Trees

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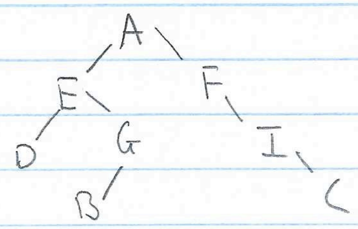
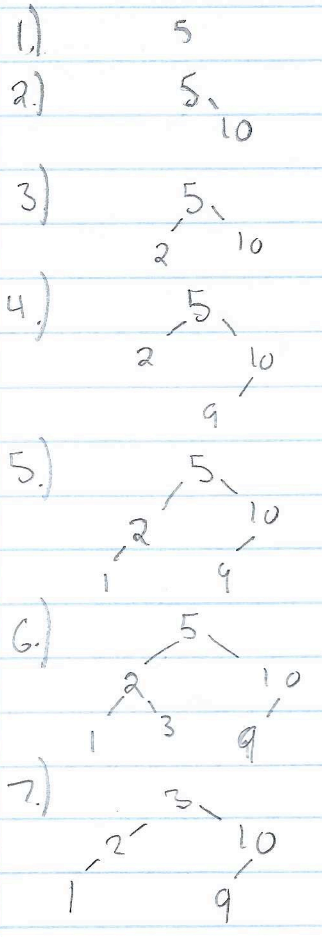
See all drawings as attached figures

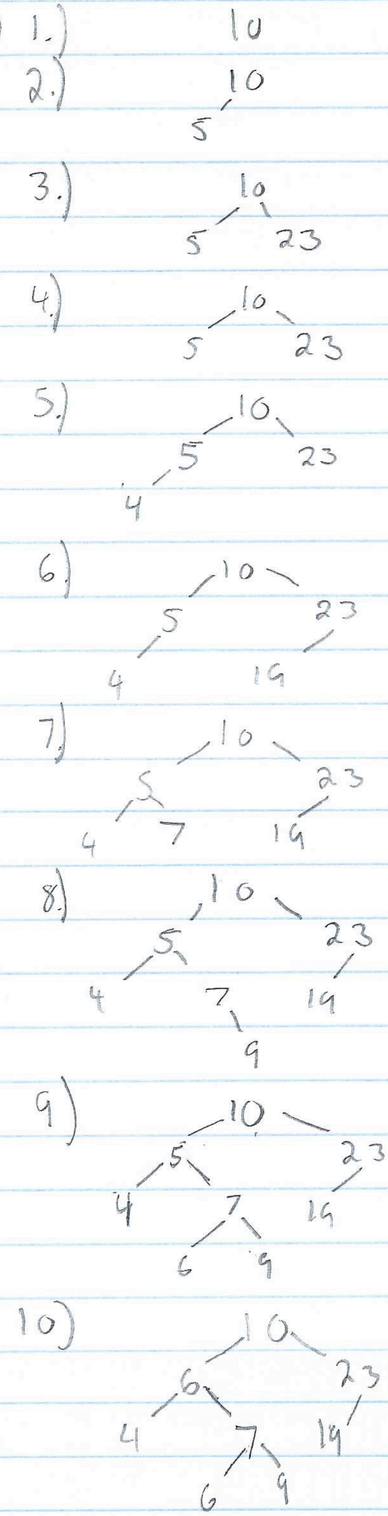
1.


A
E
F
D
G
I
B
C

2.


1.) 5
2.) 5 10
3) 5 2 10
4.) 5 2 10 9
5.) 5 2 10 1 9
6.) 5 2 10 1 3 9
7.) 3 2 10 1 9

3.


1.) 10
2.) 10 5
3.) 10 5 23
4.) 10 5 23
5.) 10 5 23 4
6.) 10 5 23 4 19
7.) 10 5 23 4 7 19
8.) 10 5 23 4 7 19 9
9) 10 5 23 4 7 19 6 9
10) 10 6 23 4 7 19 6 9

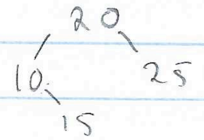
4) (a) 5

   (b) 4

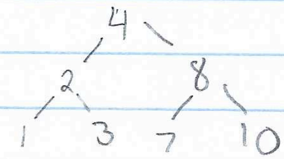
   (c) 2

   (d)
      - Preorder: 100, 50, 3, 1, 20, 80, 52, 90, 83, 99, 150, 125, 152
      - Inorder: 1, 3, 20, 50, 52, 80, 83, 90, 99, 100, 125, 150, 152
      - Postorder: 1, 20, 3, 52, 83, 99, 90, 80, 50, 125, 152, 150, 100

