

Q) Apply Compression using Run length Encoding (RLE) technique to following binary data

0 0 1 1 1 0 0 0 (0 1 1 1 0)

0 0 0 1 1 1 1 0

1 1 1 0 1 0 0 1

1 0 1 0 1 0 1 1 0 0 0

0 0 1 1 0 (0 1 1 1 0)

1 1 0 0 0 0 1 1

check boundary is valid

Consider first row

(0 1 1 1 0 0 0)  $\rightarrow$  (2 3 2) (0 0 0)

we have two '0', three '1' three '0' in order

we can write it as (2 3 2) (0 0 0)

we can also do vice versa process at any point

Second row

0 0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 1 0 1 1 0 0 1 0 0 1 0 0 1  
201 201 201 0 0 0 1 1 1 1 0

(row 1, row 2) have three '0', four '1', one '0'

we can write it as (3 4 1)

Third row  
(0 1 0 1 0 0 1) (0 1 0 1 0 0 1)  
1 1 1 0 1 0 0 1 (check boundary)

(0 8 11 21)

fourth row  
1 0 0 1 1 1 0  
(0 1 2 4 1)

fifth row

0 1 1 0 1 0 0  
1 0 0 1 0 1 1  
0 0 1 1 0 1 1 1  
(2 2 1 3) 0 1 1 0 0

Below is Compressed Data

(2 2 3) (3 4 1 2) (6 0 3 1 1 3 1) (0 1 2 4 1) (2 2 1 3)

2) Apply Compression Run-length Encoding (RLE)

technique to following gray scale data

120 120 120 110 110 110 110 110 0 0 0 0 0 0 0 0  
120 120 120 110 110 110 110 110 0 0 0 0 0 0 0 0

Sol Encode a seq of symbol into 2 bytes (Symbol, Count)  
we have 3 (120), 5 (110), 8 (0), 3 (105)

Compressed data (120, 3) (110, 5) (0, 8) (105, 3)

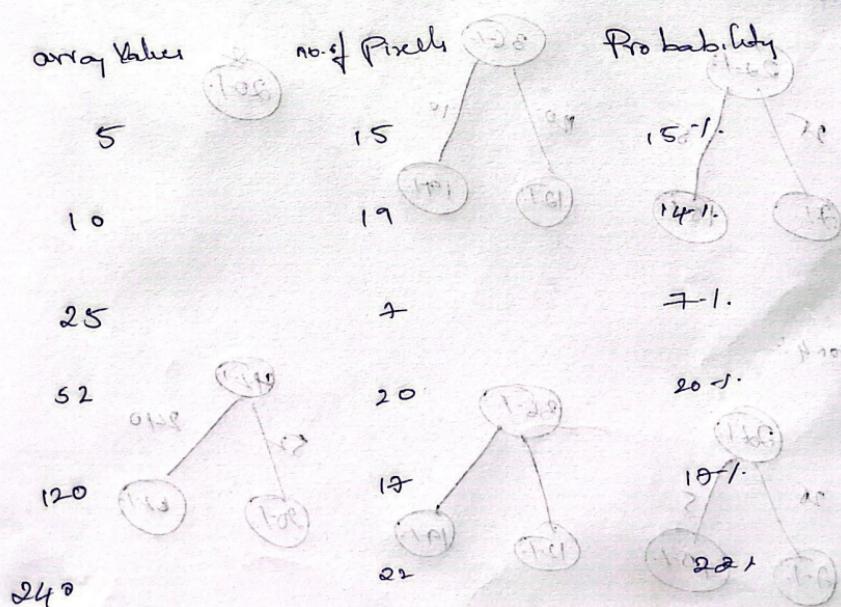
(120, 3) (110, 5) (0, 8) (105, 3)

