

Assignment #5

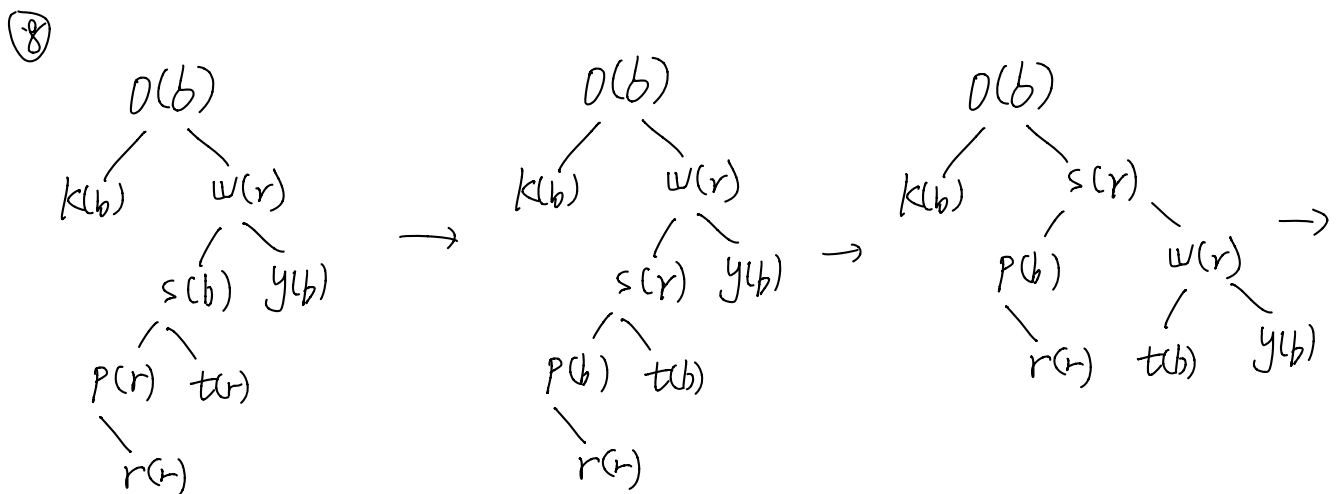
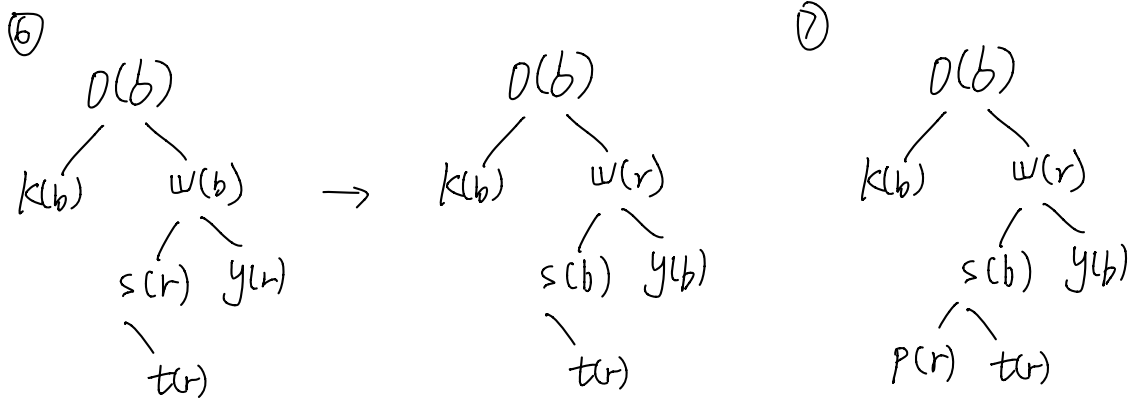
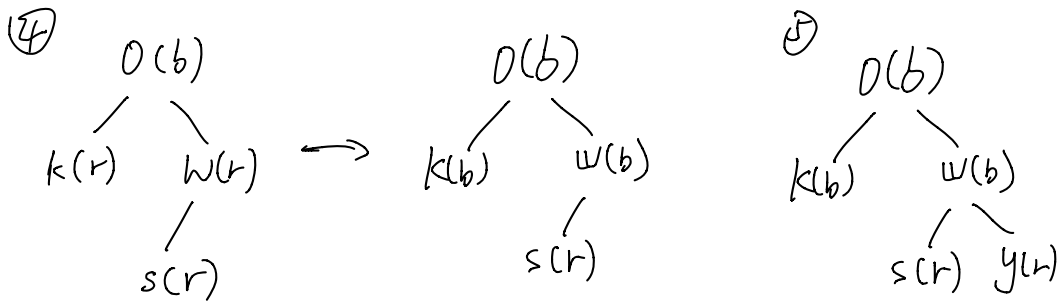
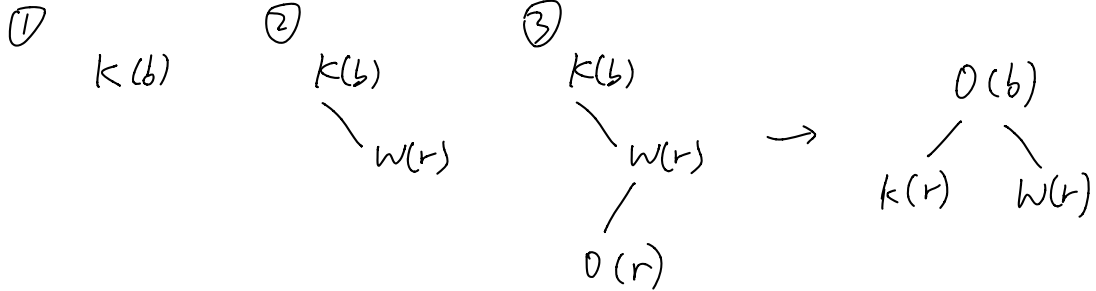
10 points

