\frac{3}{4}$ $\frac{1}{4}$

V $\frac{4}{4}$ 0 $\frac{1}{4}$ 0 $\frac{1}{4}$

Transition Prob.

N M V <E>

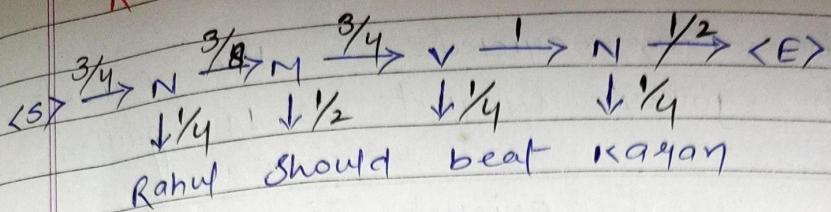
<S> $\frac{3}{4}$ $\frac{1}{4}$ 0 0

N 0 $\frac{3}{8}$ $\frac{1}{8}$ $\frac{1}{2}$

M $\frac{1}{4}$ 0 $\frac{3}{4}$ 0

V 1 0 0 0

'Rahul should beat Kavyan'



initial Probability

Words	N	M	V	$P(Word/N)$	$P(W/M)$	$P(W/V)$
Rahul	2	0	0	$1/4$	0	0
can	0	1	0	0	$1/4$	0
play	0	0	2	0	0	$1/2$
chess	2	0	0	$1/4$	0	0
Kavyan	2	0	0	$1/4$	0	0
should	0	2	0	0	$1/2$	0
clean	0	0	1	0	0	$1/4$
table	1	0	0	$1/8$	0	0
will	0	1	0	0	$1/4$	0
shyam	1	0	0	$1/8$	0	0
beat	0	0	1	0	0	$1/4$

$$P(\cdot) \geq \frac{3}{4} \cdot \frac{1}{4} \cdot \frac{3}{8} \cdot \frac{1}{2} \cdot \frac{3}{4} \cdot \frac{1}{4} \cdot 1 \cdot \frac{1}{4} \cdot \frac{1}{2}$$

$$\Rightarrow \frac{9}{128} \times \frac{3}{64} \times \frac{1}{4} = \dots$$

$$\Rightarrow \frac{27}{2^{13} \cdot 2^2} \Rightarrow \frac{27}{2^{15}} = \dots$$

$$\therefore \underline{\underline{0.00082397}}$$

Ans. 5(b)

For Sim path

$$\text{Pathlen(Hill, Shore)} \\ \Rightarrow 1 + 3 \Rightarrow 4$$

$$\Rightarrow \frac{1}{4} = 0.25$$

For Sim yesnik:

$$-\log P(\text{LCS(Hill, Shore)}) \\ -\log P(\text{geo-form}) \\ \Rightarrow -\log_2(0.00176)$$

$$\Rightarrow \underline{-6.342} \quad 9.15$$

for Sim lin:

$$\frac{2 \log P(\text{LCS(hill, shore)})}{\log P(\text{hill}) + \log P(\text{shore})}$$

$$\Rightarrow \frac{2 \log P(\text{geo-form})}{\log P(\text{hill}) + \log P(\text{shore})}$$

$$\Rightarrow \frac{2 \ln(0.00176)}{\ln(0.0000109) + \ln(0.00000836)}$$

$$\Rightarrow \underline{0.6259}$$