3) Given a gray scale image ( $10 \times 10$ ) with pixels

Gray Values	No. of Pixels
5	15
10	19
25	7
52	20
120	17
240	22

a) Create Huffman tree and coding

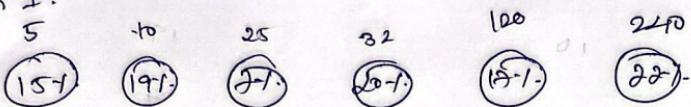
Step 1: Finding the probabilities



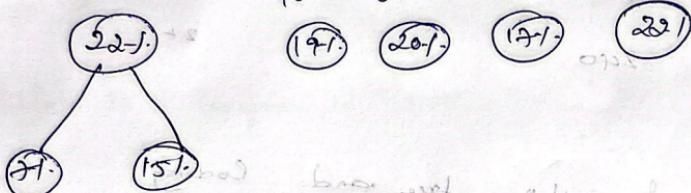
Step 2: From a binary tree by adding probability

at a time always taking 2 base values

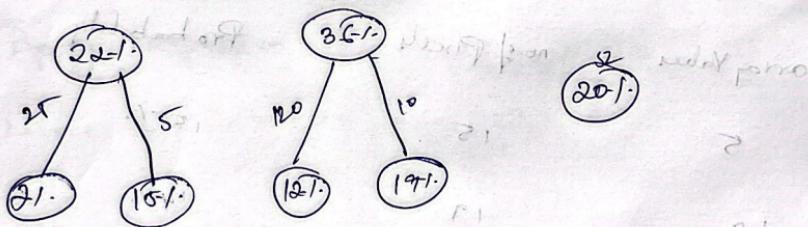
Construction 1:



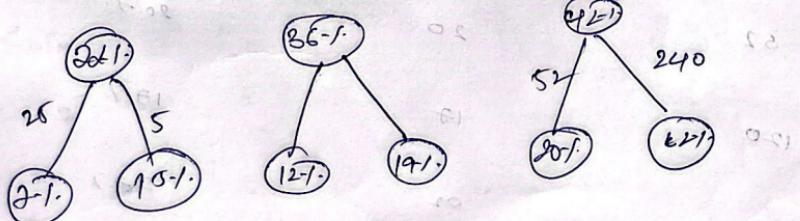
Construction 2:



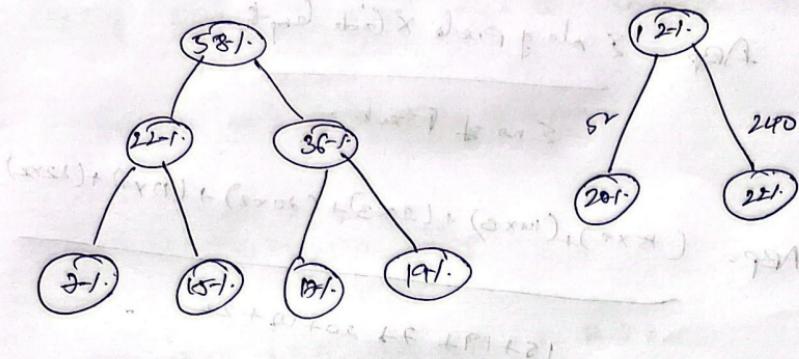
Construction 3:



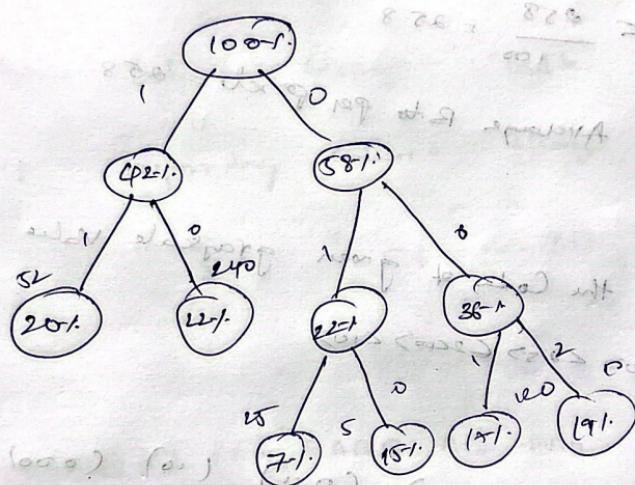
Construction 4:



Construction 5:



Construction 6:



array Value

5

10

25

52

120

240

Huffman Code

000011101001010101

000

011

11

001

10

Calculate ABP Coverage - bits - pos - pixel

$$ABP = \frac{\text{No. of Pixels} \times \text{Grid Length}}{\text{No. of Pixels}}$$