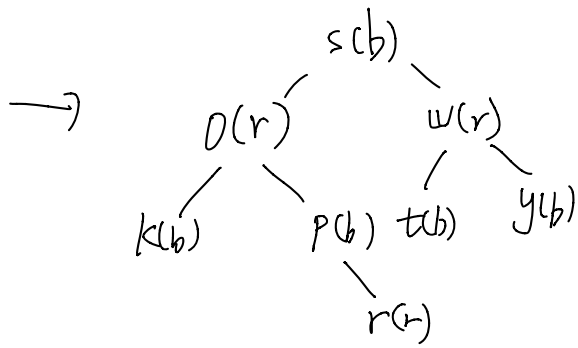
1) Draw a red-black tree for the following values inserted in this order.

Illustrate

each operation that occurs:

k w o s y t p r





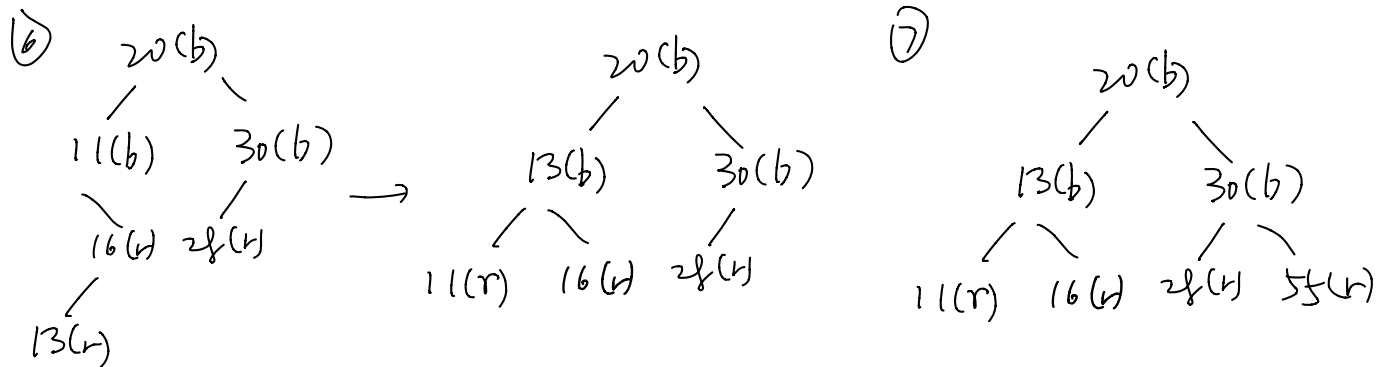