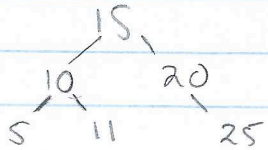
(5)



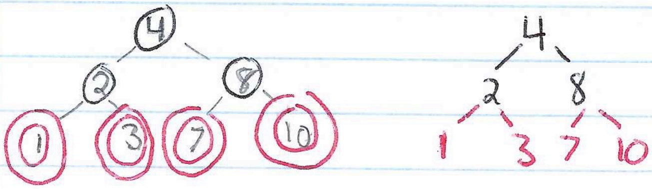
(6)



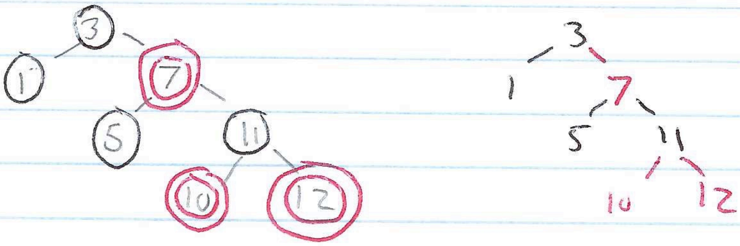
(7)



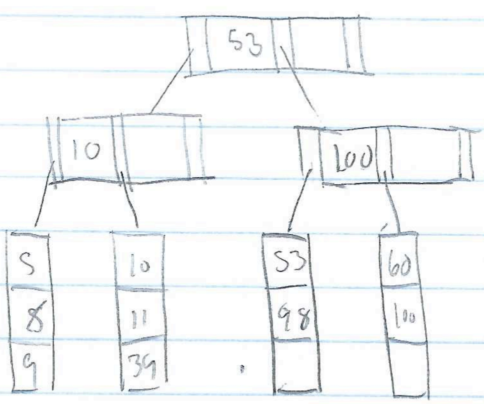
(8)



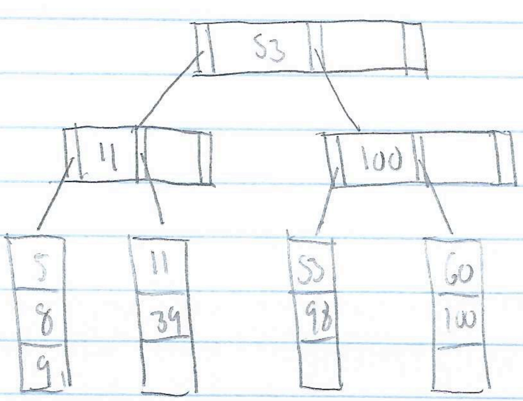
(9)



(10 A)



(10 B)



11) Each inner node has M pointers and M-1 keys. Each pointer is a 64 bit, or 8 byte, value according to the architecture, and each UUID is 128 bits, or $128/8 = 16$ bytes. This results in a total of

$$\begin{aligned} 8M + 16(M-1) &= 8M + 16M - 16 \\ &= 24M - 16 \end{aligned}$$

24M-16 bytes. Since M seems to be 5 in the visualization, this would be

$$\begin{aligned} 24 \cdot 5 - 16 &= 120 - 16 \\ &= 104 \end{aligned}$$

104 bytes for each internal node.

Each leaf node has L records and a pointer. Each customer record is

$$\begin{aligned} \text{UUID uuid} &= 128/8 = 16 \text{ bytes} \\ \text{char[32] name} &= 32 * 2 = 64 \text{ bytes} \\ \text{int ytd\_sales} &= 4 \text{ bytes} \\ Total &= 84 \text{ bytes} \end{aligned}$$

84 bytes long, and a pointer is still 8 bytes. This results in a total of $84L$+8 bytes. Since L seems to be 5 as well, this makes

$$\begin{aligned} 84 \cdot 5 + 8 &= 420 + 8 \\ &= 428 \end{aligned}$$

428 bytes for each leaf node.

On average, a tree with N records will be about $log_M(N)$ nodes tall.

For example, a tree with 30,000 records will be about $log_M(30000)$ nodes tall. If M=5, this is a height of $log_5(30000)$, which is about 6 or 7.

By the same logic, a tree with 2,500,000 records will be about $log_M(2,500,000)$ nodes tall. If M=5, this is a height of $log_5(2,500,000)$, which is about 9.