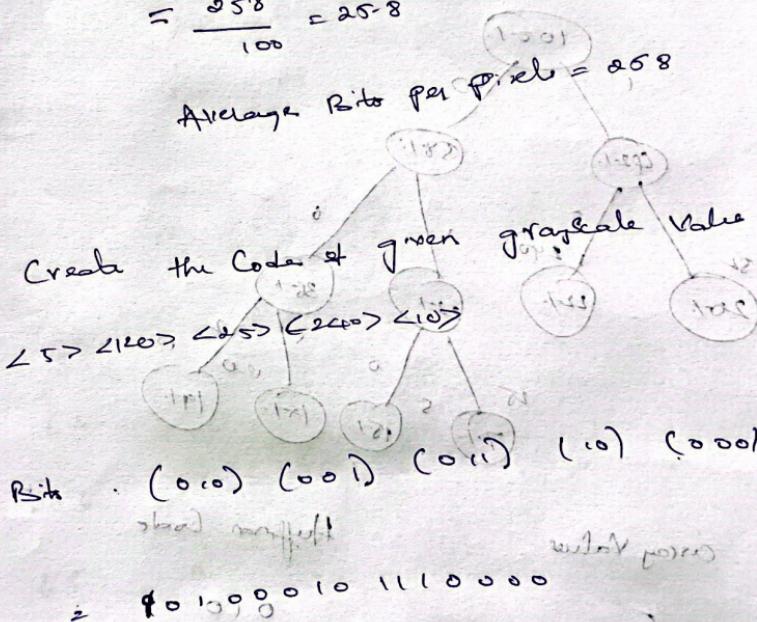
Diagram illustrating the calculation of ABP for a 5x5 grid:

- Grid dimensions: 5x5
- Grid length: 5
- No. of pixels: 25
- ABP =  $\frac{(15 \times 5) + (19 \times 5) + (7 \times 5) + (20 \times 5) + (19 \times 5) + (22 \times 5)}{25}$
- Sum of products:  $15 + 19 + 7 + 20 + 19 + 22 = 101$
- Final ABP value: 4.04

$$= \frac{258}{100} = 25.8$$

$$\text{Average Bits per Pixel} = 26.8$$

Create the Code



Sol

Risk . (0.0) (0.1) (0.11) (0.1) (0.00)

sho) millefli

4013000010 1110000

G O O

1

14

6

1

1

149

9-1

18



### Step 3

Step 3 ABAB AAA BA BB AB AAA

~~ABAAB AAA B+B DS~~ -  
Gardens at diagonal at each position was plant

Encoder	Op Code	Op	String	Table
Op Code		Symbol	Column	String
		A B C D E F G H I J K L M N O P Q R S T U V W X Y Z	A B C D E F G H I J K L M N O P Q R S T U V W X Y Z	A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

65	A	256	AB
66	B	257	BB
256	AD	258	ABA

#### Step 4:

65	A	256	AB	65
66	B	257	BA	66
256	AB	258	ABA	256
65	A	259	AA	25

## Step 5:

5! A-A B-B C-C D-D E-E F-F G-G H-H I-I J-J K-K L-L M-M N-N O-O P-P Q-Q R-R S-S T-T U-U V-V W-W X-X Y-Y Z-Z

AS A B A A A B A BB AB B A A A

~~AB A IS~~ ~~43~~

adult pride glo

13 13

65 12 A 6256 AB

65 4 7628

14. B 257 B

66 B 20° A

158 AB3A

~~AB~~ AB 258 ABA

2564 A13 F2S E

15 + 259 40

65 A 28

AA 46° AA

259 AA 26° AA

259

Step 6:

39.12

AB AB AAA A-B BB AB AAA

		254	255	A	256
65	A	256	AB		
		257		AB	
66	B	257	BA		
		258	ABA		
256	AB	258	ABA		
		259	AA		
65	A	259	AA		
		260	ABA		
259	AA	260	ABA		
		261	BAB		
259	BB	261	BAB		
		262	ABA		
		263	AA		
		264	BB		

Step 7:

AB AB AAA BA-BB ABB AAA 122

		256	AB		
65	A	256	AB		
		257	BA		
66	B	257	BA		
		258	ABA		
256	AB	258	ABA		
		259	AA		
65	A	259	AA		
		260	ABA		
259	AA	260	ABA		
		261	BAB		
257	BA	261	BAB		
		262	ABA		
61	BB	262	ABA		
		263	AA		
		264	BB		
		265	AA		
		266	BB		
		267	AA		
		268	BB		