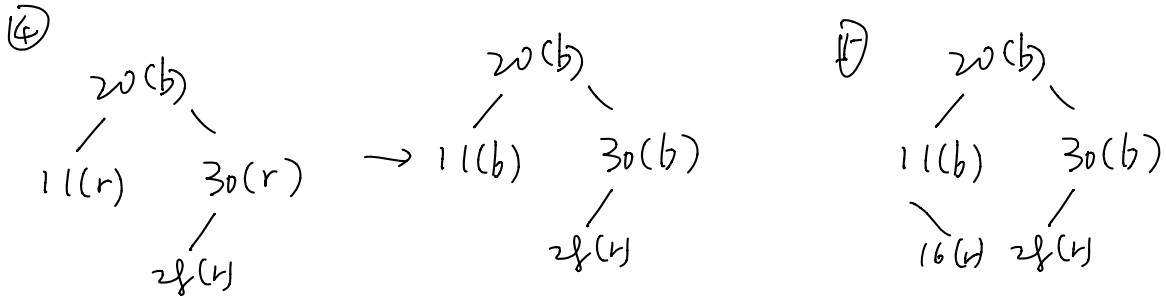
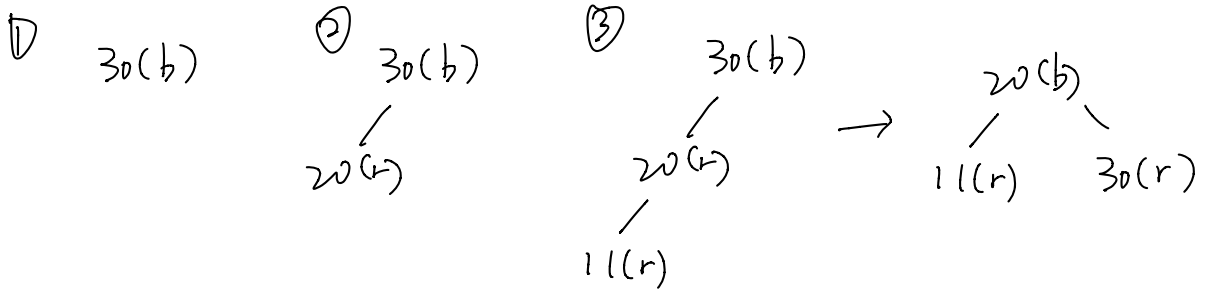
10 points

2) Draw a red-black tree for the following values inserted in this order.

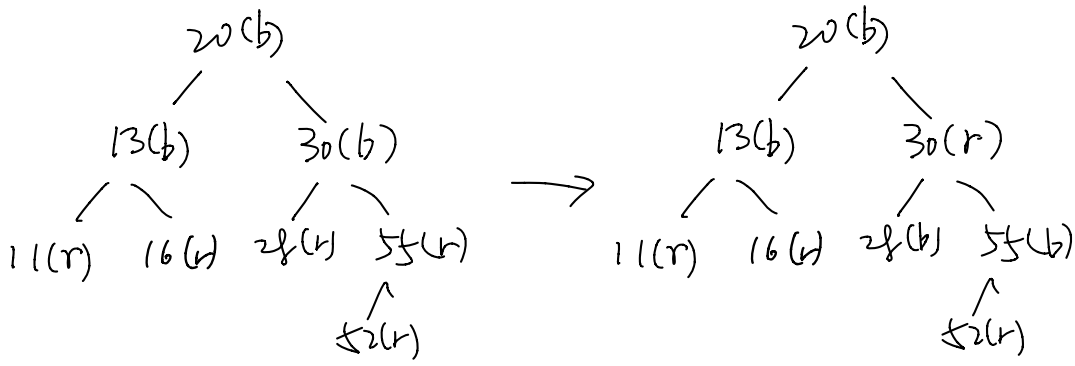
Illustrate

each operation that occurs:

