

National University of Computer and Emerging Sciences, Lahore Campus



Course: Theory of Automata-I
Program: BS (CS)
Duration: 90 Minutes
Paper Date: 02-Feb-21
Section: ALL
Exam: Sessional II

Course Code: CS301
Semester: Fall 2020
Total Marks: 30
Weight: 15%
Page(s): 5

Instruction/Notes: Attempt all questions on the question paper.
 Check your answers carefully since there are no marks for errors carried forward.
Extra rough sheets are not allowed.

Name: _____ Roll Number: _____ Section: _____

Question 1 [10]

Show whether or not the word abaaa is accepted by the given CFG using the CYK algorithm. Show all steps to get credit.

$S \rightarrow BB \mid YB \mid BX$
 $A \rightarrow XB$
 $X \rightarrow XX \mid AA \mid a$
 $Y \rightarrow AB \mid XB \mid XX$
 $B \rightarrow BY \mid b$
 $A \rightarrow a \mid b$

$BB \leftarrow S$
 $YB \leftarrow S$
 $BX \leftarrow S$
 $XB \leftarrow A, Y$
 $XX \leftarrow X, Y$
 $AA \leftarrow X$
 $AB \leftarrow Y$
 $BY \leftarrow B$

~~abaaa ∈ L~~

Fill the table below

X, Y, A <i>abaaa</i>				
X, Y, A <i>abaa</i>	X, Y, S, B <i>baaa</i>			
X, Y <i>aba</i>	X, Y, S, B <i>baa</i>	X, Y <i>aaa</i>		
Y, X, A <i>ab</i> AB AA XB YA	X, S <i>ba</i> BA AA BX AX	X, Y <i>aa</i> AA AX XX YA	X, Y <i>as</i>	
A, X <i>a</i>	B, A <i>b</i>	A, X <i>a</i>	A, X <i>a</i>	A, X <i>a</i>

S

Question 2 [10]

Convert the CFG G given below to an equivalent CFG in CNF. Show all steps and enclose the final result of each (intermediate) step in a rectangular box.

$R \rightarrow US | aS | Tb$
 $S \rightarrow TST | T$
 $T \rightarrow aTb | \epsilon$
 $U \rightarrow aU | Ub | aUb$
 $V \rightarrow ST | ab$

Note: The start variable in aforementioned grammar is R.

- A) No need to add new start variable.
B) Remove ϵ rules - $T \rightarrow \epsilon$

$R \rightarrow US | aS | Tb | \underline{b}$
 $S \rightarrow TST | T | ST | TS | \cancel{TS} | \epsilon$
 $T \rightarrow aTb$ \hookrightarrow useless remove it
 $U \rightarrow aU | Ub | aUb$
 $V \rightarrow ST | ab | T$

Remove $S \rightarrow \epsilon$

$R \rightarrow US | aS | Tb | b | U | a$
 $S \rightarrow TST | T | ST | TS | TT | \cancel{TS}$ \hookrightarrow redundant
 $T \rightarrow aTb$
 $U \rightarrow aU | Ub | aUb$
 $V \rightarrow ST | ab | T$

c) Remove unit-productions

$$R \rightarrow US \mid AS \mid Tb \mid b \mid a \mid aU \mid Ub \mid aUb$$

$$S \rightarrow TST \mid ST \mid TS \mid TT \mid aTb$$

$$T \rightarrow aTb$$

$$U \rightarrow aU \mid Ub \mid aUb$$

$$V \rightarrow ST \mid ab \mid aTb$$

d) Replace a with A & b with B

$$R \rightarrow US \mid AS \mid TB \mid b \mid a \mid AU \mid UB \mid AUB$$

$$S \rightarrow TST \mid ST \mid TS \mid TT \mid ATB$$

$$T \rightarrow ATB$$

$$U \rightarrow AU \mid UB \mid AUB$$

$$V \rightarrow ST \mid AB \mid ATB$$

e) Breaking down to 2 variables on RHS

$$R \rightarrow US \mid AS \mid TB \mid b \mid a \mid AU \mid UB \mid XB$$

$$S \rightarrow YT \mid ST \mid TS \mid TT \mid ZB$$

$$T \rightarrow ZB$$

$$U \rightarrow AU \mid UB \mid XB$$

$$V \rightarrow ST \mid AB \mid ZB$$

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$$X \rightarrow AU$$

$$Y \rightarrow TS$$

$$Z \rightarrow AT$$

Construct the state diagram of the Push Down Automata which recognizes the following language L .

