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Subject: Natural Language Processing
Course & Semester: BS(SE) – 5^{th}

Question No. 1: (5)

Explain objectives of NLP? Write the name of 2 Applications of NLP with example? Write the name of 2 Challenges of NLP with example?

ANSWER

Objective

Natural Language Processing, usually shortened as NLP, is a branch of artificial intelligence that deals with the interaction between computers and humans using the natural language. The ultimate objective of NLP is to read, decipher, understand, and make sense of the human languages in a manner that is valuable.

Applications

- **Speech Recognition**

Example:

Speech recognition applications include voice user interfaces such as voice dialing (e.g. "call home"), call routing (e.g. "I would like to make a collect call")

- **Sentiment Analysis**

Example:

"I really like the new design of your website!" → Positive.

Challenges

- **Breaking the sentence**

Example:

Splitting text into sentences might look like a simple task but it's not

- **Tagging the parts of speech (POS) and generating dependency graphs**

Example:

Suppose we build a sentiment analyser based on only Bag of Words. Such a model will not be able to capture the difference between "I like you", where "like" is a verb with a positive sentiment, and "I am like you", where "like" is a preposition with a neutral sentiment.

Question No. 2: (5)

Specify the text strings using the below regular expressions:

a. /a(bc)

- Given string: ab abc ac acb a0b a2b a42c A87d

ANSWER

ab abc ac acb a0b a2b a42c a87d

b. /[abc]

- Given string: ab abc ac acb a0b a2b a42c A87d

ANSWER

ab abc ac acb a0b a2b a42c a87d

c. /abc+

- Given string: ab abc abcc babc

ANSWER

ab abc abcc babc

d. /abc*

- Given string: ab abc abcc babc

ANSWER

ab abc abcc babc

e. /[^a-z A-Z 0-9]

- Given string: a89 opx cfff $1!

ANSWER

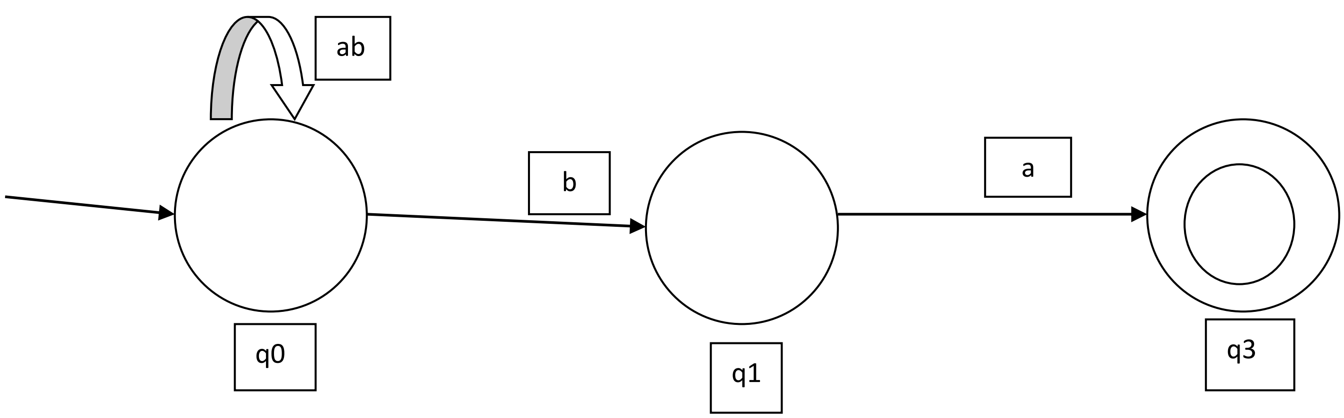
a89 opx cfff $1!

Question No. 3: (10)

a) Design an NFA over an alphabet ∑= {a, b} such that every string accepted must end with a string --ba. Identify its tuples and also convert it into DFA.