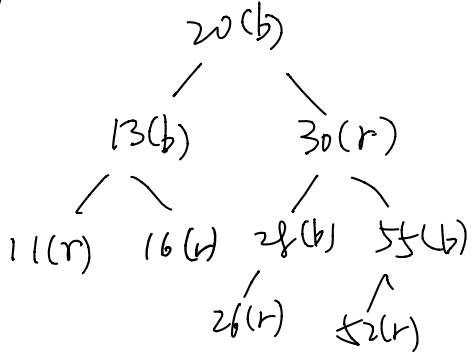
30 20 11 28 16 13 55 52 26 50 87



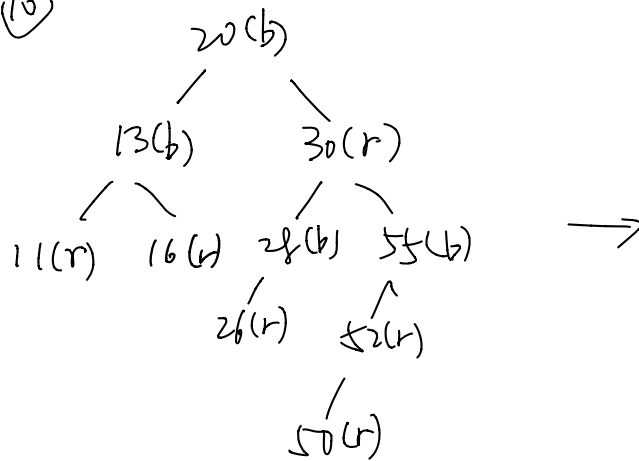
8



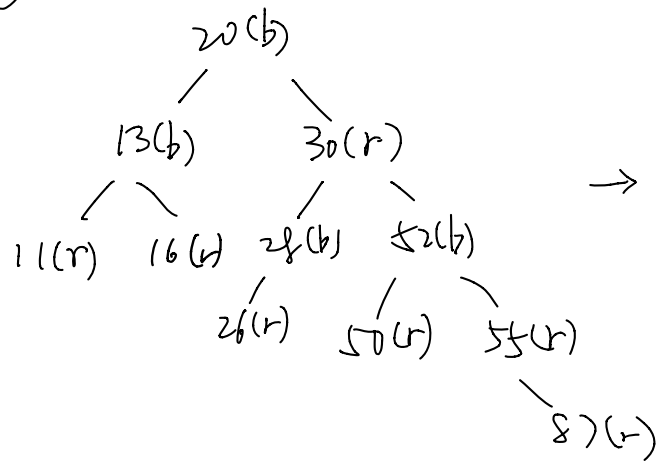
9



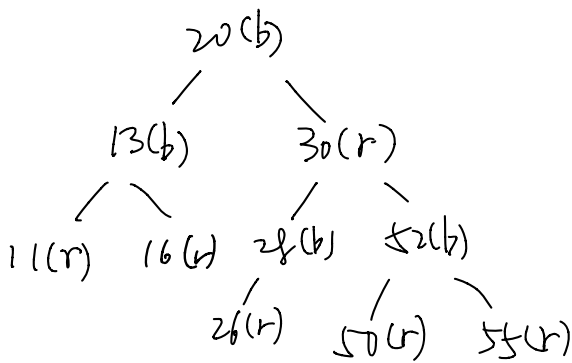
10



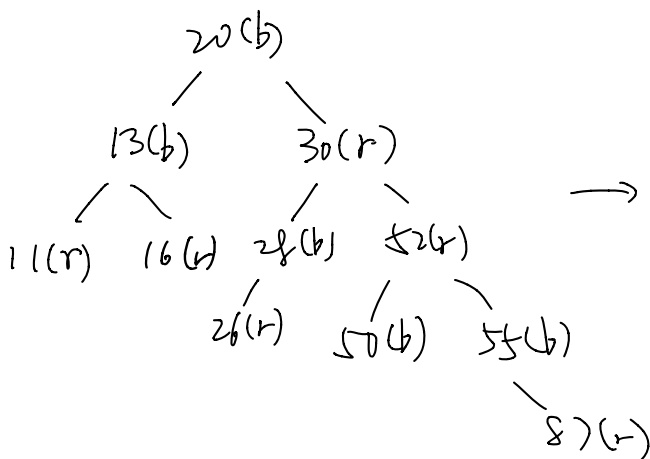
11



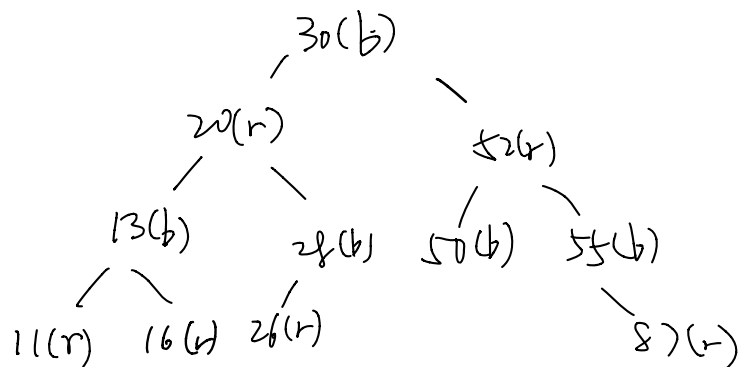
→



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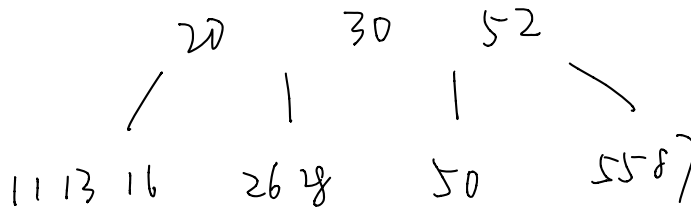


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10 points

3) Draw a 2-3-4 B-tree that corresponds to your red-black tree in problem #2.



Use a tablesize of 13 for these hashing questions:

10 points

4) Given the input {3823, 8806, 8783, 2850, 3593, 8479, 1941, 4290, 8818, 7413}

and a hash function $h(x) = x \bmod 13$, show the resulting separate chaining table.

0	4290	
1	3823	
2		
3	2850 → 8479 → 7413	
4	1941 → 8818	
5	8806 → 3593	
6		
7		
8	8783	
9		
10		
11		
12		

{3823, 8806, 8783, 2850, 3593, 8479, 1941, 4290, 8818, 7413}

1 5 8 3 5 3 4 0 4 3

10 points

5) Repeat #4 using open addressing with linear probing.