Step 8:

			A A B A B B A B A B A B A A A	1/10
A A B	AB	A	25 6	AB
65				
B	25 7		BA	
66				
AB	25 8		ABA	
25 5				
A	25 9		AA	
65				
AA	26 0		AAB	
25 7				
BA	26 1		BAB	
66				
B	26 2		BB	
26 1			BABA	
ABA	26 3		AA	

Step 9:

			A B A A B A B B A B A B A B A A A	1/10
A B	AB	A	25 6	BAB
65				
B	25 7		BA	
66				
AB	25 8		ABA	
25 6				
A	25 7		AA	
65				
AA	26 0		AAB	
20 9				
BA	26 1		BABA	
25 7				
B	26 2		BB	
66				
BAB	26 3		BABA	
26 1				
AA	26 4		AAA	
25 9				

Step 10: AB AG A-A A BABBB A BAAAB

280

65	A	256	AB
66	B	257	BA
256	AB	258	ABA
65	A	259	AA <sup>front</sup> before class
257	AA	260	ABA <sup>back</sup> after class
257	BA	261	BAB
66	B	262	BB
261	BAB	263	BABA
259	AA	264	BBAB
65	A	265	AAA

b) Apply few decoding algo to decode the code (create)

In Sept

200

b recto

四

$\angle 65 > \angle 66 > \angle 256 > \angle 65 > \angle 259 > \angle 66 > \angle 26 > \angle 259 > \angle 65$

Step 1  $\angle G S \Rightarrow \angle G C$ ,  $\angle$

• Encoded Output

260

828

六

strong

strong

## Table

710

12

4

2

3

256

AB

Page 12

2

100

4

五

八

Step 2

$\angle 65 > \angle 66 > \angle 256 > \angle 65 > \angle 259 > \angle 257 > \angle 66 > \angle 260$

$\angle 257 > \angle 65 > A$   $B$   $C$   $D$   $E$   $F$

Encoded Output AA String Table

String Start Codeword String

A 256 122 121 120 121 122

B 257 258 259 257 258 259

AB 257 258 259 257 258 259

Step 3:

$\angle 65 > \angle 66 > \angle 256 > \angle 65 > \angle 259 > \angle 257 > \angle 60 > \angle 261 > \angle 259 > \angle 65$

Below) look at start of path

Encode O/P String path as 1 path (A)

String Codeword String

B 256 AB

AB 257 258 BA

A 258 ABA

Step 4:

$\angle 65 > \angle 66 > \angle 256 > \angle 65 > \angle 259 > \angle 257 > \angle 65 > \angle 260 > \angle 259 > \angle 65$

Encode O/P String Table

String Codeword String

A 256 AB

B 257 BA

AB 258 ABA

A 257 AAT

AA 257 AAT

Step 5:  $\angle 65 > \angle 66 > \angle 256 > \angle 65 > \angle 259 > \angle 257 > \angle 67 > \angle 261 >$   
 $\angle 257 > \angle 65 >$

Encoder O/P	Strong Code word	Table Strong
A	256	AB
B	257	BA
AB	258	A-BA
A	259	AB
BA	260	AAB

Encoder O/P	Strong Code word	Table Strong
A	256	AB
B	257	BA
AB	258	A-BA
A	259	AB
BA	260	AAB

Slope:

$\angle 65 > \angle 66 > \angle 56 > \angle 65 > \angle 209 > \angle 18 \Rightarrow \angle 65 > \angle 26 > \angle 209$

$\angle 65$

A 256 AB

B 257 BA

AB 258 ABA

A 259 AA

AA 260 AAB

BA 261 BAB

B

BAB 262 BA

Slope:

$\angle 65 > \angle 66 > \angle 56 > \angle 65 > \angle 209 > \angle 18 \Rightarrow \angle 65 > \angle 209$

$\angle 209 > \angle 65$

Encodes 0/1

Start

A 256 AB

B 257 BA

AB 258 ABA

A 259 AA

AA 260 AAB

BA 261 BAB

B 262 BB

BAB 263 BABO

AA 264 AAO