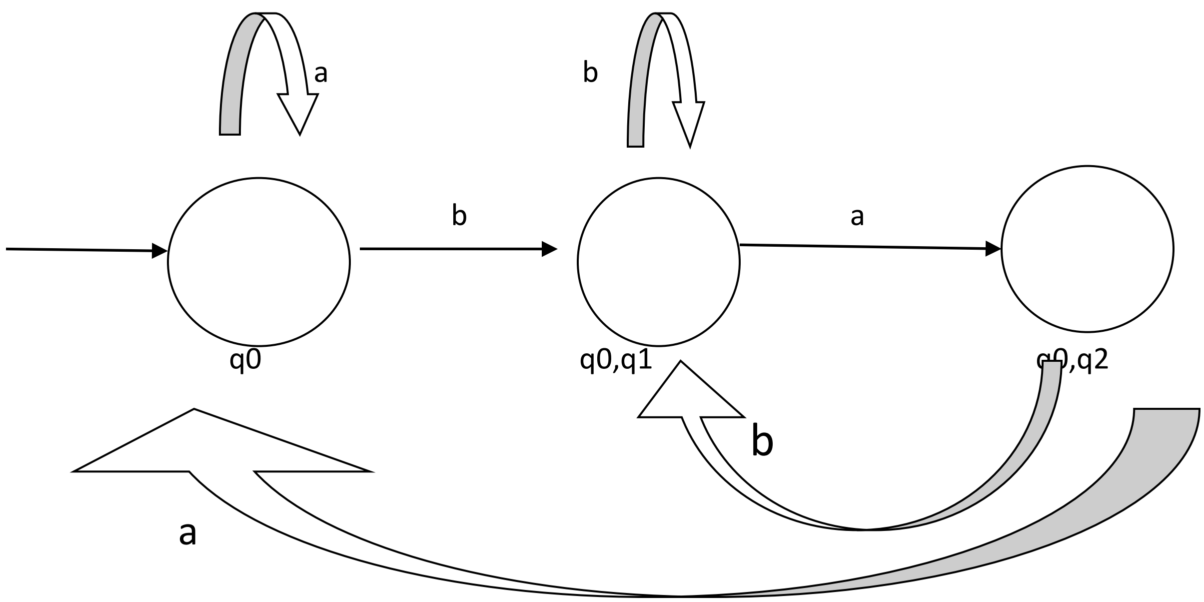
ANSWER

- **NFA**



E/Q	a	b
Q0	Q0	Q0,Q 1
Q1	Q2	null
Q2	null	null

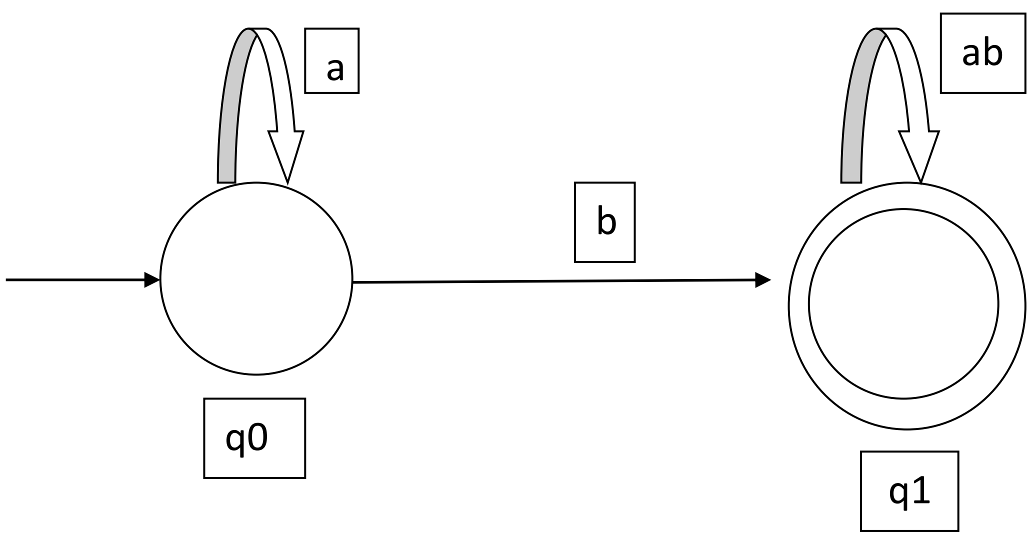
- **DFA**



E/Q	a	b
q0	q0	{ q0,q1}
{ q0,q1}	{ q0,q2}	{ q0,q1}
{ q0,q2 }	q0	{ q0,q1}

b) Design an NFA for the regular expression : a* b(a+b)*

ANSWER



Question No. 4: (15)

a) Explain Part of Speech Tagging (POS) and explain POS tag ambiguity with two examples.

ANSWER

POS Tagging:

It is a process of converting a sentence to forms – list of words, list of tuples (where each tuple is having a form (word, tag)). The tag in case of is a part-ofspeech tag, and signifies whether the word is a noun, adjective, verb, and so on.