0	4290
1	3823
2	
3	2850
4	8479
5	8806
6	3593
7	1941
8	8783
9	8818
10	7413
11	
12	

$$f(i) = i$$

10 points

6) Repeat #4 using open addressing with quadratic probing.

0	1941
1	3823
2	
3	2850
4	8479
5	8806
6	3593
7	8818
8	8783
9	4290
10	
11	
12	7413

$$f(i) = i^2$$

10 points

7) Repeat #4 using open addressing with double hashing where the second hash function is $11 - (x \bmod 11)$.

$$f(i) = i \times \text{Hash}_2(x)$$

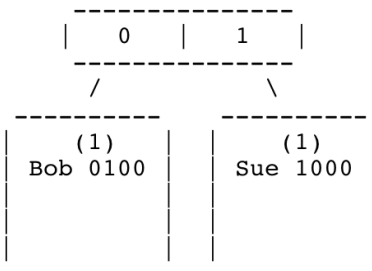
0	4290	
1	3823	$x \% 13 : 1 \quad 5 \quad 8 \quad 3 \quad 5 \quad 3 \quad 4 \quad 0 \quad 4 \quad 3$
2		
3	2850	$11 - (x \% 11) : 5 \quad 5 \quad 6 \quad 10 \quad 4 \quad 2 \quad 6 \quad 11 \quad 4 \quad 1$
4	1941	
5	8806	
6	7413	
7	8479	
8	8783	
9	3593	
10		
11		
12	8818	

10 points

8) Suppose these names have the following hash values. Insert them into the extendible hash

table shown below. Each leaf can only hold 4 entries. Note that the first two names have already been inserted. Illustrate each operation that occurs.

