Phase-Structure Grammar

1. What is the Backus-Naur form of the grammar described as follows:
   [1] a **sentence** is made up of a **noun phrase** followed by a **verb phrase** or a **noun phrase** followed by a **verb phrase** followed by a **noun phrase**.
   [2] a **noun phrase** is made up of a **noun**, an **adjective** followed by a **noun**, or an **article** followed by a **noun**.
   [3] a **verb phrase** is made up of a **verb**.
   [4] **articles** are *a* and *the*.
   [5] **adjectives** are *lengthy*, *boring*, and *inaccurate*.
   [6] **nouns** are *book*, *newspaper*, and *information*.
   [7] **verbs** are *reads* and *contains*.
   a. the Backus-Naur form

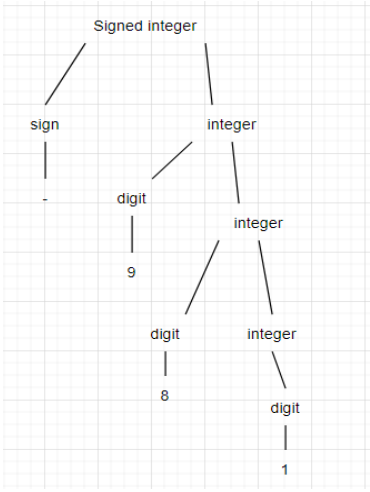
1. ⟨sentence⟩ ::= ⟨noun phrase⟩ ⟨verb phrase⟩ |⟨noun phrase⟩ ⟨verb phrase⟩ ⟨noun phrase⟩
2. ⟨noun phrase⟩ ::= ⟨noun⟩ ⟨adjective⟩ ⟨noun⟩ | ⟨article⟩ ⟨noun⟩
3. ⟨verb phrase⟩ ::= ⟨verb⟩
4. ⟨article⟩ ::= a | the
5. ⟨adjective⟩ ::= lengthy | boring | inaccurate.
6. ⟨nouns⟩ ::= book | newspaper | information.
7. ⟨verbs⟩ ::= *reads* | *contains.*

   b. Demonstrate “a lengthy book contains boring information”

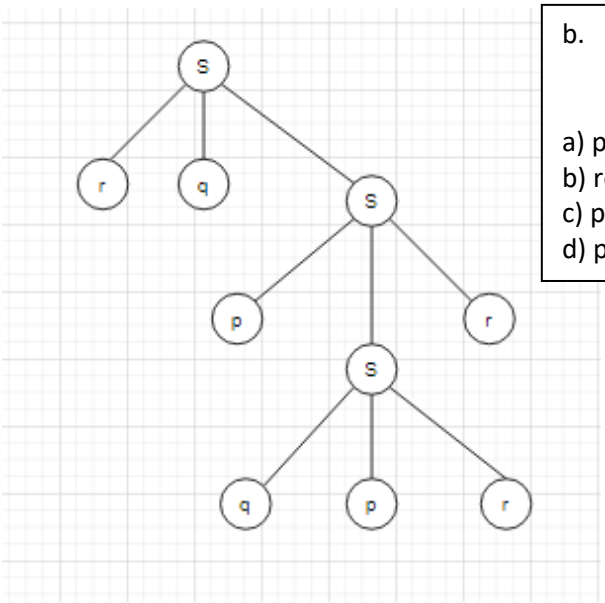
a	lengthy	book	contains	|boring	information
⟨article⟩	⟨noun phrase⟩		⟨verb phrase⟩	⟨noun phrase⟩	
⟨article⟩	⟨adjective⟩	⟨noun⟩	⟨verbs⟩	⟨adjective⟩	⟨noun⟩