Default tagging: is a basic step for the part-of-speech tagging. It is performed using the Default Tagger class. The Default Tagger class takes 'tag' as a single argument. NN is the tag for a singular noun. Default Tagger is most useful when it gets to work with most common part-of-speech tag. That's why a noun tag is recommended

For Example, if the preceding word is an article, then the word in question must be a noun. This information is coded in the form of rules. Example of a rule: If an ambiguous/unknown word X is preceded by a determiner and followed by a noun, tag it as an adjective

POS tag ambiguity:

Common parts of speech in English are noun, verb, adjective, adverb, etc. The POS tagging problem is to determine the POS tag for a particular instance of a word. The main problem with POS tagging is ambiguity.

For Example: In English: I bank1 on the bank2 on the River bank3 for my transaction. (Bank1 is verb, other are noun)

b) State difference between open vs. closed classes in POS tagging.

ANSWER

• Open vs. Closed classes

Closed:

• determiners: a, an, the
• pronouns: she, he, I
• prepositions: on, under, over, near, by, …
• Grammatical words deal with the formation of sentences.
• They have ambiguous meaning and serve to express grammatical relationships with other words within a sentence

Open:

• Nouns, Verbs, Adjectives, Adverbs.
• Lexical words deal with content and vocabulary.
• They have concrete meaning that goes beyond their function in a sentence.

c) Apply Viterbi Algorithm on the below given bigram and lexical probabilities; (10)

Initial Probabilities	
Noun	1\3
Verb	0
Other	1\3

Bigram Probabilities			
	Noun	Verb	Other
Noun	1\4	1\4	0
Verb	1\4	0	1\4
Other	1\3	0	1\3

Lexical Probabilities					
	O1=time	O2=flies	O3=like	O4=an	O5=arrow
Noun	1\5	1\5	0	0	1\5
Verb	1\5	2\5	1\5	0	0
Other	0	0	1\5	2\5	0

ANSWER

hi	**P1(h1)**	**P2(h2)**	**P3(h3)**	**P4(h4)**	**P5(h5)**
noun	1/3x1/5=1/15	1/5x1/4x1/15=1/300	0x1/150=0	0	1/5x1/4x1/16875
verb	0	2/5x1/4x1/15=1/150	1/5x1/4x1/150=1/3000	0	0
other	0	0	1/5x1/3x1/150=1/2250	1/3x2/5x1/2250=1/16875	0

Question No. 5: (15)

a) Apply Bayesian theorem over the below given string:

^John got many NLP books. ^He found them all very interesting.

Where for lexical probabilities assume John=0.5, got=0.3, many=0.2, NLP=0.1 and books=0.

ANSWER

P(T)=PWIT)=tt(ti/ti-1)-P(wi)tiP1(ti/ti-1)=P(Wi/ti)

Le corpus :^ John got many NLP books found all very interesting

POS tagged

^N V N N.^N V N A R A

- **Recording numbers**

^	0	2	0	0	0	0
N	0	1	2	1	0	1
V	0	1	0	1	0	0
A	0	1	0	0	1	1
R	0	0	0	1	0	0
.	1	0	0	0	0	0

- **Bigram Probabilties**

^	0	1	0	0	0	0
N	0	1/5	2/5	1/5	0	1/5
V	0	1/2	0	1/5	0	0
A	0	1/3	0	0	1/3	1/3
R	0	0	0	1	0	0
.	1	0	0	0	0	0

- **Lexical probability**

	John	Got	Many	NLP	books
^	0.5	0.3	0.2	0.1	0
N	0.5	0.3	0.2	-	-
V	0.5	0.3	0.2	-	-
A	0.5	-	-	-	-
R	0.5	-	-	-	-
.					

P(John/^) = P(Wi=John/ti=^)
=# (John,^)/ #^
(m y,^)/#^ = 0.5x2/2 = 0.5

=0.2x2/2 = # (got ,^)/ # ^
=0.2 = 0.3x2/2 =0.3
=(NLP,^)/^

=0.1x2/2 = <John,N)/N

=0.1 =0.5x5/5=0

(book,^)/^

=0x2=0.

b) Find the CFG of the string “abaabaa” using the production rules

S→a, S→aAS, A→bS

ANSWER

Compose the string w= abaabaa with left most derivation

S →	aAS	(Rule:2)
→	abS	(Rule:3)
→	abaAS	(Rule:1)
→	abaabss	(Rule:2)
→	abaabaS	(Rule:3)
→	abaabaa	(Rule:3)