Bob 0100
Sue 1000
Tim 1110
Ron 0010
Ann 1010
Jan 1101
Ben 0001
Don 0101
Tom 1111
Sam 1011



0	1
/	\
(1)	(1)
Bob 0100	Sue 1000

0	1
/	\
(1)	(1)
Bob 0100	Sue 1000
	Tim 1110

0	1
/	\
(1)	(1)
Bob 0100	Sue 1000
Ran 0010	Tim 1110

0	1
/	\
(1)	(1)
Bob 0100	Sue 1000
Ran 0010	Tim 1110
	Ann 1010

0	1
/	\
(1)	(1)
Bob 0100	Sue 1000
Ran 0010	Tim 1110
	Ann 1010
	Jan 1101

0	1
/	\
(1)	(1)
Bob 0100	Sue 1000
Ran 0010	Tim 1110
Ben 0001	Ann 1010
	Jan 1101

0	1
/	\
(1)	(1)
Bob 0100	Sue 1000
Ran 0010	Tim 1110
Ben 0001	Ann 1010
Don 0101	Jan 1101

0	1
/	\
(1)	(1)
Bob 0100	Sue 1000
Ran 0010	Tim 1110
Ben 0001	Ann 1010
Don 0101	Jan 1101
	Tom 1111

00	01	10	11
/	/	/	
(1)	(2)	(2)	
Bob 0100	Sue 1000	Tim 1110	
Ran 0010	Ann 1010	Jan 1101	
Ben 0001		Tom 1111	
Don 0101			

00	01	10	11
/	/	/	
(1)	(2)	(2)	
Bob 0100	Sue 1000	Jan 1101	
Ran 0010	Ann 1010	Tim 1110	
Ben 0001	Sam 1011	Tom 1111	
Don 0101			

10 points

9) Using Cuckoo hashing, hash the following keys using the (h1,h2) pairs shown.

A: 2,0
B: 0,0
C: 4,1
D: 0,1
E: 2,3

0	
1	
2	A
3	
4	

0	B
1	
2	A
3	
4	

0	B
1	
2	A
3	
4	C

0	
1	
2	
3	
4	

0	D
1	
2	A
3	
4	C

0	B
1	
2	
3	
4	

0	B
1	
2	E
3	
4	C

0	A
1	D
2	
3	
4	

10 points

10) Using Hopscotch hashing with a max hop of 4, hash the following keys.

A: 6
B: 7
C: 9
D: 7
E: 6
F: 7
G: 8

*: Blank in "Item" means no item there
*: Blank in "Hop" represent "0000"

	Item	Hop
0		
1		
2		
3		
4		
5		
6	A	1000
7	B	1001
8		
9	C	1000
10		
11		
12		

→

	Item	Hop
0		
1		
2		
3		
4		
5		
6	A	1000
7	B	1101
8	D	0000
9	C	1000
10		
11		
12		

→

	Item	Hop
0		
1		
2		
3		
4		
5		
6	A	1000
7	B	1101
8	D	0000
9	C	1000
10		
11		
12		

→

	Item	Hop
0		
1	.	.
2		
3		
4		
5		
6	A	1100
7	E	0101
8	D	0000
9	C	1000
10	B	0000
11		
12		

F

	Item	Hop
0		
1	.	.
2		
3		
4		
5		
6	A	1100
7	E	0101
8	D	0000
9	C	1000
10	B	0000
11		
12		

→

	Item	Hop
0		
1	.	.
2		
3		
4		
5		
6	A	1100
7	E	0111
8	D	0000
9	F	0010
10	B	0000
11	C	0000
12		

→

G

	Item	Hop
0		
1	.	.
2		
3		
4		
5		
6	A	1100
7	E	0111
8	D	0000
9	F	0010
10	B	0000
11	C	0000
12		

	Item	Hop
0		
1	.	.
2		
3		
4		
5		
6	A	1100
7	E	0111
8	D	0001
9	F	0001
10	B	0000
11	G	0000
12	C	0000