2. Give the Backus-Naur form for the production of signed integers in decimal notation.(A signed integer is a nonnegative integer preceded by a plus sign or a minus sign, E.g. -5, 10, -10050)
   Sol.
   ⟨signed integer⟩ ::= ⟨sign⟩ ⟨integer⟩
   ⟨sign ⟩ ::= + | -
   ⟨integer ⟩ ::= ⟨digit⟩ |⟨digit⟩ ⟨integer⟩
   ⟨digit⟩ ::= 0 | 1 | ⋯ | 8 | 9

   Construct a derivation tree for −981 using the grammar



3. Let G be the grammar with V = {p,q,r,s,}; T = {p,q,r}; Starting symbol S; and productions are: S → pSr, S → rqS, S →rr, S →pqr
   a. Construct derivation tree for rqppqrr

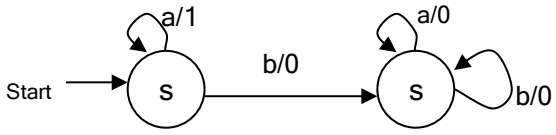


b. Use top-down parsing to determine whether each of the following strings belongs to the language generated by the grammar.

a) prrr Yes
b) rqpqr Yes
c) pqrpqr No
d) prrrr No

Finite State Machines with no output

4. **Construct the state table** for the finite-state machine with the state diagram shown in figure



State	f		g	
	Input		Input	
	a	b	a	b
S_0	S_0	S_1	1	0
S_1	S_1	S_1	0	0

- **Find the output string** generated by the finite-state machine in figure and show the successive states and outputs in Table

a) input string is ababbb

Input	a	b	a	b	b	b	-
State	S_0	S_0	S_1	S_1	S_1	S_1	S_1
Output	1	0	0	0	0	0	-

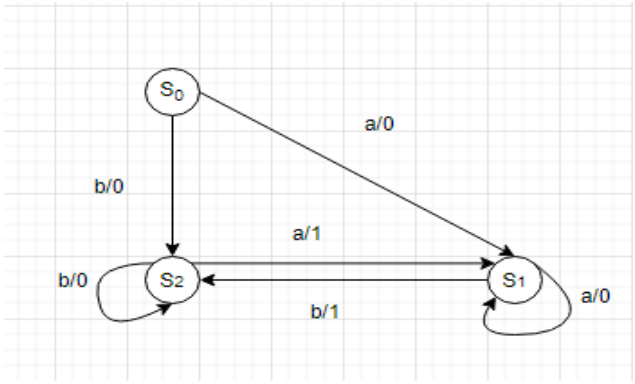
b) input string is aaabb

Input	a	a	a	b	b	-
State	S_0	S_0	S_0	S_1	S_1	S_1
Output	1	1	1	0	0	-

c) input string is baaaa

Input	b	a	a	a	a	-
State	S_0	S_1	S_1	S_1	S_1	S_1
Output	0	0	0	0	0	-

5. **Construct the** state diagram for the finite-state machine with state table



State	f		g	
	Input		Input	
	a	b	a	b
S_0	S_1	S_2	0	0
S_1	S_1	S_2	0	1
S_2	S_1	S_2	1	0

- **Find the output string** generated by the finite-state machine in figure and show the successive states and outputs in Table

a) input string is abaabaa

Input	a	b	a	a	b	a	a	-
State	S_0	S_1	S_2	S_1	S_1	S_2	S_1	S_1
Output	0	1	1	0	1	1	0	-

b) input string is babbbab

Input	b	a	b	b	b	a	b	-
State	S_0	S_2	S_1	S_2	S_2	S_2	S_1	S_2
Output	0	1	1	0	0	1	1	-