$$L = \{a^x b^y c^z \mid \underline{2z + 2} \leq \underline{y} \leq \underline{3z + 2}, x, z \geq 0\}$$

for every k there are 2 bs
or 3 bs

Method 1)

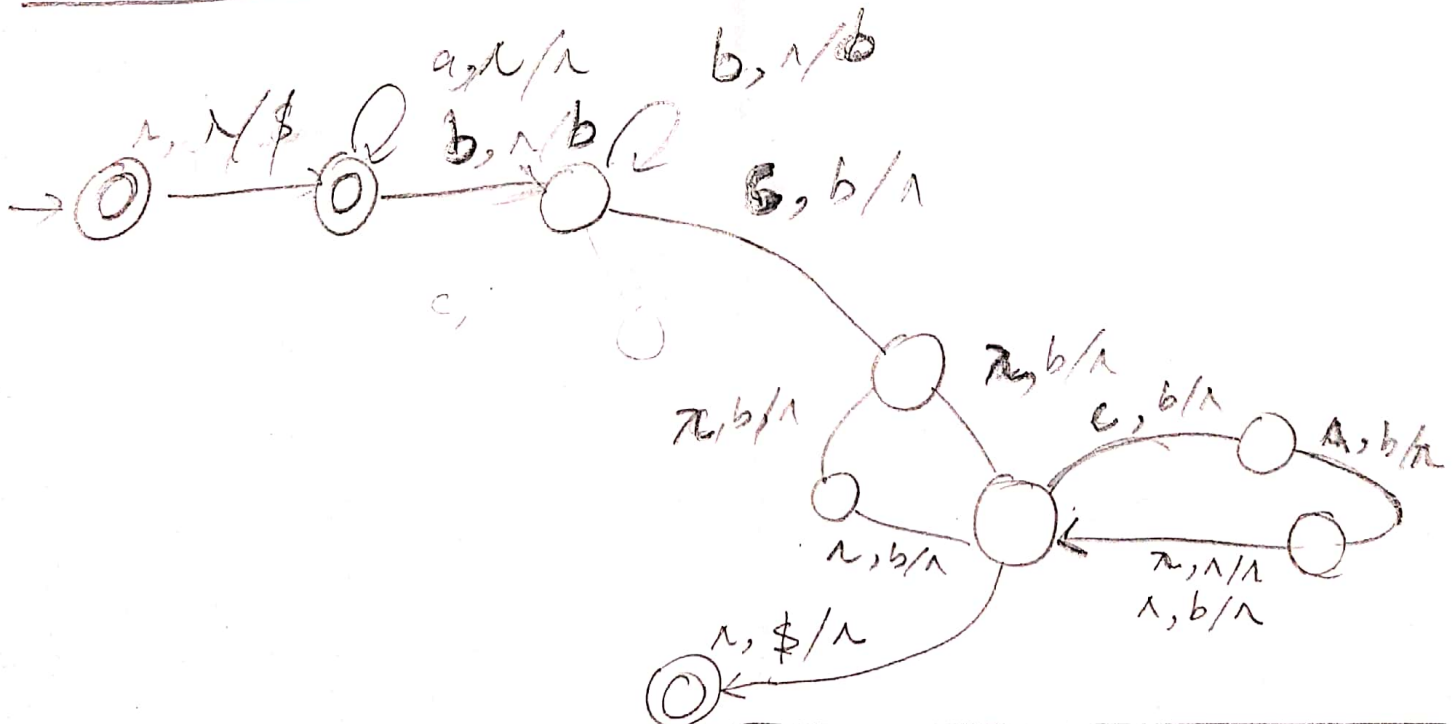
$$B \rightarrow b\bar{b}Bc / b\bar{b}bBc / \lambda$$
$$A \rightarrow aA/n$$

can make PDA from CFG.

Method 2

Direct PPA

in / pop / push



other way is for 3 bs push one b & nondet. for 2 bs push one b then for 1 c pop 1 b