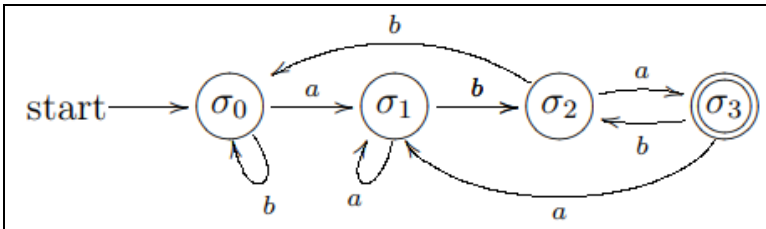
Set of Strings

6. Let A={0,11} and B = {00,01}. Find each of these sets.
   a) AB = {000, 001, 1100, 1101}
   b) BA = {000, 0011, 010, 0111}
   c) A^2 = {00, 011, 110, 1111}
   d) B^3 = {000000, 000001, 000101, 010100, 010000, 000100, 010101}
   e) A UB = {010001}

7. Determine whether the string 0101000 is in each of these sets.
   a) {101}* No
   b) {01}*{0}* Yes
   c) {0}*{10}*{0}* Yes
   d) {0}*{1}*{0}* No

DFA Automata

8. A finite-state automaton is given by a transition diagram



a) Find its states
$\sigma_0, \sigma_1, \sigma_2, \sigma_3$
b) Fins its input symbols
a, b
c) Find its initial state
σ_0
d) Find its accepting states
σ_3

e) Do the input string below accept or not (Yes/No)

aaaaabba	No
abbbaabbb	No
babbaaaba	Yes
baaabaaba	Yes

f) Write its annotated next-state table

State	f	
	Input	
	a	b
σ_0	σ_1	σ_0
σ_1	σ_1	σ_2
σ_2	σ_3	σ_0
σ_3	σ_1	σ_2

9. A finite-state automaton is given by an annotated next-state table. For each automaton

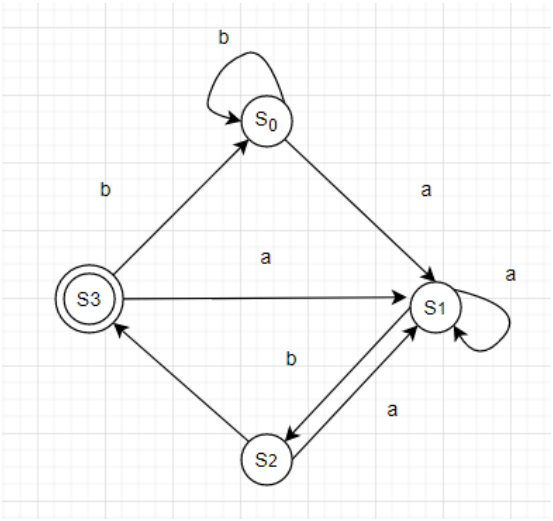
State	f	
	input	
	a	b
→ s0	S1	S0
s1	S1	S2
s2	S1	S3
◎ S3	S1	S0

a) Find its states
s0, s1, s2, s3
b) Find its input symbols
f
c) Find its initial state
s0
d) Find its accepting states
s3

e) Do the input string below accept or not (Yes/No)

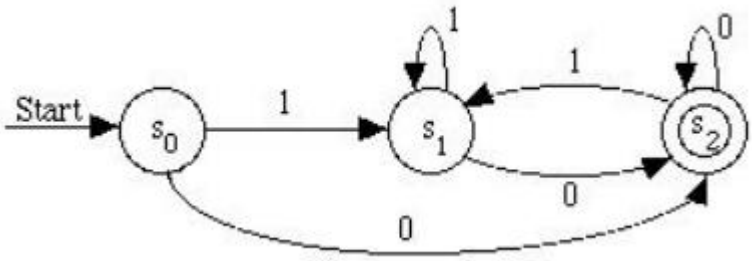
aabbabba	No
abbbaabb	Yes
babbaaaa	No
baaabaabba	No

f) Draw its transition diagram



Language Recognition

10. Determine the set of bit strings recognized by the following deterministic finite-state automaton.

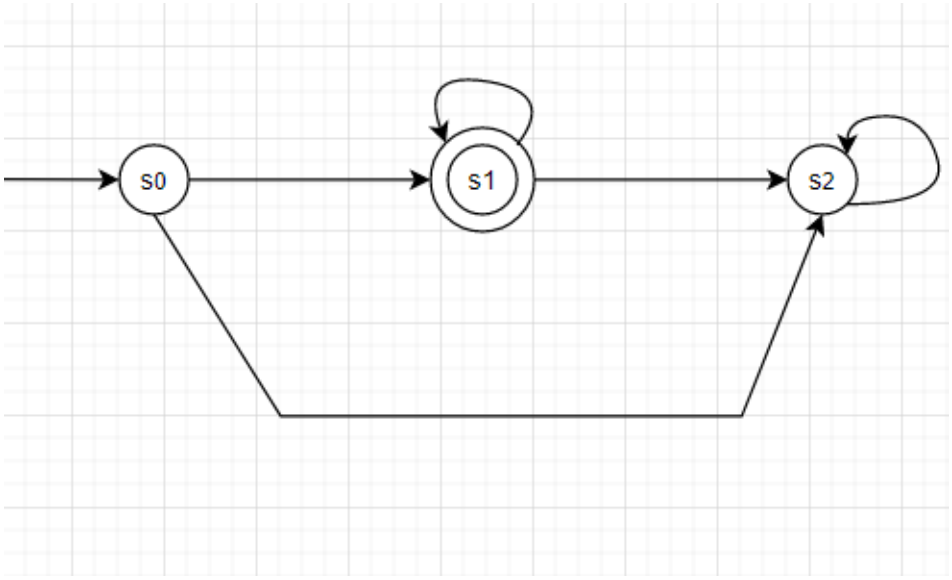


If the bit string end in 0 ,you end in state S_2. If the bit string ends in 1, you end in state S_1. Therefore, this automaton recognizes all bit strings that end in 0.

11. **Determine whether 01010001** belongs to each of these regular sets.

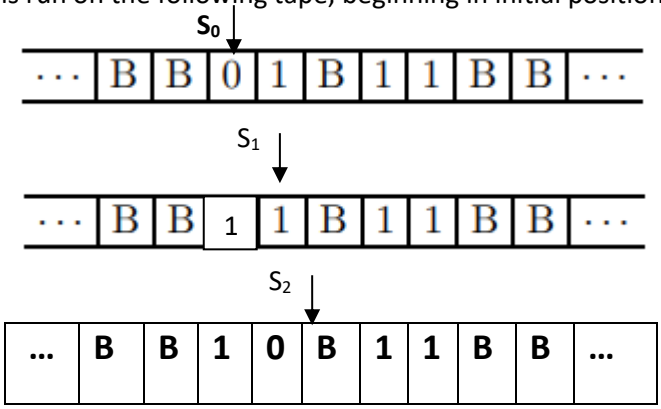
a) 01*0* No
b) 0(11)*(01)* No
c) 0(10)*0*1* Yes
d) 0*10(0 ∪ 1)* No
e) (01)*(11)* No
f) 0*(10 ∪ 11)*0*1 Yes
g) 0*(10)*11 No
h) 01(01 ∪ 0)1* No

12. Construct a deterministic finite-state automaton that recognizes the set of all bit strings such that **the first bit is 0 and all remaining bits are 1's.**



Turing Machines

13. Let T be the Turing machine defined by these five-tuples:
(s0, 0, s1, 1, R), (s0, 1, s0, 0, R), (s0,B, s1, 0, R), (s1, 0, s0, 0, R), (s1, 1, s2, 0, R), (s1,B, s2, 1, L).
If T is run on the following tape, beginning in initial position, what is the final tape when T halts?



14. Let T be the Turing machine defined by these five-tuples:
(s0, 0, s1, 1, R), (s0, 1, s0, 0, R), (s0, B, s1, 0, R), (s1, 0, s0, 0, R), (s1, 1, s2, 0, R), (s1, B, s2, 1, L).
If T is run on the following tape, beginning in initial position, what is the final tape when T halts?